FINAL ENVIRONMENTAL IMPACT STATEMENT
WATER HYACINTH CONTROL PROGRAM

Lake Victoria & Other Regional Waterways

GOVERNMENT OF UGANDA
MINISTRY OF AGRICULTURE, ANIMAL INDUSTRY AND FISHERIES
ENTEBBE, UGANDA

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In Collaboration With The
Ministry of Agriculture, Animal Industries, and Fisheries
(MAAIF)

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A LIST OF ACRONYMS AND ABBREVIATIONS

AGSEC	-	Agricultural Secretariat
APC	-	Agricultural Policy Committee
APC/MCWH	-	APC/Management Committee on Water Hyacinth
APE/GMU	-	Action Program for the Environment/Grants Management Unit
APEMAF	-	African Pesticide Management Forum
AU	-	Aquatics Unlimited
CEIAC	-	Core Environmental Impact Assessment Committee
CFR	-	Code of Federal Regulations
CITES	-	Convention on International Trade in Endangered Species
CSC	-	Core Scoping Committee
CVSC	-	Chemical Verification Sub-Committee
DANIDA	-	Danish International Development Agency
DGPS	-	Differential Global Positioning System
DO	-	Dissolved Oxygen
DWD	-	Directorate of Water Development
EA	-	Environmental Assessment
EAP	-	Emergency Action Plan
EIS	-	Environmental Impact Study/Statement
ESC	-	Expanded Scoping Committee

FAO	-	Food and Agricultural Organization
FD	-	Fisheries Department
FEIS	-	Final Draft Environmental Impact Statement
FIRI	-	Fisheries Research Institute
GDP	-	Gross Domestic Product
GEF	-	Global Environmental Facility
GIS	-	Geographical Information System
GoN	-	Government of Netherlands
GoU	-	Government of Uganda
IAP	-	Intermediate Action Plan
IEE	-	Initial Environmental Examination
LTAP	-	Long Term Action Plan
LVEMP	-	Lake Victoria Environmental Management Plan
LVFO	-	Lake Victoria Fisheries Organization
MAAIF	-	Ministry of Agriculture, Animal Industry and Fisheries
MFA	-	Ministry of Foreign Affairs
MFEP	-	Ministry of Finance and Economic Planning
MNR	-	Ministry of Natural Resources
MSDS	-	Material Safety Data Sheets
MUIENR	-	Makerere University Institute of Environment and Natural Resources

MWTC	-	Ministry of Works. Transport and Communication
NAARI	-	Namulonge Agriculture and Animal Production Research Institute
NARO	-	National Agricultural Research Organization
NEAP	-	National Environmental Action Plan
NEMA	-	National Environmental Management Authority
NGO	-	Non Governmental Organization
NRI	-	Natural Resources Institute
NTCWH	-	National Technical Committee on Control and Management of Water Hyancith
NWSC	-	National Water and Sewerage Corporation
OCMP	-	Operational Control Monitoring Program
OFD	-	Owen Falls Dam
OPUAH	-	Operational Plan for Use of Aquatic Herbicide
PEA	-	Programmatic Environmental Assessment
RDC	-	Resident District Commissioner
SAP	-	Strategic Action Plan
TA\PIP	-	Technical Assistance\Project Implementation Plant
TAT	-	Technical Assistance Team
UEB	-	Uganda Electricity Board
UF-CAP	-	University of Florida-Center for Aquatic Plants

UIA	-	Uganda Investment Authority
UMA	-	Uganda Manufacturers' Association
UNDP	-	United Nations Development Programme
UNP	-	Uganda National Parks
URC	-	Uganda Railways Corporation
USAID	-	United States Agency for International Development
USAID/AFR/PSGE	-	/Africa/Productive Sector Growth and Environment Division
USAID/REDSO/ESA	-	/Regional Development Support Office/Eastern and Southern Africa
USEPA	-	United States Environmental Protection Agency
US-EPA	-	United States-Emergency Action Plan
USG	-	United States Government
UVAB	-	Uganda Veterans Assistance Board
WHU	-	Water Hyacinth Unit
WSDOE	-	Washington State Department of Ecology

INTRODUCTION

In accordance with standard practice and with Uganda's National Environmental Statute, approved in May 1995, Sections 20 through 22, and in compliance with 22 CFR 216.3 (a)(2)(iii) of U.S. Federal Guidelines, an Environmental Impact Study (EIS) (Programmatic Environmental Assessment or PEA per USAID Guidelines), was initiated to evaluate possible alternatives to control Water Hyacinth (*Eichornia crassipes)* infestations in Lake Victoria and surrounding water bodies

The EIS/PEA was undertaken "to assess the environmental effects of a number of individual actions and their cumulative environmental impact in a given country or geographic area, or the environmental impacts that are generic or common to a class of actions...."(22 CFR 216.6(d)). The EIS/PEA will address the Emergency Action Plan for Control and Management of Water Hyacinth (November 1995), the Technical Assistance/Project Implementation Plan for the Operational Control of Water Hyacinth (November 1995), and the intermediate and long term objectives of the Water Hyacinth Control Program.

The Preliminary Draft EIS/PEA was circulated for review by the Core Scoping Committee, made up of agencies and individuals having expertise relevant to the environmental aspects of the proposed control program. Following initial review by the participants, an EIA Committee Review Meeting was held to finalize information requirements for the completion of the Final Draft Environmental Impact Statement (FEIS). Comments were received from all interested parties, and addressed in the DEIA. The DEIA Final Draft Review Public Meeting was held on July 30, 1997 and those comments and replies were adressed in this Final Environmental Impact Statement (FEIS). The FEIS will be used for the decision making process. When a decision has been made to approve the proposed control measures, action will follow in accordance to the laid down procedures.

This Environmental Impact Assessment includes information that was available at the time of preparation. Results on herbicide efficacy and residue analyses associated with tests carried out on aquatic herbicides at Kituza lab, Kajjansi pond and Wazimenya Bay In-Lake Trials, in Uganda, have been included in the document. Additional toxicology and herbicide residual data has been cited from available reference data and results from herbicide applications in the United States. Information on the on going process of mechanical and biological control in Uganda is also included.

1. PURPOSE AND NEED FOR WATER HYACINTH CONTROL PROGRAM

1.1 Problem Statement/Need

- The proliferation of water hyacinth has reached epidemic proportions throughout much of the Upper Nile system, including Lake Victoria, causing serious socio-economic and environmental problems.

1.2 Purpose and Objectives of the Control Program

The purpose of the control program is to reduce water hyacinth infestations to controllable levels with reduced impacts. The Program's Emergency, Intermediate and Long-Term Control program objectives are reviewed in the following sections.

1.2.1 Emergency Program Objectives

Approach

The Agricultural Policy Committee (APC) of the Government of Uganda (GoU) requested the National Technical Committee on Control and Management of Water Hyacinth (NTCWH) of the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) to develop an Emergency Action Plan (EAP) for the Control of Water Hyacinth in Lake Victoria. This Plan was completed in November 1995. It called for an emergency action program to be implemented pending the start up of the planned medium and longer term control measures being funded by the World Bank (WB) and the Global Environment Fund (GEF) Lake Victoria Environmental Management Program. Priority areas for emergency water hyacinth control include: Owen Falls Dam; Entebbe Water Works; Murchison Bay (Gaba Water Works); Port Bell pier; the Kagera River confluence; and selected fish landing sites (Lakes Victoria, Albert, Kyoga, and the Albert Nile). The Plan calls for an integrated program of manual, mechanical, biological and chemical control measures at each site to be implemented by a combination of private contractors and engineering firms acting under the supervision of a variety of GoU agencies, with overall coordination by the Water Hyacinth Unit (WHU), MAAIF's fisheries department, and technically backed by the NTCWH. Key stake holders including Ugandan Railways Corporation (URC), National Water & Sewerage Corporation (NW&SC), National Agricultural Research Organization (NARO), Uganda Electricity Board (UEB) and National Environmental Management Authority (NEMA) are represented. Additional details of the EAP are provided in Section 9, **Annex 2.**

The emergency program is expected to consist of herbicide applications to the water hyacinth by aircraft and boat. The goal is to reduce current biomass up to 70% to a manageable and maintenance level within the first year of initiation. Concurrently, mechanical barriers have been installed in the Kagera River to divert water hyacinth plants to the shore where they are being manually removed and placed approximately 300 meters from the river to decompose in place. Efforts currently underway in Jinja and Port Bell, using mechanical equipment and manual removal of the plants will continue. The intermediate program will consist of spot treatment of water hyacinth by spray crews in boats, replacement of the temporary boom in the Kagera River by a permanent boom structure, and distribution of biological control agents at the source of the water hyacinth problem that is located in the Kagera River in Rwanda as well as bays and inlets of Lake Victoria.

Aquatic weed harvesting systems purchased by the GoU are already in use at the Owen Falls Dam to mechanically remove water hyacinths and plans are underway implement this strategy at Port Bell. Additional equipment has been supplied through funding from the Japanese government. The aquatic weed harvesters are expected to be operated in areas where herbicide use is not practical due to water use restrictions.

The use of biological control agents at the problem source would be expected to reduce water hyacinth densities entering the Kagera river and those that bypass the boom system into Lake Victoria by approximately 30%. Biological control will allow for a reduction in plant density and will improve the efficiency of the mechanical removal program.

Additional details of the EAP are outlined in the following sections of this EIS/PEA.

Intermediate Objectives

The focus on Intermediate Objectives will begin after the Emergency Action Plan Objectives have been initiated. These Intermediate Objectives are:

- Integrate the Emergency Action Plan into the Lake Victoria Environmental Management Program (LVEMP) being funded by the WB & the GEF. One of the objectives of the LVEMP is to provide funding for the control and management of water hyacinths in Lake Victoria.

- Develop a Long-Term Operational Water Hyacinth Maintenance Program for all appropriate water bodies in the East African region. These would include the lakes and water bodies downstream from Lake Victoria where water hyacinth exists.

- Further review the potential for effective reduction of water hyacinth biomass using biological control agents. This could include searches for new insects/pathogens.

- Assess opportunities for Long-Term academic and research exchange/cooperation programs between University of Florida and Ugandan Universities, NARO, and other organizations as appropriate.

Long Term Objectives

- Implement the Water Hyacinth Control Program in other regional bodies utilizing, when possible, control strategies proven effective in Lake Victoria.
- Integrate all control programs into other regional/multi-national programs as appropriate.
- Implement biological control recommendations as identified during Intermediate efforts.
- Implement academic/research exchange programs as identified during Intermediate efforts.

The project is consistent with the Emergency Action plan (EAP) and has been tailored to meet the overall objectives of the plan. The project impacts will be the implementation of the EAP objectives and the initiation of a long term integrated water hyacinth control program for Lake Victoria. Through a planned regional workshop, a coordinated effort from an operational, academic, and research perspective will allow for the transfer of information and technologies to other problem areas within the East African region.

1.3 OBJECTIVES AND STATUTORY AUTHORITY OF PEA/EIS

1.3.1 Objectives of the PEA/EIS

This Environmental Impact Study was completed so that an Environmental Impact Statement could be prepared and submitted to NEMA by the lead agency (MAAIF), and to any other person requesting it. Based upon the lead agency's acceptance of the statement, in consultation with NEMA, the Ministry of Agriculture, Animal Industry and Fisheries will take all practicable measures to ensure that the requirements of the statement are complied with.

Consultation with selected donors, Non Governmental Organizations (NGOs), agencies and some interested parties (Expanded Scoping Committee) has been carried out to insure all environmental considerations and concerns of local and national agencies, as well as interested individuals and organizations, were included in the planning process. In addition, this process aided in concentrating planning efforts on those areas identified as significant environmental issues. A Preliminary Draft No.2, Environmental Impact Assessment (EIA) was circulated to the Core Scoping Committee and to interested agencies, organizations, and individuals for review and comment. Comments received were incorporated into Preliminary Draft No. 3 that was again circulated for review and comment. Additional comments received assisted in preparing a Preliminary Final Draft, followed by presentation to a public hearing forum. Comments raised in the public hearing are addressed in this FEIS.

1.3.2 Statutory Authority of the PEA/EIS, Uganda Environment Statute

Sections 20 through 22 of the Uganda National Environment Statute, approved in May 1995, detail the Environmental Impact Assessment process. Developers of various types of projects, including any activity out of character with its surroundings (Third Schedule, 1(a)), must submit a project brief to the lead agency (any government body in whom any law vests functions of control or management of any segment of the environment). One of three types of environmental documents is undertaken when the lead agency, in consultation with the Executive Director of the National Environment Management Authority (NEMA), determines that the project "may," "is likely to have" or "will have a significant impact on the environment" (*Ugandan procedures ,currently in draft define significance as an expert evaluation judgment of the magnitude of impact or the degree to which a proposed activity or project may (potentially) impact on the environment if implemented. Also provided are additional terms and definitions related to significance which are under development and by no means exhaustive. Environment is defined as the physical factors of the surroundings of the human beings including land, water, atmosphere, climate, sound, odor, taste, the biological factors of animals and plants and the social factor of aesthetics and includes both the natural and the built-in environment. Significant effect is defined as a substantial, or potentially substantial, adverse change in any of the physical factors of the surroundings of the human beings including land, water, atmosphere, climate, sound, odor, taste, the biological factors of animals and plants and the social factor of aesthetics and includes both the natural and the built-in environment. Impact is defined as the effect of any action that affects one or more elements of the natural, social, or economic environment, either adversely or beneficially. The degree of irreversibility of negative impacts should be addressed in the definition of significance.*) NEMA is currently preparing guidelines and regulations defining specific procedures, format and content, public participation and the like regarding adherence to Sections 20 through 22 of the Statute. The Lake Victoria Water Hyacinth Control Program is assumed to be classed as having a significant effect; therefore, an Environmental Impact Study has

been conducted to review those issues that were determined Significant and Non-Significant during the Scoping Process (the Scoping Process is described in **Section 1.4** below).

According to Section 7 [(1) (f)], NEMA has the authority to review and approve environmental impact assessments and environmental impact statements. Thus, NEMA has the final mandate for EIA approval in Uganda.

The Statute's "measures for management of the environment and natural resources" cover the use of lakes, rivers and wetlands. These restrictions are pertinent to the Lake Victoria Water Hyacinth Control Program.

Specifically, Section 35 of the Statute *prohibits* certain activities in relation to a river or lake, unless NEMA, in consultation with a lead agency, waives them. These activities include: 1) use, erection, reconstruction, placement, alteration, extension, removal, or demolition of any structure or part thereof in, on, under, or over the bed; 2) introduction or planting of any part of a plant (alien or indigenous) in a lake or river; 3) introduction of any animal, or micro-organism (alien or indigenous) on, in or under the bed of any lake or river; 4) deposition of any substance in, on or under the bed of any lake or river, if that substance would or is likely to have adverse effects on the environment; 5) diversion or blocking of any river from its normal course; and 6) draining any lake or river.

District Environment Committees, with the assistance of local environmental agents, are charged in Section 36 of the Statute with identifying river banks and lake shores that are at risk from environmental degradation, or which have value, and with taking measures to minimize the risk or recommending to NEMA the need for protection. The Minister responsible for the Statute may, on the advice of NEMA, declare protected zones along river banks and lake shores. While this section of the Statute permits sustainable uses of protected zones, where there is any doubt relating to sustainable use, an environmental impact assessment must be conducted.

Section 37 of the Statute establishes restrictions on the use of wetlands, specifically requiring written approval from NEMA in consultation with a lead agency to: a) reclaim or drain any wetland; b) erect, construct, place, alter, extend, remove or demolish any structure that is fixed in, on, under or over any wetland; c) disturb any wetland by drilling or tunneling in manner that has or is likely to have an adverse effect; d) deposit in, on or under any wetland any substance in a manner that has or is likely to have an adverse effect; e) destroy, damage, or disturb any wetland in a manner that has or is likely to have an adverse effect on any plant or animal or its habitat; or f) introduce or plant any exotic or introduced plant or animal in a wetland. An environmental impact assessment can be required in order to determine the effect of various activities on wetlands.

In general, all pertinent provisions of the May, 1995 Uganda Environment Statute are considered to apply to the project discussed in this document.

USAID prepared in February 1996 an Initial Environmental Examination (IEE) to comply with environmental review procedures for USAID assistance activities.

1.4 DESCRIPTION OF THE SCOPING PROCESS

The Scoping Process and the Scoping Document's objectives and purpose were developed to identify significant issues, identify non-significant issues, thus determining the scope of issues to be addressed in the EIS or PEA. Within the framework of the PEA as an umbrella document, the scoping process promoted public awareness and drew appropriate government agencies, donors, Non Government Organizations and others more fully into deliberations regarding the management program. The benefit of this approach was the identification of indirect and multiplier or cumulative impacts, not foreseen by individual participants.

Several factors dictated consideration of a scoping process that incorporated highly transparent participation of affected parties and interests. These factors included the multiplicity of agencies and donors concerned, the role of the Uganda National Environment Management Authority (NEMA) in establishing guidelines for and in reviewing environmental impact assessment documentation, and the threat of potential legal challenges (both in Uganda and in the US).

Scoping is a general environmental impact assessment tool, the intent of which is basically the same as the procedures being developed to implement the environmental impact assessment requirements of the Uganda Environment Statute and USAID regulations. Scoping served a variety of objectives as can be seen from a review of the Scoping Document (See, Section 9, **Annex 3).**

NEMA chaired a meeting on 14 May 1996 to discuss the PEA/EIS with NEMA, NARO, and MAAIF staff along with representatives of USAID and Aquatics Unlimited (USAID grantee, a preparer of the EIS/PEA). On 21 May 1996 NEMA chaired another meeting where the Core Scoping Committee was formed. The following decisions were made, and the process developed as follows:

a) the lead agency from the Government of Uganda's perspective is the Ministry of Agriculture, Animal, Industry and Fisheries (MAAIF);
b) an Environmental Impact Assessment document (EIS for Uganda, PEA for USAID) will be prepared;
c) a scoping process to consult with concerned parties and the affected public to determine the issues to be addressed in the EIS or PEA was followed.

1.5 EIS/PEA METHODOLOGY

1.5.1 The Scoping Committee and Process

The EIS/PEA methodology was developed to insure all of the issues that may be considered significant and non-significant were properly identified and reviewed for impact determination. The following methods were determined effective to meet requirements:

a) A Core Scoping Committee consisting of representatives from NEMA (Chair), NARO-FIRI, MAAIF-Fisheries Department, Directorate of Water Development, USAID, and Aquatics Unlimited was formed in May 1996;

b) the Core Scoping Committee reviewed and revised the draft Scoping Document (prepared by Aquatics Unlimited and USAID) in June 1996;

c) the Core Scoping Committee then circulated the Scoping Document to an Expanded Scoping Committee (ESC) for review. The ESC included approximately fifty (50) additional government agencies, other donors, NGOs, institutions, and other concerned parties;

d) the committee identified participants for a workshop to discuss the Scoping Document and determine the need for circulation or discussion of the Scoping Document in addition to the workshop. The Scoping Document was circulated to the ESC for review and comment prior to the workshop;

e) an Expanded Scoping Committee Workshop was chaired by NEMA on 10 July, 1996 at the International Conference Center, Kampala, Uganda. Approximately 40 representatives from the ESC were in attendance;

f) the Scoping Workshop identified additional issues that were considered significant and required inclusion in the review process (see **Annex 3** in section 9 for more details on additional issues identified and reviewed);

1.5.2 The Development of the EIS/PEA

a) following the Scoping Workshop, Aquatics Unlimited identified and assigned a lead person to work with the various agencies to gather information, compile research data that are required to review each issue ,and analyze the data that are gathered;

b) MAAIF assigned a lead person to liaison with AU on the preparation and review of information;

c) information gathering and research data support were provided by approximately 14 different agencies and individuals with regional expertise on the various topic areas. These agencies ranged from Makerere University, Institute of Environment and Natural Resources to the GoU Geological Survey and Mines Department to NEMA to Uganda Tourist Board to National Water and Sewage Cooperation to the MAAIF Early Warning Unit to the Fisheries Research Institute and the Directorate of Water Development;

d) Expertise involved from the various resource agencies included Biologists, Ornithologists, Mammalogists, Dendrologists, Geologists, EIS Specialists, Water Quality Analysts, Agriculturists, Surveyors, Hydrogeologists, Limnologists and research assistants. A complete list of the EIA preparers and the research agencies involved is included in **Section 8** of this document;

e) USAID, AU and the University of Florida contributed significantly to review of information associated with the various control options.

f) a Preliminary Draft No.1 of the EIA was circulated to the NEMA, MAAIF, USAID, and the University of Florida - Center for Aquatic Plants in early September 1996 for review and comment;

g) following review, information gaps were identified and additional information was included in Preliminary Draft No. 2. Preliminary Draft No. 2 was distributed to the Core Committee for review. Comments received were incorporated and Draft No. 2 was updated to Draft No. 3;

h) following review and approval of Draft No. 3, a Preliminary Final Draft of the EIS was prepared and circulated to the Core Committee for review and comment prior to an EIS Workshop on July 31, 1997 where the public was invited to participate in the final review process;

i) the Preliminary Final Draft of the EIS was reviewed through the Public Hearing on July 31, 1997

j) in September 1997, the "Report of the Public Views Presented at the Public Hearing on the Environmental Impact Study for the Water Hyacinth Control Programme for Lake Victoria and Other Regional Waterways" was submitted to MAAIF as well as Letter from NEMA revealing concerns it had with regard to the DEIS.

k) responses have been prepared and incorporated into this FEIS in response to the comments raised from Section 1.5.2 j) through additional research reviews and meetings to provide decision makers the necessary information required for informed decision making.

2. PROPOSED ACTION AND ALTERNATIVES

It is unlikely that water hyacinth, due to it's prolific nature, can ever be completely eradicated from Lake Victoria and surrounding water bodies. Rather, the objective of the proposed action is to reduce the infestation during the first year of the control program to a manageable level, then sustain control of the limited population of plants remaining. The proposed action combines the Emergency Action Plan for the Control of Water Hyacinth and the Intermediate and Long- Term plans for water hyacinth control. The proposed action combines an integration of chemical, biological, manual, and mechanical control methods. Chemical and mechanical/manual control methods predominate in the Emergency Action Plan, while biological and mechanical control measures predominate in the intermediate and long term control plans. The type of control used in a particular area will depend upon the physical characteristics of the area and associated water uses. Features such as navigability of a bay, degree of water hyacinth cover, proximity to water intakes, sensitive crops, fishing areas, water temperature and the strength of currents are important in determining the appropriate control method for a particular area of the region. The control program will be flexible to respond to changes in these conditions via monitoring the effectiveness of the proposed alternatives (chemical, biological, manual, and mechanical). Land and water use plans will be under continuous review to insure that compliance is continuously maintained.

2.1 DESCRIPTION OF THE PROPOSED ACTIONS

Emergency Action Plan

The EAP proposes to integrate mechanical and manual control methods with regulated use of approved aquatic herbicides in Lake Victoria. Aquatic herbicides are proposed to be applied by aircraft or from boats to treat water hyacinth in open water areas, in bays, and along shorelines. The areas where aquatic herbicides are applied will be selected to insure that any potential impact on water use and quality is minimized. Prior to any treatments, water intakes around treatment areas will be identified and a local public sensitization will be established. The areas where water is drawn from the shoreline for domestic use will be identified during the control process. The method of control for these areas would depend on a number of issues including availability of alternative sources of water in the neighborhood for the residents. Mechanical control techniques will be utilized in areas such as the Water Works sites, and other areas where the lake water is drawn for domestic water distribution purposes. Manual control methods will be used at various fish landing sites where limited quantities of water hyacinth require removal on a regular basis (See **Annex 2**).

Intermediate Action Plan (IAP)

The IAP will integrate the use of biological control into the mechanical, manual and chemical control program. The Intermediate Plan will review the expanded use of operational control strategies to other water bodies within Uganda as well as the integration of the EAP into the Lake Victoria Environment Management Plan.

Long Term Action Plan (LTAP)

The LTAP will involve the implementation of control strategies that have proven effective during work in the EAP and IAP. Implementation will be made in affected water bodies within the region, and will be integrated with all regional/multi-national control programs as appropriate.

Each of the four methods included in the proposed plan for control of water hyacinth is addressed in the following sections.

2.1.1 Description of the Control Options

Chemical Control

Chemical control of water hyacinth involves spraying approved aquatic herbicides directly onto plants to kill them. This method is generally the most effective for reducing water hyacinth infestations quickly, and is the most widely used strategy for aquatic weed control worldwide. To reduce the current infestation of the weed, the first application of the herbicides would be used to reduce the large populations of water hyacinth to smaller numbers, while subsequent smaller applications of herbicides would be required in the long term maintenance control program.

The use of herbicides seems to be unavoidable in circumstances where the weed has reached aggravated levels such as the situation in Uganda. If used properly, and with caution environmental problems can be avoided. Application of herbicides should be made in specific

infested sites, but never in overall application of the whole infested area to avoid depletion of oxygen due to rapid incorporation into the water of the destroyed water hyacinth mat.

The Chemical Verification Sub-Committee (CVSC) of the National Technical Committee on the Control of the Water Hyacinth was commissioned to carry out a comprehensive study of the proposed herbicide use in controlling the hyacinth with respect to the herbicides:

(i) effectiveness (efficacy) to kill water hyacinth;
(ii) environmental friendliness; and
(iii) safety to humans

The active ingredients of these herbicides were evaluated and tested for use in the Lake Victoria control program by the Chemical Verification Sub-Committee (CVSC) composed of Ugandan scientists. The CVSC evaluations were followed by the In-Lake Herbicide Trials were the review team was composed of scientists from Uganda and the United States. Together, tests have been done in the laboratory environment, man made pond environments, and in Lake Victoria, Wazimenya Bay.

Previously, three chemicals including Diquat were proposed for use, but Diquat was not awarded a certificate after the pond trials, because the manufacturer does not recommend the use of Diquat in areas where fish is used for the production of fish protein concentrate or fish meal. As a result, the two herbicides evaluated during the In-Lake Herbicide Trials in Lake Victoria, and under consideration for use in Uganda are Weedar 64 (2,4-D Amine; 2,4-dichlorophenoxyacetic acid, dimethylamine salt), and Rodeo (glyphosate N-(phosphonomethyl)glycine, isopropylamine salt). These herbicides are registered for use by the United States Environmental Protection Agency (USEPA) for water hyacinth control. Both are supplied from the manufacturer in liquid formulation and are used around the world for the control of water hyacinth.

Aquatic herbicide formulations of Glyphosate, 2,4-D and Diquat are permitted for use in three European countries, the UK, Yugoslavia and Belgium, with glyphosate approved for use in Sweden as well (Aquatic Weeds, The Ecology and Management of Nuisance Aquatic Vegetation, Oxford University Press, 1990).

Following is a summary of the reports of the herbicide trials carried out at Kituza Laboratory, Kajjansi Ponds and Lake Victoria (See full reports of results in **Annex 9**).

Summary of Kituza Laboratory and Kajjansi Ponds Herbicide Trials.

Herbicide trials were completed in the laboratory at Kituza Research Center in Mukono District and at the Kajjansi Ponds by the Chemical Verification Sub-committee, National Task Force on Control and Management of the Water Hyacinth, in October 1996. The study's main goal was to verify the efficacy, safety and environmental friendliness of the candidate herbicides in Uganda, and to compare herbicide efficacy in Uganda with results of studies conducted in other countries. A verification study on three herbicides namely Glyphosate, Diquat and 2,4-D was carried out.

The Chemical Verification Sub-committee's findings were that trace to non-detectable concentrations of residues of the candidate herbicides were found in the experimental environments in minute quantities far below toxic or tolerance levels, and hence found the products were unlikely to have adverse environmental effects after a single application event.

Based on the results of the laboratory-scale and pond (semi-natural environment) experiments, the following conclusions were reached:

- Glyphosate was recommended as the most suitable herbicide for large scale evaluation/use in the control of the water hyacinth.

- Regrowth after herbicide application was to be carefully evaluated as it would mean repeated use of the herbicides.

- Significance of the surge in algal biomass in the first and second week of spraying with Glyphosate needs to be fully evaluated if use of this herbicide is to be recommended for Lake Victoria which is already impacted by nutrient enrichment.

- Comprehensive public health and awareness programs to follow if massive herbicide application is sanctioned.

- In the event of multiple herbicide applications, studies should be conducted to rule out probable attendant environmental impacts such as accumulation of herbicide residues via the food chain.

The Sub-committee stated that evaluation would benefit from detailed, larger scale experiments in a small, closed natural system like Pan Lake. Subsequent to the pond and lab trials, In-Lake trials were carried out at Wazimenya bay. (See **Annex 9**)

The trials were recognized as the appropriate step in completing the chemical verification process to evaluate herbicides for use in a water hyacinth control program.

Summary of In-Lake Herbicide Trials Conducted in Wazimenya Bay, Lake Victoria:

The main objectives of the In-Lake Herbicide Trials were to:

(i) evaluate the efficacy of the herbicides 2,4-D and Glyphosate on water hyacinth in Lake Victoria;
(ii) asses the effects of the herbicide on water quality;
(iii) assess effects of spraying herbicides on aquatic micro and macro biota (e.g. algae, phytoplankton, zooplankton and macrofauna); and on fish;
(iv) analyze the persistence of herbicide residues for In-Lake water and bottom sediments, In-land soils and water and fish;
(v) recommend the suitability of both herbicides for control of water hyacinth; and
(vi) incorporate the findings of the trials into the Environmental Impact Assessment for the control of Water Hyacinth.

The experiments were accompanied by a public awareness campaign in Wazimenya bay.

Subsequent to the completion of the In-Lake Herbicide Trials, a report was prepared that presented the results of the In-Lake Herbicide Trials that occurred during the period of 10 February through 13 March, 1997.

Based on the results contained in the In-Lake Herbicide Trials Report, it was found that no adverse environmental effects were realized when the herbicides WEEDER (2,4-D) and RODEO (Glyphosate) were used in accordance with the manufacturer's label directions, and when applied by certified pesticide applicators.

It can be concluded from the report that the herbicides WEEDER 64 (2,4-D) and RODEO (Glyphosate) had no significant impacts on the aquatic ecosystem in and around the treatment areas. No observable negative impacts were reported as a result of the herbicide application or the resulting decomposition of the water hyacinth mats. In addition, both herbicides were undetectable in ground water, sediments and fish, thus unavailable for residue accumulation via the food chain. In addition, no significant changes in water quality occurred due to the herbicide treatments and the decomposing water hyacinth mats. The report indicates that the benefits associated with the use of aquatic herbicides in an integrated water hyacinth control program in Lake Victoria would reduce environmental impacts associated with the continued growth of water hyacinth, with no adverse environmental impacts.

In comparing the efficacy of the two herbicides, WEEDAR 64 (2,4-D) provided quicker knock down of the vegetation while RODEO (Glyphosate) provided a greater degree of control from post treatment Day 14 through Day 40. Due to the various water use restrictions associated with WEEDAR 64, RODEO would provide a greater degree of flexibility for use in an operational control program.

The two aquatic herbicides can be used in an integrated water hyacinth control program without adverse environmental impacts on humans or the aquatic environment if properly applied and used in accordance with the manufacturers label directions.

In an operational control program, each of the selected herbicide would be used in accordance with Uganda and US Environmental Protection Agency (USEPA) laws and regulations. All chemical mixtures will contain a control agent to reduce the drift of spray which may affect non-target areas. The herbicides will be applied by aircraft properly fitted for herbicide applications, and using hand-held spray guns and spray booms from boats. Water flow conditions, wind, nearby agricultural crops, presence of native vegetation, potable water intakes, sensitive fish and wildlife, and threatened or endangered species will be taken into account.

Water quality monitoring will be performed to measure herbicide residues. The residue monitoring program will be reviewed prior to the start of each year's control efforts by the Water Hyacinth Unit and oversight agencies. A water quality monitoring program and the associated details are included in the Operational Plan for Use of Aquatic Herbicides (OPUAH). Oversight agencies which are charged with protection of human health and the environment will continue to meet periodically to review and revise, as necessary, operating protocol under the nationally administered program. The water quality monitoring program will be established as part of the OPUAH once the proposed actions for water hyacinth control have been approved.

The In-Lake Herbicide Trials show that the water hyacinths can be controlled with herbicide residue levels well within allowance levels set by NEMA and the US-EPA. Herbicide residual limits approved by the US-EPA are outlined in Section 5, **Environmental Consequences**, 5.1.3, Water Quality.

Biological Control

The biological control component of the Integrated Program is already operational. It involved the release of two insect species, the *Neochetina bruci* and *Neochetina eichhornia*, which feed only on water hyacinth. Prior to the release of the weevils, a series of thorough investigations and screening tests were carried out on the weevils by a technical team at Namulonge Research Station. Host specificity tests for the weevils were done with a variety of crops of economic importance to Uganda and the region. The results showed that the weevils were incapable of laying eggs, feeding, or completing their life on the test plants. By contrast, extensive feeding, egg laying and larval development of both weevil species was observed on water hyacinth. For two of the test plant species, bananas and cabbage, the adult weevils produced some feeding scars on the leaves in no-choice tests. This damage was not significant and was shown not to be present in choice tests. The weevils did not feed on any other plant species in the choice tests. (FAO TCP 1994).

Biological control was introduced in 1994, when Benin donated 1,200 weevils to Uganda. The Weevils have since been introduced into Lake Kyoga. Breeding of weevils is also going on to try and achieve sufficient numbers for this purpose. Of late, weevils have also been introduced into Lake Victoria at three points; Kitosi in Mukono district, Masese in Jinja and in Masaka. Kenya has also initiated the release of biological control agents on water hyacinth in Lake Victoria.

To date, most hyacinth plants in Lake Kyoga, the Kyoga Nile, Lake Albert and the Albert Nile show varying signs of damage due to weevil feeding. Recently, Neochetina feeding scars have been observed on plants in Murchison bay near Gaba. It has also been observed that the weevils stunt the growth of the weed. But the effectiveness of the weevils has not been very significant mainly because sufficient populations of the weevils to control the water hyacinth have not yet been attained.

Biological control is perceived as a long-term, cost-effective method for water hyacinth management in Uganda because it is almost self perpetuating once started, and it requires no inputs other than the insects themselves.

Although biological control may produce long lasting effects, the insect colonies typically take about 3 to 4 years to become established and provide biomass reductions of approximately 30%. Even with biological control measures, an effective long-term maintenance program will require some chemical treatment and mechanical/manual control to augment the biological control efforts. The insects do not feed, reproduce, or migrate uniformly. They are also subject to the usual vagaries of biological systems such as disease, temperature extremes and mutation. Biological controls tend to stunt the growth of the weed to some degree, but weevils will not significantly reduce the abundance of plants on any particular site.

Biological control is planned for those areas least receptive to other control measures, or where it can be integrated with the other control measures to produce effective results. Other areas for potential use of biological control include dead end waters with diminished flushing flows, marsh areas, and nursery areas for water hyacinth up the Kagera River.

Mechanical/Manual Control

The selected plan for the control of water hyacinth will utilize mechanical and manual methods in areas where water use restrictions limit or prohibit the use of herbicides. Booms and barriers may

be used to restrict plants to one area and keep them from re-infesting new areas. Boom structures will be placed at the Kagera River, the Gaba and Entebbe Water Works, and near the Owen Falls Dam to divert floating plants from re-infesting treated areas or sites of water intakes.

Mechanical/manual removal will be incorporated at Fish Landing Sites and other areas where chemical and biological control options are not feasible. Land based harvesting systems (conveyors, draglines) will be used at Owen Falls Dam and Port Bell where water hyacinths accumulate due to wind and water flow patterns. Mobil floating harvesting systems will be utilized in areas around water works and other sites where water hyacinth removal by mechanical/manual means is required due to limits on herbicide use. Water hyacinths that are mechanically or manually removed will be transported away from the lake system to designated disposal sites.

In determining locations for disposal sites, the following will be considered to minimize any negative impacts that might arise:

- Sites will be located in areas where the slight odor and unsightliness of the deposited water hyacinth will not have an adverse impact on the area residents.

- Sites will be large enough to hold the biomass to be removed.

- Sites will have sufficient drainage to handle the water that will drain from biomass that is harvested.

- The harvested biomass is being evaluated for potential uses such as biogas, and other uses such as soil conditioners will be evaluated.

- No presence of sensitive habitat, rare or endangered species in the location.

2.1.2 General Location of the Proposed Actions

As outlined in sections above, an Integrated Water Hyacinth Control Program is recommended that will utilize the available control strategies in areas where their use is most effective, and where potential impacts on water use, water quality, aquatic resources and resource users will be limited.

Chemical Control

Aquatic herbicides will be utilized in open water areas, along impacted shorelines, and in sheltered bay areas where water intakes and water uses do not prohibit their application. The herbicides will be used to reduce water hyacinth populations quickly under the EAP, and will be utilized along shoreline areas, bays and sheltered coves as a maintenance tool under the Intermediate and Long-Term Control Plans. Aquatic herbicides will not be used in areas where they will have adverse effects on lake water used for domestic, agricultural or industrial uses. Areas for herbicide use are currently being identified for inclusion in the Operational Plan following the review and approval process for the proposed actions.

Biological Control

Biological control is not considered a major component of the EAP, but it will play a role in the intermediate and long-term operational control plan. Initial introductions of biological control agents are being planned for lakes in Rwanda, the source of the water hyacinth problem. Biological control agents are expected to reduce biomass at the Kagera Boom and infestations entering Lake Victoria by up to 30% once populations are established. This will increase the efficiencies of mechanical/manual control process as there will be less biomass to remove. Releases have begun in Lake Victoria, Uganda and Kenya.

Mechanical/Manual Control

Mechanical and manual control methods will be utilized around the Owen Falls Dam, Port Bell, Fish Landing Sites, the Kagera River, Water Works Sites and areas where chemical control methods are not appropriate due to their water use restrictions.

2.2 ALTERNATIVES ELIMINATED FROM FURTHER STUDY

Single Method Control

Single method control plans, i.e., chemical, biological, or mechanical/manual alone, were not considered appropriate for a flexible, integrated, cost-efficient, long-term control program. Herbicides not properly registered for use in aquatic systems were also eliminated from further study as the environmental effects are not properly documented were also eliminated from further study.

Chemical control methods alone were eliminated from further study in order to limit the amounts of herbicides used in the aquatic systems in the long-term. Mechanical and manual methods alone were ruled out as they would be unable to keep up with the water hyacinth's growth and infestation rate, and would result in a continued spread of the problem. Biological methods alone were ruled out as they only partially reduce biomass over the long term.

No Action Alternative

Under the no action plan, no control program for water hyacinth would be implemented. In the event that the Government of Uganda does not perform control activities, water hyacinth spread is expected to continue with further commercial and environmental damage in the future. Because water hyacinth is a prolific plant, spreading by both seed and vegetative propagation, it is anticipated that it would become an even more widespread nuisance and hazard if it's growth continued unchecked.

As of 1995, some studies indicated that the water hyacinth covered 80% of the shorelines on the Ugandan side of Lake Victoria. It is also said to covers 60 hectares at the Owen falls dam, 250 hectares in Entebbe around the peninsula, and 800 hectares in and around Murchison Bay. Depending on weather conditions, 0.5 hectares to 1.5 hectares of water hyacinth feed into Lake Victoria daily from the Kagera river catchment. The hyacinth has the potential of doubling every two weeks under ideal conditions. The water hyacinth infestation in Lake Victoria is estimated to be approximately 4000 hectares at the end of 1996.

The No Action Alternative would allow the continued spread of water hyacinth at a rate of approximately 30% increase in plant population per year. This would lead to potential impacts that would eventually limit fish spawning habitat, water transportation from Port Bell and reliable water supply from Gaba and Entebbe Water Works. In addition, it has been estimated that up to 25 million people rely on Lake Victoria alone for their livelihoods via the fishing and other industries. The plant, if left to expand at current rates, is expected to cause a decline in the fishing industry and would result in major economic and social changes that would disrupt the current growth and development of Uganda and the East African region in general.

The water hyacinth destroy fish spawning habitat, obstructs boat traffic, interferes with water delivery systems, reduces oxygen concentrations in the lake, increases diseases vector breading habitat, and increases the decay of organic material. The water hyacinth is promoting accelerated sediment deposition and successional growth of other weeds such as hippograss. Under the No-Action Alternative, it is expected that the water hyacinths will continue to spread at an increased rate.

2.3 COMPARISON OF ALTERNATIVES

This section presents the various alternatives with a discussion of comparative impacts of each control option (see matrix table on page 18).

Chemical Control

This option involves the use of aircraft or boats to apply aquatic herbicides to the water hyacinth. The associated costs will vary from 150,000 Ush to 300,000 Ush ($US 100.00 to 300.00) per hectare depending upon the herbicide used and the method of application (aircraft, boat). Control of 100 plus hectares per day can be achieved using aircraft, and one spray boat can treat approximately 7 hectares per day.

Mechanical Control

This option involves the use of equipment (aquatic weed harvesters, conveyors, draglines and push boats) to remove the water hyacinth from the lake system and the transfer to shore based equipment for disposal. The expected cost per hectare including equipment amortization, fuel, labor, hauling costs and disposal site preparation costs is approximately 2,500,000 Ush ($US 2,500). Production rates per machine are expected to be less then one hectare per day with equipment currently available. Disposal areas selected to date were selected through the review of environmental considerations placed on the GoU by the Government of the Netherlands (GoN) to meet their environmental review and approval processes. This was required as the GoN was providing grant funding for the harvesting equipment purchased from the Netherlands and currently used at the Owen Falls Dam. Permanent dumpsites were identified 7 kilometers from Owen Falls Dam and approximately 4 kilometers from Port Bell, behind the Luzira prison. Factors for consideration were proximity to harvesting site, land availability, visibility and odor of dumpsite, and drainage. Due to the long haul distance from Owen Falls Dam and the cost and cycle time which would result, the dumpsite in Jinja was determined to be unsuitable for fast response required at the dam. It should also be noted that UEB had initiated a harvesting operation which relied on a disposal site to their Dam site.

Biological Control

This option would reduce plant densities by approximately 30% over a five year period once the biological control agents have been established. The cost for establishment of the control strategy is low and requires the collection, distribution and monitoring of the insect populations and efficacy. The present operations at Lake Kyoga and at the new sites on Lake Victoria, which include labor, fuel, vehicle servicing, hiring canoes and paying incidental labor is estimated to be 1,500,000 Ush ($US 1,500.00) per month.

Physical Control

This option is effective on a small scale basis only with the associated costs of tools and manpower only. To remove one hectare of water hyacinth (about 600,000 kg or 600 Tons), it is expected that a minimum of 300 man hours would be required not including disposal costs. This would translate to about 2,769,000 Ush ($US 2,769.00) per hectare plus disposal and tool costs.

Table 1: Action Matrix, Comparison of Alternatives

This section presents the various alternatives with a discussion of comparative impacts. A detailed description of impacts and potential means of minimizing these impacts is provided in section 5.

Environmental concerns	Chemical control	Mechanical control	Biological control	No action alternative
Land use, Land use plans	No direct, indirect or induced impacts expected.	Identified disposal sites will not alter land use or land use plans.	Being host specific, the insects pose no threat to terrestrial plant species.	Increased restrictions on water transportation and limited use of shoreline land in the infested areas.
Hydrology	No direct, indirect or induced impacts expected.	There may be Short term isolated impacts around disposal sites depending on soil types and associated hydraulic features.	No direct, indirect or induced impacts expected.	Possible alteration of hydrological features with increased plant infestation.
Water Quality	The extent and duration of toxicity levels of the proposed herbicides would be low with long term gains. Reduction of water hyacinth will improve water quality.	Potential oil or fuel spills from mechanical equipment could impact water quality. Reduction of water hyacinth will improve water quality.	No direct, indirect or induced impacts expected.	Decreased DO levels. Increased BOD.
Aquatic Ecosystem	The extent and duration of toxicity levels of the proposed herbicides would be low, with long term gains.	Very minor impacts from a few small fish and snakes that get entangled in the machines during operations.	Agents are host specific and will not affect non water hyacinth ecosystems or habitat.	Fish kills and negative impacts to aquatic life.
Shoreline	No direct, indirect	Minor impacts from	No direct, indirect	Negative

Ecosystem, protected areas, wetlands, Shoreline resources.	or induced impacts expected.	land clearing and development of shoreline access activities expected.	or induced impacts expected.	environmental and economic impacts to the shoreline ecosystem.
Biodiversity, Threatened and endangered species	Rapid breakdown of herbicide will limit risks to fish, wildlife and vegetation. Studies have shown that herbicides do not build up in the food chain.	No direct, indirect or induced impacts expected.	No direct, indirect or induced impacts expected.	Impact biodiversity by clogging channels to resting and feeding places of terrestrial and semi-aquatic species.
Food Sources	No direct, indirect or induced impacts expected.	No direct, indirect or induced impacts expected.	No direct, indirect or induced impacts expected.	Reduced fish food sources.
Energy Sources	No direct, indirect or induced impacts expected.	Silting of turbines during the operation may lead to temporary clogging of turbines.	No direct, indirect or induced impacts expected.	Clogging of the turbines leading to power cuts and serious social and economic impacts.
Potable Water	No adverse negative impacts are anticipated due to selection of secluded herbicide treatment areas.	No direct, indirect or induced negative impacts anticipated.	No direct, indirect or induced negative impacts anticipated.	Impacts to Water Works, shortage of potable water supply.
Irrigation	No direct, indirect or induced negative impacts anticipated because herbicide treatments will be within specified distances from irrigation intake site.	No direct, indirect or induced impacts expected.	No direct, indirect or induced impacts expected.	Limited accessibility to water intake areas for irrigation purposes.
Socio-Economics	No direct, indirect or induced impacts expected.	No direct, indirect or induced impacts expected.	No direct, indirect or induced impacts expected.	Serious negative social and economic impacts for the region
Human Health Concerns	Normal operations would not pose risk to public health. No direct, indirect or induced impacts expected.	No direct, indirect or induced impacts expected.	No direct, indirect or induced impacts expected.	Increase in disease carrying vectors, impacting the health of the populations.
Air Quality	No direct, indirect or induced impacts expected.	Temporary odors may exist in and around the disposal sites and the shoreline based unloading sites.	No direct, indirect or induced impacts expected.	No direct, indirect or induced negative impact anticipated
Geology	No direct, indirect	Short term impacts of a	No direct, indirect	Possible long term

	or induced negative impact anticipated	slightly altered geology resulting from placement of water hyacinth in the disposal areas anticipated	or induced negative impact anticipated	alteration of geological features as decayed hyacinth builds at lake bottom.
Soil	Soils will act as temporary binding sites for chemical ingredients of the proposed herbicides.	Soils are expected to be slightly altered from the placement of water hyacinth in disposal areas.	No direct, indirect or induced negative impact anticipated	No direct, indirect or induced negative impact anticipated
Industrial	No herbicide treatments within the specified distance of an intake site.	No direct, indirect or induced negative impact anticipated	No direct, indirect or induced negative impact anticipated	Limited industrial activities in the region from water intake clogging.
Transport	No direct, indirect or induced negative impact anticipated	No direct, indirect or induced negative impact anticipated	No direct, indirect or induced negative impact anticipated	Limited lake transport activities in the region.
Cultural and historic resources	No direct, indirect or induced negative impact anticipated	No direct, indirect or induced negative impact anticipated	No direct, indirect or induced negative impact anticipated	Limited accessibility to cultural and historic resources on the islands.
Demography	No direct, indirect or induced negative impact anticipated	No direct, indirect or induced negative impact anticipated	No direct, indirect or induced negative impact anticipated	Negative socio-economic impacts to the populations along the lake shores.
Ground Water	No direct, indirect or induced negative impact anticipated.	No direct, indirect or induced negative impact anticipated	No direct, indirect or induced negative impact anticipated	Water levels would shift towards the lower level in the long run.

Matrix Of The Various Environmental Concerns And Their Assigned Rank and Weight

Table 2: This section presents the various Environmental Concerns and their associated Rank and Weight..

Environmental concerns	Rank	Weight	Chemical Control	Mechanical Control	Biological Control	No Action Alternative
Human Health	1	20	0 (0)	0 (0)	0 (0)	-2 (- 40)
Energy	2	19	+1 (+19)	+2 (+38)	0 (0)	-2 (- 38)
Food Sources	3	18	0 (0)	0 (0)	0 (0)	-2 (-36)
Potable Water	4	17	-1 (-17)	+1 (+17)	0 (0)	-1 (-17)
Socio-Economic	5	16	0 (0)	+1 (+16)	0 (0)	-2 (-32)
Water Transport	6	15	+2 (+30)	+1 (+15)	0 (0)	-2 (-30)
Water Quality	7	14	-1 (-14)	+2 (+28)	+1 (+14)	-2 (-28)
Aquatic Ecosystem	8	13	+2 (+26)	+1 (+13)	0 (0)	-2 (-26)
Ground Water	9	12	0 (0)	0 (0)	0 (0)	0 (0)
Biodiversity	10	11	0 (0)	0 (0)	-1 (-11)	-1 (-11)
Shoreline Ecosystem	11	10	-1 (-10)	+1 (+10)	0 (0)	-2 (-20)
Land Use Plans	12	9	+2 (+18)	-1 (-9)	0 (0)	-2 (-18)
Hydrology	13	8	+2 (+16)	+1 (+8)	+1 (+8)	-2 (-16)
Air Quality	14	7	0 (0)	0 (0)	0 (0)	0 (0)
Industrial	15	6	0 (0)	0 (0)	0 (0)	-1 (-6)
Irrigation	16	5	-1 (-5)	+1 (+5)	0 (0)	-1 (-5)
Demography	17	4	+1 (+4)	+1 (+4)	0 (0)	-2 (-8)
Soil	18	3	0 (0)	+1 (+3)	0 (0)	0 (0)
Geology	19	2	0 (0)	-1 (-2)	0 (0)	-1 (-2)
Cultural	20	1	0 (0)	0 (0)	0 (0)	0 (0)
Totals			+6 (+67)	+11 (+146)	+1 (+11)	-27 (-333)

Rank: Each of the Environmental Concerns was assigned a Rank based on the importance of the concern to the region.

Table 3: MATRIX COMPARISON OF ALTERNATIVES COST BENEFITS:

Environmental Concerns	Chemical Control	Mechanical Control	Biological Control	No Action Plan
Rank	+6	+11	+1	-27
Weight	+67	+146	+11	-333
Cost Benefit	60,300,000,000 $US 60.30 Million	131,400,000,000 $US 131.40 Million	9,900,000,000 $US 9.90 Million	-302,000,000,000 $US 302 Million*

Scale				
Positive	+2	Major Positive Impact	Habitat Improvement/ Economic Benefit	
	+1	Minor Positive Impact		
Neutral	0	No Impact		
	-1	Minor Negative Impact		
	-2	Major Negative Impact	Habitat Loss/Economic Loss	

*The dollar costs associated with the water hyacinth infestations alone have been determined to be $US 2 Million (UEB) impact on Hydropower Production at Owen Falls Dam, $US 300 Million impact on Fisheries and related lake related industries (fisheries, transport, agricultural, industrial, health, socio economic, etc.) (the LVEMP reported that a 5% reduction in productivity would have an associated cost of $US150 Million per year. If fish spawning habitat and related industries are lost due to the continued spread of the water hyacinth in the region, it is estimated to be a minimum 10% reduction, thus $US300 Million). The total economic impacts associated with the No Action Plan as listed above equal $US a minimum 302 Million. The total negative impact points associated with the No Action Plan equal 333 (from Table 2 above), thus each impact point has an associated dollar value of 302/333, or $US 0.90 Million.

The positive impacts associated with the Integrated Control Program have a dollar value of $US 202 Million (Chemical = 67 points, Mechanical = 146 points, Biological = 11 points, total of 224 points multiplied by $US 0.90 million per point).

The negative impacts associated with the No Action Plan have a dollar value of SUS -302 Million (No Action = 333 points multiplied by SUS 0.90 per point).

Table 4: MATRIX COMPARISON OF THE COSTS OF THE CONTROL OPTIONS:

Methods of control	Estimated Operational costs per hectare	Advantages of each control option	Disadvantage of each control option	Mitigation measures
Mechanical control	2,500,000 Ush $US 2,500	Rapid and physically removes the weed and accumulated nutrients from the water body.	High startup costs, difficult to access the weed. Requires disposal sites, and maintenance costs of heavy equipment	Select disposal area based on right criteria.
Manual control - (Kagera)	2,769,000 Ush $US 2,769.00	Low start up costs. No maintenance costs required. Offers less disruption to the environment	Slow. Expensive in the long run. Requires disposal sites	Select disposal area based on right criteria
Chemical control - (Based on studies)	150,000 to 300,000 Ush $US 150.00 to 300.00	Ease of application. Low costs. Offers most complete form of control. A Cheaper option.	Possible damage to non-target plants	Apply herbicides in accordance to safety label instructions. Apply herbicide in strips. Herbicides to be applied by certified applicators.
Biological control-(Lake Kyoga)	2,800 Ush $US 28.00	Offers least environmental impacts.	Weevils are never sufficient to control the weed due to fluctuations in populations.	None documented to date.

No Action Alternative

This option would allow the water hyacinths continued spread that would pose further economic and environmental damage to the region. It has been estimated that approximately 30 million people in the region depend on Lake Victoria for food and jobs, and the continued spread of the water hyacinth would affect the livelihood of these people. The Lake Victoria Environment Management Project (LVEMP 1996) estimated that if the lake was allowed to deteriorate at say 5 percent reduction in prodictivity (due to various factors including the water hyacinth), the consequent loss for the whole region would be to the order of US$ 150 million annually. It is estimated that the loss from the continued spread of hyacinth to be a minimum 10 percent reduction in productivity, or $US 302 million annually.

Alternatives presented here comprise of the Proposed Action and the No Action Plan. Under the proposed actions, the water hyacinth will be reduced to controllable levels using a combination of the available alternatives thus reducing environmental impacts, while the No Action Plan will lead to further decline in the environmental quality, and the associated economic ramifications.

The negative impacts associated with the No Action Plan have a dollar value of $US302 Million (No Action = 333 points multiplied by $US 0.90 per point), as outlined in Table 2 of this Section.

2.4 IDENTIFICATION OF PREFERRED ACTIONS

The preferred action is to implement an Integrated Water Hyacinth Control Program as herein proposed using an integrated approach of chemical, mechanical and physical methods during the EAP, and expanding the program to include biological during the Intermediate and Long Term Plan.

Mechanical Control

Mechanical control methods will be utilized in areas where chemical methods are restricted due to water use concerns, and where physical methods are not possible due to plant volumes present. These areas will include the Water Works Sites (Entebbe, Jinja, Gaba) where water use restrictions for potable water prohibit use within 0.80 kilometers of water intakes, and other sensitive areas where community interests such as bathing, domestic water supply and fishing restrict or prohibit the use of herbicides.

Chemical Control

Aquatic herbicides will be utilized in open water and shoreline areas where water use restrictions will not affect community needs. These areas will exclude the Water intake sites and other highly sensitive areas of community interest. Rodeo or Weedar 64 is recommended for all open water and shoreline treatments where potential impacts are considered low, while Rodeo is recommended for treatments in and around sensitive and populated shoreline areas.

Biological Control

Biological control methods will be initiated at the source of the problem up the Kagera River in Rwanda and all suitable bays in Lake Victoria. Releases will include areas within 0.80 kilometers of Water Works Sites and other water intakes for domestic water uses. It is envisaged that biological control will play a long term role in the control efforts on a much wider area of hyacinth coverage.

Physical Control

Physical control methods have been implemented at some of the Fish Landing Sites as well as at the temporary boom site on the Kagera River. Prior to the arrival of mechanical equipment, physical removal was being performed at the Owen Falls Dam site.

3.0 AFFECTED ENVIRONMENT

Lake Victoria, with a total surface area of 68,800 sq. km. and an adjoining catchment of 184,000 sq. km, is the world's second largest body of fresh water, second only to Lake Superior in size. It is also relatively shallow, with a maximum depth of only 80m, and an average depth of 40 m, and holds a volume of about 2,760 km3 of water. The lake's shoreline is about 3,500 km, enclosing innumerable small shallow bays and inlets, many of which include swamps and wetlands. About 85 percent of the water entering the lake is from precipitation directly on the lake surface, with the remainder coming from rivers which drain the surrounding catchment. The Kagera river

is said to contribute about 7 percent of the total inflow, or half of that over and above direct precipitation. (LVEMP June 18 1996)

Lake Victoria is bordered by Uganda, Tanzania, and Kenya, and is a source of livelihood for an estimated population of 25 million people, and is used for a variety of important socio-economic purposes. Most importantly, the lake is fished commercially using gill nets (the commonest fishing gear), trawlers, and by artisans using seines and lines from beaches and canoes. However, the near shore artisan fisheries are declining because of the weed infestation. The water hyacinth is especially concentrated in Ugandan waters due to the prevailing southerly winds which blow mats of the weed all the way from the mouth of the Kagera river.

Significant Resources

The following provides a discussion of resources considered significant. These were selected because the project could potentially impact them, and because they are of public concern or they are protected by National statute.

3.1 LAND USE, PLANS AND POLICIES

3.1.1 Land Use, Plans and Policies - Lake Victoria Crescent

Land uses around Lake Victoria and other regional water bodies include agricultural use, fishing villages, transportation hubs, small scale resorts, urban development and industrial sites. The major issue in land use is the land tenure system that is characterized by:

- Customary tenure (the dominant system - inherited land without a title)
- Leasehold from either urban authorities or Uganda Land Commission
- Freehold ownership (e.g. Mailo land)
- Public land

The majority of the population owns land under customary tenure which is not very secure because it lacks land titles. This type of land tenure discourages individual initiative to undertake conservation and sustainable land use (National Report on Environment and Development 1992). A government effort is currently underway to assess the feasibility of converting all tenures into freehold ownership which allows individual ownership of land through a land title.

3.1.2 Land Cover-Lake Victoria Crescent

The Lake Victoria crescent area from Sango Bay forests to Jinja has a stretch of Papyrus, wetlands, grasslands and tropical high-forests. The area from Entebbe region towards Jinja is made up of small scale non-uniform farm land, developed areas, and woodlands averaging 4 meters in tree height. Mukono area is made up of uniform and large scale farm lands, with tea and sugar estates dominating the region towards Lugazi. From Tororo to Iganga District region in the northeast, the area is made up of bush land with thickets averaging less than 4m in height. From Jinja area towards Kakira and Lugazi is developed land, with agricultural plantations dominating. The Lake Victoria region of Mukono contains flower producers, cocoa and coffee estates, and

matooke crops. Sese, Damba and Bufumira Islands contain full stocked tropical high forests, woodlands, grasslands, small scale farm lands and small area bush lands. The Sigulu Islands contain woodlands, small scale non-uniform farm lands and small grasslands. Dagusi Island contains grassland and a small area of tropical high forest currently under encroachment.

Table 5: AGRICULTURAL LAND USE FOR LAKE VICTORIA CRESCENT AREA - 1994

	MUKONO	KALANGALA	MASAKA	MPIGI
Total Area	14,241 sq km	9,340 sq km	6,986 sq km	7,175 sq km
Area under water & swamps	9,648 sq/km	2,200 sq km	1,455 sq km	-
Area Under Forest	444 sq km	908 sq km	134.98 sq km	6,109 sq km
Arable Land	4,149 sq/km	432 sq km	53.965 sq km	4,406 sq/km
Area Under Cultivation	498 sq km	102 sq km	1,224 sq km	1,495 sq km
Number of Farm Holdings	191,057	-	186,549	152,311
Number of Farm Families	191,057	-	139,789	152,311
Livestock Date: Cattle Goats Sheep Pigs Poultry	131,171 61,168 16,632 29,285 702,368	3,890 281 - 1,449 7,676	205,400 100,230 27,757 37,623 479,938	146,817 67,477 28,355 58,244 931,652
Lake Fisheries Fish Caught @ Year	55,396 m/tons	20,076 m tons	13,994 m tons	15,533 m tons
Fish Farming	160 Fish Ponds	No Fish Ponds	13 Fish Ponds	35 Fish Ponds

Table 5 continued

	KAMPALA	RAKAI	JINJA	IGANGA	TORORO
Total Area	181 sq km	4,973 sq km	733.6 sq km	13,113.5 sq km	2,634sqkm
Area Under Water & Swamps	12 sq km	-	120.1 sq km	-	-
Area Under Forest	-	1,388 sq km	57.1 sq km	-	653sqkm
Arable Land	169 sq km	3,900 sq km	536.1 sq km	4,583.6 sq km	2,336sqkm
Area Under Cultivation	4.01 sq km	3,889 sq km	490.2 sq km	3,528.7 sq km	7,917sqkm
Number of Farm Holdings	62,000	63,962	20,000	157,630	82,240
Number of Farm Families	129,040	63,916	20,000	157,630	82,240
Livestock Data: Cattle Goats Sheep Pigs Poultry	 - - - - -	 149,911 26,139 4,523 5,944 446,275	 20,120 0,162 1,094 1,908 194,821	 153,248 233,469 32,174 40,774 1225,249	150,272 61,983 22,596 13,193 803,986
Lake Fisheries of Fish Caught @ Year	1,318 m tons	2,282 m/tons	315 m tons	32,109 m tons	118mtons
Fish Farming	17 Fish ponds	1 Fish Pond	89 Fish Ponds	106 Fish Ponds	113 Fish Ponds

(Early Warning Unit, MAAIF, 1995)

3.2 HYDROLOGY

The main hydrological feature of Uganda is the extensive inter-connected system of lakes forming the upper part of the White Nile. This vast hydrological network dominated by Lake Victoria drains a total area of 190,000 sq./km in Rwanda, Burundi, Tanzania, Kenya and entire southern part of Uganda.

The source of the Nile is considered to be where Lake Victoria passes over Rippon falls. These falls have been submerged by the Owen falls dam, built several hundred meters down stream from Rippon falls. The dam was constructed in the 1950s. This is the only outlet for Lake Victoria. The most notable rivers flowing into Lake Victoria are the Nzoia River from Kenya, the Mara River from Tanzania and the Kagera River from Tanzania, Uganda and Rwanda/Burundi. The 130 km stretch of the Nile from Lake Victoria to Lake Kyoga is termed the Victoria Nile. This part of the Nile falls approximately 105 meters total over both the Owen Falls Dam (20m) and a series of rapids. Lake Kyoga is drained through the Victoria Nile, then enters a series of rapids and falls before flowing into Lake Albert at a level of 410 meters below Lake Kyoga. At Lake Albert, the Victoria Nile is joined by the only other major tributary within the Ugandan territory namely the Semuliki River. This river drains Lakes George and Edward, both lakes in the Rift Valley and the high rainfall area of the Rwenzori Mountains. Lake George and Lake Edward are connected through the Kazinga channel. The river then flows from Lake Albert on a gentle slope to the Sudanese border, where it is known as the Albert Nile. The branch originating at the outlet of Lake Victoria is called the White Nile, while the branch originating in Ethiopia is called the Blue Nile. In Sudan, it is called the main Nile or Bahr el Jebel. (Uganda Water Action Plan Doc. 007 1995).

The Lake Victoria area receives high rainfall (1250-1500 mm) and is distributed in two seasons from March to May and from September to November. There is very little temperature variation throughout the year and the average minimum is 17.4° C while the average maximum is 26.7° C. **(See Map of Lake Victoria, Annex 6)**

3.3 WATER QUALITY

Major Water Quality Changes in Lake Victoria

Lake Victoria plays a major role in providing drinking water for the major urban areas and lake shore communities and provides cheap animal (fish) protein to the surrounding peoples. Other water resources of Victoria contribute to the welfare of human populations in the Lake Basin. The Lake Basin is also the most agriculturally productive and industrialized region in Uganda. The lake is distinctive for long residence time of its waters, and its dependence on rainfall to maintain water balance.

During the past decade, research conducted on Lake Victoria has revealed that the lake has undergone profound changes during the last 30 years and its aquatic resources are endangered by these changes.

There have been dramatic changes in the nutrient concentrations of Lake Victoria. Si (Soluble reactive silica) in the range 67 to 75 uM (4.0 - 4.5 mg liter as Silicon) has decreased by a factor of ten while sulfate has been reduced five fold (Hecky and Bugenyi 1992, Hecky et al. 1993;

Mugidde 1993 a; Bootsma and Hecky 1994; Lehman and Branstrator 1994). This observed drawdown of Si is even more extreme than that found during eutrophication of the Laurentian great lakes (Schelske 1988). The lake exhibits relatively high concentrations of phosphates compared with other large lakes in the world. Ambient SRP (soluble reactive phosphorus) concentrations can exceed 1 uM in the open waters of Lake Victoria. Compared with historical concentrations of the 1960s, present-day concentrations of phosphate has doubled and is in excess of that required to support the algal standing crops.

The algal biomass or chlorophyll levels of Lake Victoria have increased five fold compared to the 1960s. High algal biomass creates a higher oxygen demand by the decomposers which accounts for reduced hypolimnetic (bottom water) oxygen concentrations and localized anoxia (oxygen depletion) in the water column. This elevated algal biomass is stimulated by the high nutrient inputs from the catchment. Because of the changes in P and Si concentrations it seems that the nitrogen cycle has changed tremendously to support the increased biomass. The algae that fix nitrogen have a biological advantage in Lake Victoria now, as evidenced by dominance of blue greens heterocystous algae. This is a contrast to 1960s when flora rich in diatoms such as Melosira and Stephanodiscus were dominant and have now been replaced by diatom Nitzchia. The algal blooms have become intense and common and are a potential threat to water quality through production of phytotoxins that further degrade the water environment. The algal primary is twice as high compared to historic values and productivity has become light limited due to self-shading effects. This has been accompanied by a dramatic reduction in the lake transparency and clarity.

Thermal and oxygen stratification of Lake Victoria is now more pronounced and prolonged than reported in the 1960s. In the 1960s Lake Victoria was characterized by a weak thermal and chemical stratification throughout most of the year. The seasonal mixed layer was about 40 to 50 m thick with complete water mixing twice a year, in January and July. Today, the mixed layer is substantially thinner, between 20 to 35 m thick. The diurnal thermocline is shallower due to increased particulate matter, such as plant organic material that absorbs light in the water column, reducing mixed layer depth. The oxycline of Lake Victoria is now more elevated and the deeper waters regularly contain less than 1 mg liter-1 oxygen. The oxygenated habitable water volume has decreased and may limit the habitable area for aerobic communities, especially fish. Oxygen depletion leads to fish kills during intense vertical mixing and puts to doubt the sustainability of the current high fish yield and biodiversity in Lake Victoria.

Coincident with these changes in the water quality have come species invasions and massive reduction of the endemic fish fauna of the lake. Fish species composition and fish species diversity have decreased dramatically while fish yield has increased about five times.

Alterations in the food web structure seem to be changing water quality through top down effects. Loss of the tremendous diversity of the endemic fish species of Lake Victoria may partly be explained by the current changes in water quality, especially, anoxia and dominance of blue green algae which are unpalatable to fish and other aquatic organisms. In addition, enhanced nutrient recycling seem to stimulate algal production and biomass, and consequently affect the biotic properties of the water. These, with perhaps climatic changes, have combined to cause a reduction in biological diversity. This decline has been exacerbated by the effects of proliferation of the water hyacinth (Eichorniae crassipes) as the related causes include decreased dissolved oxygen levels under the water hyacinth mats, reduced light penetration and increased sedimentation rate in the effected areas of the lake system.

The primary cause of changes in the water quality of Lake Victoria is not known, but it is likely related to nutrient enrichment. There is still a lack of knowledge documenting the effects on Lake Victoria from pollution/eutrophication; factors that facilitate nutrient(s) causing pollution/eutrophication; factors that facilitate nutrient enrichment into the lake e.g. humans activities in the water shed; the role of invertebrates (zooplankton and benthos) in enhancing nutrient recycling. The alteration in the trophic structure with a reduction in herbivorous fish and a subsequent rise in algal biomass may have contributed to the current changes in the water quality of Lake Victoria.

Thermal stratification and mixing patterns may possibly explain some of the observed changes in the water quality of Lake Victoria. Victoria is susceptible to seasonal mixing events, which reoxygenate its depth and redistribute nutrients through the water column. It is conceivable that natural changes in wind, solar energy and temperatures have changed the mixing patterns and intensity with deficits and establishment of nitrogen fixing blue green algae that flourish under such conditions and that provides a scenario for positive feed back on the nitrogen cycle.

3.4 AQUATIC ECOSYSTEM

The ecosystem and aquatic biodiversity of Lake Victoria has undergone significant changes over the last three decades. Some of the factors that have contributed to the changes in the Lake Victoria ecosystem include; the introduction of alien fish stock, over exploitation of the fisheries, a rise in lake levels during the 1960's, regional climate changes, increased nutrient inputs from the atmosphere and catchment, reduction and reclamation of the buffer wetland zone, and colonization of the lake by the water hyacinth (Balirwa J. S 1995).

As recently as 1970, the Lake was known to contain at least 350 fish species, of which more than 250 were endemic haplochromines (Kaufman 1991b). Unfortunately, Lake Victoria has recently experienced the greatest vertebrate mass extinction of modern time (i.e., the loss of almost all of the deep-water cichlid species, as well as nearly half of the Lake's shallow-water species), principally as a result of the introduction of the exotic Nile *Perch (Lates niloticus)* and *Tilapia (Oreochromis niloticus)* in the late 1960's. By the 1980s the Nile Perch and Oreochromis niloticus had increased in numbers and virtually taken over the lake fishery (State of the Environment Report, 1994).

These introductions together with impacts from expanded human population activities, climate changes and the water hyacinth infestation have combined to adversely affect the ecology of the lake.

Water Hyacinth depresses species diversity in a significant manner under and around its shoreline mats. The weed significantly reduces the biomass and numerical levels of fish compared with other shoreline habitats (Natural Resources Institute (NRI) Final Technical Report 1993). According to the NRI report, this condition is associated to low oxygen levels, attributed to the greatly reduced air-water interface, the lack of photosynthetic activity due to shading and the oxygen demand of decaying detritus accumulating under the mat. Such conditions are unsuitable for most fish and many aquatic invertebrates.

Actively growing water hyacinth produce up to 12.8 tons dry weight of organic matter per hectare per year. In a 100 hectare cove covered, for example, with 95% or 95 hectares of water hyacinth,

and only 2 to 5 hectares of open water (depending upon how hard the wind blows the plants together), there will be very little oxygen in the water, and most likely there will not be any fish in the cove. Because of low or reduced oxygen levels, fish will move out into the main lake where oxygen levels are more suitable. Fish can sense oxygen stress, and will move great distances to find oxygen rich waters.

In addition to low oxygen levels under water hyacinth mats, there is little to no light penetration which results in little to no plankton growth. This may cause a corresponding drop in fish production (NRI Final Technical Report 1993). The weed prevents the growth of submerged plants and may overwhelm emergent vegetation (See section 9 Annex 1 Table 3).

3.5 SHORELINE ECOSYSTEM, PROTECTED AREAS, WETLANDS, SHORELINE RESOURCES

Lake Victoria has a highly indented shoreline with a large number of shallow bays and inlets, with a number of swamps and wetlands which differ a great deal from one another. The portion of the shoreline included within the borders of Uganda is about 1,730 km, the remaining area being shared between Kenya and Tanzania. The shores of the lake are populated in areas, and the lake is used for a variety of important socio-economic purposes.

The vegetation around Lake Victoria supports a variety of vegetation cover types such as fresh water marsh, riparian vegetation, valley grassland, and cultivated agriculture. Much of the lake margin is swampy, with numerous islands, papyrus swamps, and some patches of swamp forest. The area surrounding the lake is also particularly rich in butterflies, mammals and birds. Small sanctuary areas have recently been set aside at Entebbe (5200 ha) and Jinja (800 ha); while the rest of the lake shore is largely unprotected.

Key sites for the conservation of water birds along Lake Victoria shores include: Sango Bay, Diimo Shoreline, Mabamba-Nakiwogo Area and Lutembe Bay. (See map in **Annex 6**)

Mabamba - Nakiwogo Bay Area:

This area is located west and south-west of Entebbe International Airport. The shoreline vegetation is dominated by papyrus swamp. In the Mabamba bay, there is an extensive stand of Miscanthus swamp interspersed with Cladium towards open water. The Nakiwogo area has a patch of water-lilies (a relatively rare habitat type on the Ugandan shores of Lake Victoria).

Lutembe Bay Area:

Lutembe bay is located within Murchison bay from Bwerenga to Lutembe Beach Resort. The bay is fringed by papyrus swamp on the open water side and Miscanthus swamp towards the dry land. The fringing hill sides have been recently invaded by horticulture enterprises.

The significance of this area stems from the presence of small "Islands" of mud within the open water. These muddy areas are important roosts for both resident and migrant species. The area regularly supports over 20,000 water birds at one time and therefore qualifies for designation as a RAMSAR site (globally significant wetland resource). At one time, the area supported at least 10% and up to 25% of the flyway population of Gull-billed Terns (Taylor and Rose, 1995). It is a

feeding area for migrant waders which are not found in such congregations anywhere else on the lake shore. The area supports at least 101 water bird species.

Sango Bay:

Sango bay in the context of this report refers to the area south of Nabugabo Lake (Masaka District) down to Kagera River. The most important site within the area is Sango bay itself, a papyrus fringed area that is an important roost for migrant hirundines (bird) and feeding area for terns. In addition, the area supports a high bird diversity as indicated in the Table 3 below.

The open sandy shores in much of this area support migrant waders. The area between Malembo bay and Mujuzi river supports a particularly high species diversity as indicated in the table below:

Table 6. A comparison in the diversity of water birds in different areas of the Lake Victoria shores:

Wetland system	Afrotropical species	Palearctic species	Total
Lutembe Bay	77	24	101
Sango Bay	69	17	86
Diimo Shoreline	59	24	83
Total for Lake Victoria	**87**	**28**	**115**

Source: Julius Arinaitwe (Unpublished information) 1996

3.5.1 Wetlands

Uganda's Wetlands occupy about 10% of the country's land area. The wetland resources cover a wide range of habitats constituting permanent swamps, seasonally flooded wetlands and small valley swamps. The papyrus swamp wetlands are a prominent feature of the marginal zones of Lake Victoria in Uganda (Carter 1955).

The wetlands support a wide variety of plants and animal life and offer refuge to some rare species of fauna, and are important habitats for some threatened bird species. A portion of the nation derives its living from the wetlands where agricultural activities and livestock grazing occurs. The wetlands also provide a source of water for the surrounding communities. In addition to this food support function, they carry out hydrological functions such as flood peak reduction, shoreline stabilization and ground water recharge. In general, the wetlands help improve the water quality.

More recently, a program in the National Wetlands Conservation and Management Program of the Ministry of Natural Resources is in the process of carrying out an inventory of the wetlands of Uganda, including parts of Lake Victoria (data not available at the time of reporting).

3.6 BIODIVERSITY, THREATENED AND ENDANGERED SPECIES

Diverse and abundant species of plants, reptiles, amphibian, birds, and mammals inhabit the complex habitat of the Lake Victoria watershed created by the combination of open waters, marshlands, riparian vegetation, valley grasslands, and agricultural lands. The marshland habitat provides cover, food, and nesting sites.

The watershed is a valuable habitat for a number of reptiles and amphibians. Although the marshland areas support a number of different species, the majority of species are associated with valley grasslands and adjacent wet areas.

Over 500 passerine bird species are known to occur in the region, 15 of which are endemic species. Waterfowl and shorebird species are found throughout the shorelines and wetlands, which are associated with agricultural lands. A majority of these species are migratory. Passerine or songbird species are found in great numbers. Most of these species are associated with the riparian vegetative cover type that provides excellent habitat conditions for these birds. Raptor species such as hawks and owls nest within the larger trees of the riparian and grassland habitats and feed on small mammals that inhabit the surrounding areas of the Lake. Upland game species found are associated with valley grassland, riparian, and agricultural habitats. Their abundance and species composition vary seasonally and depend, to a large extent, upon the type of agricultural crops cultivated.

Semi-aquatic and terrestrial mammals are abundant in the watershed, due to the large areas of grasslands, the isolation from large urban areas, and the presence of riparian and grassland vegetation. Adequate food and habitat are present for most species. Common semi-aquatic mammals inhabiting the Lake Victoria Region include Elephant, Hippopotamus, Buffalo while the terrestrial mammals include Lions, Zebras, Giraffes, Cheetahs, Leopards, and a number of Antelope and Primate species.

Tables 4 through 8 (**Section 9, Annex 1**) describe the most up to date information available regarding rare, endangered, or threatened species of birds, fish, mammals, reptiles, and plants.

3.7 FOOD SOURCES

3.7.1 Fishing

Fish is an important resource to the Lake Victoria region. It provides food and protein supplement to the population as well as a low cost but nutritious substitute to an otherwise expensive beef diet. Fish also provides a source of income to the regional Governments both as a local and export commodity. It is thought that fish contribute more than 50% of the total solid animal protein intake for the national population of Uganda, with average per capita consumption estimated at about 13 kg/yr. (State of Environment Report, 1994). It has also been estimated that the annual per capita consumption of fish in Kampala and the fisher-folk communities around Lake Victoria (Uganda) is on the order of 50-60 kg/yr., almost four to five times the national average. The fisheries resource also provides a significant employment opportunity to an estimated 75,000 persons directly and another 500,000 indirectly as a result of fisheries activities (State of Environment Report, 1994).

The effects of water hyacinth on the biodiversity and abundance of fish and invertebrates in Lake Victoria was reviewed in Uganda from 1 January - June 30 1993 by N G Willoughby and I G Watson (Fisheries and Aquatic Resources), and S Lauer and I F Grant (Field Ecology). Fish samples were collected using electro-fishing from 30 sites, representing 6 major habitat types - open shoreline, rock shore, Vossia, papyrus, Typha and water hyacinth (Eichhornia). A total of 57 species were caught, comprising 2,860 specimens, and weighing a little more than 36kg. The catches included 12 non-haplochromine species (12% by number of the total, 27% by weight) and 45 haplochromine species (88% by number, 73% by weight).

Results indicate that the biodiversity of fish species around water hyacinth (4 - 5 species) is less than that found in other habitats (4 - 9 species), and that the differences are statistically significant at the 10% level of probability. The differences in biomass of fish per sample were found to be much lower around hyacinth (means of 313 - 375g; ranges 26 - 1,274g) than elsewhere (means 432 - 3,112g; ranges 2 - 6,283g). Differences in the number of specimens per sample for hyacinth (means 28 - 38; ranges 3 - 95) were lower than elsewhere (means 23 - 332; ranges 1 - 716). Analysis of variance tests showed the differences between grouped habitat results (i.e Eichhornia vs the rest) were statistically significant at the 5% level of probability for the biomass, and at the 1% level for the number of specimens. The introduced cichlid, Oreochromis niloticus, was the most widely distributed species in the shallow water habitats sampled, being found in 18 of the 30 sample sites, followed by the introduced predator, Lates niloticus, which was found at 12 sites. Only 3 species, 2 haplochromines (Psammochromis saxicola (17% of total biomass caught) and Astatotilapia 'robust nubila' (13%) and the tilapia Oreochromis niloticus (13%) contributed more than 5% to the total biomass figures. Many of the tilapias and haplochromines were coming into breeding condition, though neither of the two key introduced species, Orreochromis niloticus or Lates niloticus, provided maturing specimens from the habitats sampled. Most of the fish captured had empty stomachs. Of those which had been feeding, the tilapias consumed more detritus and plant material, while the haplochromines consumed mainly chironomid and other insect larvae. The absence of lakefly larvae in stomach contents suggests that the fish in the littoral area of the lake do not venture into open water to feed.

The key finding of the work is that it has been possible to demonstrate that water hyacinth does depress species diversity in a statistically significant manner under and around its shoreline mats in the habitats sampled. It was also shown that the weed significantly reduces the biomass and numerical levels of fish compared with other shoreline habitats. From the fisheries viewpoint, Eichhornia should therefore be controlled, wherever feasible (N G Willoughby and I G Watson (Fisheries and Aquatic Resources), and S Lauer and I F Grant (Field Ecology)).

Over the past few years, the quantity of fish caught in Uganda's waters has increased, surpassing the peak of 1978. In 1992, Lake Victoria contributed 49% of the national catch in Uganda's waters, while L. Kyoga contributed 39%, L. Albert, 8%, L. George and Edward 8% and the rest of the waters 8%. This was due to increased availability of the Nile perch which now constitutes almost 90% of the total catch from Lake Victoria (Table 3 below indicates the various species caught by district in the Lake Victoria Crescent Area as of 1994). Of late, a number of factors have combined to affect the growth of this industry and it is under threat from four principal sources of pollution; eutrophication, degradation of the fringe vegetation, climate change and the water hyacinth (State of the Environment Report 1994). Without these conditions, it is believed that fisheries production would increase significantly, especially with the reduction and control of the water hyacinth, a non native infestation.

Water hyacinth infestation of shorelines and bays of both the mainland and islands of Lake Victoria is threatening the livelihood of fishermen. The income of fishermen is reduced due to landing problems, increased fuel costs, delays, and poor quality fish. Subsistence fishermen who depend on in-shore fishing with hooks and traps are being forced to move out of operation.

Table 7: Fish Species Caught by District (Metric Tonnes) in the Lake Victoria Crescent Area:

District	Lates	Tilapia	Rastrargentea	Clarias	Prolopterus	Marmyrus	Bagrus
Tororo	65.8	45.3	0	0	1.3	0.1	0
Iganga	20,133.5	7,334.1	3,457	48.2	370.3	656.1	18.4
Jinja	70.7	243.4	0	0.1	0.8	0	0
Mukono	30,365.5	13,458.1	10,681.7	417.9	50.6	181.8	235.1
Kampala	682.3	625.3	0	0	10.4	0.6	0.3
Mpigi	9,701.2	5,639.5	0	22.0	161.7	2.3	5.3
Rakai	1,588.5	125.1	558.7	7.4	1.7	0.2	0.3
Masaka	10,397.0	1,972.9	1,536.7	6.0	71.9	6.6	3.2
Kalangala	14,198.5	3,406.3	1,958.8	164.6	190.2	35.1	82.7

(Early Warning Unit -MAAIF, 1994)

3.7.2 Agriculture

Agriculture is the backbone of Uganda, Kenya and Tanzania's economies. The agricultural sector in Uganda consists of both crop and livestock production, and generates more than 50% of the country's Gross Domestic Product (GDP) (State of the Environment Report 1994). Uganda is primarily an agrarian economy and because of the dominant role of agriculture, a vast majority of Ugandans depend on this sector. The fast growing population puts more pressure on the agricultural sector as demand for food increases. This implies further encroachment on land, increased irrigation and agrochemicals, which can have effects on the aquatic environment, if not well planned. Agricultural activities in the watershed contribute approximately 50% of the nutrient inputs (50% N & 56.1% P) into Lake Victoria (LVEMP, June 18 1996).

Agricultural production for the Lake Victoria Crescent area includes, maize, beans, sorghum, rice, cassava, sweet potatoes, ground nuts, soybean, simsim, Irish potatoes and bananas, while livestock production includes cattle, goats, sheep, pigs and poultry. (See **Table 2** for agricultural land use information for Lake Victoria Crescent Area.)

3.8 ENERGY SOURCES

The energy sector of Uganda is made of four sub-sectors: wood fuel, petroleum, electricity and new and renewable sources of energy.

The electricity based energy sub-sector is generated primarily from Owen Falls Dam at Jinja, located in the northern part of Lake Victoria, Uganda. The identified potential is 2700MW. The Murchison site has a potential of 600 MW and Bujagali site 250MW. Only 180 MW is installed at the moment. There is a current objective to increase the capacity of the Owen Falls Power Station. There are also plans to construct new plants by the year 2000 at Bujagali, Kamdini, Ayago and possibly Murchison Falls (State of the Environment Report, 1994).

Uganda is well endowed with solar radiation and the use of solar energy especially in communication, refrigeration and household emergency lighting is picking up steadily, but still in limited quantities. The government has also been engaged in evaluating biogas digesters and electrical generators. There are already a number of privately owned biogas plants mostly found in the cattle rearing parts of the country. One experimental biogas plant has been installed at Upper Prison Luzira. This plant, is the first of its kind in Uganda that uses the water hyacinth to generate energy . Existing biogas plants mostly use cow dung.

3.9 WATER SOURCES

The water sources of Uganda include direct precipitation, (with an annual average rainfall of 600 to 1,600mm), runoff, subsurface (underground) and the surface waters of major lakes and rivers. Lakes, rivers and wetlands in the catchment region cover about 18% of Uganda's total surface area. The Ugandan portion of Lake Victoria accounts for over 82% of the total lake surface area within the country.

3.9.1 Drinking, Bathing and Other Personal Uses

The rural population is still dependent on Lake Victoria, springs, wells, rivers and direct rain water for their domestic uses. Piped water is rare, while boreholes are on the increase. The water supply sources for the rural communities from streams, rivers or lakes are sometimes contaminated and are responsible for water borne related illnesses. In the major urban centers, about 50% of the households have access to piped water. (Uganda Water Action Plan Doc-007 1995)

3.9.2 Irrigation

In recent years, irrigation has attracted increased attention in Uganda. Today, irrigation is being looked at as a way of increasing productivity of the agricultural sector of Uganda. This will create a higher demand on water resources. An estimated total of 32,510 hectares of land was irrigated in 1992. A total of about 206 million m^3 of water is used annually for irrigation (Uganda Water Action Plan Doc-007 1995). Limited irrigation development will require substantial water resources which may create competition with other users in areas of scarce water resources.

In Lake Victoria crescent areas, there are plans by many horticultural farmers to implement small scale irrigation systems, but feasibility studies of possible irrigation schemes have not been carried out. At this point, development of irrigation requirements seem rather difficult to estimate.

3.9.3 Industrial

Major industrial activities in Uganda are located along the shoreline of Lake Victoria and lake water is the source of water for these industries. These activities are concentrated in the south of Uganda, particularly around Kampala and Jinja near the shores of Lake Victoria and the Victoria Nile. The Lake as well as being a source of water receives most of the effluents from the industrial activities. The fast growth of industries along the Lakes shore will put an additional stress on the water quality.

The major industrial activities in Uganda consist of the manufacture of textiles and garments, leather, sugar, foods, soft drinks, beer and flour milling as well as fish processing plants. The industries are mainly engaged in the processing of raw materials for domestic and export purposes. To-date there are approximately 5,000 registered factories.

At the country's present level of industrial growth, existing environmental problems will increase. The industrial waste water emitted to Lake Victoria from most of the industrial activities is not adequately treated, and many industries cannot account for the amount of effluent or the pollutants emitted through their operations.

The industries which have contributed significantly to the pollution of the Lake vary. Breweries discharge untreated caustic soda, yeast, alcohol fermenting barley and other organic solids into Lake Victoria, with waste waters discharged into the lake estimated at $500m^3$ /day. Fish kills have already been experienced in areas close to factories (State of the Environment Report, 1994). Textile factories on the shores of Lake Victoria produce waste from their printing and dying processes. This waste contains caustic soda, hydrogen peroxide, sodium, silicate and a multitude of dyes. Sugar factories produce waste water comprised of cane wash, cellulose matter, cane juice and alcohol, that is discharged into the rivers untreated. Leather tanneries discharge $420m^3$ of untreated waste water into the lake each day. This waste consists of serious pollutants such as D.D.T, Dichlorobenzines and other pesticides that can be harmful to human health and aquatic life. The waste discharged is corrosive, has a high BOD (700 mg/liter), and includes suspended solids. Adequate treatment to neutralize the discharges is lacking (State of the Environmental Report, 1994).

3.9.4 Groundwater

The groundwater sources of Uganda are comprised of five aquifer systems. The yield from these aquifer systems ranges from 0.4 to 2.0m^3 per hour. Since Uganda lies on the basement complex of pre-cambrian rocks consisting of schist, marbles, granites, geniuses and quartzite, ground water resources are generally poor. Ground water occurs in limited yields along fissures, cracks and joints of the granite-gneiss formation.

The occurrence of groundwater depends on the rock type, and there are three basic types of rock around Lake Victoria region, the Pre-Cambrian Gneiss, Buganda/Toro rocks, and Sedimentary rocks.

The Buganda/Toro rocks which are found in Mpigi and parts of Jinja and part of Iganga are highly weathered into fine-medium grained material, mainly hardened clays. They have low permeability both vertical and horizontal. This means that if contaminated, the water is easily filtered. The Buganda/Toro rocks are not good for ground water supply purposes. The Pre-Cambrian Gneiss rocks are found on the western part of Lake Victoria, in parts of Tororo, Iganga and a bit of Masaka. When they weather they form medium to course grained particles which have fairly high permeability, thus are good for ground water supply purposes. Contamination of water in these areas is fairly high, and contaminants in the Lake may affect localized ground water supplies. Sediments around Lake Victoria's western shore are fine grained and occurrence of water is limited. Generally, within Kampala, the possibility for contamination of deep ground water is low because the permeability of the soil is very low.

There is an estimated 9,000 natural springs in Uganda with approximately 2,300 protected. Approximately 8,129 boreholes have been drilled to provide water for the recipient population (State of the Environment Report 1994). (Data on boreholes in the Lake Victoria crescent is not available).

3.10 LAKE TRANSPORT

Transport traffic on Lake Victoria may increase as the countries in the region continue to industrialize. Much of the water transport consists of about 600 small canoes and motor boats.

There are five Ugandan ferries that were acquired in 1987 and operate on Lake Victoria, Kyoga and Albert. About twenty ferries and tugs operate in the whole region of Lake Victoria. Waste matters from these ships is dumped straight into the lake waters. Bilges are pumped out and discharged into the lake, tube oil is not purified on most vessels, and sewage is also pumped directly into the Lake. With this present trend, and an evident lack of management plans, increased activities may prove significant to the lake. Infestation of the water hyacinth, a non-native species, has increased transport problems. Disruptions, delays, and operating costs are on the increase, both at Port Bell and at other transport points between the islands and the mainland.

3.11 TOURISM AND RECREATION

The Lakes of Uganda cover about 18% of the total surface area of the country providing part of the beauty that is Uganda. The regional lakes provide different attractions, while recreation on Lake Victoria centers on boating and fishing.

Uganda's main tourist attractions center on its terrestrial biodiversity, represented in both the forest and protected wild life areas. Although a comparatively small country, Uganda is home to a large number of species of birds from great eagles and rare Shoebill storks to tiny, iridescent sunbirds. Flamingos gather on the smaller lakes, which abound with Kingfishers, Bee-eaters and Fish Eagles. The plains and scrubland are home to a diversity of bird life.

Many of the islands of Lake Victoria are uninhabited, so the forests and swamps along the coasts make the islands a perfect habitat for the birds. The land is rich in plant life, and many of the species are reportedly new to botanists. The Sese Islands in the North-Western section of Lake Victoria offer a variety of tourist attractions. The wildlife on the islands include hippo and crocodile, as well as waterbuck, and the sitatunga antelope.

In Lake Victoria it is not uncommon for recreational fishermen to catch a 60 kg Nile Perch as well as Tilapia and Tiger fish which add to the spot fishing. Giant crocodiles are seen on many spots along the rivers.

3.12 HUMAN HEALTH CONCERNS

3.12.1 Diseases

There is a strong link between the quality of the environment and human health. What happens in the environment directly or indirectly impacts health. The People of Uganda are exposed to a number of environmental factors that influence their health, and it is often difficult to know which agent is the cause of illness or death (State of the Environment Report, 1994).

Health impacts from polluted water are likely contributors to poor health in Uganda, though there is lack of researched evidence on this. The only conventional sewage treatment plants receiving industrial waste water are at Bugolobi works in Kampala and Kirinya works in Jinja. Some of the industries believed to impact the health of Ugandans include textile industries which use chemicals believed to cause cancer in mammals.

The water hyacinth fosters the spread of bilharzia and malaria by providing excellent breeding conditions for the vectors. Ideal vectors breading sites are wet ponded areas with still water conditions. Water hyacinth mats result in an increase in still water breading sites in and around secluded shorelines and bays. The spread of water hyacinth in Lake Victoria and the other regional water bodies has resulted in the increase in ideal vector breading sites.

In the absence of researched and documented data, it is assumed that continued uncontrolled water pollution is already a cause of concern to the health of the population in Uganda.

3.13 AIR QUALITY

Uganda could easily be affected by air pollutants from neighboring countries. Occasionally, Uganda and the whole region experience smoke and Sahelian dust which raises background air pollution levels considerably. In towns along the Lake Victoria basin, winds have a major northerly component in the morning and revert to a southerly component in the afternoon. This raises the possibility of night time smog over the lake basin settlements. (National Report on Environment and Development 1992)

Dust, which mostly originates from the processing of solid raw materials in Ugandan industries is beginning to cause concern. Industries that process coffee, cotton, wood and sugarcane generate toxic organic dust, while cement and clay generate inorganic dust. (State of the Environment Report 1994).

Though the air quality in the region is generally good, it is affected from indigenous sources which include automobiles, industrial emissions and agricultural burning. It is believed that biological rather than industrial processes are the main sources of pollutants in the region. Recent studies indicated high carbon dioxide levels over Lake Victoria, probably due to increased vegetation burning, a common practice used to increase soil fertility.

There is, however, still much to be done in the way of research to assess the air pollution potential in Uganda. Although pollution levels are still low compared to industrialized countries, local industrial emissions from the region can have effect if not monitored and controlled.

3.14 CULTURAL AND HISTORIC RESOURCES

There are a number of ancient remains and defensive earthworks located around the country dating from the stone age to recent times. Many just contain a trace of human habitation or simply mounds of earth.

Cultural and Historic sites around the Lake Victoria crescent include:
Historic:

- St. Stanley Fort in Kalangala
- Forts at Luzira built during 1890 through 1905
- Ft. Thurston in Jinja

Archeological sites:

- Middle and later stone age sites around Luzira, Lugazi and Entebbe.
- Royal Tombs at Luzira
- Early stone age sites at Bugungu

3.15 GEOLOGY OF THE LAKE VICTORIA BASIN

Lake Victoria lies between two arms of the East African rift valley. The lake basin in Uganda contains a variety of geological features whose rock ages range from Precambrian to Recent.

The basement complex is comprised of granitic geniuses and migmatites that forms elongate outcrops northwest of Entebbe, around Murchison Bay, Gobero Bay, Wasimenya Bay, Grant Bay and parts of Sese Islands. Most regions in Tororo and Iganga districts around Lake Victoria are also underlain by granitic geniuses. Well foliated amphibolites and quartz-hornblende geniuses of basement complex outcrop are found north of Waiya Bay in Entebbe.

Along an arc extending from the northern shores of Lake Victoria from Jinja to Masaka, outcrops form the Buganda -Toro system. These outcrops are predominantly pelitic and have been metamorphosed to form rocks which vary from slightly cleaved phyllitic mudstones and shale's to mica schist's. Psammitic sediments forming sandstone's and quartites occur at or near the base. Amphibolites and hornblende - schist's with associated phyllites and thin quartzite's are most prominently developed along the shores of Lake Victoria in the area near Jinja. The amphibolites are believed to be derived from volcanic or intrusive basic rocks. (King and de Swart, 1967).

Sese and Kome Islands are underlain by both a basement complex and Precambrian rocks of Buganda-Toro system. With the exception of a large area at the north and south end of Bugala Islands, the whole of Bunyama Island, south and central Bukasa Island, north end of Kome Island and the whole of Damba Island, are underlain by geniuses and schist's. The Islands are mostly underlain by the quartzite's of Buganda-Toro system, (Simmons, 1926).

Outcrops of Permo-Carboniferous (Karroo) of argillite series composed of banded grit, free blue-white shale's and mudstone cover a strip of ground about 1.5 km wide extending approximately east-west across Entebbe peninsula.

There is strong development of Tertiary laterites in the form of surface ironstone northwest of Buvuma Channel, southwest of Grant Bay and on Goba peninsula. The laterite may attain heights of ten meters (10 m) or more in places adjacent to a cliff face, or large vertical exposures such as those near the Geological Survey offices at Entebbe. A lot of scattered laterite outcrops occur north of Lake Victoria both in Entebbe and Kampala areas. Laterite varies in character from a hard concretionary or cellular rock to a softer more clayey material occurring as murram, more or less cemented together (Pallister, 1959).

The present papyrus-filled swamps which occupy most of the low lying areas around the lake are made up of gray silts varying in texture from clay to sand. These are the materials being used locally for brick making and can be found around Murchison Bay, Wasimenya Bay, Kisubi, Waiya Bay, Butolo Peninsula, Buwuku Bay, Gobero Bay etc. Un-consolidated lake deposits of gravel are found on Entebbe peninsula north of Kigungu hill where six meters (6 m) of rock has been exposed to excavation. The gravel is composed of well rounded quartz and quartzite fragments.

Sand deposits of varying grades occur along the shoreline at Grant Bay, Kamuli Bay, Seri Bay, Nyoba Bay, Nyimu Bay, etc. These deposits of sand also occur along the shoreline of the inlets to the west of Entebbe peninsula. Swamp deposits, alluvium and beach deposits also occur west of the lake shoreline running from Namara plain through Lwaminda swamp to Lukaya town. The same deposits can be seen along the shoreline in Tororo and Iganga districts.

Weathering and erosion of granitic geniuses, quartzite's and sandstone's form varying grades of sand deposits while weathering and erosion of shale's, phyllites and amphibolites has produced different grades of clay. (Geology and Mines Department 1996)

3.16 SOIL

From the Kagera basin to Mpigi the soils are made up of Alluvium, recent lacustrine deposits and peat swamps. The rest of Lake Victoria crescent is made up of various soil types ranging from brown to yellow-red sandy clay loam's with laterite horizon, dark red friable clays (latosolic soils), red to dark red friable clays with laterite horizon, Alluvium, recent lacustrine deposits and peat swamps around Entebbe area. From Entebbe area, the soils composition again ranges from brown to yellow-red sandy clay loam's with laterite horizon, dark red friable clays and to Shallow stony soils with rock outcrops up to Iganga. The Sese Islands and Buvuma Islands are composed of red friable clays (latosolic soils), red to dark friable clays with laterite horizon, and brown to yellow-red sandy clay loam's with laterite horizon.

The soils within the Lake Victoria Basin are generally deficient in nitrogen and phosphate (LVEMP 1995). As a result, fertilizers and pesticides play a major role in boosting food production in the region, while contributing to nutrient loading of Lake Victoria.

Erosion, a principal form of soil degradation has been largely caused by a combination of poor farm practices and high population pressures especially around the lake shores. Use of agricultural mechanization such as tractors, contributes to soil degradation, but this is at present still very limited. Plans are underway to move towards encouragement of ox-ploughing (State of Environment Report 1994.)

3.17 SOCIO-ECONOMICS

The rapid expansion of the water hyacinth in Lake Victoria is already showing serious social and economic impacts. The gross economic product of the lake catchment is in the order of US$ 3-4 billion annually, and supports an estimated population of 25 million people at incomes in the range of 90,000-270,000 Ush (US$ 90-270) per capita p.a.. The lake catchment thus provides for the livelihood of about one third of the combined populations of the three countries, and about the same proportion of the combined gross domestic product. It has been estimated that if the deterioration of the lake resulted in (say) 5 percent reduction in productivity of the whole region, the consequent loss would be of the order of US$ 150 million annually (LVEMP 1995). The water hyacinth may play a big factor in contributing to the deterioration of the lake's productivity if left unchecked. If fish spawning habitat and related industries are lost due to the continued spread of the water hyacinth in the region, it is estimated to be a minimum 10% reduction, thus $US300 Million.

The dominant socio-economic activities around the lake and its watershed include agriculture, fisheries, lake transportation, recreation and water supplies for domestic and industrial use in the urban centers. Important activities within the fisheries, transport, electricity supply and water quality are already affected by the spread of the water hyacinth. Some of the effects to these activities are outlined below.

In reference to Table 2, Section 2.3, the total socio-economic impacts have been estimated at US$302 million dollars.

Fisheries

The inability to gain easy access to the landing sites has caused fish to be brought to boat landings after prolonged periods in poor condition and to be rejected by fish buyers. The water hyacinth forces fish to move to open waters, eventually reducing the potential for fish to spawn and nursery in the bays due to low oxygen levels under the hyacinth mats. The fish persons under these conditions take longer to land and also use more fuel per catch of fish. The water hyacinth in the bays can also cause health hazards when they become breeding places for mosquitoes which may carry malaria, and it provides hiding places for poisonous snakes.

Transport

The present situation limits the number of landing sites the canoe transporters can use at any one time. Docking of the railway-ferries at Port Bell is hampered by compressed water hyacinth between the pier and the ferry. This sometimes can cause mechanical damage to the ferry and several hours of delay during docking. According to Uganda Railways Corporation (URC), the turn around time of the ferries has increased by 6-12 hours since the infestation of the weed, increasing fuel consumption. At Port Bell, more than 1000 liters of diesel may be used for a wagon ferry to break through the weed (Latigo, Ogenga 1997). Repair services and other docking facilities fees have increased, and engine servicing is done after every journey due to blockage of pipes caused by the weed infestation. It has also been reported by URC that the bridge that connects the ferry to the land has suffered damages due to the high speed at which the ferries have to move to cut through the weed while docking. URC has also incurred losses through ferry damages when the fenders which serve as shock absorbers are damaged beyond repair. The cost of replacing the fenders is yet to be established by URC. In mid May 1997 it was reported on Capital Radio that the URC is spending 12 Million Ush per week for the

mechanical removal of water hyacinths from Port Bell. It was also stated that these expenditures were not providing much relief from the water hyacinths. URC has yet to establish the total extra costs it incurs as a result of the hyacinth.

Uganda Electricity Board

The turbines of the hydro-electric power station are often shut down in order to clean turbine screens and plugged cooling-system filters. Before the water hyacinth problem, cleaning of filters/ coolers was done twice a month. These days, it is sometimes done weekly or even more often when the hyacinth invasion is heavy. Each generator has a capacity of 18 megawatts and switching it off means not only a loss of revenue to the UEB but also a black out for consumers, leading to higher costs and inconveniences to producers elsewhere in the economy (FAO mission report 1995). The blockage of the cooling systems for both the generator transformers, generators and interbus transformers results into loss of capacity as well as reduction of life-time of the equipment. According to UEB, the frequent and massive load shedding results in loss in energy sales amounting to a tune of 150 million Ush ($US 150,000.00) per month.

The manual removal of the weed at the dam (by 60 to 80 laborers) costs the Uganda Electricity Board about 200,000 Ush ($US 200.00) per day. (FAO mission report 1995). Both the mechanical and manual removal of the weed by UEB is at a cost of approximately 12 million Ush ($US 12,000.00) per month.

Although the various control strategies, especially the physical and mechanical control methods have created employment opportunities for some Ugandans, the socio-economic improvements to the region expected from the proposed actions through the reduction in water hyacinth that currently disrupt and interfere with a variety of activities will supersede this advantage.

3.17.1 Demography

Human population in the Lake Victoria region is estimated to be about twenty five million people. (LVEMP June 1996). The lake basin is a source of food, drinking water, irrigation, transport, agriculture, industrial waste etc.. The high concentration of people in the lake region has led to the emergence of large settlements lacking social amenities, is leading to social and health problems, poor sanitation and an increase in disease, rendering the lake environmentally unstable. Over the past decade, an overall degradation of the resources and the lake shore coupled with the water hyacinth infestation is obstructing fishing access and interfering with the shallow water fish spawning areas of the lakes.

4. REGULATORY AND INSTITUTIONAL SETTING

4.1 GOVERNMENT OF UGANDA AGENCIES

There are many autonomous institutions in Uganda which have environmental functions. The most important include:

- Government ministries and parastatal organizations

- Private institutions: Business institutions involved in trading and manufacturing.
- Non-Governmental Organizations, both local and foreign.

Uganda has a number of government and parastatal organizations concerned with conservation and management of Uganda's aquatic environment. Some of these include, National Environment Management Authority (NEMA), Department of Environment Protection, Department of Fisheries, Forestry Department, Department of Agriculture, Department of Animal Industry, Fisheries Research Institute (FIRI), Makerere University institute of Environment and Natural Resources (MUIENR), National Water and Sewerage Corporation (NWSC), Uganda Electricity Board (UEB), Uganda National Parks (UNP), and Department of Energy.

The management of the aquatic resources in Uganda has been carried out based on numerous laws and regulations, often without published policies. As a result, not much importance has been attached to these laws (State of Environment Report 1994). A lack of emphasis of environmental issues has in the past limited public participation and awareness of the importance of the natural resources, resulting in poor communication channels between policy makers and the local populace. Today, we see greater awareness and government commitment to environmental issues, but there is also an increased need to disseminate information to the grassroots level. Government has taken some positive steps to address these problems. Some of these steps include the creation of NEMA, and the drafting of an environmental law and policy. It is therefore evident that Uganda is in the process of realizing greater commitment to natural resources management.

The Ministry of Natural Resources, which includes the departments of Water, Energy, Minerals and Environmental Protection is responsible for coordinating and enhancing natural resources management, harmonizing the interests of the resource users, monitoring pollution levels, and advising government on policy and legislative reforms for ensuring sound environmental management (State of the Environment Report 1994).

4.2 REGIONAL COOPERATION

Uganda has many shared resources. Eight riparian states depend upon the waters shared with Uganda. These include: Kenya, Tanzania, Rwanda, Burundi, Sudan, Zaire, Egypt, and Eritrea. The regional countries have developed or are developing schemes for the environmental protection of shared resources. Some of these include: The Kagera River Basin Organization, Lake Victoria Environment Management Program, TECCONILE, and the Lake Victoria Fisheries Organization (LVFO).

The need for cooperation for three East African countries, Uganda, Kenya and Tanzania, has been expressed through various effort to form a regional framework. Each country now has a National Environmental Action Plan (NEAP). The three plans focus on Lake Victoria demands through a regional management framework. In May 1994, the three governments entered into a joint agreement to implement a Lake Victoria Environment Management Program. A Tripartite agreement to this effect was signed August 5 1994. This agreement constitutes a framework for action fully responsive to the requirement for a Strategic Action Plan (SAP). The SAP identifies, acknowledges and analyses the transboundary water related environmental concerns which the three governments share in common. (LVEMP June 18 1996)

The World Bank and the Global Environment Fund are in the process of funding the Lake Victoria Environmental Management Program that will deal with the control of water hyacinth over the long term. A Tripartite agreement on the use of the proposed actions will be a topic of a Regional Workshop (Uganda, Rwanda, Tanzania, Kenya) being planned by AU and the University of Florida that will be scheduled following the completion of the EIA/PEA so that it will be available for review and discussion.

For the intermediate and long term control efforts to be successful, it is important that regional collaboration and the coordination of efforts is achieved to eliminate duplication of efforts and to jointly consolidate a regional control plan that is both effective, monitorable, and meets the goals of reducing the current and expected impact of the water hyacinth infestation while limiting negative environmental impacts.

4.3 DONOR INTERESTS

Resource management and other donor interests vary with a common theme of long term sustainable growth and economic development.

4.4 INTERNATIONAL COOPERATION

Uganda recognizes the value of participation in global, regional and sub-regional environmental activities. The LVEMP, TECHNONILE, and other interest groups and donors such as United Nations Food and Agricultural Organization (FAO) and United Nations Development Program (UNDP) provide segments of regional collaboration. The United States Agency for International Development has provided funds for a segment of Regional Collaboration on Water Hyacinth Control issues.

4.5 INTERNATIONAL CONVENTIONS, TREATIES AND AGREEMENTS

Uganda is a signatory to a number of international conventions and protocols protecting the environment. Some of these include:

1. Convention on the Continental Shelf (1958)
2. Convention on fishing and conservation of the living resources of the high seas (1958)
3. Convention on High Seas (1958).
4. Treaty banning Nuclear Weapons Tests in the atmosphere in outer space and under Water (1963)
5. Treaty on the Principle governing the Activities of States in the Exploration and use of outer space including the moon and other Celestial bodies (1967)
6. African Convention on the Conservation of Nature and Natural Resources (1968)
7. Convention on Wetlands of International Importance Especially as Water Fowl Habitat (1971).
8. Convention Concerning the Protection of the World Cultural and Natural Heritage (1971).
9. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973)
10. Vienna Convention for the Protection of the Ozone Layer (1985)
11. Montreal Protocol on Substances that Deplete the Ozone Layer (1985)

12. Convention Concerning Safety in the Use of Asbestos (1985).
13. The Convention on Biological Diversity (1992).
14. The Framework Convention on Climate Change (1992).
15. The Lake Victoria Environmental Management Program (1995)
    Source: NEAP (1992) Review of Existing Legislation in the Field of Environment.

5. ENVIRONMENTAL CONSEQUENCES

5.1 IMPACTS OF PREFERRED ACTIONS

The subsections listed in Chapter 3 have been repeated here with emphasis on impacts to each resource/topic and indirect and induced impacts to be treated within each topic. Short versus Long-Term impacts are discussed as appropriate for each topic. Cumulative impacts are dealt with within each topic as appropriate.

To eliminate or reduce potential direct, indirect and or induced impacts from the proposed actions, control measures will be taken under each of the proposed actions. As such, a review of the control measure is included under each of the topic areas where potential impacts have been identified and outlined in this section.

5.1.1 Land Use and Land Use Plans and Policies

Chemical Control

To reduce potential impacts from the drift of herbicides during treatments, herbicides will be not be applied by aircraft when wind speeds are at or above 8.3 km/hr. Ground applications may be made in sheltered areas with wind speeds of up to 13 km/hr. In both ground and aerial applications, proper drift control agents will be added to the formulation to reduce herbicide drift from the target area. These control measures will limit incidences of drift from chemical spraying that could affect the surrounding land area.

Mechanical Control

No direct, indirect or induced adverse impacts have been identified from the mechanical control measure. The disposal sites which have been identified will not alter land use or land use plans. The identified disposal sites for the Owen Falls Dam and Port Bell sites have existing haul roads and most likely will require more maintenance than they are currently receiving. The condition of these roads can only improve due to the increased attention. The disposal sites at the Kagera River disposal area are located away from the river on old agricultural land. It is expected that the soil conditions will improve due to the decomposition of the disposed water hyacinths.

Biological Control

No direct, indirect or induced impacts have been identified from the biological control to land use or land use plans. The biological control agents are water hyacinth specific and thus pose no threat to terrestrial plant species.

5.1.2 Hydrology

Because the removal of water hyacinth by any means (mechanical, biological, chemical) is not expected to impact water movement patterns, water quantity or water quality, and overall impacts to hydrology are not expected.

5.1.3 Water Quality

The negative effects on water quality that water hyacinth mats have would be alleviated by the control program. The use of biological control agents, mechanical equipment or the application of herbicides in the region for water hyacinth control is not expected to adversely affect water quality (see section 5.1.3.2 below). Any herbicides used would be applied in accordance with US-EPA laws and regulations in accordance with all label directions, and safeguards will be taken to contain any potential oil and fuel spills from mechanical equipment operations.

Chemical Control:

The chemical control component of the proposed program is expected to require smaller amounts of herbicide each year down to some maintenance level as the infestation is controlled. While water hyacinth will likely never be completely eradicated from the region, it can be reduced to a controllable level. The candidate herbicides active ingredients (Glyphosate, 2, 4-D) are used in the catchment area in agricultural applications (NARO Report on Pre-Herbicide Application Studies: Water Hyacinth Control, May 1996). Because some of the herbicide from terrestrial applications eventually reaches Lake waters through runoff and irrigation return flows, background levels of herbicides were investigated by NARO in Pan Lake at Kajjansi using two different methods of analysis, analysis using Gas Liquid Chromatography, was not able to detect the presence of 2, 4-D, and Glyphosate. The second method, Anode Stripping Voltammetric, showed a statistical probability that 2, 4-D and Glyphosate are present in Lake Victoria Water, but at insignificant levels (NARO Report on Pre-Herbicide Application Studies: Water Hyacinth Control, May 1996).

The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) will oversee the control program, including approving the herbicide residue monitoring protocol each year prior to the start of the spraying operation. The intensive water sampling that accompanied the In-Lake Herbicide Trials found low to undetectable residues, with all residues well under the US-EPA and National allowable limits within a few hours of treatment as has also been the case in the NTCWH Pond and Laboratory Trials conducted in Uganda, and also in studies carried out outside Uganda. The predominant herbicides to be used in the operational control program will be Weedar 64 (2,4-D), and Rodeo (Glyphosate). Other herbicide formulations that become available with proper registrations for use on water hyacinths will be reviewed for effectiveness and inclusion in the chemical control program.

IN LAKE HERBICIDE TRIALS

Water Quality data from the In-Lake Herbicide Trials, Wazimenya Bay, Lake Victoria, Uganda showed that there were no negative impacts associated with the use of aquatic herbicides for the control of water hyacinth in Lake Victoria. Water Quality parameters sampled and tested during the trials were Secchi depth, water temperature, pH, dissolved oxygen, Phosphorus and Nitrogen.

The results presented in the In-Lake Herbicide Trials Report are reported to be in agreement with the parameters tested during routine sampling exercises conducted by Uganda's National Water and Sewerage Corporation at Gaba II Water Works.

SECCHI DEPTH SAMPLES

Secchi Depth varied between a minimum of 0.100 meter to a maximum of 1.64 meters; the mean levels varied from a minimum of 0.59 meters to a maximum of 1.23 meters. Secchi Depth readings increased as distances increased away from the plots into open water. Secchi Depth was not likely to have been affected by limited herbicide treatments or decaying vegetation, but would have been influenced more by natural conditions such as algae blooms, storm events, wind induced currents or upwellings, and migratory waterhyacinth mats.

WATER TEMPERATURE SAMPLES

Water temperatures were constant throughout the trials fluctuating between a minimum 24.3 C to a maximum of 29.1 C. The minimum mean was 26.2 C and the maximum mean was 26.8 C. No significant difference was observed between plots, however temperatures were observed to be cooler 5 meters into the mat and increased at distances away from the plots into open waters. Temperatures are not likely to have been affected by the limited herbicide treatments or decaying vegetation, but would have been influenced more by natural conditions such as solar radiation, cloudy or hazy conditions, wind induced currents or upwellings or migratory water hyacinth mats.

pH SAMPLES

pH values varied widely within and between plots from a minimum of pH 4.72 to a maximum of pH 8.64. No significant differences were observed between plots and the control plot, however sample points 5 meters into the plot generally had lower pH readings and pH increased into the open water areas. Migratory hyacinth mats and decomposition of treated and untreated hyacinth were also likely contributors to widely varying pH values.

DISSOLVED OXYGEN SAMPLES

Dissolved Oxygen (DO) fluctuated within plots during the trial period ranging from a minimum 0.4 mg/L (0.4 ppm) to a maximum of 7.2 mg/L (7.2 ppm). The mean DO levels ranged from a minimum of 3.0 mg/L (3.0 ppm) to a maximum mean of 5.3 mg/L (5.3 ppm). DO levels usually increased with greater distance from the plot edge into open water areas. DO levels did not differ significantly between treated plots and the control plot. Migratory water hyacinth mats were probably the most influential factor affecting DO readings, but waves or wind induced currents and upwellings could also have played a factor. Migratory hyacinth mats block sunlight thereby reducing phytoplankton oxygen production. In addition, naturally occurring decomposition or herbicide induced decomposition of the water hyacinth may cause reductions in DO levels.

PHOSPHORUS, REACTIVE (PO_4^{3-}) AND PHOSPHORUS, TOTAL (PO_4^{3}) SAMPLES

Reactive Phosphorus concentrations ranged between 0.01 mg/L (0.01 ppm) to a maximum of 0.42 mg/L (0.42 ppm) the trial period. The mean levels for Reactive P ranged from a minimum of 0.01 mg/L (0.01 ppm) to a maximum mean of 0.075 mg/L (0.075 ppm). Differences were observed within plots and Reactive P concentrations levels usually decreased with greater distance from the plot edge into open water

areas. Migratory water hyacinth mats were probably the most influential factor affecting Phosphorus readings, but weather, water currents and upwellings could also have played a factor. No significant differences were observed between plots and the control plot.

Total Phosphorus concentrations ranged between a minimum of 0.01 mg/L (0.01 ppm) to a maximum of 1.33 mg/L (1.33 ppm) during the trial period. The mean levels for Total P ranged from a minimum of 0.15 mg/L (0.15 ppm) to a maximum mean of 0.36 mg/L (0.36 ppm). No significant differences were observed between plots and the control plot, but differences did appear within plots. Total P concentrations levels usually decreased with greater distance from the plot edge into open water areas. Migratory water hyacinth mats were probably the most influential factor affecting Total P readings, but waves or wind induced currents and upwellings could also have played a factor.

NITRITE, LR (NO_2^-) AND NITRATE, MR (NO_3^-) SAMPLES

Nitrite concentrations ranging from between a minimum of 0.00 mg/L (0.00 ppm) to a maximum of 0.16 mg/L (0.16 ppm) were observed during the trial period. The mean levels for Nitrite ranged from a minimum of 0.00 mg/L (0.00 ppm) to a maximum mean of 0.003 mg/L (0.003 ppm). No significant differences were observed between plots and the control plot, however differences were seen within plots. Nitrite concentration levels usually decreased with greater distance from the plot edge into open water, although these decreases were marginal. As stated above, many environmental factors can influence nitrite levels.

Nitrate concentrations ranging from between a minimum of 0.02 mg/L (0.02 ppm) to a maximum of 0.110 mg/L (0.110 ppm) were observed during the trial period. The mean levels for Nitrate ranged from a minimum of 0.07 mg/L (0.07 ppm) to a maximum mean of 0.082 mg/L (0.082 ppm). Nitrate concentration levels fluctuated slightly between plots, though no significant differences were observed between plots and the control plot or within plots. As stated above, many environmental factors can influence nitrite levels.

Table 8: Maximum Contaminant Levels (MCL -USA) for the candidate herbicides. Source: United States Government Printing Office Access, 1997.

Herbicide	Potable Water ($\mu g\ L^{-1}$)[1]	Fish/Shellfish ($mg\ Kg^{-1}$)[4]
2, 4-D	70[2]	1.00/1.00[5]
Glyphosate	700[3]	0.25/3.0[6]

Notes:

1. 1 $\mu g\ L^{-1}$ is equal to 1 mg/L x 10^{-6} or 1 part per billion (ppb).
2. USEPA - 40 CFR 141.61 (c) (9). Federal Register, December 30, 1992. Revised as of 30/12/96
3. USEPA - 40 CFR 141.61 (c) (27). Federal Register, January 17, 1994. Revised as of 30/12/96
4. 1 mg/kg =1 mg/L x 10^{-3} or 1 part per million (ppm).
5. USEPA - 40 CFR 180.142 (f). Federal Register, revised as of July 1, 1996.
6. USEPA - 40 CFR 180.364 (b). Federal Register, revised as of July 1, 1996.

RESIDUE WATER SAMPLES

A total of 156 water residue samples were collected during the In-Lake Herbicide Trials. Herbicide residue levels were analyzed at North Coast Laboratories in the USA and at Makerere University in Kampala, Uganda. The results are outlined below and presented in the following Table.

Makerere University - Kampala

2,4-D: 2, 4-D concentrations in water from in and near the treatment plots ranged from a maximum of 175µg L^{-1} (175ppb) to a minimum of < 0.01 µg L^{-1} (0.01 ppb). Maximum levels appeared two hours after application. Samples taken 5 meters inside the mat (treatment plot) initially exceeding the MCL's and within 24 hours levels were below the MCL in all plots for the remainder of the trial period. Refer to Appendix B for further details.

GLYPHOSATE : Glyphosate concentrations in water ranged from a maximum of 245µg L^{-1} (245ppb) to a minimum of < 0.01 µg L^{-1} (0.01 ppb). Maximum levels appeared two hours after application. Samples taken 5 meters inside the mat were at all times below the MCL in all plots. Refer to Appendix B for further details.

North Coast Laboratories, USA

2,4 - D: 2,4-D concentrations ranged from non-detectable to 560 µg L^{-1} (560 ppb). The highest level appeared two hours after application with the sample taken 5 meters inside the treated plots (Table 10), which corresponds to the highest 2, 4-D concentrations detected at Makerere University. Analysis reveals that the Maximum Contaminant Level (MCL) for drinking water of 70 µg L^{-1} (70 ppb) was never exceeded outside the treatment area (e.g. edge, 30, and 100 meters), and within 48 hours residue levels were nearing the MCL inside the treatment area.. Residue levels of 2,4-D could periodically be detected directly inside (5 meters in) the treated plots to levels of 1.0 µg L^{-1} (1.0 ppb), the minimum laboratory detection level for 2,4-D water residues.

GLYPHOSATE: Glyphosate concentrations in water ranged from non detectable to 500 µg L^{-1} (500 ppb). The highest level appeared two hours after application from a sample taken 5 meters inside the treatment area (Table 10), which again corresponds to the highest glyphosate concentrations detected at Makerere University. Analysis reveals that for collected samples the Maximum Contaminant Level (MCL) for drinking water of 700 µg L^{-1} (700 ppb) was never exceeded either inside or outside the treatment area (e.g. 5 meters inside, edge, 30, and 100 meters). Glyphosate residues on Day 2 (48 hours after application) were not detected inside (5 meters in) or outside the treatment areas and they remained undetectable for the balance of trial period. The minimum laboratory detection limit for Glyphosate residues in water samples is 5.0 µg L^{-1} (5.0 ppb).

Table 9: Herbicide residues for In Lake water collected from herbicide plots in Wazimenya Bay, Lake Victoria following treatment of water hyacinth with maximum rates of 2, 4-D and Glyphosate. Residues reported in μg L^{-1} (ppb).

		Time after treatment							
Plot	**Site**	**0**	**2hrs**	**1day**	**2**	**7**	**14**	**21**	**30**
A(Glyphosate)	0	-	140	69	0	-	0	0	0
	1	-	42	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
D(Glyphosate)	0	0	500	0	0	0	-	0	-
	1	-	17	0	0	0	0	0	0
	2	-	0	0	0	0	-	0	0
	3	-	0	0	0	0	0	0	0
B(2, 4-D)	0	0	160	14	120	5	2	0	0
	1	-	33	2	0	0	0	0	-
	2	-	0	0	-	0	0	0	0
	3	0	2	0	-	0	0	0	0
C(2, 4-D)	0	0	560	52	-	-	0	0	2
	1	0	43	0	-	-	0	0	0
	2	0	7	0	-	-	0	0	0
	3	-	2	0	-	-	0	0	0
E(Control)									
Glyphosate	0	-	0	0	0	0	0	0	0
	1	0	0	0	-	0	0	0	0
	2	-	0	0	0	0	0	0	0
	3	0	0	0	0	0	-	0	0
2, 4-D	0	0	0	0	0	0	0	0	0
	1	-	0	0	-	0	0	0	0
	2	0	0	0	0	0	0	0	0
	3	-	0	0	0	0	-	0	0

Source: In-Lake Herbicide Trials Results & Conclusion Report (May 1997)

Site 0 = inside treated plots, 1 = edge of treated plot, 2 = 30 meters from treated plot and 3 = 100 meters from treated plot - = no data collected

There are various water use restrictions associated with the candidate herbicides as follows:

- Weedar 64 (2, 4-D Amine): Delay the use of treated waters for irrigation and domestic purposes for three weeks after treatment unless an approved assay shows that the water does not contain more than 0.10 ppm 2, 4-D acid (Weedar 64 Specimen Label, Form No. 95065, EPA Approved: 6/3/94).

- Rodeo (Glyphosate): There is no restriction on the use of treated water for irrigation, recreation or domestic purposes. Do not apply within 0.80 km of an active potable water intake (Rodeo Technical Fact Sheet, August 1993).

Conclusion

Based on the results reported in the In-Lake Herbicide Trials, Results and Conclusions, it can be concluded that the herbicides WEEDAR 64 (2,4 D) and RODEO (Glyphosate) had no significant impacts on water quality or on the aquatic ecosystem in and around the treatment areas. No observable negative impacts were reported as a result of either the application of the herbicide or the resulting decomposition of the water hyacinth mats. The In-Lake Herbicide Trials Report recommended that the potential use of these two aquatic herbicides be incorporated into the Environmental Impact Study for the control of water hyacinth in Lake Victoria and the region. The benefits associated with the use of aquatic herbicides in an integrated water hyacinth control program in Lake Victoria would reduce environmental impacts associated with the continued growth of water hyacinth, with no adverse environmental impacts.

In comparing the efficacy of the two candidate herbicides, WEEDAR 64 (2,4-D) provided quicker knock down of the vegetation while RODEO (Glyphosate) provided a greater degree of control from post treatment Day 14 through Day 40. Due to the various water use restrictions associated with Weedar 64, Rodeo would provide a greater degree of flexibility (during dry periods) for use in an operational control program.

The aquatic herbicides RODEO and WEEDAR 64 can be used in an integrated water hyacinth control program without adverse environmental impacts on humans or the aquatic environment if properly applied and used in accordance with the manufacturers label directions.

In the experimental herbicide applications conducted in Lake Victoria, it was found that herbicide concentrations were below the Maximum Contaminant Levels for drinking water immediately following treatment for Rodeo (Glyphosate) and within seven (7) days for Weedar 64 (2, 4-D) sprayed at the maximum label application rates.

5.1.3.1 Herbicide Breakdown and Environmental Persistence

When herbicides are sprayed onto the water hyacinth mats, a number of different processes occur. Both Weedar 64 (2,4-D) and Rodeo (Glyphosate) are systemic herbicides. The herbicide is applied directly to the water hyacinth plant. The plant leaves absorb the chemical and it is then trans-located throughout the plants system. Herbicides may bind to organic particles in the water or soil or onto plants. Some of the herbicide will also enter the water where it undergoes a complex series of reactions and breaks down into other chemical compounds. The rate of

herbicide breakdown will depend on pH, water temperature, the presence of algae, and bacteria to metabolize the chemical metabolism by plants (ESA/Madrone 1984).

Rodeo (Glyphosate) is considered to be relatively non-persistent, due primarily to microbial decomposition. It rapidly and tightly binds to soil and clay particles and organic detritus in the water column. Once bound to suspended soil particles, its persistence in the water column is determined by temperature, degree of water movement, water pH, and type of soil present (Gren 1983). (Also see In-Lake Herbicide Trials results).

A review of 34 papers concerning the persistence of 2,4-D in water under both laboratory and field conditions concluded that (1) under laboratory conditions, 2,4-D repeatedly decomposed in water in periods of hours to days; (2) under some warm water field conditions, 2,4-D has repeatedly been shown to be reduced to non detectable levels (low ppb range) in closed water bodies in approximately 1 month; and (3) persistence of 2,4-D at extremely low levels may be encouraged by water movements in lakes, reservoirs, and streams (Gren 1983). Also, 2,4-D may break down due to photo decomposition or by algal or bacterial decomposition (ESA/Madrone 1984).

Experimental applications of 2,4-D and Glyphosate in Lake Victoria, Wazimenya Bay using the maximum application rates showed that even at these high application rates, dissipation of the herbicides over the 30-day sampling period was demonstrated for both surface and bottom water samples. Initial residues in the 2-hour post-treatment samples sometimes exceeded the 70 ppb Federal allowance residue level for 2, 4-D, and the majority of 1-day samples reported levels below 70 ppb with generally undetectable and only trace quantities after 7-days. Initial residues in the 2-hour post-treatment were below the 700 ppb Federal allowance residue level for Glyphosate, with generally undetectable and only trace quantities after 1-day. (In-Lake Herbicide Trials Report).

Herbicides residues from the proposed program would be expected to be lower and to dissipate more quickly than in this study because of the lower uniform application rates of the candidate herbicides. Monitoring chemical residues of Weedar 64 (2,4-D) would be continued under the proposed Operational Control Program. Rodeo (Glyphosate) monitoring would not be performed because it inactivates so rapidly as demonstrated in the In-Lake Herbicide Trials.

5.1.3.2 Potential for Impact From Repeated Chemical Control Measure.

Glyphosate herbicides dissipate and degrade very rapidly in aquatic systems. They also dilute very rapidly in flowing or deep water bodies. Results from numerous studies demonstrate that Glyphosate dissipates quite rapidly in the environment, with half lives in all cases of less than one year and typically less than 60 days. Even though small levels have been detected in soils one year after treatment, there was no build up of Glyphosate residues after yearly applications (Monsanto 1995). The studies also demonstrate that Glyphosate does not accumulate after multiple applications, either during the same year or over several years (Feng et al. (1990), Goldsborough and Beck (1989), Goldsborough and Brown (1993)). Thus the chemical characteristics of glyphosate and its metabolites are such that they are not expected to bioaccumulate in animal tissues. This is due to their high water solubility and extremely low octanol/water partition coefficients (Montgomery, 1993). The In-Lake Herbicide Trials further demonstrated that Glyphosate was non detectable within 2-days following application in Lake Victoria.

Dissipation of 2,4-D is mostly by microbial degradation. A small amount of photodecomposition and breakdown by tolerant plants also occurs. Complete decomposition usually takes place after about 2 weeks and can be as short as 1 week in rich, warm natural waters. 2,4-D breaks down into naturally occurring compounds, including carbon dioxide, water, ammonia and chlorine. Like Glyphosate, there are no cumulative impacts of the herbicide. It breaks down quite rapidly and does not bioaccumulate (Otto et al. 1983). The In-Lake Herbicide Trials further demonstrated that only trace levels of 2, 4-D were present 30 days following application in Lake Victoria.

5.1.3.3 The Impact of Decomposing Water Hyacinth and Sedimentation to the Lake Bottom

Water Hyacinth with a fresh biomass of 600 metric tons/ha (600,000 kg/ha, an average weight) will have a dry weight approximately 6% of the fresh weight (Knipling et al 1970). Therefore, the dry biomass will be 36 metric tons/ha (36,000 kg/ha). When treated with herbicides, approximately 75% (27 metric tons/ha or 27,000 kg/ha) of biomass oxidizes at the water surface depending upon environmental conditions. The balance of 25% (9 metric tons/ha or 9000 kg/ha) sinks or is unaccounted for (Haller 1981). This total is close to a similar study (Joyce, 1985) which gives a total value of 10.37 T/Ha for treating a 100% infestation in an experimental tank.

Thus, from the above studies it appears that organic detritus that results from spraying water hyacinth is about 9 metric Tons/ha (total) and the detritus that forms annually under living hyacinths due to natural growth and death of plants is about the same.

The control of water hyacinth using herbicides should not negatively impact Dissolved Oxygen (DO) levels in Lake Victoria as a result of the biological degradation of the organic material. During the In-Lake Herbicide Trials, it was found that dissolved oxygen levels under the hyacinth mats was relatively low, and thus decomposition of the treated hyacinth would not further affect fish populations in and around water hyacinth mats. No research has been specifically conducted on the possibility of deoxygenation due to rapid degradation, however several authors have mentioned it as a concern (Linz, 1992). Sacher (1978) reports that deoxygenation is not likely in the use of Rodeo herbicide due to the relatively slow mode of herbicidal action.

The proposed integrated Water Hyacinth Control Program will reduce the total hectares of water hyacinth in the region. The result will be increased dissolved oxygen levels in waters presently covered (infested) by water hyacinth mats.

The Rate of Herbicide Effectiveness (Kill Rate)

During the In-Lake Herbicide Trials, it was demonstrated that Rodeo (Glyphosate) and Weedar 64 (2,4-D) showed plant symptoms appearing within 4-8 hours after herbicide application. Rodeo treated plots showed that 20% of the water hyacinth plants remained healthy at post treatment day 30 with 0 to 10% healthy plants on post treatment day 40. Weedar 64 treated plots showed that 20% of the water hyacinth plants remained healthy at post treatment day 30 with 10% healthy plants on post treatment day 40 (In-Lake Herbicide Trials Report, May 1997). Visual effects include gradual wilting, yellowing, followed by complete browning, deterioration of plant tissues and ultimate decomposition of the underwater roots and rhizomes.

Biological Control

There are no foreseen direct, indirect and or induced impacts from the biological control segment of the proposed action on water quality. The reduction in water hyacinths will improve water quality via the reduction in decaying biomass.

Mechanical Control

Potential oil or fuel spills and grounding of mechanical equipment on the lake bottom could produce temporary impacts to water quality. For a safe guard, it is recommended that proper containment booms accompany the mechanical harvesting equipment for deployment in the event of an accidental oil or fuel spill. Potential impacts due to increased turbidity from propulsion and the grounding of equipment during the unloading process is expected to be minimal and localized.

5.1.4 Aquatic Ecosystem

Fish and Aquatic Life

The water hyacinth control program is expected to benefit fish and aquatic life by reducing the extent of this non-native plant infestation. No adverse negative impacts to fish and aquatic life are expected from biological or mechanical control or the placement of booms. Mechanical harvesting and placement of booms may disrupt the natural habitat of fish during the actual operations, but this would be temporary.

Chemical Control:

The chemical control component does not pose significant risk to fish in the region, as explained in detail below. Known tolerance levels of fish and aquatic invertebrates to Rodeo (Glyphosate) and Weedar 64 (2,4-D) are considerably higher than the maximum residue levels reasonably expected from the herbicide control program. Application rates, restrictions and residual levels are outlined in Section 5.1.3, Water Quality.

FISH TISSUE RESIDUE ANALYSIS, IN-LAKE HERBICIDE TRIALS

Fish were collected during the In-Lake Herbicide Trials and herbicide residue levels were analyzed at ANRESCO Laboratories in the USA and at Makerere University in Kampala, Uganda. The results are outlined below and presented in the following Table.

Glyphosate and 2,4-D was non detectable in fish tissue samples during the trial period. Fish fry were visible at most times in all sample points at all plots. Behavior and mobility were normal at all times. No dead fish were ever observed. The minimum detection limit for 2,4-D in fish tissue is 0.05 mg/kg (0.05 ppm or 50 ppb).

Table 10: Herbicide residues for Fish Tissue from herbicide plots in Wazimenya Bay, Lake Victoria following treatment of water hyacinth with maximum rates of Glyphosate and 2, 4-D. Residues reported in mg kg $^{-1}$ (ppm). North Coast Laboratories, USA.

		Time after treatment (days)		
Plot	**Material**	**0**	**7**	**21**
A (Glyphosate)	Tilapia	-	-	-
D (Glyphosate)		-	-	-
B (2,4 D)	Tilapia	0	0	0
C (2,4 D)		-	-	-
E (Glyphosate)	Tilapia	-	-	-
E (2,4 D)		0	0	0

- = No data analysis available

FISH OBSERVATIONS

A total of 30 fish observations were scheduled during the In-Lake Herbicide Trials. Fish would not survive in the cages which resulted in observing fish in and around the plots. As a result, fish were not restricted in movement and were free to travel in and out of plots representing a more normal and natural event. Fish fry (juveniles) observed during the trial period were found behaving normally, displaying typical swimming posture and mobility at all points within the plots.

Studies in southeastern United States have found that fish in very static waters do absorb 2,4-D, but it dissipates within a few days. A residue limit of 1.0 ppm for 2,4-D has been set by the USEPA for fish flesh (21 CFR 193.100). In aquatic applications of 2,4-D in Oklahoma and Washington by Otto et al. (1983), fish flesh samples were found to be well within the established food additive tolerance of 1.0 ppm despite the very high application rates used. Also, 2,4-D has not been shown to accumulate in the flesh of fish, blue crabs, or benthic invertebrates (Gren 1983).

Glyphosate does not have a toxic effect on aquatic life and is relatively non persistent in the environment, primarily due to microbial decomposition. It is rapidly and tightly bound to soil particles. It does not bioaccumulate in the food chain. Because of its rapid inactivation in water, it is not expected to adversely affect aquatic life. Latka (1992) has concluded that unlike plant tissues, residuals are not found in fish because there is no affinity between glyphosate molecule and the typically lipophilic fish tissue. Because of high water solubility and affinity to sediment particles, any glyphosate will pass unchanged through the mouth or gills, remaining either in solution or suspended particulates.

A potential temporary impact to aquatic life could result from herbicide induced die-offs of water hyacinth causing oxygen deficits if treatment occurs in shallow, quiescent sloughs. Fish kills do occasionally result from anoxic conditions in such sloughs due to nutrient rich inflows, high temperatures, and natural plant die-offs. The In-Lake Herbicide Trials data showed that dissolved oxygen levels under water hyacinth mats were low and unsuitable for fish populations. Herbicide spraying may result in localized fish kills from an oxygen deficit, although precautions will be

taken to limit herbicide use in dead end bays and areas where conditions for this exists. Over the long-term, fish habitat would be improved by the removal of water hyacinth and dissolved oxygen levels along shoreline areas impacted by the water hyacinth would increase.

In a worst-case scenario, if an accidental spill of herbicide occurred, no significant, long-term impacts to aquatic life would be expected because restrictions allow only one open container of herbicide on a spray boat, or aerial application aircraft at a time. Also because of expected rapid dilution in open water, the extent and duration of toxic levels of herbicides would be low.

BIOTA

PHYTOPLANKTON SAMPLES

Major phyla represented and reported during the phytoplankton sampling exercise were Blue Green Algae, Green Algae, and Diatoms. Blue Green Algae (Cyanobacteria) dominated the three phyla with Microcystis spp. in most abundance, followed in decreasing abundance by Anabaenopsis spp., and Mersimopedia spp. Diatom (Bacillariophyta) were the next most important phyla represented, with Nitzschia spp. being most dominant, followed by Navicula spp., and Cocconeis spp. Green Algae (Chlorophyta) phyla were found in relatively low numbers throughout the trial period. It should also be observed that there was a continuous presence of phytoplankton in the plots for the duration of the trials (See Appendix D, In-Lake Herbicide Trials for full report by the lead scientist (Professor Stephen Byamijali) responsible for Phytoplankton studies).

It was observed from pre-treatment and post-treatment counts, that at each sampling site for all plots, there were predominantly higher phytoplankton counts at the edge of the water hyacinth mat as opposed to 5 meters inside the hyacinth mat where sunlight blocked plankton production. It was also suggested that lower numbers of phytoplankton in the hyacinth mats could be a result of herbicide application having reduced phytoplankton population numbers, yet the control plot exhibited similar population numbers and distribution, therefore it would, indeed, be difficult to draw this conclusion. Horizontal water movements and the ability that movement plays in transporting herbicide exposed algal cells out of the plot, in addition to the effect a large water body plays in diluting herbicides, were factors also suggested as potentially influencing the sampling exercise. Herbicides were diluted by lake water, but were also broken down or made biologically unavailable through photolysis, plant metabolism and microbial action in the case of 2,4-D, or through adsorption or microbial action in the case of Glyphosate. It should also be noted that weather patterns, migratory waterhyacinth mats, water currents, water temperature and seasonal changes can also be important variables in phytoplankton population and distribution.

Literature shows that these herbicides have no influence on phytoplankton at the levels detected in water, 2 hours post-treatment.

It was stated by the lead scientist of the phytoplankton study that no conclusion or recommendation could be made on the effect herbicides have on phytoplankton communities since the trial could not control natural factors. Herbicides would have obvious effects in isolated and controlled experiments where natural influences could be limited or reduced. This kind of experiment could reveal different results, but these would be for conditions unlike those present in Lake Victoria. Nevertheless, the fact that phytoplankton were present throughout the study period and that there was no noticeable effect cannot be ignored.

CHLOROPHYLL-a SAMPLES

Chlorophyll - a levels fluctuated within plots and between plots over the thirty day trial period. Glyphosate treated plots saw values vary from a minimum of 9.04 µg L^{-1} (9.04 ppm) to a maximum of 43.7 µg L^{-1} (43.7 ppm) with mean concentrations ranging from a minimum of 10.43 µg L^{-1} (10.43 ppm) to a maximum of 37.5 µg L^{-1} (37.5 ppm). Values for 2,4-D treated plots ranged from a minimum of 3.48 µg L^{-1} (3.48 ppm) to a maximum of 61.86 µg L^{-1} (61.86 ppm) with mean concentrations ranging from a minimum of 6.06 µg L^{-1} (6.06 ppm) to a maximum of 45.87 µg L^{-1} (45.87 ppm). The control plot, E, which had no herbicide applied, varied from a minimum of 5.56 µg L^{-1} (5.56 ppm) to a maximum of 34.75 µg L^{-1} (34.75 ppm) with mean concentrations ranging from a minimum of 5.56 µg L^{-1} (5.56 ppm) to a maximum of 34.75 µg L^{-1} (34.75 ppm). It is interesting to note that minimum values for all the plots occurred on Day 7, a day that began with fog and saw migratory hyacinth mats invade the trials site. (For a full report by the lead scientist (Dr. Timothy Twongo) on Chlorophyll-a studies, see Appendix E, In-Lake Herbicide Trials).

The variability of the Chlorophyll-a results suggest that factors related to environmental conditions (e.g. wind and water currents, water hyacinth mats, light duration and penetration, ...) were a greater influence to Chlorophyll-a concentrations than herbicides residues which dissipated to very low levels within 72 hours.

ZOOPLANKTON SAMPLES

Major zooplankton Orders identified and quantified were, in order relative abundance, Copepoda, Rotifera, and Cladocera. The presence, distribution and relative abundance of these zooplankton remained continuous during the 30 Day trial period (See In-Lake Herbicide Trials Report, Appendix F for full report by the lead scientist responsible (Dr. Yusuf Kizito) for Zooplankton studies).

The lead scientist responsible for zooplankton studies has noted that the constant mixing of lake water was responsible for the continuous presence of zooplankton throughout the period, and adds that the results should not be misinterpreted to mean that application of herbicides have no significant toxic effects. It was also expressed that herbicide toxicity on zooplankton is more appropriately assessed in the laboratory where conditions can be more easily controlled and dilution of herbicide concentrations can be prevented. These values are reported in the literature and are many times higher then concentrations of herbicides found 2 hours post-treatment.

Continuous mixing of lake water through natural means certainly assists in the dissipation of herbicides as does the methods of degradation mentioned in the previous section, 3.0.3.1 Phytoplankton. It is agreed that toxicity tests are more appropriate in the laboratory and have, indeed, been carried out by herbicide manufacturers, independent laboratories, and government agencies in many countries on a variety of zooplankton including Daphnia, a species in the Order- Cladocera. Cladocera, a major Order present in Lake Victoria were collected, identified and counted during the herbicide trials in Wazimenya Bay. Referring to Section 3.0.1 Herbicide Residues, In-Lake Herbicide Trials Report, Table 4 - Toxicological characteristics of the candidate herbicides, it can be seen that 48 hour LC_{50} levels for Daphnia (Order - Cladocera) are 930 mg/L (930 ppm) for RODEO - Glyphosate and 184 mg/L (184 ppm) for WEEDAR 64 - 2, 4-D technical. In-Lake Water Samples reveals that the highest herbicide residue levels occurred 2 hours after application at 500 µg L^{-1} (500 ppb) for Glyphosate and 560 µg L^{-1} (560 ppb) for 2,4 D. These 2 hour maximum levels are far below those levels specifically toxic to Daphnia, and those levels expected toxic to zooplankton in general.

MACROFAUNA SAMPLES

Macrofauna were primarily identified for the following classes, families, genus' or groups: Odonata, Oligochaeta, Leeches, Ephemeroptera, Chironomidae, Caridina, Bivalvia, and Gastropoda.

MACROFAUNA BIOMASS SAMPLES (BELOW WATER LINE)

Macrofauna abundance and distribution in the roots and debris (below water biomass) 5 meters into the treatment area and at 1 meter into the treatment area varied between plots, and over the 30 day trial period. No adverse effect to macrofauna diversity and abundance can be attributed to the use of either herbicide.

Macrofauna population and distribution studies can be effected by season, macrofauna breeding cycles, weather or storm events, and a number of other variables. It would therefore require comparison to long term surveys to identify any negative consequences related to herbicide use in the control of waterhyacinth. It should be realized, however, that any changes in macrofauna populations would not be unexpected after the application of herbicides since macrofauna found in the water hyacinth roots and debris are occupying a niche that is a target for control. As plants pass through the phases of necrosis, conditions previously suited to some macrofauna - waterhyacinth associations would become less desirable to some species because of the changing physical landscape of the habitat. Water quality parameters were observed not to change significantly and herbicide residues dissipated rapidly, thereby ruling out declines due to these factors. When plants reach the final stages of necrosis and are swept away by winds, water currents, or collapse on the water surface, the hyacinth mats would have become a habitat that no longer resembles the original mat; macrofauna composition, diversity and abundance would be required to adjust to the changed environment. Some species would be expected to benefit since they may previously have been occupying a niche considered marginal when their habitat of preference was a waterhyacinth free environment, while others would be expected to decline for the opposite reason.

Prior to the invasion of water hyacinth to the region's water bodies, this water hyacinth niche did not exist as such and lake waters no doubt had a much different biotic composition and structure. Therefore, any declines that can be interpreted in the results, or that may appear in any approved future control program should be reviewed in relation to the migration of macrofauna to more suitable habitats.

BENTHIC MACROFAUNA SAMPLES

Chemical Control

Macrofauna population and distribution in benthic sediments 5 meters into the treatment area and 1 meter into the treatment area varied between plots and over the 30 day trial period. No adverse effect to macrofauna can be attributed to the use of either herbicide (In-Lake Herbicide Trials Report, May 1997).

Biological Control

Biological control agents will not adversely affect Fish and Wildlife concerns as they are host specific and will not affect non water hyacinth wetland ecosystems or habitats. Fish and wildlife habitat is expected to improve through the reduction in water hyacinth as the fish spawning areas will expand and shallow water feeding habitat for wildlife will return to pre infestation levels.

Mechanical Control

The use of mechanical equipment for the control of water hyacinth is not expected to adversely impact the aquatic ecosystem. Small fish that have the potential to be removed with vegetation during mechanical weed control operations is not expected as the oxygen levels under the water hyacinth mats is too low to support fish. Snakes and other small animals may become entangled in the water hyacinth mats and be removed during the process.

5.1.5 Shoreline Ecosystem

Includes Protected Areas, Wetlands and Shoreline Resources. No direct, indirect or induced negative impacts from the proposed actions have been identified except as listed below. The shoreline habitat is expected to improve via the proposed actions from the removal of water hyacinths currently impacting shoreline areas.

Chemical Control

No induced impacts from the use of herbicides is expected due to the application techniques that will limit herbicide drift to the shoreline ecosystem. The In-Lake Herbicide Trials showed that there was no impact from the herbicide applications to the shoreline ecosystem.

Biological Control

There are no foreseen impacts to the shoreline ecosystem from the biological component of the proposed actions.

Mechanical Control

Minor impacts to the shoreline ecosystem are expected from land clearing and development of shoreline access, work and water hyacinth removal sites. Care will be taken to utilize sites where shoreline access activities are currently underway and protective measures will need to be incorporated into the operational control plans to reduce shoreline destabilization and potential for erosion from wind and wave actions. Access sites will require the proper layout and plan to avoid erosion for equipment access.

5.1.6 Biodiversity and Threatened and Endangered Species

The habitat area for threatened and endangered species is expected to improve via the proposed actions from the removal of water hyacinths currently impacting wetland habitat areas.

No negative or detrimental impacts from the control program to threatened and endangered species are expected to occur. Reduction of water hyacinth mats would be expected to benefit native plant and animal species, and fish spawning habitat would be restored from the removal of the hyacinth mats.

Wildlife

Terrestrial and semi-aquatic wildlife are not expected to be detrimentally impacted by any component of the water hyacinth control program. Waterfowl would be benefited by the removal of this non-native plant by the opening of infested areas to habitat.

Chemical Control

Terrestrial wildlife will be unaffected by the chemical control component of the proposed program. Since rapid breakdown of the herbicides is expected, risks of adverse impacts to wildlife through body contact or drinking would be low. None of the two herbicides are known to build up in the food chain.

According to a recent study carried out by the Industry Task Force on 2,4-D Research data form Swansboro North Carolina, from an LD^{50} standpoint, 2,4-D is less toxic than caffeine and slightly more toxic than aspirin

Biological Control

No direct, indirect or induce negative impacts are anticipated.

Mechanical Control

No direct, indirect or induced impact anticipated.

5.1.7 Food Sources

The fish habitat will improve via the proposed actions from the removal of water hyacinths currently impacting shallow water spawning areas.

Chemical Control

No adverse negative impacts to the food sources are expected.

Biological Control

No direct, indirect or induced negative impacts anticipated.

Mechanical Control

Access roads and dumping areas may affect agricultural producing and grazing areas on a small scale, should these areas be required during mechanical operations, but this would be temporary. The present operations at the dam indicate that hyacinth that is harvested and dumped, has stimulated soil fertility in the area through addition of elements and improved soil composition at the dump sites.

5.1.7.1 Fishing

See the review of Fish and Aquatic life above for any impacts from the proposed actions. Fishing activities are expected to improve because fishermen will no longer be trapped by the weeds and fish spawning habitat will be improved along shoreline areas.

5.1.7.2 Agriculture

Agriculture is expected to improve in areas where the water hyacinth is currently clogging water intakes for agricultural use via the proposed actions from the removal of water hyacinths currently impacting intake areas.

Chemical Control

Because broad-leaved plants are sensitive to Weedar 64 (2,4-D), some agricultural crops grown in the region, such as beans, cassava, sweet potatoes, soybean, Irish potatoes and bananas could be impacted by either Weedar 64 (2,4-D) spray drift or contaminated irrigation water if residues were high enough. As discussed, drift control agents will be used with all herbicides. Spraying would not be performed on windy days. Hand-held spray guns and specialized fixed wing aircraft would further ensure that the intended target plants, rather than sensitive crops, receive the herbicide. The rapid decomposition and low residue levels of the herbicides would lead to very low expected risks to crops. Agricultural products would be irrigated with lake water from spraying sites in accordance with the herbicide restrictions.

Biological Control

Biological control agents are not expected to adversely affect agricultural concerns as they are host specific and will not feed on any other types of plants or crops.

Mechanical Control

The mechanical control program is not expected to effect agricultural activities and could provide a soil additive source to improve crop yields in the event further studies are conducted to document the benefits of the potential uses of hyacinths in Uganda.

5.1.8 Energy Sources

The proposed program would enhance energy production through the removal of the water hyacinth mats accumulating at Owen Falls Dam that are currently a disruption. Currently, there is a biomass plant that uses the harvested hyacinth, situated at Luzira Upper prison. The plant's maximum capacity is 250 kg of hyacinth per day. The energy produced is used to prepare meals. Presently, the plant only uses 50 kgs to prepare one meal, breakfast. Fuel and transport difficulties prevent the plant from being fully operational.

Chemical Control

If chemical control were to be used near the Owen Falls Dam, potential impacts from the use of herbicides to kill water hyacinths in front of the dam site could include temporary clogging of intake screens of generating turbines. In the event that herbicides are used at the dam, a program to clean the turbines would need to be implemented as required to reduce impacts to this operation.

Biological Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

Mechanical Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

5.1.9 Water Sources

Water sources are expected to improve from the proposed actions as current problems with the clogging of water intakes with water hyacinth would be reduced or eliminated.

Chemical Control

The effects on water quality for people who collect their water from the lake is expected to be minimal due to the selection of secluded herbicide treatment areas. There would be no spraying within 0.8km of a water intake point. USEPA has established the MCL for Glyphosate at 700 ug/l, based upon a Drinking Water equivalent Level of 105 mg/l (derived from a reference dose of 3.5 mg/kg/day) (USEPA 1992a). The MCL is the level considered protective of a person who in theory may drink water at a level of contamination every day for his/her lifetime.

In a worst-case situation where herbicide might be accidentally spilled at the mouth of a domestic water intake, the water purveyor would be immediately notified so that remedial action is taken in the form of shutting off the intake until residues reached acceptable levels, or dilution from other water sources. A notification method will be developed in the operational plan. Containers of herbicides carried on the boat would be roped together and fixed with floats to make them easily retrievable should the boat overturn.

Biological Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

Mechanical Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

5.1.9.1 Drinking, Bathing and Other Personal Uses

Chemical Control

Chemical treatments will be conducted in areas with water use restrictions in mind. In areas where water is used for domestic purposes, treatments will be made in accordance with herbicide labels.

Biological Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

Mechanical Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

5.1.9.2 Irrigation

Chemical Control

Chemical treatments will be conducted in areas with water use restrictions in mind. In areas where water is used for irrigation purposes, treatments will be made in accordance with herbicide labels, and will include no herbicide treatments within the specified distance from an irrigation intake site.

Biological Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

Mechanical Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

5.1.9.3 Industrial

Chemical Control

Chemical treatments will be conducted in areas with water use restrictions in mind. In areas where water is used for industrial purposes, treatments will be made in accordance with herbicide labels, and will include no herbicide treatments within the recommended specified distances.

Biological Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

Mechanical Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

5.1.9.4 Groundwater

Chemical Control

Chemical treatments will be conducted in areas with water use restrictions in mind. As the herbicides registered and approved for use in aquatic sites all bond with organic and other sediment types, any potential contaminants would be filtered by sediments. In the event a ground water well is located adjacent to a proposed treatment site, precautions will be developed in the Operational Plans to reduce any potential impacts to ground water. These may include no herbicide treatments within a specified distance of an open ground water well. Tests have shown that glyphosate based herbicides bind tightly to the soil. As a result, there is extremely low potential for contamination of ground water, when used according to label directions.

IN-LAND WATER SAMPLES (In-Lake Herbicide Trials)

During the In-Lake Herbicide Trials, bore holes were dug approximately 5 meters inland for the collection of In-Land Water and In-Land Soil samples to detect any movement of the herbicide through the water table. After collecting pre-treatment samples on Day 0, samples thereafter were collected on Day 7, and Day 30.

A total of 18 water residue samples were collected from the bore holes during the In-Lake Herbicide Trials. Herbicide residue levels were analyzed at North Coast Laboratories in the USA and at Makerere University in Kampala, Uganda. The results are outlined below and presented in the following Table.

2,4-D: 2,4-D was not detected in the In-Land water samples except on one occasion. The only detected sample (27 $\mu g\ L^{-1}$) occurred seven days after application in Plot B (See Table 9). The MCL for that one detectable sample fell within the allowable level for drinking water of 70 $\mu g\ L^{-1}$ (70 ppb), but it was believed that this one detection was an anomoly. The discovery of 2, 4-D in this one In-Land water sample was not expected and it is highly unlikely that movement of the herbicide occurred through the water table: 2,4-D was not detected in Plot C. Prior to Day 7 sampling, local villagers observed that Plot B borehole had dried out and no water would be available for sample collection. Local leaders took it upon themselves to dig another hole so that the scientists would have water to collect, but dug a large diameter hole closer to the lake edge (approximately 1 meter) than the 5 meters In-Land described in the design. The new bore hole was at a point where the herbicide application occurred very close to the lake edge. After collecting the water sample from the new borehole, villagers were requested by Aquatics Unlimited to deepen the original hole so that Day 30 samples could be collected per the design. The detection of 2,4-D in this instance should be viewed with some unknown factors in mind, and in retrospect, the sample should probably not have been taken. Unknown circumstances and events that occurred prior to digging the new hole are likely to have contributed to residue detection. The minimum laboratory detection limit for 2,4-D water residues is 1.0 $\mu g\ L^{-1}$ (1.0 ppb).

GLYPHOSATE: Glyphosate concentrations were non detectable for all samples during the trial period. (See Table 12). The minimum laboratory detection limit for Glyphosate residues in water is 0.05 µg L^{-1} (0.05 ppb).

Table 11: Herbicide residues for In - Land water and soil from herbicide plots in Wazimenya Bay, Lake Victoria following treatment of water hyacinth with maximum rates of Glyphosate and 2, 4-D. Residues reported in µg L^{-1} (ppb).

		Time after treatment (days)		
Plot	**Material**	**0**	**7**	**30**
A (Glyphosate)	Soil	-	0	0
	Water	0	0	0
D (Glyphosate)	Soil	0	-	0
	Water	0	-	-
B (2, 4-D)	Soil	0	0	0
	Water	0	27	0
C (2, 4-D)	Soil	0	-	0
	Water	-	0	-
E(Control)				
Glyphosate	Soil	0	0	0
Glyphosate	Water	0	0	0
2, 4-D	Soil	0	0	0
2, 4-D	Water	0	0	0

- = No data analysis available

Biological Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

Mechanical Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

5.1.10 Transport (Water)

In the transport sector, the water hyacinth has resulted in disruptions, delays and rising operating costs. There is delay in fish deliveries and quality loss. There have been disruptions and cut off of movement of goods and people using boats and paddle.

The proposed program would improve water transport through the removal of the water hyacinth mats that are currently a disruption. There are no foreseen adverse impacts from the Chemical, Biological or Mechanical control program.

5.1.11 Tourism and Recreation

The control program would benefit Regional water-oriented recreation activities such as boating, swimming, and boat and bank fishing by clearing choked shoreline and open water areas of water hyacinth.

Chemical Control

Human health risks from body contact during swimming and water-skiing near herbicide treated plants would not be expected to occur because the herbicide residues would be well within established levels shortly after spraying. In case of an accidental spill of herbicide, the appropriate emergency services office would be notified so that they may restrict recreational use of the contaminated water until the herbicide has dissipated to the acceptable level outlined on the herbicide label or set by the Government of Uganda in accordance with US-EPA Regulations.

Biological Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

Mechanical Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

5.1.12 Human Health

Human health is expected to improve via the reduction in disease carrying vector breeding habitat.

Chemical Control

There is varying degrees of sensitivity to chemical exposure that varies from skin rash due to chemical contact, to death from drinking the herbicides. Section 9, **Annex 5** contains the herbicide labels and Material Safety Data Sheets (MSDS') for the proposed herbicides.

For precautionary measures, herbicide applications will be conducted by properly trained and licensed Aquatic Herbicides Applicators and herbicide storage will be in accordance with laws and

regulations established by the Government of Uganda in accordance with US-EPA storage and handling procedures.

Normal operations of the chemical component of the program would not pose risks to public health. Residue levels would be expected to be well within National and US-EPA allowable limits, as has been demonstrated by the residue monitoring data referenced in section 5.1.3, Water Quality. Under the operating protocol of the program, no herbicide spraying would take place within 0.8 km of water intakes at Gaba and Entebbe and Jinja Water Works, eliminating the potential for contamination of domestic water supplies.

Toxicity

The toxicity of Weedar 64 (2,4-D), and Rodeo (Glyphosate) residues are measured according to their acute toxicity, or immediate poisoning effect, as well as the long-term effect of low-level residues (levels below drinking water standards).

The EPA performed a review in 1979 of the existing data base supporting 2,4-D registrations. The conclusion reached was that the scientifically valid toxicology studies on 2,4-D did not indicate that the continued use of 2,4-D posed a significant health hazard when used in accordance with label directions and precautions. The EPA also concluded, however, that more information on the toxicological properties of 2,4-D was necessary and ordered additional data from the herbicide registrants. The 1980 order required 2,4-D registrants to supply data on acute toxicity, tumor formation, reproduction, birth defects, neurotoxicity and metabolism (U.S. EPA 1982). A six year research effort was initiated in 1988 at a cost of some USD $25 million. As a result, "extensive research confirms that the herbicide 2, 4-D poses no significant risk to workers health or the environment" (Turf & Landscape Press, 1996). That conclusion supported by almost 270 studies conducted during the past six years, was presented in Chicago Ill, USA, 2 November, 1995, at a day long symposium by members of the Industry Task Force. "2,4-D, when ingested orally, is actually less toxic then many other more commonly consumed compounds, including caffeine, and is about as toxic as aspirin". Among the other findings: 2,4-D has a moderate to low acute toxicity; has a low reproductive toxicity; does not cause birth defects; does not cause genetic damage; has a low potential to damage the body's nervous system. Chronic effects are also limited to high doses. Based on extensive toxicology, it is highly improbable that 2,4-D causes cancer.

Results from studies conducted under controlled laboratory conditions indicate that both Rodeo and Glyphosate are practically non toxic to mammals following acute oral or dermal exposures. Subchronic and chronic toxicity studies have also shown limited toxicity. Glyphosate is incompletely absorbed following oral administration. Glyphosate that is absorbed is rapidly excreted (almost entirely in the urine) as unmetabolized glyphosate.

A series of bioaccumulation studies done to determine if glyphosate concentrated in the edible portions of fish and marine organisms indicated that glyphosate did not accumulate. Transfer of organisms to glyphosate free water resulted in virtually complete elimination of glyphosate. The data thus obtained from various studies (see references) with mammals, birds, fish and marine organisms firmly indicates that glyphosate will not accumulate in the food chain.
The EPA has classified glyphosate as category E - Evidence of Noncarcinogenicity in humans. This classification indicates that there is no evidence of carcinogenicity in adequate studies and precludes quantitative toxicity assessment for carcinogenic effects. Long term (chronic)

toxicological studies have also been conducted to determine the effects of prolonged exposure to glyphosate. These studies were conducted on rats, mice and other laboratory animals. High doses were administered on a daily basis for the average lifetime (two years) of rats and mice and for one year for dogs. This resulted in glyphosate being classified as category E by the EPA. Long term feeding studies have also shown that glyphosate does not cause birth defects or reproductive problems in laboratory animals. Pregnant rabbits and rats given high dose levels of glyphosate delivered normal offspring's. Feeding studies with chickens, cows and pigs have shown extremely low to no residues in meat and fat following repetitive exposure. The study about the toxicological effects of glyphosate containing herbicides is very wide. A listing of some common chemicals is given in the table below as a relative reference.

Table 12: APPROXIMATE TOXICITY VALUE FOR OTHER COMMON CHEMICALS RELATIVE TO GLYPHOSATE & 2, 4-D

COMPOUND	LD50
Glyphosate	>5,000 mg/kg *
Table salt	3,000 mg/kg
Vitamin A	2,000 mg/kg
2, 4-D	1,161 mg/kg
Aspirin	1,000 mg/kg
Caffeine	164 mg/kg
Nicotine	54 mg/kg

* For oral exposure to rats. Source : Monsanto, 1983

N.B LD_{50} refers to a single orally administered dose of a substance that is lethal to 50 % of an animal test population.

Table 13: TOXICOLOGICAL CHARACTERISTICS OF THE CANDIDATE HERBICIDES ON FISH AND INVERTEBRATES.

Herbicide/Test Organism	Hours LC_{50} (mg L^{-1})	Acute oral LD_{50} (Rats) mg/kg
Glyphosate - Rodeo		
Rainbow trout	96 hr - >1000	
Carp	.. - >10,000	>5000
Bluegill sunfish	.. - >1,000	
Daphnia	48 hr - 930	
2,4-D - WEEDER 64		
Rainbow Trout	96 hr - 250	
Bluegill sunfish	.. - 524	1161
Daphnia	48 hr - 184	

SOURCES: WSSA HERBICIDE HANDBOOK - 7th EDITION, 1994 (WEED SCIENCE SOCIETY OF AMERICA) FOR GLYPHOSATE AND RHONE POULENC AG COMPANY, MATERIAL SAFETY DATA SHEET FOR WEEDAR 64, 1995.

Biological Control

No direct, indirect or induced negative impacts from the proposed action on human health is anticipated.

Mechanical Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

5.1.12.1 Public Awareness

Public awareness campaigns were carried out during the Pond Trials at Kajjansi and the In-Lake Herbicide Trials at Wazimenya Bay to sensitize the affected populace about the intended trials.

On 25 November, 1996 the Water Hyacinth Unit and Aquatics Unlimited visited with Mukono District Center, LC III, and LC I officials to seek their cooperation and assistance for In-Lake Herbicide Trials. Through their support, public sensitization programs were organized and held at two schools in Mubanda and Butere villages (Wazimenya Bay communities) on November 29, 1996 for the purpose of educating the villagers on GoU efforts for controlling waterhyacinth, and the need to conduct In-Lake herbicide trials. Following introductions and discussion on the government's efforts, a video developed by the University of Florida - Center for Aquatic Plants presenting integrated control efforts in the USA that was dubbed into Luganda was shown to the participants. A question and answer session then took place which addressed the concerns raised by the participants, particularly with respect to herbicides. The meetings concluded with the communities agreeing to support activities related to the herbicide trials.

Prior to the herbicide application, fliers (handouts) in Luganda and English were distributed to the adjacent villages with suggestions to follow during the 30 day trial period. Signs were placed in front of each plot identifying the area as a herbicide trial site, requesting that persons stay away from the area, and identifying the Ministry responsible for the exercise. In addition, local leaders supported efforts by patrolling the area and reminding persons not to carry out certain activities within the treated areas during the 30 day trial period.

On February 19, 1997, eight days after the herbicide application, members of the Parliamentary Sessional Committee on Agriculture, a member from the Sessional Committee on Natural Resources, several reporters and film crews, the Water Hyacinth Unit and Aquatics Unlimited proceeded to Wazimenya Bay from Monyoyo Boat Landing in the FIRI vessel MPUTA. Members were briefed on the exercise and encouraged to ask questions related to the exercise. Footage of the outing appeared on UTV and in The New Vision. Regional Countries were informed of herbicide trial activities prior to actual commencement through the Lake Victoria Fisheries Organization inaugural Council of Ministers meeting that was held in Kampala Uganda on 19th December 1996. Additionally, several articles appeared in The Monitor, The New Vision, and The East African Newspapers.

The above public sensitization efforts and methods will be expanded in the and incorporated into the integrated Operation Control Program if approved to sensitize affected communities in proposed herbicide treatment areas.

5.1.13 Air Quality

Chemical Control

Herbicide treatments will include the use of drift control agents that will eliminate or reduce any potential impacts to air quality such as herbicide drift and odor problems. Glyphosate has a low vapor pressure and does not tend to vaporize, thus the likelihood of air movement is very low.

Biological Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

Mechanical Control

Temporary odors may exist in and around the water hyacinth disposal sites as well as the shoreline based unloading sites. Precautions will be taken to minimize odors that will include the spreading of the plant mass to allow for proper decomposition. The identified disposal sites at Port Bell and Owen falls dam Jinja are in locations where potential odors will not effect local communities.

5.1.14 Cultural and Historic Resources

The proposed Chemical, Biological and Mechanical components of the proposed action would have no effect on these resources.

5.1.15 Geology

The proposed Chemical, Biological and Mechanical components of the proposed action would have no effect on these resources.

5.1.16 Soils

Chemical Control

During the In-Lake Herbicide Trials, bore holes were dug approximately 5 meters inland for the collection of In-Land Water and In-Land Soil samples to detect any movement of the herbicide through the water table. After collecting pre-treatment samples on Day 0, samples thereafter were collected on Day 7, and Day 30.

A total of 15 soil residue samples were collected from the bore holes during the In-Lake Herbicide Trials. Herbicide residue levels were analyzed at North Coast Laboratories in the USA and at Makerere University in Kampala, Uganda. 2, 4-D and Glyphosate was non detectable for all samples during the In-Lake Herbicide Trials period. See the Table in Section 5.1.9.4 **(Herbicide residues for In - Land water and soil from herbicide plots in Wazimenya Bay, Lake Victoria following treatment of water hyacinth with maximum rates of Glyphosate and 2, 4-D. Residues reported in $\mu g\ L^{-1}$ (ppb)** for additional details.

The only foreseen impacts from the proposed action is that the soils will act as temporary binding sites for the chemical ingredients of the proposed herbicides. The rate of decomposition of Weedar 64 (2,4-D) depends on the rate of application, microbial population, temperature, organic matter, and other soil characteristics. The study of 2,4-D persistence in the Oklahoma and Washington lakes included hydrosoil analysis. Generally, low to undetectable residues were found in hydrosoils over the 56 days of analysis. Hydrosoil concentrations of 2,4-D resulting from the 20 and 40 lb./acre applications of the liquid amine formulation ranged from 0 to 0.316mg/kg (316 ppb) (Otto et al. 1983).

Biological Control

No direct, indirect or induced negative impacts from the proposed action on these resources is anticipated.

Mechanical Control

The soils associated with the disposal sites are expected to be slightly altered from the placement of water hyacinth in the disposal area. The long term impact will be minimal, and the removed vegetation will be incorporated into the soil in each area and will act as a soil conditioner, potentially improving disposal site soil conditions.

5.1.17 SOCIO - ECONOMIC

The fisheries sector makes a significant contribution to the Gross Domestic Product (GDP) and substantial incomes for the Ugandans engaged in this industry. As well as being an important source of protein for most Ugandans, the fisheries sector generates about 100 billion per year in export earnings. It is therefore indeed an important economic resource that needs to be jealousy guarded.

Of great concern is the possible rejection of fish for export purposes to the export countries in the event that herbicides are used. The principal market for Ugandan fish export is Kenya which imports mostly smoked and sundried Tilapia, followed by Western Europe where they import fresh Nile Perch and Tilapia. Zaire is the third and she imports salted and smoked Tilapia (State of the environment report 1994).

It is assumed that rejection of this resource will be based on possible contamination of fish by the herbicides. However, it is worth noting that the herbicides proposed for use will not accumulate in the fish tissues because these herbicides are water soluble and not fat soluble, and they dissipate very rapidly in the water. If herbicides were ingested however, they would be rapidly excreted such that they would not be found present in fish tissue after a short period. Tests carried out in the In-Lake trials indicate that no herbicide residues were detected in the fish tissues as early as two hours after spraying.

On the contrary, Long term socio-economic improvements are expected from the proposed actions through the reduction in water hyacinth that currently disrupt and interfere with a variety of activities (**see 3.17**). Economic Improvements are expected from increased fish spawning habitat, from the ability to more easily access fishing areas, reduced damage or fouling of fishing nets and boat engines which, among other things, can cause fish to be brought to boat landings after

prolonged periods in poor condition and cause rejection by fish buyers, and improved accessibility to boat landings. Canoe operators who rely on the water for transporting passengers and goods will also benefit from reduced infestations. Reduced maintenance costs associated with ferry transportation, power generation and water supply can also be expected. Reduction in hyacinth will also reduce breeding areas for certain disease vectors thereby improving some health aspects of the population and reducing health costs. The various control strategies can also provide regional employment opportunities helping to improve economic status.

Demographic improvements are expected due to the ability of human populations within the region to gain improved access and utilization to all water bodies. Current water hyacinth infestations reduce water access by some communities especially during periods of wind induced hyacinth mat movement. Resident water hyacinth growing along shorelines have forced some villages to abandon boat landings causing hardships or forcing relocation to neighboring villages, undeveloped areas or to cities.

5.2 IMPACTS OF NO ACTION ALTERNATIVES

Under the No Action Plan, no integrated control program for water hyacinth would be implemented. In the event that the regional Governments do not perform control activities, water hyacinth spread is expected to continue with further commercial and environmental damage in the future.

Native aquatic vegetation would be displaced by the fast-growing water hyacinth, reducing the suitability of habitat for waterfowl and fish, and reducing the diversity of aquatic invertebrates. Mosquitoes breeding would be increased. Water quality, particularly in shallow areas would be reduced due to nutrient enrichment from naturally shedding plant parts decaying, and from lowered dissolved oxygen levels. Noxious odors may be given off by severely degraded water quality.

The No Action Plan would imply continued loss of revenue for the Governments, further socio-economic losses as well as continued deterioration of the lake. It has been estimated that if the deterioration of the lake resulted in (say) 5 percent reduction in productivity of the whole region, the consequent loss would be of the order of US$ 150 million annually (LVEMP 1995). If fish spawning habitat and related industries are lost due to the continued spread of the water hyacinth in the region, it is estimated to be a minimum 10% reduction, thus $US300 Million. The water hyacinth will play a big factor in contributing to the deterioration of the lake's productivity if left unchecked.

The total negative impacts points associated with the No Action Plan equal 333 (from Table 3, Section 2.3).

Table 3: MATRIX COMPARISON OF ALTERNATIVES COST BENEFITS:

Environmental Concerns	Chemical Control	Mechanical Control	Biological Control	No Action Plan
Rank	+6	+11	+1	-27
Weight	+67	+146	+11	-333
Cost Benefit	60,300,000,000 $US 60.30 Million	131,400,000,000 $US 131.40 Million	9,900,000,000 $US 9.90 Million	-302,000,000,000 $US 302 Million*

*The associated dollar costs associated with the water hyacinth infestations on Uganda along have been determined to be $US 2 Million (UEB) impact on Hydropower Production at Owen Falls Dam, $US 300 Million impact on Fisheries, related industries, socio economic impacts. The total economic impacts associated with the No Action Plan as listed above equal $US 302 Million. The total negative impacts points associated with the No Action Plan equal 333 (from Table 2 above), thus each impact point has an associated dollar value of 302/333, or $US 0.90 Million.

The negative impacts associated with the No Action Plan have a dollar value of $US -302 Million (No Action = 333 points multiplied by $US 0.90 per point).

6.0 ENVIRONMENTAL MITIGATION AND MONITORING PLAN

Monitoring

A monitoring program for the proposed actions is being developed by Aquatics Unlimited and the Water Hyacinth Unit that will utilize computer based mapping technologies to track the water hyacinth infestations. In addition, a Global Positioning System is being supplied that will track the movement of the herbicide application equipment to document treatment areas. Water quality monitoring as well as the monitoring of mechanical and biological control methods is under final development. Aquatic herbicide applicators will be properly trained by AU-UFCAP and will include Occupational Health issues related to the industry. Water hyacinth disposal sites will be monitored to document the effects on wildlife populations, surrounding habitat, odor and other potential concerns. Water hyacinth populations will be monitored via the satellite imaging process, and these process will also be used to monitor shoreline vegetation to properly document any unforeseen impacts. The WHU will coordinate and incorporate data obtained from the water hyacinth control program with fish population monitoring to properly document related effects. Information on the various aspects of the monitoring program will be provided in greater detail and included in the Operational Plans for the project following EIA/PEA approvals to proceed.

Mitigation

In regards to mitigation, following is a list of the five types of mitigation that might or might not apply to the various aspects of the proposed actions. A review of each of the types is as follows:

- Avoiding the impact by not taking an action or parts of an action: The chemical control component of the proposed actions has been established to avoid impacts to domestic and other water uses by being eliminated from use in certain areas as outlined in this EIA.

- Minimizing impacts by limiting the degree of magnitude: The controlled use of aquatic herbicides through repeat applications over a period of time will limit the degree of magnitude on water quality when compared to the treatment of all of the water hyacinth mats at one time.

- Rectifying the impact by repairing, rehabilitating or restoring the affected environment: Mitigation measures to insure that shoreline habitats disrupted from mechanical control equipment and procedures are repaired will be included in the Operational Plans. Haul roads to the disposal sites will require repairing and in some areas for heavy truck traffic.

- Measures will be put in place to prevent accidental spillage of chemicals and fuel from the boats during spraying.

- Reducing or eliminating the impact over time by preservation and maintenance operations: Under the long term program, a water hyacinth maintenance control program will be initiated that will reduce the impacts of water hyacinth on the various systems by reducing overall water hyacinth populations. Biological control introductions at the problem source in Rwanda will aid in reducing impacts on Lake Victoria from these infestations.

- Compensating for the impact by replacing or providing substitute resources or environments: The proposed actions have been developed and will be implemented if approved in a fashion that will eliminate the need for replacing or providing substitute resources or environments. There may be time during the chemical control segment of the proposed actions where an outside water supply may be provided to local communities in the event this option benefits the overall actions and is acceptable to local communities.

MAAIF and NEMA will determine the proper mitigation measures in the event mitigation is required due to some unforeseen component of the proposed control actions. The required mitigation and monitoring will be incorporated into tenders/bids for the proposed actions so that contractors are aware of the required monitoring and mitigation requirements of the proposed actions.

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Section 9

ANNEXES

ANNEX 1

Table 13:
BIRD SPECIES OF
REGIONAL CONSERVATION CONCERN

Table 14:
RARE, THREATENED AND ENDANGERED
FISH SPECIES WHOSE DISTRIBUTION MAY INCLUDE
LAKE VICTORIA BASIN

Table 15:
RARE, THREATENED AND ENDANGERED
MAMMAL SPECIES WHOSE DISTRIBUTION INCLUDES
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Table 16:
RARE, THREATENED AND ENDANGERED
REPTILE SPECIES WHOSE DISTRIBUTION INCLUDES
THE LAKE VICTORIA REGION

Table 17:
RARE WETLAND PLANTS FOUND IN
THE LAKE VICTORIA CRESCENT

Table 13: BIRD SPECIES OF REGIONAL CONSERVATION CONCERN

Species	Threat	Distribution	Comments	Genus	Species
Basra Reed Warbler	Near-threatened	U.K. T	Lives in swamps	Acrocephalus	Griseldis
African Reed Warbler	Near-threatened	U.K. T	Lives in swamps	Acrocephalus	Baeticatus
Marsh Widowbird	Vulnerable	U.K. T	Lives in swamps	Euplectes	Hartlaubi
White-backed Night Heron	Near-threatened	U.K. T.R	Lives in swamps and wooded shores	Gorsachius	Leuconotus
Shoebill	Vulnerable	U.K. T.R	Lives in swamps	Balaeniceps	Rex
Northern Brown-throated Weaver	Regional responsibility	U.K. T.R	Lives in swamps	Ploceus	Castanops
Woolly-necked Stork	Near-threatened	U.K. T.R. B	Lives in grasslands and open shores	Ciconia	Episcopus
African Marsh Owl	Near-threatened	U.K. T.R. B	Lives in swamps	Asio	Capensis
Goliath Heron	Near-threatened	U.K. T.R. B	Feeds from Lake shores	Ardea	Goliath
Madagascar Squacco Heron	Vulnerable	U.K. T.R. B	Feeds from Lake shores	Ardeola	Idea
Brown-chested Wattled Plover	Near-threatened	U.K. T.R. B	Feeds from Lake shores	Vanellus	Superciliosus
Rufous-bellied Heron	Vulnerable	U.K. T.R. B	Feeds from Lake shores	Ardeola	Rufiventris

Table 13: BIRD SPECIES OF REGIONAL CONSERVATION CONCERN (Continued)

African Finfoot	Vulnerable	U.K. T.R. B	Lives is swampy Lake edges	Podica	Senegalensis
Saddle-billed Stork	Vulnerable	U.K. T.R. B	Feeds from Lake shores	Ephipiiorhynchus	Senegalensis
Giant Kingfisher	Near-threatened	U.K. T.R. B	Feeds from Lake shores	Ceryle	Maxima
[Maccoa Duck]	Vulnerable	U.K. T.R. B	No recent records	Oxyura	Maccoa
Darter	Vulnerable	U.K. T.R. B	Feeds from the lake	Anhinga	Rufa
African Marsh Harrier	Vulnerable	U.K. T.R. B	Feeds from fringing swamps	Circus	Ranivorus
Black Heron	Vulnerable	U.K. T.R. B	Feeds from Lake shores	Egretta	Ardesiaca
Purple Heron	Near-threatened	U.K. T.R. B	Feeds from Lake shores	Ardea	Purpurea
Red-chested Sunbird	Regional responsibil ity	U.K. T.R. B	Breeds from Lake shores	Nectarinia	Erythroceria
Lesser Jacana	Near-threatened	U.K. T.R. B	Lives in water-lily patches in bays	Microparra	Capensis
African Pygmy Goose	Vulnerable	U.K. T.R. B	Lives in water-lily patches in bays	Nettapus	Auritus
Carruthers' Cisticola	Regional responsibil ity	U.K .T.R .B	Lives in swamps	Cisticola	Carruthersi

Table 13: BIRD SPECIES OF REGIONAL CONSERVATION CONCERN (continued)

Papyrus Yellow Warbler	Vulnerable	U,K ,T,R ,B	Lives in swamps	Chloropeta	Gracilirostris
White-winged Warbler	Regional responsibility	U,K ,T,R ,B	Lives in swamps	Bradypterus	Carpalis
Great Snipe	Near-threatened	U,K ,T,R ,B	Lives in grass swamps and open shores	Gallinago	Media
White Pelican	Regional responsibility	U,K ,T,R ,B	Feeds from the lake	Pelecanus	Onocrotalus
Green-Backed Heron	Near-threatened	U,K T,R, B	Lives in wooded shores	Butorides	Striatus
Papyrus Canary	Regional responsibility	U,K ,T,R ,B	Lives in swamps	Serinus	Kiliensis
White-backed Duck	Vulnerable	U,K ,T,R ,B	Lives in water-lily patches in bays	thalassornis	Leuconotus
Golden-backed Weaver	Regional responsibility	U,K ,T,R ,B	Breeds from lake shore	Ploceus	Jacksoni
Black Heron	Near-threatened	U,K ,T,R ,B	Feeds from Lake shore	Egretta	Ardesiaca
Grey Crowned Crane	Near-threatened	U,K ,T,R ,B	Lives in grass swamps and open shores	Balearica	Regulorum

(Makerere Institute of Environment and Natural Resources. Biodiversity databank 1996)
U = Uganda, K = Kenya T = Tanzania R = Rwanda B = Burundi

Table 14: RARE, THREATENED AND ENDANGERED FISH SPECIES WHOSE DISTRIBUTION MAY INCLUDE LAKE VICTORIA BASIN

Common and Scientific Names	Status	Distribution	Comments
Bagrus docmac - Semutundu	Rare	Open water	A few still occur near offshore islands and at the dam.
Late niloticus - Nile Perch	Abundant	Lake wide	Currently the most important commercial fish species in the lake.
Brycinus jacksonii	Rare	Open water	A few specimens occasionally seen.
B. sadleri	Common	Inshore open water	Has undergone a recent resurgence and are currently abundant in open waters close to shores.
Oreochromis niloticus	Abundant	Inshore	Another commercially important fish species second to the Nile Perch.
O. variabilis	Very rare	Inshore	Was once one of the most important commercial species but almost disappeared later. Currently a few are resurfacing among the hyacinth at the shores.
O. esculentus	Very rare	Inshore	Same as above but their numbers are still very low.
O. leucosrictus	Common	Inshore. pools and dams	An introduced fish species. Can tolerate low oxygen conditions and therefore common among hyacinth and in marshes.
Tilapia zilli	Common	Inshore open water. rivers and swamp	Another introduced tilapine which is also common among shoreline hyacinth mats.
Clarias gariepinus - Male	Common	Inshore open water. rivers and swamp	Juveniles currently hiding in refugia habitats. Common near swamp shores.
Xenoclarias eupogon	Absent	Open deep water	been eliminated from the open water through predation and the advancing oxycline.
Garra johnstoni	Rare	Inshore	Has taken refuge within rocky shores.
Labeo victorianus - Ningu	Common	Inshore and rivers	Once a popular table fish. is now restricted to areas with rocks or near inflowing rivers.
Barbus altianalis	Common	Inshore and rivers	Same as above.
Barbus profundus	Common	Open water	Occurred in deeper open waters. Its numbers were not high. A few still present among Mukene shoals.

Table 14: RARE, THREATENED AND ENDANGERED FISH SPECIES (Continued)

Barbus spp	Common	Inshore, rivers, streams and swamps	Over ten small sized fishes common in rivers, swamps and marshes draining into the lake.
Rastrineobola argentea-Mukene	Abundant	Lake wide	The only commercially important native fish species in the lake. Its biomass is believed to have increased after the reduction in numbers of haplochromines.
Aplocheilicythys spp	Common	Rivers and swamps	Common in swamps and rivers flowing into the lake.
Nothobranchius spp	Common	Rivers and swamps	Same as above.
Protopterus aethiopicus-Mamba	Common	Inshore and swamps	An air breathing fish species currently making a comeback in the lake. Many young of this species found under the roots of water hyacinth.
Afromastacembelus frenotus	Common	Inshore, among aquatic macrophytes	Their numbers not significant. Also found hiding under hyacinth mats.
Synodontis victoriae-Nkolongo	Rare	Inshore and Rivers	Formed an important river fishery during their breeding runs streams. Now restricted to areas near rivers e.g. at Kasensero at the mouth of River Kagera.
S. afrofischeri	Common	Open water	Common in habitats with rocky bottoms.
Mormyrus kannume-Kasulu	Common	Inshore and streams	Same as above.
Petrocephalus catostoma	Common	Inshore and streams	In the lake now occur in shallow inshore bays with aquatic macrophytes.
Marcusenius grahami	Common	Inshore and streams	Same as above.
Gnathonemus longibarbis	Common	Inshore and streams	Same as above.
G. victoriae	Common	Inshore and streams	Same as above.
Schilbe intermedius	Common	Inshore and streams	Same as Labeo victorianus. Still abundant in Lake Nabugabo

Table 14: RARE, THREATENED AND ENDANGERED FISH SPECIES (Continued)

HAPLOCHRO MINES-NKEJJE			
Allochromis welcommei	Absent	Open water	Only one species described. Was still very rare before disappearance.
Astatotilapia spp	Common	Inshore and streams	21 spp described. Many remain undescribed.
Enterochromis spp	Absent	Inshore	3 spp all not encountered laterly.
Gaurochromis spp	Rare	Inshore	3 spp. Only one remains in Lake Nabugabo
Haplochromis spp	Absent	Inshore	3 species described. Now absent.
Harpagchromis spp	Rare	Lake wide	20 spp. Large sized spp. eliminated through predation by the Nile Perch.
Labrochromis spp	Absent	Inshore	7 spp previously described.
Lipochromis spp	Absent	Lake wide	7 spp previously described.
Neochromis nigricans	Common	Inshore among rocks	1 sp. Still common among submerged rock
Paralabidochromis spp	Common	Inshore presently associated with Aquatic Vegetation	6 spp described. Many new species now turning up. Is presently the dominant haplochromine among hyacinth.
Proguathochromis spp	Rare	Lake wide	Originally 33 species described. All open water species eliminated by predator. Rock and macrophyte dwelling species still occurring.
Psammochromis spp	Rare	Lake wide	5 spp. Same fate as above.
Ptyochromis spp	Common	Inshore sandy beaches	3 spp. Still common near rocky shores.
Pyxichromis Parorthostoma	Absent	Open water	1 species described. No longer seen.
Xystichromis spp	Absent	Inshore among aquatic macrophytes	3 spp. Originally few in numbers and being larger sized were also eliminated by the predator
Yssichromis spp	Common	Open water	5 spp. Only one species abundant in open waters offshore.

			Others are rare or absent.

Table 14: RARE, THREATENED AND ENDANGERED FISH SPECIES (Continued)

Incertae Sedis	Rare	Open water	4 species known. Rarely seen.
Astatoreochromis alluaudi	Common	Inshore near aquatic macrophytes	A molluscivore fairly common close to shores especially near macrophyte cover.
Macropleurodus bicolor	Absent	Inshore sandy beaches	Oral shelling snaileater. No longer encountered.
Hoplotilapia retroducns	Absent	Inshore sandy beaches	Same as above.
Platytancodus degeni	Absent	Inshore sandy beaches	Same as above.

(Source: Uganda Fisheries Research Institute, 1996)

Table 15: RARE, THREATENED AND ENDANGERED MAMMAL SPECIES WHOSE DISTRIBUTION INCLUDES THE LAKE VICTORIA REGION:

Common Name	Scientific Name
Hippopotamus	Hippopotamus amphibious
African spot necked other	Lutra maculicolis
*+Sitatunga	Tragelaphis spekeii
Marsh Mongoose	Atilax pahidinosus
Slender Mongoose	Herpestes sanguineus
Servaline Genet	Genatta senalina
Red Tailed Monkeys	Cercopithecus ascanius
Vervet Monkeys	Cercopithecus ascanius
*Black & White Colobus	Colobus guereza
!Papyrus Rat	Pelomys isseli
Micro-chiropteran bats	

Source: Makerere University Institute of Environment and Natural Resources - Biodiversity Data Bank. 1996

* For scheduled mammals
\+ A unique subspecies of this is found in Sese Islands
! The only populations of this species to-date are found on a few Lake Victoria Island and one mainland site.

Table 16: RARE, THREATENED AND ENDANGERED REPTILE SPECIES WHOSE DISTRIBUTION INCLUDES THE LAKE VICTORIA REGION:

Common Name	Scientific Name
Nile Crocodiles	Crocodyhis niloticus
Nile Monitor Lizard	Varanus niloticus
Python	Python sebal
Water cobra	
Nile soft shell turtle	

Source: Makerere University Institute of Environment and Natural Resources - Biodiversity Data Bank. 1996

There are very few large terrestrial mammals still surviving in the Lake Victoria shore region. For this reason it is not likely that the lake is or does service as an important watering point for many other mammals.

Table 17: Rare Wetland plants found in the Lake Victoria Crescent

Family	Genus	Species
Cyperaceae	Ascolepis	eriocauloides
Cyperaceae	Ascolepis	protea
Cyperaceae	Bulbostylis	filamentosa
Cyperaceae	Bulbostylis	schimperiana
Cyperaceae	Bulbostylis	subumbellata
Cyperaceae	Cyperus	amauropus
Cyperaceae	Cyperus	circumclusus
Cyperaceae	Cyperus	cyperoides
Cyperaceae	Cyperus	ferrugineoviridis
Cyperaceae	Cyperus	halpan
Cyperaceae	Cyperus	plateilema
Cyperaceae	Cyperus	sphacelatus
Cyperaceae	Cyperus	tenax
Cyperaceae	Eleocharis	acutangula
Cyperaceae	Eleocharis	marginulata
Cyperaceae	Eleocharis	naumanniana
Cyperaceae	Fimbristylis	subaphylla
Cyperaceae	Fuirena	pachyrrhiza
Cyperaceae	Fuirena	pubescens
Cyperaceae	Kyllinga	carulaginea
Cyperaceae	Kyllinga	crassipes
Cyperaceae	Kyllinga	welwitschii
Cyperaceae	Lipocarpha	chinensis
Cyperaceae	Lipocarpha	nana
Cyperaceae	Oxycaryum	cubensis
Cyperaceae	Pycreus	macranthus
Cyperaceae	Pycreus	polystachyos
Cyperaceae	Pycreus	umbrosus
Cyperaceae	Rhynchospora	angolensis
Cyperaceae	Rhynchospora	candida
Cyperaceae	Rhynchospora	gracillima
Cyperaceae	Scleria	distans
Cyperaceae	Scleria	gracillima
Hydrocharitaceae	Egeria	densa
Hydrocharitaceae	Lagarosiphon	ilicifolius
Nymphaeaceae	Nymphaea	heudelatii
Potamogetonaceae	Potamogeton	octandrus
Potamogetonaceae	Potamogeton	pusillus

(Source: Knox E. B. and Bakamwesiga II. 1996).

There is no list by IUCN nor the East African Plant Group that has been compiled on the status of plants in Uganda or East Africa as a whole. This list is based on the surveys that have been carried out by MUIENR in some parts of Lake Victoria basin.

ANNEX 2

EMERGENCY ACTION PLAN FOR THE CONTROL AND MANAGEMENT OF WATER HYACINTH

AGRICULTURAL POLICY COMMITTEE

EMERGENCY ACTION PLAN FOR CONTROL OF WATER HYACINTH

RECOMMENDATIONS OF THE NATIONAL TECHNICAL COMMITTEE ON CONTROL AND MANAGEMENT OF WATER HYACINTH (NTCWH)

KAMPALA

NOVEMBER, 1995

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ABBREVIATIONS AND ACRONYMS

AGSEC	Agricultural Secretariat
APC	Agricultural Policy Committee
APC/MCWH	APC Management Committee on Water Hyacinth
CVSC	Chemical Verification Sub-Committee
FAO	Food and Agricultural Organization
FD	Fisheries Department
FIRI	Fisheries Research Institute
NEMA	National Environmental Management Authority
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MFA	Ministry of Foreign Affairs
MFEP	Ministry of Finance and Economic Planning
MNR	Ministry of Natural Resources
MWTC	Ministry of Works Transport and Communication
NAARI	Namulonge Agricultural and Animal Production Research
NARO	National Agricultural Research Organization
NEMA	National Environmental Management Authority
NTCWH	National Technical Committee on Control and Management
NWSC	National Water and Sewerage Corporation of the Water Hyacinth
OFD	Owen Falls Dam
UEB	Uganda Electricity Board
URC	Uganda Railways Corporation
UVAB	Uganda Veterans Assistance Board
WHU	Water Hyacinth Unit

SUMMARY OF PROPOSALS

1. JUSTIFICATION

The water hyacinth proliferation has reached epidemic proportions with serious socio - economic impact and requires an emergency action program pending the medium and long term control measures under the Lake Victoria Environmental Management Project.

2. EMERGENCY ACTION PLAN

The sites, control measures and institutional responsibilities for the Emergency Action Program are recommended as follows:-

a) Owen Falls Dam :

Strategy:	Integrated approach using weed barriers, physical removal and chemical spraying .
Action/Responsibility:	Contract Private sector for mechanical and manual removal under supervision of UEB/NTCWH; (ii) Contract private sector for chemical spraying under supervision of MAAIF/NTCWH/ UEB; and (iii) Contract private firm to reinforce the boom under the Owen Falls Dam bridge and constructing a new boom upstream under supervision of UEB.

b) Entebbe Water Works:

Strategy:	Erect an outer screen to bar invasion of water hyacinth and remove accumulated weed manually.
Action/Responsibility:	Engineering firm to be contracted to erect screen and contract labour for manual removal under supervision of NTCWH & NW&SC

c) Murchison Bay (Gaba Water Works):

Strategy:	Construct floating weed barriers at the water intake points and remove the accumulated weed manually.
Action/Responsibility:	Engineering firm to be contracted to construct floating weed barriers and contract labour for manual removal of weed.

d) **Port Bell Pier:**

Strategy:	Integrated approach using mechanical and manual control.
Action/Responsibility:	Contract private sector for mechanical and manual control under supervision of NTCWH and URC.

e) **Kagera River:**

Strategy:	Integrated approach using retractable boom, physical removal and biological control.
Action/Responsibility:	Contract private sector for physical control under supervision of NTCWH/MAAIF. Introduce bio - agents under supervision of NARO/NTCWH.

f) **Landing Sites on Lake Victoria, L.Kyoga, L.Albert and Albert Nile:**

Strategy:	Manual removal of water hyacinth and administration of herbicides on dynamic large weed biomas that choke the sites.
Action/responsibility:	(i) Provide tools, protective wear and other equipment to affected communities and sensitize affected communities; (ii) to facilitate manual removal under supervision of district, county, sub-county officials and RCs; and (iii) contract private firm for chemical control under supervision of NTWCH activities to be monitored by NTCWH/WHU.

3. INSTITUTIONAL ARRANGEMENTS FOR IMPLEMENTATION

The envisaged institutional arrangements for the implementation of the Emergency Action Plan are as follows:-

(a) APC Management Sub-Committee on Water Hyacinth Control for policy and co-ordination.(Terms of reference-TOR and composition are in Annex 2)

(b) National Technical Committee on the Control and Management of Water Hyacinth (NTCWH) set up by Minister, MAAIF for overseeing, implementation, supervision and monitoring. (Composition and TOR are in Annex 3).

(c) Water Hyacinth Unit (WHU) to be set up in Fisheries Department, MAAIF to serve as Secretariat to NTCWH and work as full time implementation agency (Annex 5).

(d) Short-term International Consultancy on chemical and mechanical control to be provided to the WHU during the first three months (TOR in Annex 6)

(e) Chemical Verification and Monitoring Committee (a Sub-Committee of NTCWH) - already in existence to compile and verify information on chemical control and determine mode of application in the Emergency Program.

4. DURATION

The Emergency Action Plan is expected to be implemented within 1 year

5. BUDGET

The total cost of the Emergency Action Plan is estimated at US$ 4.78 million (Annex 7) and summarized below:-

Components	Total Cost (US$)
A. Support to Water Hyacinth Unit	309,100
B. Support to Management/Coordination	22,770
C. Chemical Verification/Monitoring Activities	33,979
D. Control Programs	
i) Landing Sites for Manual Removal by Communities	866,250
ii) Owen Falls Dam	1,786,224
iii) Kagera River	491,700
iv) Water Works (Entebbe, Gaba and Jinja)	774,444
v) Port Bell Pier	1,142,328
TOTAL	5,426,795

The Government contribution will include staff salaries, office accomodation, logistic support, equipment and machinery already purchased and costs incurred for various activities already undertaken as well as overhead expenses of affected agencies such as UEB, NW&SC and URC.

1. INTRODUCTION

1.1 Water hyacinth, probably the most noxious aquatic weed in the world, is native to South America where it occurs basically harmlessly in streams and seasonally flooded environments. The plant is, however, one of the most widely distributed aquatic weeds, having been translocated almost all over the tropical and sub-tropical world mainly by collectors of ornamental plants.

1.2 Water hyacinth was first reported in Uganda on Lake Kyoga in May 1988 and then on Lake Victoria in December 1989 having entered the latter lake from River Kagera. The water weed spread rapidly over the years to fringe over 50% of the shores of Lake Kyoga, about 80% of Lake Victoria, over 80% of the banks of River Nile and most of the northern tip of Lake Albert. Total weed cover estimates of about 3,100 ha were made in 1994.

1.3 Water hyacinth proliferation in Uganda shows variable rates. It is extremely rapid in nutrient enriched environments such as that in Murchison Bay and at the deltas of major rivers like the Kagera and Katonga. However, the prolification appears to be poor in bays like Buka and Macdonald which have no major inflow. Where weed proliferation is rapid, the accumulating biomass imposes a heavy burden on the water environment and resource use.

1.4 The water weed occurs as resident strips or in form of mobile mats. Resident water hyacinth in lakes occurs in sheltered, shallow (rarely deeper than five metres), muddy bays and inlets where it forms shoreline strips of five to 15 m wide, extending to 30 m or more in specially sheltered inlets. The mats along the river banks are generally narrow (about five metres) except inside the bends where the current is slow. Rapid water hyacinth proliferation leads to formation of mobile mats which may accumulate to large sizes under sheltered conditions.

1.5 Some situations of prolific weed production in Uganda have produced enormous biomass whose impacts on the water environment and resources have attained emergency status which has serious socio-economic implications.

1.6 Recognizing the critical need for an Emergency Action Plan to arrest the proliferation of the weed, The Agricultural Policy committee(APC) requested the National Technical Committee on Control and Management of Water Hyacinth(NTCWH) set up by MAAIF (Annex 3) to design an Emergency Action Plan. The Terms of Reference (TOR) for the assignment is given in Annex 4.

1.7 Based on the TOR, the NTCWH has examined the various studies already undertaken, findings and recommendations of various conferences and workshops held during the last 2 years, the working papers prepared for the Lake Victoria Environmental Management Project and the Technical Report as well as the Time Bound Action Plan prepared by FAO (July 1995).

1.8 The committee also carried out field visits of affected sites and held discussions with the concerned institutions and agencies. This report summarizes succinctly the findings and recommendations of the NTCWH together with proposals for an Emergency Action Plan to control the water hyacinth.

2. JUSTIFICATION

An estimated area of 2000 ha spread over the shorelines and bays of both mainland and islands of Lake Victoria is now infested by water hyacinth besides other areas including Lake Kyoga and along the River Nile. River Kagera delivers 3.5 ha of water hyacinth every week. Due to the prevailing winds and being the water outlet, Uganda is on the receiving end for water hyacinth production. The severity of the water hyacinth is further aggravated by a build up of nutrients in the lake due to inflow of sewerage and nutrients from rivers feeding into the lake. Seriously affected areas are:-

- 90 per cent of shorelines of the mainland which include:-
  - drinking water intake points for Kampala, Entebbe and Jinja
  - ferry pier at Port Bell
  - fish landings.
- Owen Falls Dam which supply electricity
- Coastlines with landing shores and bays of islands
- Areas along River Nile, L. Kyoga and L. Albert.

Serious economic, social, health and environmental impacts have been observed as indicated below:-

2.1 Fishing Sub-sector

i) Reduction of fish production due to unsuitability of shores for fish survival/aquatic life, spawning and breeding - Bays are breeding and nursing grounds for fish particularly tilapia.

ii) Threaten the livelihood of fishermen. Income of fishermen is reduced due to landing problems, increased fuel costs, delays and poor quality of fish. Subsistence fishermen who depend on in-shore fishing with hooks and traps are being forced out of operations.

iii) Export based fish processing industries are faced with the problem of irregular supply, poor quality of fish, increasing operation costs and prices.

2.2 Drinking Water Supply

i) Drinking water supply to Kampala, Entebbe, Jinja and other areas are getting affected due to week choking at water intakes.

ii) Quality of drinking water supply to the lake basis and other rural communities is affected due to decomposing organic matter in a massive scale.

2.3 Transport Sector

- Disruptions, delays and rising operation costs are on the increase both at Port bell and transport between islands and mainland.

2.4 Power Generation

- Electricity operations of the Owen Falls Dam is being threatened.

2.5 Environmental and Health Hazards

- Water hyacinth harbours disease vectors, interferes with water balance of the lake and reduces bio-diversity.

Because of serious economic, social, health and environmental impacts of water hyacinth and its rapid expansion, there is an urgent need for an emergency action program to arrest the expansion and bring about reduction of the weed to manageable levels so as to reduce negative effects of water hyacinth.

3. DETAILS OF WATER HYACINTH INFESTATIONS.

The following areas have been identified by NTCWH to have serious hyacinth infestations which require Emergency Control Programs:-

3.1 Owen Falls Power Plant

i. It was estimated in early September, 1995 that about 60 ha of water hyacinth (equivalent to over 70,000 tonnes) is stranded above the Owen Falls bridge. Large mats of the weed hover about the waves in the vicinity of Fielding, Thruston and Hannington bays, eventually to be drifted down to the bridge by appropriate winds.

ii. It is also expected that much of the 250 ha of water hyacinth estimated around Entebbe Peninsular in July 1995, will, eventually find its way to Fielding, Thruston and Hannington Bays and may end up at the Dam.

iii. The intake dam and headrace area at Owen Falls Dam is separated from the accumulated biomass of water hyacinth upstream by a single set of booms constructed in the 1950's. The structure is under tremendous strain due to the massive weight of water hyacinth and it has, in fact, lost some of its component booms (3rd Sept. 1995).

iv. Massive invasion of the screens to the turbine chambers and the cooling systems for both transformers and turbines by sinking mats of the weed, could precipitate crisis problems to power generation. This situation is likely to happen if the weed is left to continuously pile up upstream or if the existing mass is caused to sink en-masse.

v. Intensified mechanical control can only be expected to start earliest November, 1995 when the first set of mechanical harvesters is expected.

vi. There is abundant scientific data demonstrating that herbicide (chemical) application has been found to be the most cost-effective method for controlling water hyacinth. There is, however, great potential for the general public to fear and mistrust the use of chemicals on waters which they are likely to come in contact with. It is true that the use of chemicals has negative effects on the environment and may cause some bio-diversity loss. Nevertheless, the presence of the water hyacinth mats also has similar effects. The Task Force considered the trade-offs and opted for limited and controlled use of herbicides in specific areas of heavy infestations only.

3.2 Water Abstraction

The Presence of large mobile mats of water hyacinth in Lake Victoria, Gaba, Entebbe and Jinja which belong to National Water and Sewerage Corporation, plus any private ones along the lake shores such as the one for Buluba Hospital in Thruston Bay - Iganga District.

The impacts include:

- physical obstruction of access to abstraction points for all water works.

- clogging of screens and pumps by rotting debris as it slowly sinks. This impact is most serious at Entebbe Water Works where the abstraction point lies only one metre below the water surface.

- Deterioration in water quality especially due to turbulence when stationary mats around water abstraction points move.

3.3 Murchison Bay

i. Murchison Bay has the highest water hyacinth biomass turn-over rate along the shores of Lake Victoria in Uganda and there is firm indication that virtually all the water weed that ends up at the Owen Falls Dam originates from here.

ii. In July 1995, Murchison Bay was estimated to have had about 800 ha (about 500,000 tonnes) of lush water weed; almost 50% of the estimated 2,000 ha for the entire shoreline of Lake Victoria in Uganda.

iii. Information from NW&SC indicates that they get more problem at Gaba when the weed mat moves off, creating a lot of turbulence than when it is stable. Massive increase of decomposing biomass in inner Murchison Bay could seriously aggravate the current physical and chemical impacts due to the weed and create a bigger crisis than is presently being experienced.

iv. The huge concentration of water hyacinth biomass in Murchison Bay causes major problems to Uganda Railways Corporation regarding vessel operation at Port Bell: damage to the vessels and structure of the linkspan; loss of time during manoevours to get into position and removing debris from clogged cooling system etc.

3.4 Landing sites

i. It is estimated that over 80% of the landing sites along the shoreline of Lake Victoria in Uganda are obstructed by water hyacinth permanently or temporarily. Probably 50% of the landing sites on Lake Kyoga are affected by the water weed and so are all those at the northern and the southern tips of Lake Albert.

ii. Closure of some landing sites such as those along the eastern shores of Murchison bay deprives the local community in the area of affordable transport routes and access to markets and other social and economic facilities.

3.5 Influx from River Kagera

It is estimated that River Kagera empties into Lake Victoria 1 to 3.5 ha of water hyacinth weekly. This is equivalent to between 350 and 1,225 tonnes.

4. AVAILABLE CONTROL OPTIONS

The following available options were considered by NTCWH for control of water hyacinth:-

i) Physical removal entails the use of manual labour aided by suitable hand tools. This measure is effective only for clearing small infestations which at present occur at the shores of islands, some landing sites, the shores of mainland and areas along the river Nile. Community participation facilitated with Government intervention by providing suitable hand tools and protective gears is considered a feasible proposition in such cases.

ii) Mechanical Control involves the use of machines such as harvesters, barriers or booms, conveyors, batch removal equipment etc. Mechanical control is considered effective and feasible in the short term as an emergency measure to remove weed infestation in large areas. However, it does not take into consideration the dynamic nature of the weed growth and does not permanently eradicate the weed.

iii) Biological Control envisages introduction of self-sustaining bioagents (weevils) to control the weed. However, this method is regarded as long term cost effective method of the hyacinth management as its effects are gradual. Two bioagents viz. Neochetina bruchi and Neaochetina eichhrniae have been recently approved by the Governments of Uganda, Kenya and Tanzania to be release din Lake Victoria. These weevils have been screened and tested at Namulonge Research Station and released in Lake Kyoga.

iv) Chemical Control involves the use of herbicides to control the water hyacinth. Chemical control has been successfully used in several countries in Africa i.e. Nigeria, Zimbabwe, South American countries) to manage water hyacinth.

v) Utilization Option envisages the use of the hyacinth for industrial such as biogas production, animal feed, paper manufacture etc. Some firms have already shown interest in this regard. However, NTCWH is of the view that it negates the approach which basically aims at control of the weed and would send a wrong message with the implications that would encourage water hyacinth proliferation.

5. INITIATIVES ALREADY TAKEN

The Ministry of Agriculture, Animal Industry and Fisheries, within the limits of the resources available since the appearance of this weed in Uganda in 1987 has carried out the following with the view to controlling its spread.

a. surveillance to establish the distribution and abundance of the weed on our waters;
b. sensitization of the public on dangers of the weed;
c. mobilization of communities for manual control;
d. seminars and workshops to assist in drawing up control options;
e. enlistment of financial and material support for the control program;
f. training of staff on control techniques;
g. provision of hand tools and protective clothing for manual removal;
h. breeding of biological control agents;
i. arrangements to procure weed harvesters for mechanical control; and,
j. making contacts with Kenya, Tanzania, Rwanda, Burundi, Sudan, Zaire, and Egypt for regional collaboration and operations within the Nile Basin.
k. The demobilized soldiers of the Uganda Veterans Assistance Board (UVAB) have been used for manual removal of water hyacinth in Murchison Bay.

In 1991 FAO implemented a project aimed at creating awareness among the population, government authorities, and other technical institutions about problems created by water hyacinth infestation. The World Bank provided funds for introduction of bioagents for the control of the weed and for training of national experts. The affected parastatals (URC, UEB, NW&SC) are spending enormous amounts of funds to clear the weed physically to protect their installations. Despite all these efforts, it is disheartening to note that the weed is still spreading fast and the situation is increasingly becoming more serious and, therefore, demands immediate remedial action.

Government also requested the FAO in 1995 to look into the problems of water hyacinth and come up with proposals for its control on emergency basis pending the medium and long term Lake Victoria Environmental Management Project. The Lake Victoria Environmental Management Project which is already in the pipe line is a regional project looking into the problems of management of the Lake Victoria environmental resources on sustainable basis in the medium and long term perspective. The medium and long term control and management of water hyacinth should be integrated into the regional programs of Kagera Basin Organization (KBO) and TECHONILE. Based on the Government request, the FAO carried out a comprehensive survey and prepared a technical report as well as an emergency action plan both of which were submitted to Government for consideration.

The NTCWH has thoroughly examined both reports and taken them into consideration in finalizing the committees recommendations which are summarized in the sections below: Annexure 7 also contains the response of the NTCWH on the FAO proposed Time Bound Action Plan.

6. RECOMMENDED EMERGENCY STRATEGIES AND ACTION PLAN

There are three options available for the control of the water hyacinth - physical removal (including mechanical removal), chemical spraying and biological control. There is no possibility of total elimination. Each of these options have been reviewed and it is apparent that none is sufficient enough to be used singly. An integrated approach has to be, therefore, adopted.

6.1 Owen Falls Power Plant

i. **Installation of booms** : With immediate effect reinforce the old boom structure at the gateway to the intake dam and headrace area. Construct another boom structure at an appropriate location (possibly at the Ripon Falls) upstream to trap the incoming weed away from near the Owen Falls Dam structure.

ii. **Physical removal**: Intensify the physical removal (manual, cranes, and harvesters when they arrive) and screen cleaning operations at the dam intake end. Given the enormous mass present, its thickness and weight, it may be necessary to spray to make it lighter and then remove it before it sinks.

iii. **Limited Use of herbicides**: Verify the possibility of flushing out large masses of decaying water hyacinth through the sluice gates and effect supervised and controlled use of herbicides to kill water hyacinth at the sluice end of Owen Falls bridge to relieve the emergency infestation situation. This should be synchronized with the opening and shutting of the sluice gates to ensure that sinking mats of the weed are flushed out and those straying to the inlets to the generating sets and cooling chamber do not overwhelm UEB's capacity to clean their screens. The existing fresh material is increasingly becoming thicker and more difficult to remove either manually or mechanically. Chemical spraying kills the weed mass making it lighter and easier to disentangle. This option may be necessary to facilitate the physical removal of the weed.

6.2 Water Abstraction

6.2.1 Entebbe Water Works:

NW&SC should contract an engineering firm to design and construct an outer screen to bar invasion of the water abstraction area by floating mats of water hyacinth.

6.2.2 Gaba Water Works:

Floating weed barriers should be constructed at the water abstraction points. Besides, NWSC should continue with the relief measures currently in force i.e. manual removal and cleaning of facilities. These should be beefed up with mechanical harvesting once the machines are procured.

6.2.3 Jinja Water Works:

NW&SC should contract an engineering firm to design and construct an outer screen to bar invasion of the water abstraction area by floating mats of water hyacinth.

6.3 Operations of Water Transport Vessels at Port Bell

Uganda Railways Corporation (URC) should continue with manual removal of the hyacinth. These will be re-enforced with the arrival of mechanical harvesters.

6.4 Landing Sites

i. Large mats of water hyacinth located offshore, especially those that get evacuated from Murchison bay, should be sprayed with herbicides under supervision.

ii. Care should be taken never to spray herbicides on huge mats that are likely to be drifted within range of Owen Falls Dam or into Murchison bay (near Gaba Water works) before they sink.

iii. Appropriate hand tools be supplied to facilitate relief from residual water hyacinth by manual extraction at landing sites on the shores of lake Victoria when large mats are re-located. Similar arrangements should be made for the communities on lakes Kyoga and Albert and the Albert Nile. It is essential to mobilize willing or facilitated community participation for manual removal to succeed.

vi) It is essential to mobilize willing or facilitated community participation for manual removal to succeed. Hence, there is a need for sensitization and training program for the affected communities with regard to effective use of hand tools and precautions to be undertaken in the case of herbicide application.

v. Sufficient protective clothing to guard against various hazards such as snake bite and possible contraction of bilharzia associated with water hyacinth mats should be provided.

6.5 Influx from River Kagera

Construct a retractable boom close to the mouth of River Kagera to trap water hyacinth and remove it mechanically. It is anticipated that the rate of arrival of the weed at the boom may occasionally exceed the capacity to remove it causing water hyacinth to pile upstream. Under such circumstances, the boom would be retracted to relieve the pressure. Initiate action to introduce bioagents for medium and long term control.

7. IMPLEMENTATION

i. The implementation of Emergency Action Plan will be overseen by the APC Management Committee (Annex 2). The NTCWH will have overall responsibility to implement, coordinate and manage the Emergency Action Plan. The NTCWH recommends that a Water Hyacinth Unit (WHU) which will act as its secretariat for day to day operations, be established in Fisheries Department, MAAIF, which, at present, has the overall technical responsibility to manage lakes and fish landing sites. This unit will be under the Commissioner of Fisheries as project Co-ordinator who is also a member of NTCWH. The Unit will consist of national staff, from the Fisheries Department who are trained and are well conversant with control measures for water hyacinth. Short-term International Consultancy will be needed particularly during the initial implementation stage as indicated in the TOR in Annex 6. WHU should be provided with the necessary logistic support to facilitate day-to-day operations, monitoring and supervision.

ii. Environmental impact assessment before and after implementation of strategies like chemical control shall continue to be made by the Chemical Verification Team, which is a sub-committee of the NTCWH. The team has already taken and is analyzing pre-application samples and preparing test sites for the verification of possibilities of wider herbicide usage on large floating mats.

iii. Actual implementation of the emergency control measures may be better achieved by soliciting private sector participation through open tendering. The committee therefore recommends that implementation be carried out on contractual basis with private operators. UVAB may be contracted for manual/physical control measures.

iv) NTCWH/WHU will closely collaborate with the affected institutions and provide them with technical guidance and supervision.

v) NTCWH/WHU in liaison with concerned district officials should undertake sensitization and training programs, distribution of equipment for hyacinth removal in affected communities and provision of supervision as well as technical guidance.

vi. Even if biological control of water hyacinth is not an emergency option, regional consent for this option should be obtained and biological control of water hyacinth be initiated on Lake Victoria.

vii. There is also need to obtain regional consent for chemical control.

viii. The Implementation Matrix giving the critical action elements, time frame and responsibility of the various institutions are given in Annex 1.

8. BUDGET

By taking into consideration the various recommendations made and the logistic support needed for implementation, NTCWH has worked out the budget which is given in Annex 7. The total amount required under the Emergency Action Plan works out to US $ 5,426,795. The budget does not include Government contribution by way of staff salaries, office accommodation, logistical support, equipment and machinery already procured as well as costs of various activities already undertaken. Besides, Government contribution will include overhead expenditures of affected agencies, such as UEB, NW&SW and URC. Donor agencies should be requested to meet the budgeted amount of US$ 5.43 million mainly for technical assistance, equipment and operational expenditures for implementing the recommended Emergency Action Plan.

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ANNEX 3

SCOPING DOCUMENT

SCOPING DOCUMENT
WATER HYACINTH CONTROL PROGRAM
UGANDA

Submitted: June 28, 1996

Prepared By:
AQUATICS UNLIMITED
And
USAID
in collaboration with
NEMA

Submitted To:
THE EXPANDED SCOPING COMMITTEE

MEMBERSHIP OF THE EXPANDED SCOPING GROUP

Ministry of Finance and Economic Planning

National Agricultural Research Organisation (NARO)

National Environment Management Authority (NEMA)

Fisheries Research institute (FIRI)

Fisheries Department (FD)

Namulonge Animal and Agricultural Research Institute (NARI)

Directorate of Water Development (DWD)

National Water and Sewerage Corporation (NWSC)

Uganda Electricity Board (UEB)

Uganda Railways Corporation (URC)

Makerere University Institute of Environment and Natural Resources (MUIENR)

Makerere University Department of Chemistry

Makerere University Department of Zoology

Uganda Fisheries Association (correct title to be provided)

Uganda Environmental Lawyers Association

Green Watch

The Uganda Water Hyacinth Society (correct title to be provided)

Askia Muhammad II Water Hyacinth Control and Environment Protection Initiative

Uganda Veterans Association

Uganda Wildlife Society

Wildlife Clubs of Uganda

East African Wildlife Society

African Pesticide Management Forum (APEMAF)

World Learning/NRMS

World Conservation Union (IUCN)

Uganda Investment Authority (UIA)

Uganda Manufacturers Association (UMA)

Lake Victoria Environmental Management Programme (Regional coordinator)

United States Agency for International Development (USAID)

United Nations Development Programme (UNDP)

United Nations Food and Agriculture Organisation (FAO)

The World Bank

The European Union

The Royal Netherlands Embassy

The Government of Japan

The Danish International Development Agency (DANIDA)

The Overseas Development Agency (ODA)

Norwegian Agency for Development Corporation

Swedish International Development Agency

The Belgian Embassy

The French Embassy

Department of Meteorology

Department of Botany Makerere University

Rakai District

Masaka District

Mpigi District

Kampala District

Entebbe Municipal Council

Jinja District

Mukono District

Iganga District

Tororo District

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Annex 1

OFD	-	Owen Falls Dam
PEA	-	Programmatic Environmental Assessment
TAT	-	Technical Assistance Team
UEB	-	Uganda Electricity Board
UF-CAP	-	University of Florida-Center for Aquatic Plants
UIA	-	Uganda Investment Authority
UMA	-	Uganda Manufacturers' Association
UNDP	-	United Nations Development Programme
URC	-	Uganda Railways Corporation
USAID	-	United States Agency for International Development
USAID/AFR/PSGE	-	/Africa/Productive Sector Growth and Environment (Division)
USAID/REDSO/ESA	-	/Regional Development Support Office/Eastern and Southern Africa
USEPA	-	United States Environmental Protection Agency
USG	-	United States Government
UVAB	-	Uganda Veterans Assistance Board
WHU	-	Water Hyacinth Unit

Scoping Document

WATER HYACINTH CONTROL PROGRAM, UGANDA

June 28, 1996

Prepared by: Aquatics Unlimited & USAID in collaboration with NEMA

1. Introduction

1.1 Basis for Environmental Impact Assessment and Scoping Process

This document, called a Scoping Document, represents an important step in the preparation of environmental documentation for the Lake Victoria Water Hyacinth Control Program. It has been prepared to satisfy: 1) guidelines being developed to implement the Uganda National Environment Statute (May 1995) as specified in Sections 20 through 22 of the Statute; and 2) the requirements for scoping according to USAID procedures (22 Code of Federal Regulations Part 216). USAID in accordance with its procedures prepared an Initial Environmental Examination (IEE) in February 1996 in order to allow technical assistance and other assistance to the National Technical Committee on Control and Management of Water Hyacinth (NTCWH) to proceed. That IEE resulted in a determination that certain activities could proceed but that an Environmental Assessment (EA) be prepared (see Annex 1 and Section 1.3.2 below). The USAID IEE can be considered approximately equivalent to the "environmental impact review" or "environmental impact evaluation" conducted under the Uganda Environment Statute, on the basis of which a determination is similarly made that an "environmental impact study/statement" or EIS (see Section 1.3.1 below) shall be prepared

The scoping process is the first, preparatory step towards the conduct of an EA or EIS. The EA or EIS will be known in two ways to be consistent with both USAID and Ugandan environmental impact assessment procedures:

> In accordance with the Uganda National Environment Statute (Sections 20(5)C and Section 21), the document will be called an **Environment Impact Study or Statement**;
>
> In accordance with USAID environmental procedures (22 CFR Part 216.6), the document will be called a **Programmatic EA (PEA)**, which is undertaken to "assess the environmental effects of a number of individual actions and their cumulative environmental impact in a given country or geographic area or the environmental impacts that are generic or common to a class of actions..." [22 CFR 216.6(d)]. The PEA is expected to address both the Emergency Action Plan for Control of Water Hyacinth as well as the intermediate and long-term objectives of the water hyacinth control program. This PEA has been conceptualized as an "umbrella" document in support of the multi-donor effort for control of water hyacinth in Lake Victoria.

As stated in Uganda's Environment Statute (Section 7(1) (f)), NEMA is charged with the function "to review and approve environmental impact assessment and environmental impact statements" submitted in accordance with the statute or any other law.

1.2 Purposes of Scoping

The purpose of scoping and this scoping document is to identify significant issues, identify non-significant issues and eliminate them from detailed study and, thus, determine the scope of issues to be addressed in the PEA or EIS. Within the framework of the PEA as an umbrella document, the scoping process should promote public awareness and draw appropriate government agencies, donors, NGOs

and others more fully into deliberations regarding the management program A potential benefit of this approach is the identification of indirect and multiplier or cumulative impacts, not foreseen by individual actors

In the scoping process for the EA of the water hyacinth control program, several factors dictate consideration of a scoping process that incorporates highly transparent participation of affected parties and interests. These factors include the multiplicity of agencies and donors concerned, the role of the Uganda National Environment Management Authority (NEMA) in establishing guidelines for and in reviewing environmental impact assessment documentation, and the threat of potential legal challenges (both in Uganda and in the US).

Scoping is a general environmental impact assessment tool, the intent of which is basically the same in procedures being developed to implement the environmental impact assessment requirements of the Uganda Environment Statute and in USAID regulations. Scoping serves a variety of objectives For the Water Hyacinth Control Program PEA or EIS, objectives include

- Scope of the content of the PEA or EIS (significant and not significant issues);
- Timing and schedule,
- Allocation of assignments (how analysis will be conducted and the disciplines),
- Identification of roles, and specifically review and consultation needs, of Ugandan agencies, other country agencies, regional groups and donors;
- Identification of information, data and documents, including other impact assessments, that others have prepared or intend to prepare that will be useful in preparation of the PEA or EIS;
- Identification of interested parties and groups,
- Initiation of an environmental education process regarding the water hyacinth and Lake Victoria environmental management; and
- Open and transparent out-reach and participation of affected parties and interests

The format and contents of this scoping document follows the requirements of USAID for such a document and is considered to include all the procedural requirements for such a document according to draft NEMA procedures.

1.3 Background on Uganda National Environment Statute and USAID IEE

1.3.1 Uganda Environment Statute

Sections 20 through 22 of the Uganda National Environment Statute, approved in May 1995, deal with the environmental impact assessment process Developers of various types of projects, including any activity out of character with its surroundings (Third Schedule, 1(a)), must submit a project brief to the lead agency (any government body in whom any law vests functions of control or management of any segment of the environment). One of three types of environmental documents is undertaken when the lead agency, in consultation with the Executive Director of the National Environment Management Authority (NEMA), determines that the project "may," "is likely to have" or "will have a significant impact on the environment " NEMA is currently preparing guidelines and regulations defining specific procedures, format and content, public participation and the like regarding adherence to Sections 20

environmental impact assessment can be required in order to determine the effect of various activities on wetlands.

In general, all pertinent provisions of the May, 1995 Uganda Environment Statute are considered to apply

1.3.2 USAID IEE

USAID prepared in February 1996 an Initial Environmental Examination or IEE in order to comply with its procedures for environmental review of USAID assistance activities The following summary is taken from that IEE, which is reproduced in its entirety in Annex 1

> *The proliferation of water hyacinth has reached epidemic proportions throughout much of the Upper Nile system, including Lake Victoria, causing serious socio-economic and environmental problems. In response to this situation, concerned Government of Uganda (GoU) interests have developed an Emergency Action Plan for the Control of Water Hyacinth in Lake Victoria, which calls for an emergency control program to be implemented over the next (one) year, pending the startup of planned medium and longer term control measures to be included under the new GEF-supported Lake Victoria Environmental Management Project. This proposed grant activity provides for U.S. technical assistance, training and limited operational support for the successful planning and coordination of the execution of this Plan, as well as planning for longer term control program operations. These services will be provided by the staff of the U.S. firm, Aquatics Unlimited (AU), in cooperation with the University of Florida's Center for Aquatic Plants (UF-CAP).*
>
> *Since the U.S. technical assistance team (TAT) will be playing a key advisory and coordinative role in the final planning and implementation of many of the greater, longer-term water hyacinth control program activities and based on the finding that certain of these proposed control program activities could result in a significant effect on the (Lake) environment, the proposal correctly calls for an Environmental Assessment (EA) as the responsible approach towards the proper planning and implementation of this program. Therefore, a Positive Determination [meaning an EA is required] is recommended for this activity, per 22 CFR 216.3(a)(2)(iii), including the procurement or use of pesticides (per 22 CFR 216.3(b)(1). It is also strongly recommended that the Mission and grantee pursue a programmatic approach towards the completion of this EA, covering not only the more immediate USAID-financed activities included within the short-term Emergency Control Plan, but also all agreed upon control program inputs over the intermediate and longer-term time horizons as well, taking maximum advantage of the considerable U.S. expertise and experience which can be applied in this behalf in this instance.*
>
> *The herbicide testing trials proposed within this grant activity should receive a Negative Determination with Conditions, pursuant to Section 216.3(b)(2)(iii) of 22 CFR 216, to allow these herbicide "research or limited field evaluation" trials to proceed in a timely manner to provide critical input into the completion of the EA discussed above. The stringent conditions attached to this recommended determination are presented in Section 4.2.2 in the text [of the IEE, Annex 1]*
>
> *A Negative Determination [meaning an EA is not required] is also recommended for the Kagera River boom installation sub-activity pursuant to Section 216.3(a)(2)(iii) of 22 CFR 216, with the recommendation that care be devoted to the proper siting of this installation to maximize the potential beneficial effects of natural (i.e., wind, water current) weed*

cleaning removal processes, [illegible]
maintenance requirements

All other aspects of this activity, i.e., technical assistance, training, etc., merit a Categorical Exclusion from further environmental review pursuant to Sections 216.2(c)(1)(i) and 216.2(c)(2)(i) of 22 CFR 216

These recommendations should prove sufficient to alleviate any significant environmental concerns associated with this proposed grant activity. It is concluded that, if implemented as recommended above, this grant activity can be completed in an environmentally sound and sustainable manner in full accordance with all salient Agency and USG policies and regulations.

Readers of this scoping document should note that herbicide testing including in-lake trials and installation of the boom can be implemented prior to PEA completion according to the above quoted USAID IEE (See IEE annex).

1.4 Scoping Committee and Proposed Process

NEMA chaired a meeting on 14 May 1996 to discuss the PEA/EIS with NEMA, NARO, and MAAIF staff along with representatives of USAID and representatives of Aquatics Unlimited (USAID grantee who will be preparing the PEA). The results of that meeting were

a) the lead agency from the Government of Uganda's perspective is the Ministry of Agriculture, Animal, Industry and Fisheries (MAAIF);

b) an environmental impact assessment document (EIS for Uganda, PEA for USAID) will be prepared,

c) a scoping process to consult with concerned parties and the affected public to determine the issues to be addressed in the EIS or PEA will be followed,

d) a core scoping committee consisting of representatives from NEMA (Chair), NARO-FIRI, MAAIF-Fisheries Department, Directorate of Water Development, USAID, and Aquatics Unlimited was formed;

e) the scoping committee will review and revise a draft scoping document (to be prepared by Aquatics Unlimited and USAID),

f) the scoping committee will then circulate the scoping document to an expanded review group, including additional government agencies, other donors, NGOs and institutions, and other concerned parties. The committee will identify participants for a workshop to discuss the scoping document and determine the need for circulation or discussion of the scoping document in addition to the workshop.

2. Activity Description

2.1 Integrated Program

2.1.1 Overview

The program consists of an Emergency Action Plan for Control of Water Hyacinth, a Technical Assistance/Project Implementation Plan for the Operational Control of Water Hyacinth as well as intermediate and long term objectives of the water hyacinth control program. The proposed Plan provides for a long term, flexible integration of biological, chemical, mechanical and manual control techniques Chemical and mechanical control methods predominate in the Emergency Action Plan, with biological and mechanical control measures predominating in the long term control plans. The type of control used in a particular area will depend upon the physical characteristics of the waterway.

Aquatics Unlimited, under a USAID Grant, is providing Technical Assistance, supporting Regional Collaboration, and providing Operational Support (monitoring program, in-lake herbicide trials, operational control of water hyacinth at the Kagera River) to the GoU's Water Hyacinth Unit.

Geographic Area Covered

The geographic scope is assumed to be lakes and rivers that are part of the Lake Victoria ecosystem (Uganda, Kenya and Tanzania need to be included in the scoping process and based on available evidence concerning the sources of the problem, Rwanda also)

Control Methods:

Mechanical control: There are many mechanical means of removing floating plants. Booms have been used successfully to reduce dispersion, and to prevent reentry of water hyacinths into key areas (e.g water intakes, dams, etc.). Successful mechanical efforts require continuous monitoring and action. Harvesting methods include removal, chopping in place, drag lines, hydraulic excavators, etc The relative merits of water versus land based weed harvesters in various locations will be assessed in the EA.

Chemical control: Recommendations will be based on currently registered materials regulated by U.S. EPA and approved for use in aquatic environments. Approved chemicals may change in the future, because these materials are periodically reviewed for effectiveness and safety, and additional herbicides may become registered for use.

There are currently three products (2,4-D, Diquat and Glyphosate) commonly used around the world to control floating aquatic plants. Each is used differently, and effective and safe use requires following the label requirements by trained personnel. Training will be discussed later

Biological control There have been several insects introduced into various regions of the world (including Africa) for the control of water hyacinth

Research has shown that the introduced bio-control insects reduce plant height and density but rarely reduce area of infestation. Successful implementation of an overall plan for water hyacinth control requires very careful identification as to where and why particular strategies will be recommended, and under what conditions short-term control will be sacrificed for biological control benefits, where short-term control will replace biological control if the latter is not providing acceptable control, and where biological control will be initiated Once

introduced, the bio-control insects typically spread throughout infested areas. While biological control may not provide immediate acceptable levels of control, it may reduce costs for long term maintenance control. In other words, to be a useful tool in the overall program, biological control does not have to provide near total reduction in biomass. Any reduction in biomass that reduces program costs by at least as much as the cost for the biological control effort may be worthwhile.

Integrated control: The various water resource uses of the lakes of the region will require an integrated strategy, including many combinations of mechanical/physical, chemical, and biological control.

Regional Collaboration

Aquatics Unlimited has agreed to develop a list of regional collaborators (Uganda, Kenya, Tanzania and Rwanda) that incorporates government, public and private sector groups involved with policy planning, research and or impacted by water hyacinth problems in water bodies throughout the region.

A site visit and review of the regional water hyacinth problems will be conducted in conjunction with the identified collaborators for a first hand evaluation of the regional water hyacinth problems and to meet, discuss, and open channels of communication between the regional collaborators. Aquatics Unlimited, will develop and coordinate a regional workshop with identified collaborators to review regional control strategies and strategies implemented and/or being implemented on Lake Victoria and/or in the region. Finally, a regional Water Hyacinth Working Group will be developed.

As national coordination is a function of NTCWH and regional coordination normally pursued under appropriate existing mechanisms i.e. LVEMP, LVFO, East African Community etc., efforts will be made to work within these existing mechanisms.

Public Sensitization

A Public Sensitization program will be developed within the NTCWH to inform the affected public on the PEA/EIS process, the selected action plan for the control of water hyacinths, implementation updates, and other relevant project information. AU will provide technical assistance for this program.

2.1.2 Emergency Program

Approach

The Agricultural Policy Committee (APC) of the GoU requested the National Technical Committee on Control and Management of Water Hyacinth (NTCWH) of the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) to develop an Emergency Action Plan for the Control of Water Hyacinth in Lake Victoria (Plan). This Plan was completed in November 1995. It calls for an emergency action program to be implemented over the next (one) year pending the startup of planned medium and longer term control measures to be included under the new GEF-supported Lake Victoria Environmental Management Project. Priority areas for emergency hyacinth control include Owen Falls Dam, Entebbe Water Works, Murchison Bay (Gaba Water Works), Port Bell pier, the Kagera River confluence, and selected fish landing sites (Lakes Victoria, Albert, Kyoga, and the Albert Nile). The Plan calls for an integrated program of manual, mechanical, biological and chemical control measures at each site to be implemented by a combination of private contractors and engineering firms acting under the supervision of a variety of concerned GoU agencies, including the Water Hyacinth Unit (WHU) of MAAIF's Fisheries Department, NTCWH, Uganda Electricity Board (UEB), National Water and Sewerage Corporation (NW&SC), Uganda Railways Corporation (URC), and the National Agricultural Research Organization (NARO), and National Environmental Management Authority

(NEMA). The total estimated cost of plan implementation is approximately $8 million. Additional details of the Plan are provided in the corresponding document of the same name (November 1995), Annex 2

Herbicide Trials

Herbicide trials are needed to obtain good, detailed, site-specific information regarding the relative technical, socio-economic and environmental advantages and liabilities associated with several proposed chemical control agents under Uganda/Lake Victoria conditions. This information is considered critical for any informed decisions regarding the ultimate role and limitations of these chemicals in the greater hyacinth control program effort. Accordingly, this information will also provide critical inputs into the successful completion of the PEA/EIS discussed above, without which this important assessment would lose much of its potential value for use in this environmentally crucial aspect of proposed control program operations

Aquatics Unlimited through USAID will provide "operational support" to NARO, to "complete current herbicide trials, and conduct limited in-lake trials to document efficacy and dissipation" of the proposed chemical control products within the Lake Victoria context (Aquatics Unlimited Proposal, p. 11). The three herbicides currently under consideration for use in these trials include Glyphosate (brand name "Rodeo"); 2,4 D (brand name "Weedar"); and Diquat (brand name "Reward"). All of these herbicides are registered with the U.S. Environmental Protection Agency (USEPA) and have received restricted approvals for use in aquatic weed control situations, i.e., when applied in strict accordance with the manufacturers' labeling instructions under the supervision of certified herbicide application personnel. The experimental trials will be conducted initially in controlled, closed aquatic situations, i.e., laboratory tanks, small ponds, etc. Subsequently, limited trials will be conducted within the Lake proper to obtain as realistic data as possible regarding the efficacy and environmental characteristics of these chemicals in actual Lake conditions.

These herbicide "research or limited field evaluation" trials need to proceed in a timely manner to provide critical input into the completion of the PEA/EIS discussed above. USAID has recommended procurement from the U.S. of the above three chemical products, in limited quantities sufficient only for the satisfactory completion of these trials, to ensure that only the most current and pure stocks of these products are used in these trials for maximum evaluative effect. The USAID IEE imposes the following conditions upon the technical assistance for the herbicide trials (see Annex 1 for full text):

- *The chemical products used in these trials be restricted only to the three USEPA-registered and approved products listed above*

- *The use of these chemical products be restricted solely to the experimental water hyacinth control program trials described above, with any excess product being properly disposed of in accordance with USEPA and manufacturers' recommendations*

- *The storage, handling, use and disposal of these products, and any other materials which may have become contaminated from contact with these products during these trials, will be conducted in strict accordance with the manufacturers' labeling instructions, and any additional restrictions or specifications recommended by the USEPA for these products in this specific application context, i.e. Lake Victoria, Uganda*

- *All such use of said products be conducted under the close supervision of trained, certified U.S. herbicide application personnel, with certifications and experience pertaining to the use of the specific products undergoing testing in these trials.*

- *Use of these products in these trials be restricted to surface applications only. i e . from boats and or the shore or fixed structures protruding from the shore. no aerial applications of these products should be attempted under these trials*

- *The in-lake testing be limited to the minimum product amounts and extent of treatment required for the successful achievement of the research and evaluative purposes of these trials No control program operations may be undertaken with these products under the auspices of these trials.*

- *Care should be taken in locating in-lake test treatment areas away from human inhabitants and commercially significant or ecologically sensitive areas Precautions should be taken to secure all test sites from inadvertent human or biological encroachment until the area is restored to safe conditions.*

- *Appropriate medical personnel, who have prior experience with or have been trained to treat humans suffering from the topological effects of these products, are available, with a sufficient stock of appropriate antidote medications, to deal with any medical emergencies which might arise during the use of these products in these trials.*

- *Permission has been obtained for the use of these products in these trials, in accordance with all of the above conditions, from the cognizant GoU environmental authorities (i e . the NEMA or its designee).*

The NTCWH has stated that only laboratory level trials with chemical control have been undertaken. The technical committee will first carefully evaluate the results of the activity before proceeding to the field trails stage. The USAID IEE states that it is in everyone's best interests to allow these trials to proceed under the guidance and supervision of experienced U.S. professional personnel. This information from field trials is considered necessary in order to provide appropriate documentation in the PEA and thus will be need prior to EA completion. A thorough survey and evaluation of Lake Victoria's Ugandan shores will first be undertaken before selecting sites for herbicide trials

2.1.3 Longer Term Management and Control of Water Hyacinth

Intermediate Objectives

It is anticipated that focus on Intermediate Objectives will begin after the Emergency Action Plan Objectives have been initiated These objective are:

- Integrate the Emergency Action Plan into the GEF Lake Victoria Environmental Management Project being implemented by the World Bank.

- Develop a long-term Operational Water Hyacinth Maintenance Program for all appropriate water bodies in the region

- Further review the potential for effective reduction of water hyacinth biomass using biological control agents This could include searches for new insects/pathogens.

- Assess opportunities for long-term academic and research exchange/cooperation programs between University of Florida and Ugandan Universities, NARO, and other organizations as appropriate.

Long-term Objectives are:

- Implement the Water Hyacinth Control Program in other regional bodies utilizing, when possible, control strategies proven effective in Lake Victoria

- Integrate all control programs into other regional/multi-national programs as appropriate

- Implement biological control recommendations as identified during Intermediate efforts

- Implement academic/research exchange program as identified during Intermediate efforts

The project is consistent and has been tailored to meet the overall objectives of the Emergency Action Plan (EAP). The project impacts will be the implementation of the EAP objectives and the initiation of a long term integrated water hyacinth control program for Lake Victoria. Through the regional workshop(s), a coordinated effort from both an operational perspective as well as an academic and research perspective will allow for the transfer of information and technologies to other problem areas within the region.

2.2 Proposed Action and Alternatives

2.2.1 Proposed Control Actions

Proposed control action is defined as an integrated control program utilizing chemical, biological, manual and mechanical control methods. Alternative control methods appropriate to location will be evaluated, alternatives that occur in a different time sequence will be evaluated.

It is unlikely that water hyacinth, due to its prolific nature, can ever be completely eradicated from Lake Victoria and surrounding water bodies. Rather, the objective of the proposed plan is to reduce the infestation during the first year of the control program to a manageable level, then to control the limited population of the plants remaining. The proposed plan is a long-term program for water hyacinth control, which uses an integration of chemical, biological, manual and mechanical control methods. Chemical and mechanical control methods predominate in the Emergency Action Plan, with biological and mechanical control measures predominating in the long term control plans. The type of control used in a particular area will depend upon the physical characteristics of the waterway. Features such as a non-navigable bay, degree of water hyacinth cover, proximity to water intakes, sensitive crops, fishing areas, water temperature and flow are important in determining the appropriate control method for a particular area of the region. The control program will be flexible to respond to changes in these conditions.

Emergency Action Plan Objectives

- Implement appropriate remote monitoring methods to document pre- and post-treatment water hyacinth infestation levels as well as reporting methods for project progress.

- Eliminate, to the extent possible, water hyacinth inputs from Kagera River.

- Complete current herbicide trials, and conduct limited in-lake trials to document efficacy and dissipation, obtain regional support for herbicide use

- Implement controlled use of herbicides in specific areas of heavy infestations where use will not adversely affect the environmental. This will be determined during the EA process

- Remove plants from in front of Owens Falls Dam, and prevent future accumulations

- Reduce water hyacinth in the Port Bell area to levels that will allow unrestricted access by boat traffic

- Initiate mechanical control strategies suitable to protect drinking water supply intakes at Entebbe Water Works, Jinja, and other locations

- Determine the most effective method of providing fishing and landing site access This could include hand tools (rakes, wheelbarrows, gloves, training, etc), but other methods (push boats, etc) should be reviewed

- Review and develop control strategies for other water hyacinth infested water bodies in Uganda (Lake Kyoga, Lake Albert, and Albert Nile)

Intermediate and long term control strategies, specific for location, will be determined as a consequence of the findings of the EA.

2.2.2 Proposed Alternatives for Disposal Sites

Where mechanical and manual control methods are implemented, disposal sites for the removed water hyacinths will need to be located. The selection of disposal sites will be dependent upon potential environmental impacts, associated transportation and preparation costs, and technical feasibility.

2.2.3 No Action Alternative

In EAs or EISs, the no action alternative is typically considered (and must be considered for a USAID document). The no action alternative (sometimes referred to as the no build or do nothing alternative) is generally defined as meaning that the proposed activities will not take place The resulting environmental effects from taking no action are compared with those that would occur as a consequence of the proposed action or alternatives to it. Where a choice of no action could result in predictable actions by others, such consequences are included in the analysis. The no action alternative serves as a benchmark against which effects of the proposed action and alternatives are compared.

It is important to recognize that the future consequences of no action are compared to the future consequences of the proposed action or its alternatives. Thus, conceptually no action is not equivalent to the existing or current state of conditions Sometimes existing conditions are used as a proxy to approximate future no action conditions, particularly when major changes are not anticipated and the future is deemed likely to be much like the past The appropriate comparison, however, is predicted, project-induced change (because of the proposed action) versus change otherwise expected without th proposed action In the case of the water hyacinth control, the adverse consequences of no action will be accentuated, while the comparative benefits of action will be greater

2.3 Capacity Building

The University of Florida, Center for Aquatic Plants (UF-CAP) project cooperation will allow for th exchange of academic information regarding such subjects as ecology, fisheries, and biological, chemical, mechanical control methodologies, and capacity building training and educational/exchang programs for long term program sustainability The UF-CAP has been a major source of methods development, basic research and public education in all aspects of aquatic plant management, inclu biological control (insects and pathogens), chemical control (application techniques, herbicide fate,

interactions with aquatic ecosystems), mechanical control (harvesting efficiency, impacts to aquatic environments), and aquatic ecology.

The Implementation Plan for the Operational Control of Water Hyacinth in Lake Victoria will be completed, and will incorporate the provisions and review of control strategies resulting from the EA Procedures Manuals will be developed for site-specific control strategies

The capacity building program will be further developed during the same time frame as the preparation of the PEA/EIS, and appropriate aspects of the program will be summarized in chapter 6 of the PEA (See Section 4.2).

2.4 Monitoring Program

Program monitoring methods will be developed to effectively track and document the implemented control strategies as well as their environmental impacts

Overall program monitoring methods will utilize currently available technologies to develop base line maps of the initial project area in Lake Victoria within a Geographical Information System. The GIS system will allow for the accurate assessment of conditions at start-up, and will allow for project tracking to document control efforts The baseline attributes will be updated through the use of Differential Global Positioning Systems (DGPS) and remote sensing technologies By incorporating all the data within a GIS, the monitoring system will be able to provide an historical record of control efforts in paper format at any time over the course of the project. Use of these systems as appropriate will allow the production of maps showing distribution of water hyacinth over time, treatment areas, progress and results of the Emergency Action Plan implementation program Equipment and imagery have been identified and a system is planned to be operational in Uganda, following the development of baseline data maps.

Methods will also be developed to monitor water quality and other environmental indicators, after implementation of the selected control strategies following PEA/EIS completion Site specific monitoring programs will be developed.

3. Environmental Assessment Issues

3.1 Definition of Significance

The term "significant effect" has potentially different definitions The relevant definitions from USAID, general US, and Ugandan procedures are reviewed here in order to provide the basis for determining how issues will be judged to be potentially significant or not during the scoping process

USAID regulations define a "significant effect" (for effects outside the US) as one which "does significant *harm* to the environment " US federal regulations applicable to activities within the US have a more expansive definition of significance For the purposes of this PEA/EIS an expanded definition of significance is recommended in light of the need to have a document that is consistent with Uganda's procedures and in light of the nature of the water hyacinth control program This definition of significance is intended to include the socio-economic context and local areas affected The following definition (from the US Council on Environmental Quality) considers both context and intensity and includes both beneficial and adverse effects

> *"Context This means that the significance of an action must be analyzed in several contexts such as a society as whole, the affected region, the affected interests and the locality Significance varies with the setting Both short-term and long-term effects are relevant*

Intensity: This refers to the severity of impact. The following should be considered in evaluating intensity:

(1) Impacts that may be both beneficial and adverse.

(2) The degree to which the proposed action affects public health or safety.

(3) Unique characteristics of the geographic area, such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers or ecologically critical areas.

(4) The degree to which the effects on the quality of the human environment are likely to be highly controversial.

(5) The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.

(6) The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.

(7) Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

(8) The degree to which the action may adversely affect ..or may cause loss or destruction of significant scientific, cultural or historical resources.

(9) The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical ..

(10) Whether the actions threatens a violation of .. law or requirements imposed for the protection of the environment."

Ugandan procedures, currently in draft, define significance as an expert evaluation/judgement of the magnitude of impact or the degree to which a proposed activity or project may (potentially) impact on the environment if implemented. Also provided are additional terms and definitions related to significance which are under development and by no means exhaustive. Environment is defined as the physical factors of the surroundings of the human beings including land, water, atmosphere, climate, sound, odour, taste, the biological factors of animals and plants and the social factor of aesthetics and includes both the natural and the built in environment. Significant effect is defined as a substantial, or potentially substantial, adverse change in any of the physical factors of the surroundings of the human beings including land, water, atmosphere, climate, sound, odour, taste, the biological factors of animals and plants and the social factor of aesthetics and includes both the natural and the built in environment. Impact is defined as the effect of any action that effects one or more elements of the natural, social, or economic environment, either adversely or beneficially. The degree of irreversibility of negative impacts should be addressed in the definition of significance.

3.2 Significant Issues

Mechanical, biological and chemical means of water hyacinth control can variously affect many resources either in the short-term, in the long-term, adversely or beneficially and in different ways depending upon location. Thus, many environmental resources and characteristics may be significant to some degree. A preliminary list follows:

- Land Use, Plans and Policies that pertain to the aquatic environment, and potential shoreline disposal sites need to be reviewed to determine consistency and compatibility of proposed actions with these plans, especially any areas that are or are intended to be protected.

Review and Consultations regarding Scoping

8 Information gathering and review period	21 June, 1996	21 July, 1996
9 Core Scoping Committee Review Meeting	23 July, 1996	

EA Draft Preparation

10 Compilation of materials for Draft EA	14 June, 1996	21 August, 1996
11 Preliminary Draft EA Completed	21 August, 1996	
12 Core EA Committee Review Meeting	22 August, 1996	
13 Final Draft EA	21 September, 1996	
14 Expanded EA Review Group Meeting	22 September, 1996	
15 Public EA Draft Review Meeting	25 September, 1996	

EA Distribution

16 Final EA Document Approval and Record of Decision	30 September, 1996
17 Final EA Available to Public	5 October, 1996

4.2 PEA/EIS Draft Format (Table of Contents)

Executive Summary

1 Purpose and Need for Lake Victoria Water Hyacinth Control Program
1.1 Problem Statement/Need
1.2 Purpose and Objectives of Control Program
- Emergency Control Program
- Intermediate Control Program
- Long-term Control Program

1.3 Objectives and Statutory Authority of PEA/EIS
1.4 Description of Scoping Process
1.5 PEA/EIS Methodology
1.6 Consultation and Review Process for PEA/EIS

2 Proposed Action and Alternatives
2.1 Description of Proposed Actions
- Biological Control
- Chemical Control
- Mechanical Control

2.2 Alternatives Eliminated from Further Study
2.3 No Action Alternative
2.4 Comparison of Alternatives
- Matrix Comparison

2.5 Identification of Preferred Actions

3 Affected Environment
3.1 Land Use and Land Use Plans and Policies
3.2 Hydrology
3.3 Water Quality

- National laws and regulations governing the aquatic environment will be reviewed to insure compliance during the PEA/EIS process International Agreements will also affect potential decisions about control methods

- Planned Intervent .ns, other than water hyacinth control within the affected geographic area will also need to be considered.

- Aquatic ecosystem impacts maybe associated with the available control strategies. These could include short term water quality impacts associated with herbicide treatments, short term adverse effects on fish, invertebrates and aquatic plants, as well as potential short-term effects on benthic communities. Although no long-term impacts on the aquatic ecosystem are likely to be associated with various control strategies, the PEA will address this issue and document why no long-term impacts are not anticipated. Water balance of the lake will also be addressed. In the long-term, beneficial impacts on the aquatic ecosystem are the objective.

- Shoreline Ecosystem impacts may result from planned activities, such as disturbance to wetlands or in areas where disposal of harvested plants is planned Protected Areas or Areas Meriting Protection will need to be reviewed in order to minimize any possible adverse impacts Shoreline agricultural land will need to be documented within the program area in order to minimize potential for short-term impacts on the use of such land. The EA will, for all sites, consider disposal areas once the water hyacinth is brought on land.

- Biodiversity, Endangered, Threatened, Rare, Endemic Species are topics that require review in order to ensure that no adverse effects to species or habitats would occur. The presence of protected species or an important area of biodiversity would be an important factor in determining the choice of control methods.

- Food Sources: Because Lake Victoria and associated rivers constitute not only important subsistence food source but also a major commercial source of foreign exchange earnings, considerable attention will need to be paid to the potential for impacts on fisheries. Perceived (as opposed to actual) impacts of limited chemical control will need to be addressed in order to ensure that importers of Lake Victoria fish are satisfied that all standards in products are met. Similarly in shoreline areas, potential effects on soils and on cultivated areas must be addressed in order to show that impacts on soil qualities and agriculture will be minor and minimized.

- Energy Sources: Impacts of control techniques will be addressed to ensure that potential for disruption to power supplies and effects on intakes are avoided. These considerations will determine the choice of control methods

- Water Sources: Potential effects of various control methods on drinking water (urban intakes and rural use), use of water for bathing, and use by livestock must be addressed in order to avoid negative consequences regarding clogging of intakes or changes in water quality. Uses of irrigation water, industrial water uses and of groundwater should be addressed as appropriate to specific locations. The impact of various control methods on the use of chemicals for water treatment processing will also be addressed Because Lake Victoria is also a waste receiver, capacity to receive effluents at acceptable levels as well as the effects of effluent on water Hyacinth control will be addressed

3 4 Aquatic Ecosystem
3 5 Shoreline Ecosystem
Includes Protected Areas, Wetlands and Shoreline Resources
3 6 Biodiversity and Threatened and Endangered Species
3 7 Food Sources
Fishing
Agriculture
3 8 Energy Sources
3.9 Water Sources
Drinking, Bathing, and other personal use
Irrigation
Industrial
Groundwater
3 10 Transport
3 11 Tourism and Recreation

3 12 Human Health
Diseases
Sensitivity to Chemical Exposure
3 13 Air Quality
3 14 Cultural and Historic Resources

4 Regulatory and Institutional Setting
4 1 Government of Uganda Agencies
4 2 Other Countries
4 3 Donor Interests
4.4 International Conventions, Treaties and Agreements

5 Environmental Consequences
5 1 Impacts of Preferred Actions
Repeat the subsections listed in Chapter 3, with emphasis on impacts to each resource/topic—indirect and induced impacts to be treated within each topic. Short versus long-term impacts to be discussed as appropriate for each topic. Cumulative impacts to be dealt with within each topic as appropriate and summarized at the end of Section 5.
5 2 Impacts of No Action Alternative
6. Environmental Mitigation and Monitoring Plan
7. References
8 List of Preparers
9. Annexes
9 1 Scoping Document
9 2 Data Annexes
9 3 Procedures for Control Methods

5. Conduct of Analyses and Disciplines Participating

The analysis of information will be based on available data, samples and results obtained from herbicide trials and from protocols for actions taken. Preparers and contributors by agency with each discipline are listed below:

- Aquatics Unlimited, Coordination of PEA/EIS Process, review, data organization and document preparation

ANNEX 1

INITIAL ENVIRONMENTAL EXAMINATION

PROGRAM/ACTIVITY DATA:

Program/Activity Number: Action Program for the Environment (APE)/617-012)

Country/Region Uganda/Greater Horn of Africa (GHA)

Program/Activity Title: Lake Victoria Water Hyacinth Control Program

Funding Begin: _FY91__ **Funding End:** _FY96___ **LOP Amount:** $ 3.1 0 million
Sub-Activity Amount: $ 1 0 million

IEE Prepared By: Eric R. Loken/Charlotte A. Bingham **Current Date:** 2/23/96

IEE Amendment (Y/N): _N__ If "yes", Number & date of original IEE __N/A__ __/__/__

ENVIRONMENTAL ACTION RECOMMENDED:

Categorical Exclusion	__X__	Negative Determination	__X__
Positive Determination	__X__	Deferral	____

ADDITIONAL ELEMENTS:
EMEMP _____ CONDITIONS ___X____ PVO/NGO _____

SUMMARY OF FINDINGS:

1. Since the U.S. technical assistance team (TAT) will be playing a key advisory and coordinative role in the final planning and implementation of many of the greater, longer-term water hyacinth control program activities and based on the finding that certain of these proposed control program activities could result in a significant effect on the (Lake) environment, the proposal correctly calls for an Environmental Assessment (EA) as the responsible approach towards the proper planning and implementation of this program. Therefore, a Positive Determination is recommended for this activity, per 22 CFR 216.3(a)(2)(iii), including the procurement or use of pesticides (per 22 CFR 216.2(b)(1)). It is also strongly recommended that the Mission and grantee pursue a programmatic approach towards the completion of this EA, covering not only the more immediate USAID-financed activities included within the short-term Emergency Control Plan, but also all agreed upon control program inputs over the intermediate and longer-term time horizons as well, taking maximum advantage of the considerable U.S. expertise and experience which can be applied in this behalf in this instance.

2. The herbicide testing trials proposed within this grant activity should receive a Negative Determination with Conditions, pursuant to Section 216.3(b)(2)(iii) of 22 CFR 216, to allow these herbicide "research or limited field evaluation" trials to proceed in a timely manner to provide critical input into the completion of the EA discussed above. The stringent conditions attached to this recommended determination are presented in Section 4.2.2 in the text.

3. A Negative Determination is also recommended for the Kagera River boom installation sub-activity, pursuant to Section 216.3(a)(2)(iii) of 22 CFR 216, with the recommendation that care be devoted to the proper siting of this installation to maximize the potential beneficial effects of natural (i.e., wind, water current) weed cleaning/removal processes, facilitate successful boom operations and ease its longer-term maintenance requirements.

4. All other aspects of this activity, i.e., technical assistance, training, etc., merit a Categorical Exclusion from further environmental review pursuant to Sections 216.2(c)(1)(i) and 216.2(c)(2)(i) of 22 CFR 216.

APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED:

CLEARANCE:
Mission Director _____ Date _____
Donald B. Clark

CONCURRENCE:
Bureau Environmental
Officer _____ Date _____
John J. Gaudet Approved _____
Disapproved _____

File No: 24ugan2.iee (AID/A)

CLEARANCE:
General Counsel
(Africa Bureau) _____ Date. _____

ADDITIONAL CLEARANCES

Mission Environmental Officer/Activity Manager _____ Date _____
Daniel B. Moore

Regional Environmental Officer _____ Date _____
Eric R. Loken

INITIAL ENVIRONMENTAL EXAMINATION

PROGRAM/ACTIVITY DATA:

Program/Activity Number: Action Program for the Environment (APE)/617-0123
Country/Region Uganda/Greater Horn of Africa (GHA)
Program/Activity Title Lake Victoria Water Hyacinth Control Program

1.0 BACKGROUND AND PROJECT DESCRIPTION

1.1 Problem Statement

Water hyacinth *(Eichhornia crassipe)* was first noted in Lake Kyoga in 1988, and then in Lake Victoria in 1989. It is postulated that water hyacinth originates mainly in the shallow eutrophic lakes of Rwanda, especially the Upper Akagera basin, and along the banks of the Kagera River. Many weed mats enter Lake Victoria from the Kagera River and are eventually blown all the way to the northern shore in Uganda, and to a lesser extent Kenya. The amount of weed entering the Lake from the Kagera River has been estimated at some 3 ha/week (Goodland, 1995). As soon as the weed reaches sheltered shores, it rapidly proliferates This situation is exacerbated by a buildup of nutrients in the Lake from sewage inflow and nutrient runoff from the various watershed tributaries and discharges into the Lake.

Presently, the proliferation of water hyacinth has reached epidemic proportions throughout much of the Upper Nile system. It now seriously affects all of the major lakes in Uganda, in particular, Lakes Victoria and Kyoga as well as the Nile River. An estimated 90 percent, or some 2,000-4,000 hectares (ha), of Lake Victoria's shorelines and bays lying within Ugandan territorial waters are now infested by the water weed. The entire Lake is estimated to contain over 1.25 million metric tons of the floating nuisance. (Goodland, 1995)

This severe infestation is causing serious socio-economic and environmental problems in such areas as:

- fisheries (unsuitability of fish spawning and breeding areas, inaccessibility of fish landing areas, irregular supplies, poor quality of catch and increased operating costs);
- drinking water supply (general water quality impacts resulting from massive amounts of organic decomposition of dead weed, clogged water intakes at Kampala, Entebbe and Jinja);
- transport (disruptions, delays and rising operating costs at Port Bell and between the islands and the mainland);
- power generation (threatened operations at Owen Falls Dam and hydroelectric station); and
- environment and health (water hyacinth harbors water borne disease vectors, interferes with the water balance of the Lake and reduces biodiversity)

As a result of the severity of these problems, there is a compelling need for action to arrest the further expansion of the weed and bring about its reduction to manageable levels

1.2 Emergency Action Plan for Control of Water Hyacinth

In response to this situation, the Agricultural Policy Committee (APC) of the Government of Uganda (GoU) requested the the National Technical Committee on Control and Management of Water Hyacinth (NTCWH) of the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) to develop an Emergency Action Plan for the Control of Water Hyacinth in Lake Victoria (Plan) This Plan was completed in November 1995 It calls for an emergency action program to be implemented over the next (one) year pending the startup of planned medium and longer term control measures to be included under the new GEF-supported Lake Victoria Environmental Management Project. Priority areas for emergency hyacinth control include. Owen Falls Dam; Entebbe Water Works; Murchison Bay (Gaba Water Works); Port Bell pier; the Kagera River confluence, and selected fish landing sites (Lakes Victoria, Albert, Kyoga, and the Albert Nile). The Plan calls for an integrated program of manual, mechanical, biological and chemical control measures at each site to be implemented by a combination of private contractors and engineering firms acting under the supervision of a variety of concerned GoU agencies (Water Hyacinth Unit (WHU) of MAAIF's Fisheries Department, NTCWH, Uganda Electricity Board (UEB), National Water and Sewerage Corporation (NW&SC), Uganda Railways Corporation (URC), and the National Agricultural Research Organization (NARO) The total estimated cost of plan implementation is $5 4 million. Additional details of the Plan are provided in the corresponding document of the same name (November 1995).

1.3 USAID Activity Description

1.3.1 General Information

The planned $1.0 million of USAID assistance under this activity will provide technical support services to work with the concerned GoU agencies noted above to assist and coordinate implementation of the Plan's operational objectives. These services will be provided by the staff of the U.S. firm, Aquatics Umlimited (AU), in cooperation with the Universty of Florida's Center for Aquatic Plants (UF-CAP).

AU specializes in waterway restoration and maintenance technologies and solutions, in particular in integrated aquatic plant control programs. Staff expertise at AU include experienced limnological consultants, mechanical engineers, Certified Aquatic Plant Control Advisors, Certified Aquatic Herbicides Applicators and a well-versed management team with field support technicians working throughout the world. Since its establishment in 1974, AU has worked on projects in Japan, Korea, Taiwan, the Philippines, Malaysia, Indonesia, Mexico and Saudi Arabia, in addition to its many activities completed in the United States.

The UF-CAP cooperation in this activity will allow for the exchange of academic information regarding such subjects as ecology, fisheries, and biological, chemical, mechanical control methodologies, and capacity-building training and education/exchange programs for longer-term program sustainability. The UF-CAP has been a major source of methods development, basic research and public education in all aspects of aquatic plant management, including biological control (insects and pathogens), chemical control (application techniques, herbicide fate, interaction with aquatic ecosystems), mechanical control (harvesting efficiency, impacts to aquatic environments), and aquatic ecology

1.3.2 Detailed Activity Description

The following sections are based on the AU proposal for this grant.

1.3.2.1 Activity Objectives

A. **Technical Assistance and Coordination:**

The project goal is to review and develop appropriate, cost-effective control systems and procedures so they can be implemented as the Emergency Action Plan funding becomes available. The following action plan objectives will be addressed during the technical assistance and coordination phase of the project:

a. Assist APC/NTCWH in obtaining and providing the required information to obtain donor funding, including review of donor in-kind support to ensure that contributions are effective and further the objectives of the project.

b Complete an environmental assessment covering the various proposed control strategies that will include an evaluation of the economic, social and environmental risks and benefits of the planned activities and will include a determination as to whether any of the planned control strategies will result in significant environmental impacts. Efforts will be made to avoid any identified impacts.

c. Develop appropriate remote monitoring methods to document pre- and post-treatment water hyacinth infestation levels as well as reporting methods for project tracking.

d. Review available methods and develop processes to eliminate, to the extent possible, water hyacinth inputs from Tanzania via the Kagera River.

e. Complete current herbicide trials, and conduct limited in-lake trials to document efficacy and dissipation; obtain regional support for herbicide use.

f. Review available methods (following the completion of the Environmental Assessment) and make initial preparations for the controlled use of herbicides in specific areas of heavy infestations in and around Entebbe Peninsula, Murchison Bay, Buvuma Channel, and other appropriate areas.

g. Review available methods and make the initial preparations to remove plants from in front of Owen Falls Dam, and prevent future accumulations.

h. Review methods and make the initial preparations to reduce water hyacinth in the Port Bell area to levels that will allow unrestricted access by boat traffic.

i. Review methods and prepare to initiate mechanical control strategies suitable to protect drinking water supply intakes at Entebbe Water Works, Jinja, and other locations.

j. Determine the most effective method of providing fishing and landing site access. This could include hand tools (rakes, wheelbarrows, gloves, training, etc.), but other methods (push boats, etc.) will be reviewed.

k. A Public Sensitization Program will be developed and implemented with regional authorities having control of Lake Victoria.

l. Review and develop control strategies for other water hyacinth infested water bodies in Uganda (Lake Kyoga, Lake Albert, and the Albert Nile).

B. **Regional Collaboration:**

a. A list of regional collaborators (Uganda, Kenya, Tanzania) will be developed that incorporates government, public and private sector groups involved with policy planning, research and or impacted by water hyacinth problems in water bodies throughout the region.

b A site visit and review of the regional water hyacinth problems will be conducted in conjunction with the identified collaborators for a first hand evaluation of the regional water hyacinth problems and to meet, discuss, and open channels of communication between the regional collaborators.

c. Develop and coordinate a regional workshop with identified collaborators to review regional control strategies and strategies implemented and/or being implemented on Lake Victoria and/or in the region.

d. Develop a regional Water Hyacinth Working Group.

C. Operational Support:

1. Monitoring Methods

a. The monitoring methods will utilize currently available technologies to develop base line maps of the initial project area in Lake Victoria within a Geographical Information System. The GIS system will allow for the accurate assessment of conditions at start-up, and will allow for project tracking to document control efforts. The baseline attributes will be updated through the use of Differential Global Positioning Systems (DGPS) and remote sensing technologies. By incorporating all the data within a GIS, the monitoring system will be able to provide an historical record of control efforts in paper format at any time over the course of the project.

Use of these systems as appropriate will allow the production of maps showing distribution of water hyacinth over time, treatment areas, progress and results of the Emergency Action Plan implementation program.

2. Herbicide Trials

a. Complete current herbicide trials, and conduct limited in-lake trials to document efficacy and dissipation.

b. Obtain regional support for controlled herbicide use in recommended treatment areas.

3. Kagera River Area

a. Install retractable boom (retractable to release plants if necessary). When control effort cannot keep up with biomass, plants can be released into the lake

b Setup water hyacinth removal system that works in conjunction with the retractable boom system.

c. Determine source of water hyacinth in Tanzania, and determine control options.

1.3.2.2 Intermediate Objectives

It is anticipated that focus on Intermediate Objectives will begin after the Emergency Action Plan

1. Integrate the Emergency Action Plan into the Lake Victoria Environmental Management Project.

2. Develop a long-term Operational Water Hyacinth Maintenance Program for all appropriate water bodies in the region.

3. Further review the potential for effective reduction of water hyacinth biomass using biological control agents. Could include searches for new insects/pathogens.

4. Assess opportunities for long-term academic and research exchange/cooperation programs between University of Florida and Ugandan Universities, NARO, and other organizations as appropriate.

1.3.2.3 Long-Term Objectives

1. Implement the Water Hyacinth Control Program in other regional bodies utilizing, when possible, control strategies proven effective in Lake Victoria.

2. Integrate all control programs into other regional/multi-national programs as appropriate.

3. Implement biological control recommendations as identified during Intermediate efforts.

4. Implement academic/research exchange program as identified during Intermediate efforts.

1.3.2.4 Relationship to Emergency Action Plan Objectives

The project is consistent and has been tailored to meet the overall objectives of the Emergency Action Plan (EAP). The project impacts will be the implementation of the EAP objectives and the initiation of a long term integrated water hyacinth control program for Lake Victoria. Through the regional workshop(s), a coordinated effort from both an operational perspective as well as an academic and research perspective will allow for the transfer of information and technologies to other problem areas within the region.

1.3.2.5 Measurable Outputs/Deliverables

The project will generate the following measurable outputs and deliverables:

1. An environmental assessment of the water hyacinth control program will be completed that will include and cover a review of potential impacts of the proposed control strategies.

2. The Implementation Plan for the Operational Control of Water Hyacinths in Lake Victoria will be completed that incorporates the provisions and review of control strategies resulting from the environmental assessment

3. Results and a review of public sensitization/information campaigns will be summarized

4. The Operational Control Monitoring Program (OCMP) will be completed and implemented. The OCMP will provide the required data and information to properly track and document pre and post control water hyacinth infestation levels as well as reporting and monitoring methods

for project control monitoring

5. Results from the limited in-lake herbicide trials will be reported and incorporated into the environmental assessment.

6. Water Hyacinth inputs from Tanzania via the Kagera River will be controlled p or to entering Lake Victoria via the implementation of mechanical control methods. A report on the operational control program for the Kagera River will be provided.

7. A review of regional collaboration efforts will be completed that includes the outcome and a review of regional site visits and discussions, the list of regional collaborators, a report on the regional workshop, and a report on the progress for the establishment of a regional Water Hyacinth Working Group.

1.3.2.6 Impact Indicators

The measurable objectives as outlined above will be incorporated into the impact indicators to document project results. Expected results from the project as outlined will include the following:

1. A monitoring method that documents the results of implemented control strategies.

2. An Operational Water Hyacinth Control Plan for Lake Victoria.

3. A reduction in water hyacinth entering Lake Victoria from Tanzania via the Kagera River.

4. A regional Water Hyacinth Working Group will be established with regional collaborators.

5. The objectives of the Emergency Action Plan for the Control of Water Hyacinth will have been addressed and partially implemented through the completion of the Operational Water Hyacinth Control Plan for Lake Victoria.

1.3.2.7 Administration/Supervision

AU and the UF-CAP will provide technical staff as required to implement and carry out the Project Implementation Plan Objectives as outlined above.

All personnel involved in the project working for AU and UF-CAP will be termed the Technical Assistance Team (TAT). The TAT will work directly with, and will be a part of the Water Hyacinth Unit (WHU). The WHU Coordinator will supervise the cooperation between personnel of the WHU and TAT. The WHU will report to the Coordinator.

Aquatics Unlimited will administer, supervise and coordinate activities of the TAT group members provided by AU and UF-CAP for all activities associated with the Technical Assistance Project Implementation Plan for the Operational Control of Water Hyacinth

AU & the UF-CAP will provide additional technical assistance as may be required and requested from time to time from the WHU, NTCWH, the APC and USAID.

Technical Assistance for implementation of the project objectives as outlined above is the number one priority.

2.0 COUNTRY AND ENVIRONMENTAL INFORMATION (BASELINE INFORMATION)

2.1 Lake Victoria Ecosystem

The main hydrological feature of Uganda is the extensive interconnected system of lakes forming the upper part of the White Nile. This vast hydrological network, dominated by Lake Victoria, drains a total area of about 190,00 sq. km in Rwanda, Burundi, Tanzania, Kenya and the entire southern part of Uganda

Lake Victoria itself is Africa's largest lake and the second largest freshwater lake in the world, with a total surface area of 68,800 sq km (i.e., larger than all of Switzerland). However, it is also shallow, with a maximum depth of only 80 m. Geological evidence suggests that the lake nearly dried up 13,500 years ago, and that many of species found in the lake may have evolved within this short interim period (Owen, et. al., 1990). At least partially as a result of this recent history, the lake contains a wealth of endemic species; as recently as 1970, the lake was known to contain at least 350 fish species, of which more than 250 were endemic haplochromines (Kaufman, 1991b). Unfortunately, Lake Victoria has recently experienced the greatest vertebrate mass extinction of modern time (i.e., the loss of almost all of the deepwater cichlid species, as well as nearly half of the Lake's shallow-water species), principally as a result of the introduction of the exotic Nile Perch *(Lates niloticus)* and Tilapia *(Oreochromis niloticus)* in the late 1960s.

The shores of the lake -- bordering Uganda, Tanzania and Kenya -- are fairly densely populated, and the lake is used for a variety of important socio-economic purposes. Most importantly, the lake is fished commercially using trawlers and by artisans using seines and lines from beaches and canoes; however, the near-shore artisanal fisheries are declining. Much of the lake margin is swampy, with numerous islands and papyrus swamps and some patches of swamp forest. Small sanctuary areas have been set aside at Entebbe (5,200 ha) and Jinja (800 ha); the rest of the lakeshore is largely unprotected. The area surrounding the lake is also particularly rich in butterflies, mammals and birds. For example, more than 500 passerine bird species are known to occur in the region, 15 of which are endemic (Shumway, 1993).

Currently, the Lake ecosystem is under severe threat from the overexploitation of its resources (mainly fisheries), and the progressive deterioration of water quality due to the water hyacinth invasion, and untreated domestic, municipal, agricultural, mining runoff and waste discharges and other forms of industrial pollution. The litany of its environmental problems includes:

- a two to three-fold increase in primary productivity;
- a four to five-fold increase in biomass;
- an increase in turbidity;
- a significant decrease in silica, indicating changes in the algal species composition;
- a decrease in the area of surrounding wetlands and swamps;
- increased anoxia;
- increased blue-green algal blooms; and
- increased fish kills.

The net result of these factors is an ecosystem undergoing significant changes due to severe environmental stress.

2.2 Current Water Hyacinth Control Program Activities

Efforts to control water hyacinth in the Lake to date may generally be characterized as late in coming, still in their infancy, with thus far little or no appreciable impact on the problem. Manual measures attempted to date include the construction of various floating booms adjacent to major

water intake structures (e g , Owen Falls Dam). These structures usually also entail periodic maintenance by crews of manual laborers.

The only major attempt at mechanical weed control in the Lake to date was a $320,000 mechanical harvester provided with Danish assistance two years ago. Unfortunately, this harvester broke down the day it was commissioned at Port Bell pier and has not operated since. A big grabcrane is now occupied full-time trying to keep the piers relatively weed-free (with only limited success).

Many organisms have been screened worldwide over the last few decades in search for some agent which damages water hyacinth but nothing else. Two fast-breeding species of weevil (*Neochetina eichorniae* and *Neochetina bruchi*) seem to meet these criteria, as determined through extensive worldwide trials conducted to date. Uganda's National Agricultural Research Organization at Namolongo acquired brood stock of these two weevils from Australia's Commonwealth Science Council, and have successfully bred them in artificial tanks. These two weevils were introduced to Lake Kyoga in June 1993; as of early 1995, the weevil had spread on its own to practically all areas of the lake. The year 1996/97 will tell if the weevil will start to damage the weed to which it has spread. Similar experimental weevil-based biolgical control programs are underway in Kenya (Lake Navaisha) and Tanzania (Pangani Falls Hydropower Project); however, generally, these other countries are more reluctant to support full-scale biological control efforts as they have less of a hyacinth problem within their respective portions of the Lake

Although details remain sketchy, experimental testing of various chemical control agents (aquatic herbicides) has also begun. While currently under active consideration for use by the NTCWH, to the best of our knowledge, no direct chemical control applications have been attempted within the Lake proper to date.

2.3 GoU Environmental Considerations

The Uganda National Environment Statute, approved in May 1995, is broad in coverage and establishes: 1) general principles of environmental management; 2) various institutional arrangements; 3) requirements for environmental planning at both the national and district levels; 4) a framework for environmental impact assessment, environmental audits and environmental monitoring; 5) requirements for adoption of environmental standards; 6) environmental management measures for sensitive resources; 7) provisions for pollution control licensing; and 8) provisions for environmental restoration orders and easements. Of particular concern to this IEE (and the subsequent EA) are the provisions for Environmental Impact Assessment (EIA), water quality standards, and the management measures pertinent to river banks and lake shores.

Sections 20 through 22 of the Statute deal with the environmental impact assessment process. Developers of various types of projects, including aerial spraying and any activity out of character with its surroundings (Third Schedule, Items 5 and 1(a), respectively), must submit a project brief to the lead agency (any government body in whom any law vests functions of control or management of any segment of the environment) One of three types of EIA is undertaken when that agency, in consultation with the Executive Director of the National Environment Management Authority (NEMA), determines that the project "may", "is likely to have" or "will have a significant impact on the environment." It is assumed that the program/project would be classed as having a significant effect and that, therefore, an *environmental impact study*, as opposed to an environmental impact review or environmental impact evaluation, would need to be conducted NEMA is currently preparing guidelines and regulations defining specific procedures, format and content, public participation and the like for adherence to this EIA statute. After the environmental impact study is completed, an *environmental impact statement* must be prepared and submitted to

NEMA, the lead agency, and to any other person requesting it. Based upon the lead agency's acceptance of the statement, in consultation with NEMA, the developer must take all practicable measures to ensure that the requirements of the statement are complied with.

Water quality standards, according to Section 26 of the Statute, are to be established for all waters and various uses, including water for drinking, industry, agriculture, recreation, fisheries, wildlife and any other water use prescribed. Because it is possible that such standards may be adopted or in process during the time the EA for the subject program is in preparation, it will be important to maintain contact with NEMA regarding the applicability of such standards and, as appropriate, to provide guidance or assistance to NEMA in the development of such standards.

Measures for management of the environment and natural resources cover the use of lakes and rivers. Specifically, Section 35 of the Statute prohibits certain activities in relation to a river or lake, unless NEMA, in consultation with a lead agency, waives them. These activities include: 1) use, erection, reconstruction, placement, alteration, extension, removal, or demolition of any structure or part thereof in, on, under, or over the bed; 2) introduction or planting of any part of a plant (alien or indigenous) in a lake or river; 3) introduction of any animal, or micro-organism (alien or indigenous) on, in or under the bed of any lake or river; 4) deposition of any substance in, on or under the bed of any lake or river, if that substance would or is likely to have adverse effects on the environment; 5) diversion or blocking of any river from its normal course; and 6) draining any lake or river. District Environment Committees, with the assistance of local environmental agents, are charged in Section 36 of the Statute with identifying river banks and lake shores that are at risk from environmental degradation or which have value, and with taking measures to minimize the risk or recommending to NEMA the need for protection. The Minister responsible for the Statute may, on the advice of NEMA, declare protected zones along river banks and lake shores. While this section of the Statute permits sustainable uses of protected zones, where there is any doubt relating to sustainable use, an environmental impact assessment must be conducted.

Based on these various provisions, any final environmental determinations regarding this activity will need to be properly vetted with and approved by the cognizant GoU environmental authorities as indicated above. Due to the tripartite nature of the Lake, attention should also be devoted to the need for compliance with similar environmental provisions in Kenya and Tanzania.

3.0 EVALUATION OF PROJECT/PROGRAM ISSUES WITH RESPECT TO ENVIRONMENTAL IMPACT POTENTIAL

3.1 Water Hyacinth Impacts

In general, the main impacts associated with water hyacinth include:

- de-oxygenation of water from the decomposition of large amounts of dead plants, which disrupts the aquatic food chain and energy transfer mechanism, kills organisms and impairs water quality;

- interference with fish reproduction by carpeting off breeding grounds,

- obstruction of waterways, navigation, hydroelectric and water supply intake works machinery; and

- fostering the spread of water-borne diseases, such as bilharzia and malaria, by increasing/enhancing vector breeding grounds.

As described in Section 1.1 above, Lake Victoria is currently suffering from each of these problems. Although all of the Lake's problems certainly cannot be attributed to water hyacinth, it is clear from the available evidence that this aquatic plant infestation is a significant contributor to many of these observed adverse impacts and trends.

3.2 Impacts of Control Measures

The major mechanisms for control of water hyacinth are manual and mechanical, chemical, biological, and an integrated combination of these mechanisms. There are many manual and mechanical means of controlling and/or removing floating plants. For example, various types of floating booms have been used to reduce water hyacinth dispersion, and to prevent its reentry into key areas (e.g., water intakes, dams, ports, etc.). In addition, various manual and mechanical harvesting methods have also been employed, including manual removal, chopping in place, drag lines, hydraulic excavators or dredges, etc. Successful manual and mechanical programs require continuous monitoring and maintenance, as a result, they often become prohibitively expensive over time (especially when used in isolation). In addition, such programs tend more to treat the symptoms rather than the root causes of the hyacinth problem, and, for these reasons, they usually prove insufficient over the long-term by themselves.

In general, manual and mechanical control measures create few environmental impacts. However, most floating control structures require constant maintenance to ensure that they are not undermined by weed buildup, and to prevent the possibility of dead plants sinking to the bottom and causing increased nutrient-loading and eutrophification of the waterbody. In addition, in many situations, such floating structures create obstructions to navigation, which must be properly addressed for any long-term applications. The aesthetic and environmental implications of waste plant deposition can also become a problem for large-scale removal operations.

Many organisms have been screened worldwide over the last few decades in search for some biological control agent which damages water hyacinth but nothing else. Based on extensive worldwide trials, two fast-breeding species of Amazonian weevil (*Neochetina eichorniae* and *Neochetina bruchi*) seem to meet these criteria. The weevil damages hyacinth in three ways: (1) egg laying punctures the weed's petioles; (2) the weevil grub from the hatched egg eats much of the petiole; and (3) the adult damages the leaf by eating its waterproof surface. The results of the trials conducted to date with these biological agents have demonstrated promising results.

Of course, the chief concern of such biological control programs is the potential adverse ecological consequences associated with the introduction of exotic species into a system. However, as indicated above, trials conducted throughout the world to date (including Africa) indicate that this does not appear to be a significant threat with these highly-specific weevils. Operationally, the main disadvantage to biological control is the relatively long period of time required for it to achieve a significant effect (at least several years, and, perhaps, much longer in a waterbody the size of Lake Victoria), which would appear to be most problemmatical in the serious conditions currently existing within many areas of the Ugandan portion of the Lake. Conversely, biological control is relatively cheap and lasts forever, and entails little or no maintanence costs.

There are currently several chemical products (e.g., Glyphosate, 2,4 D and Diquat) which are commonly used around the world to control floating aquatic plants. The chief concern with all of these chemicals is their toxicity to humans and aquatic organisms, and their persistence in the food chain and the environment. The main issue with the use of such herbicides is the method of application, with the worst problems accruing from drift associated with aerial applications. The least drift arises from manual spraying from boats. Drift of chemical spray onto agricultural tracts

organisms. It is difficult for humans to comply with the occupational health precautions associated with these products, especially in tropical/LDC situations, such as that under consideration here.

In addition, chemical control programs pose the additional problems associated with the eventual disposition of the dead weed mass. If not properly disposed of, the danger exists that the dead mat of hyacinth will submerge and eventually sink to the bottom of the lake. Once there, the dead mats deplete oxygen from the water column during aerobic decay (adding significantly to the eutrophification problem noted above). Later, the dead mat rots anaerobically, producing methane and making the mat float to the surface. Hyacinth mats rotting aerobically or anaerobically kill fish, hence, they are much more damaging than live mats. Rotting hyacinth mats can cause massive fish kills, lead to proliferation of toxic microorganisms and severely impair water quality.

Based on the above discussion of available control techniques, it would appear that each mechanism possesses certain limitations (environmental and otherwise) to its exclusive application in the current Lake Victoria context. Therefore, an integrated approach is called for here, combining each of the three strategies discussed above in a carefully delineated, coordinated control plan and program executed in a strategic manner. This is the approach that is recommended in the proposed USAID grant.

Of course, it should also be noted here that, over the long term, management of the entire Lake Victoria watershed is the ultimate solution to this problem, as it is suspected that agricultural runoff is a main contributor of the nutrients required for the proliferation of this aquatic weed.

4.0 RECOMMENDED MITIGATION ACTIONS (INCLUDING MONITORING AND EVALUATION)

4.1 Environmental Assessment

This activity provides for U.S. technical assistance, training and limited operational support for the successful planning and coordination of the execution of the Emergency Water Hyacinth Control Action Plan described in Section 1.2 above. Through its general coordinative role and its intermediate and long-term control program planning objectives, this work will address such issues as herbicide use and the full-scale, long-term application of the other agreed upon control measures described above within the Lake environment; however, the present proposal calls for no direct USAID funding support for such activities at this time (with the exceptions of the herbicide testing trials and Kagera River control activities described in Section 1.3.2.1). As currently proposed, funding for the procurement and/or use of herbicides and the bulk of the intermediate and long-term control program costs will be obtained from the GoU and other donor sources (e.g., the Lake Victoria Environmental Management Project currently includes provision for $6.0 million for such water hyacinth control measures, Goodland, 1995). Therefore, "technically" this proposal could be awarded a lesser environmental determination pursuant to the Agency's Environmental Procedures (22 CFR 216).

However, since the U.S. TAT will be playing a key advisory and coordinative role in the final planning and implementation of many of these actual control program activities, the proposal correctly calls for an Environmental Assessment (EA) as the responsible approach towards the proper planning and implementation of this program. This proposition is in agreement with the Positive Determination for this activity recommended on page 1, based on the finding that this program could result in a significant effect on the (Lake) environment (per 22 CFR 216.3(a)(2)(iii)), including the procurement or use of pesticides (per 22 CFR 216.3(b)(1).

The proposed EA would cover "the proposed control strategies that will include an evaluation of the economic, social and environmental risks and benefits of the planned activities" (AU proposal, p. 9). Subsequent clarification of this statement indicates that this assessment would, in fact, adopt a "programmatic" approach towards this subject, covering not only the more immediate USAID-financed activities included within the short-term Emergency Control Plan, but also all agreed upon control program inputs over the intermediate and longer-term time horizons as well, in short, that this assessment would, to the best of its ability, cover the entire long-term Lake Victoria control program effort. Considering the potential environmental liabilities within the Lake Victoria ecosystem associated with this major hyacinth control effort and the propitious timing and key advisory role of this proposed USAID assistance, satisfactory completion of this programmatic EA should be considered as one of the most important mitigative measures and activity outcomes of this proposed USAID support grant.

Therefore, it is **strongly recommended herein that the Mission and grantee pursue this programmatic approach towards this assessment**, taking maximum advantage of the considerable U.S. expertise and experience which can be applied in this behalf in this instance. Guidance for completing this EA is provided in 22 CFR Sections 216.3(a)(4)-(9), for the EA process, 216.3(b)(1), for the proposed chemical control measures, 216.5, for any endangered species considerations, and 216.6, for the EA content and form. This information, together with a draft outline for the Scoping Statement required for this EA (per Section 216.3(a)(4) of said procedures), has already been transmitted to the Mission and Bureau Environmental Officer to expedite the timely completion of this assessment requirement. As mentioned above, the EA preparation process should also be conducted with a view to accommodate its approval by the cognizant environmental authorities in Uganda, Kenya and Tanzania.

4.2 Pre-Assessment Activities

4.2.1 Introduction

With this agreed-upon determination to complete a programmatic EA for this program, the bulk of the more serious environmental concerns regarding this activity have been properly addressed. However, there remains a need to address certain proposed program activities which must be completed either before the EA can be completed or in order for the EA to be successfully completed. These activities include the herbicide testing trials and the installation of a floating boom structure at the Kagera River confluence.

4.2.2 Herbicide Trials

The AU proposal includes a modest amount of "operational support" to "complete current herbicide trials, and conduct limited in-lake trials to document efficacy and dissipation" of the proposed chemical control products within the Lake Victoria context (p. 11). The three herbicides currently under consideration for use in these trials include Glyphosate (brand names "Roundup" and "Rodeo"); 2,4 D (brand name "Weedar"), and Diquat (brand name "Reward") All of these herbicides are registered with the U S Environmental Potection Agency (USEPA) and have received restricted approvals for use in aquatic weed control situations, i e , when applied in strict accordance with the manufacturers' labelling instructions under the supervision of certified herbicide application personnel The experimental trials will be conducted initially in controlled, closed aquatic situations, i.e., laboratory tanks, small ponds, etc. Subsequently, limited trials will be conducted within the Lake proper to obtain as realistic data as possible regarding the efficiacy and environmental charactieristics of these chemicals in actual Lake conditions. Although details remain sketchy at best, conversations with concerned AU staff and the above excerpt from the AU

proposal appear to indicate that the *ex situ* trials have already been initiated by concerned GOU personnel.

The purpose of these herbicide trials is to obtain good, detailed, site-specific information regarding the relative technical, socio-economic and environmental advantages and liabilities associated with these several proposed chemical control agents under Uganda/Lake Victoria conditions. This information is considered critical for any informed decisions regarding the ultimate role and limitations of these chemicals in the greater hyacinth control program effort. Accordingly, this information will also provide critical inputs into the successful completion of the programmatic EA discussed above, without which this important assessment would lose much of its potential value for use in this environmentally crucial aspect of proposed control program operations.

For these reasons, it is herein strongly recommended that this aspect of this grant activity receive a **Negative Determination with Conditions**, pursuant to Section 216.3(b)(2)(iii) of 22 CFR 216, to allow these herbicide "research or limited field evaluation" trials to proceed in a timely manner to provide critical input into the completion of the EA discussed above. Although not necessarily contemplated within the current grant proposal, it is further recommended that this determination also permit the procurement from the U.S. of the above three chemical products, in limited quantities sufficient only for the satisfactory completion of these trials, to ensure that only the most current and pure stocks of these products are used in these trials for maximum evaluative effect The proposed **Conditions** to this recommended determination are:

1. The chemical products used in these trials be restricted only to the three USEPA-registered and approved products listed above. Use of any other/additional chemical products in these trials must be approved in advance through the completion of an additional, revised IEE specifically for this purpose.

2. The use of these chemical products will be restricted solely to the experimental water hyacinth control program trials described above, with any excess product being properly disposed of in accordance with USEPA and manufacturers' recommendations.

3. The storage, handling, use and disposal of these products, and any other materials which may have become contaminated from contact with these products during these trials, will be conducted in strict accordance with the manufacturers' labelling instructions, and any additional restrictions or specifications recommended by the USEPA for these products in this specific application context, i.e. Lake Victoria, Uganda. [N.B.: The manufacturers' labelling instructions are already on file for these products with the USAID Mission in Kampala, the REDSO REO in Nairobi and the BEO in Washington, D.C.]

4. All such use of said products be conducted under the close supervision of trained, certified U.S. herbicide application personnel, with certifications and experience pertaining to the use of the specific products undergoing testing in these trials.

5. Use of these products in these trials be restricted to surface applications only, i.e., from boats and/or the shore or fixed structures protruding from the shore; no aerial applications of these products should be attempted under these trials.

6. The in-lake testing be limited to the minimum product amounts and areal extent of treatment required for the successful achievement of the research and evaluative purposes of these trials. No control program operations may be undertaken with these products under the auspices of these trials.

7. Care should taken in siting in-lake test treatment areas away from human [illegible] commercially significant or ecologically sensitive areas. Precautions should be taken to secure all test sites from inadvertent human or biological encroachment until the area is restored to safe conditions.

8. Appropriate medical personnel, who have prior experience with or have been trained to treat humans suffering from the toxological effects of these products, are available, with a sufficient stock of appropriate antidotal medications, to deal with any medical emergencies which might arise during the use of these products in these trials.

9. Permission has been obtained for the use of these products in these trials, in accordance with all of the above conditions, from the cognizant GoU environmental authorities (i.e., the NEMA or its designee).

Further justification for this recommended determination is provided by the fact that the GoU fully intends to proceed with these trials prior to the completion of the aforementioned EA and without the benefit of experienced, certified U.S. supervision, in the absence of such a favorable determination in this instance. Under these circumstances, it would seem to be clearly in everyone's best interests to allow these trials to proceed under the guidance and supervision of experienced U.S. professional personnel (and with the best U.S. products available for this purpose).

4.2.3 Kagera River Area Boom Installation

This activity calls for the design, fabrication and installation of a retractable boom in the area of the Kagera River confluence with Lake Victoria to begin to arrest a major source of the introduction of additional plants into the Lake. The boom would be retractable to permit the release of excess plants into the Lake, if necessary, to safeguard the structure itself as well as to permit any navigation that may be required in this area. This retractable boom will also be designed to work in the future in tandem with other appropriate control measures at this site.

As mentioned above, there are usually only minimal environmental concerns associated with the use of such manual control techniques. For this reason, a Negative Determination is also recommended for this Kagera River sub-activity pursuant to Section 216.3(a)(2)(iii) of 22 CFR 216. It is recommended that care be devoted to the proper siting of this installation to maximize the potential beneficial effects of natural (i.e., wind, water current) weed cleaning/removal processes, facilitate successful boom operations and ease its longer-term maintenance requirements. Goodland (1995) provides some useful additional recommendations in this regard.

4.3 Other Activities

All other aspects of this activity, i.e., technical assistance, training, etc., merit a Categorical Exclusion from further environmental review pursuant to Sections 216.2(c)(1)(i) and 216.2(c)(2)(i) of 22 CFR 216.

4.4 Conclusions

The mitigation recommendations indicated above should prove sufficient to alleviate any significant environmental concerns associated with this proposed grant activity. It is therefore concluded that, if implemented as recommended above, this grant activity can be completed in an environmentally sound and sustainable manner in full accordance with all salient Agency and U.S.G. policies and regulations.

5.0 SUMMARY OF FINDINGS

The proliferation of water hyacinth has reached epidemic proportions throughout much of the Upper Nile system, including Lake Victoria, causing serious socio-economic and environmental problems. In response to this situation, concerned Government of Uganda (GoU) interests have developed an Emergency Action Plan for the Control of Water Hyacinth in Lake Victoria, which calls for an emergency control program to be implemented over the next (one) year, pending the startup of planned medium and longer term control measures to be included under the new GEF-supported Lake Victoria Environmental Management Project. This proposed grant activity provides for U.S. technical assistance, training and limited operational support for the successful planning and coordination of the execution of this Plan, as well as planning for longer term control program operations. These services will be provided by the staff of the U.S. firm, Aquatics Umlimited (AU), in cooperation with the University of Florida's Center for Aquatic Plants (UF-CAP).

The summary findings and recommendations of this IEE for this proposed activity are as follows:

1. Since the U.S. technical assistance team (TAT) will be playing a key advisory and coordinative role in the final planning and implementation of many of the greater, longer-term water hyacinth control program activities and based on the finding that certain of these proposed control program activities could result in a significant effect on the (Lake) environment, the proposal correctly calls for an Environmental Assessment (EA) as the responsible approach towards the proper planning and implementation of this program. Therefore, a Positive Determination is recommended for this activity, per 22 CFR 216.3(a)(2)(iii), including the procurement or use of pesticides (per 22 CFR 216.3(b)(1). It is also strongly recommended that the Mission and grantee pursue a **programmatic approach** towards the completion of this EA, covering not only the more immediate USAID-financed activities included within the short-term Emergency Control Plan, but also all agreed upon control program inputs over the intermediate and longer-term time horizons as well, taking maximum advantage of the considerable U.S. expertise and experience which can be applied in this behalf in this instance.

2. The herbicide testing trials proposed within this grant activity should receive a **Negative Determination with Conditions**, pursuant to Section 216.3(b)(2)(iii) of 22 CFR 216, to allow these herbicide "research or limited field evaluation" trials to proceed in a timely manner to provide critical input into the completion of the EA discussed above. The stringent conditions attached to this recommended determination are presented in Section 4.2.2 in the text.

3. A **Negative Determination** is also recommended for the Kagera River boom installation sub-activity pursuant to Section 216.3(a)(2)(iii) of 22 CFR 216, with the recommendation that care be devoted to the proper siting of this installation to maximize the potential beneficial effects of natural (i.e., wind, water current) weed cleaning/removal processes, facilitate successful boom operations and ease its longer-term maintenance requirements.

4. All other aspects of this activity, i.e., technical assistance, training, etc., merit a Categorical Exclusion from further environmental review pursuant to Sections 216.2(c)(1)(i) and 216.2(c)(2)(i) of 22 CFR 216.

These recommendations should prove sufficient to alleviate any significant environmental concerns associated with this proposed grant activity. It is concluded that, if implemented as recommended above, this grant activity can be completed in an environmentally sound and sustainable manner in full accordance with all salient Agency and U.S.G. policies and regulations.

AQUATICS UNLIMITED
WATER HYACINTH CONTROL PROGRAM

International Conference Center
P O Box 7057, Suite 235 Kampala, Uganda
Phone 256-41-250-550 Fax 256-41-257-824

Scoping Document Expanded Committee Meeting Minutes July 10 1996

Opening by P S Ministry of Natural Resources

General Comments Water Hyacinth spreading fast, country suffering economic impacts, many problems for fisherman and transporters, impacts to waterworks, power generation problems, declining fish stocks which increases the cost of fish reduces protein intakes by people because of the cost, impacts to health, nuisance Public is worried and asking what is government doing because peoples lives and livelihood are in danger Look at the options for control and think about the risks and consider the recommendations that "they make" Sensitization plays an important role The need for district involvement important Consider the constraints by past strategies Need an action as everyday there is no action the problem increases Government wants action.

Prof. Okedi thanked the Permanent Secretary will try to abide on guidance Murchison Bay estimate 800 ha water hyacinth or 500,000 metric tonne. Kagera River inputing about 3 5 ha/week The weed multiples every 2 weeks NEMA has role to ensure EIA to be carried out

Construction and booms at the Water Works and Dam should proceed as well as Kagera River Boom Efficacy tests herbicidal will also be taking place. Aquatics Unlimited has done commendable job by laying ground work for EIA.

Tom McNabb Spoke about AU role in preparing the EA process and technical support of program

James Dunn:- Water Hyacinth serious situation local/regionally must deal with problem in environmental friendly way - Meaning of negative/determination, in USAID's IEE

Frank Turyatunga:- Scoping Process was an initial stage. NTCWH has always recommended EIA It wad decided erection of boom could proceed. Issues that must be addressed - mechanical and chemical control Before EIA completion individuals should get involved and what issues should be addressed regarding the control measures What are the issues that should be addressed vigorously? Gave reasons for scoping

Comments regarding additional significant issues were then accepted from the floor

Public Health and Agricultural concerns
Timing of the tests
Disposal/Utilization
Cumulative effects
Synergistic effects
Establishment of water quality standards - which is being coordinated by NEMA
Impacts of onshore and offshore construction
Potential effects to fish and exports
Proper lab testing equipment
Review in country chemical useage

Relocation of people during control
Due to time element eliminate no action alternative
Involvement of local specialists, capacity building
Public Sensitization - flow of info one way, should listen to what the public has to say

Meeting was then closed at 5:00 PM

WORKSHOP TO DISCUSS THE SCOPING DOCUMENT OF THE UGANDA WATER HYACINTH CONTROL PROGRAM HELD ON 10TH JULY, 1996 AT INTERNATIONAL CONFERENCE CENTER, COMMITTEE ROOM A:

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38.	"	B.Z. Dramadri	Permanent Secretary - Ministry of Natural Resources	P.O.Box 7070 Kampala	242
39.	"	Prof. John .Y. Okedi	Executive Director - NEMA	P.O.Box 22255 Kampala	23

ANNEX 4

PROCEDURES FOR PROPOSED OPERATIONS:

DRAFT NO. 3

****

1997

SUMMARY OF PROPOSED OPERATIONS

WATER HYACINTH CONTROL PROGRAM

LAKE VICTORIA, UGANDA

Prepared by:

AQUATICS UNLIMITED

&

THE
WATER HYACINTH UNIT
Ministry of Agriculture, Animal Industries and Fisheries

March 1997

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SUMMARY SHEET

1996 WATER HYACINTH CONTROL REPORT

- Approximately 295 hectares of Water Hyacinth were controlled in 1996 compared with the removal of small un-documented number of hectares in 1995.

- Of the 295 total hectares of Water Hyacinth controlled in 1996, approximately 179 Ha were mechanically removed from in front of the Owens Falls Dam, 2 hectares from Port Bell, 11 hectares from the Kagera River Boom, 100 hectares were physically removed at fish landing sites and 3 Ha from water works sites. As these numbers are only good estimates, reporting methods are being finalized to properly document 1997 control rates.

- Based on 1996 year end results, we anticipate that the 1997 control program will be able to mechanically remove 250 hectares from the Owens Falls Dam area, 60 hectares from Port Bell operations, 125 Ha from the Kagera River Boom Site, 200 from the various Fish Landing Sites, and approximately 1000 to 2000 hectares will be controlled using aquatic herbicides (considering favorable results from the In-Lake Herbicide Trials).

MAPS OF AREA

INTRODUCTION

1996 was a startup year for the Water Hyacinth Unit, Water Hyacinth Control Program that began with the initiation of an Environmental Impact Assessment to document the environmental affects of the available control options (mechanical, biological, chemical) and moved through the year with the organization and coordination of the various GoU agencies involved. The fall of 1996 resulted in the arrival of mechanical harvesting equipment from the Netherlands (two sets) that were initially evaluated at Port Bell, and then relocated to the Owens Fall Dam site. Mechanical equipment operations were a bit slow in the beginning due to various logistical requirements such as the coordination of funds for operations and the training of operational staff. By January 1996, the operations seemed to have developed to the point that realistic production rates could be determined for the 1997 program year. During 1996 donor funding began to arrive for the purchase of addition mechanical control equipment, hand tools for the physical removal program at various fish landing sites, and general operational expenses that are associated with the program.

CONTROL PLAN & ACTIVITIES - OVERVIEW

In 1996, the emphasis of the Water Hyacinth Control Program was to complete the Environmental Impact Assessment, develop a coordinated effort between the agencies involved, develop a monitoring system to track program progress to evaluate various control options such as mechanical equipment, aquatic herbicides, diversion booms at the Kagera River, biological control plans, and make the necessary investigations required to properly establish an operational control program to be implemented in mid 1997.

MECHANICAL REMOVAL PLAN

The mechanical control program will focus efforts at the Owens Falls Dam site through the first half of 1997 and will be evaluated at that time to determine if some or all of the equipment can be relocated for use at other sites. This will depend on the ability to remove the majority of the Water Hyacinth currently present at the dam, and the ability of utilizing other control options such as booms and aquatic herbicides to limit new infestations at the dam site.

The Kagera River Boom system will be supported in early 1997 with the arrival of a conveyor system from the United States that is expected to increase the capacity and production rates compared to the boom and physical removal program that was initiated in October 1996.

Additional equipment deliveries are expected toward late fall 1997 following a tender approval for the purchase of equipment with Japan Aid Funding. The addition of additional mechanical harvesters will allow for a greater impact from this control option. Presently the mechanical control operations are limited to approximately 200 hectares per year due to the production capacity of the equipment on hand.

MANUAL REMOVAL PLAN

Through funding from the United Nations Development Program (UNDP), hand tools anc protective gear are being purchased and distributed to various fish landing sites with highl impacted lake access due to the Water Hyacinth infestations. It is not expected that a majc control effort will be achieved via this control method, but rather some plant material will t removed to allow easy access to the landing sites.

BIOLOGICAL CONTROL PLAN

The biological control plan for 1997 plans to include the establishment of rearing sites and the release of insects up the Kagera River in Rwanda. It has been determined that biological control in this area is a priority as this is the major nursery area feeding the problem in Lake Victoria. A survey of secluded bays and Water Hyacinth nursery areas in Lake Victoria is underway to determine the most appropriate areas for insect release in the Lake.

While the biological control program is not expected to eliminate the problem, it is expected that the program will help reduce and limit total biomass both entering Lake Victoria from the Kagera and multiplying within the Lake.

AQUATIC HERBICIDE CONTROL PLAN

In-Lake Herbicide Trials were initiated in February 1997 to further evaluate the potential for using aquatic herbicides in the 1997 control program. The two candidate herbicides, Rodeo and Weedar 64 have been used throughout the world for the control of Water Hyacinth for decades and are both registered for use by the United States Environmental Protection Agency. Trial results will be available by the end of April 1997, and will be incorporated into the EIA. In the event the In-Lake Trials document the efficacy of the herbicides for use in the control program (as has been shown in other parts of the world), it is expected that approximately 1000 to 2000 hectares will be controlled with herbicides in 1997. The major focus areas will be the large migrant mats of Water Hyacinth present from Entebbe to the Uganda-Kenya boarder, followed by

shoreline treatments to restore shallow water spawning beds from Entebbe to the Uganda-Kenya boarder.

PROBLEM AREAS AND CONTROL OPTIONS-OVERVIEW

- Kagera River

  The initial 1997 control plan for the Kagera River will continue with the current removal of Water Hyacinth prior to them entering Lake Victoria near Goma (production increase are expected by April 1997 following the installation of the conveyor system). In addition, the release of biological control agents at the problem source in Rwanda is under investigation. In the event aquatic herbicides are approved for use, an evaluation will be made regarding the feasibility of treating the Water Hyacinth plants as they float down the river, where they would then enter Lake Victoria and slowly decompose during their travel time north through the Lake system.

- Entebbe Peninsula

  In the event aquatic herbicides are approved for use, the large migrant mats of Water Hyacinth that move within this area will be controlled using herbicides. In the event herbicide use is not approved, additional funding will be sought for the purchase of mechanical harvesting equipment which would result in little to no control in this area during 1997.

- Murchison Bay-Port Bell

  In the event aquatic herbicides are approved for use, the large migrant mats of Water Hyacinth that move within this area will be controlled using herbicides. In the event herbicide use is not approved, additional funding will be sought for the purchase of mechanical harvesting equipment for use in this area which would result in little to no control in this area during 1997. The harvesting equipment being purchased through Japan Aid assistance will be utilized in this area following arrival in late 1997, early 1998 (final equipment orders are still being negotiated at this time that will be followed by an 8 month minimum delivery period).

- Owens Falls Dam

  The control program for the Owens Falls Dam area will continue with the two sets of mechanical equipment currently operating on site. The placement of a diversion boom upstream from the dam site is under investigation as well as the potential use of aquatic herbicides to reduce plant volumes prior to them being wind and current driven to the dam site.

- Water Works Sites

  The 1997 control program for the Jinja and Entebbe Water Works sites includes the evaluation of diversion booms to keep hyacinth away from the water intakes. A boom has been shipped from the United States for use at Entebbe water works that will be evaluated at the water works prior to installation.. If the boom is successful, additional booms will be purchased for other areas. The Gaba water works site water intake is not presently

affected by the Water Hyacinth due to the design of the in-take structure, and it is expected that other control options as outlined above in Murchison Bay will reduce the Water Hyacinth impacts at Gaba.

- Shoreline Fringe Areas

  In the event aquatic herbicides are approved for use, the shoreline fringe mats of Water Hyacinth within these areas will be controlled using herbicides. In the event herbicide use is not approved, other unknown economical options will be explored.

COORDINATION OF ACTIVITIES

The Ministry of Agriculture, Animal Industry and Fisheries, Water Hyacinth Control Unit (WHU) will be coordinating activities with the various GoU agencies involved with the control program. Aquatics Unlimited under grant funding from the United States Agency for International Development will be working with and supporting the WHU in the control program efforts. Due to the restructuring of coordination efforts in late 1996, it is expected that the program will move forward in 1997 with the implementation of additional control options following the completion and approved recommendations of the EIA.

FIELD OPERATIONS - SUMMATION

Control efforts in 1996 were realized following the delivery of mechanical harvesting equipment late in the year. Prior efforts mainly aimed at the physical removal of the Water Hyacinth employed proved unrealistic except on a small scale basis. It is expected that control in the range of 1500 to 2500 hectares can be realized during 1997 if control options are approved following the final EIA document distribution. In the event control strategies are limited to physical,

mechanical and biological methods during the 1997 season, control rates will be limited to a maximum of approximately 600 hectares.

WATER QUALITY MONITORING & ANALYSIS

A Water Quality Monitoring Protocol was developed for the In-Lake Herbicide Trials that would be revised and implemented with critical parameters such as residue in conjunction with the 1997 operational control program. The final Operational Control Program Water Quality Monitoring Protocol will be incorporated as an annex to this document. The in-lake trials report has been completed and is incorporated as annex 9. The report outlines major water quality changes that require monitoring.

APPENDIX A - COMPARISON OF AREA CONTROLLED BY YEAR

LAKE VICTORIA-UGANDA	1995 HECTARES	1996 HECTARES	1997 HECTARES	1998 HECTARES	1999 HECTARES	2000 HECTAR
Owens Falls Dam	178					
Port Bell	2					
Fish Landing Sites	100					
Water Works Sites	3					
Kagera River Boom	11					
SUBTOTALS	294					

LAKE VICTORIA-KENYA	1995 HECTARES	1996 HECTARES	1997 HECTARES	1998 HECTARES	1999 HECTARES	2000 HECTA
Unknown at this time						
SUBTOTALS						

COMPARISON OF AREA CONTROLLED BY YEAR

continued

LAKE VICTORIA-TANZANIA	1995 HECTARES	1996 HECTARES	1997 HECTARES	1998 HECTARES	1999 HECTARES	2000 HECTARES
SUBTOTALS						

KAGERA RIVER-RWANDA	1995 HECTARES	1996 HECTARES	1997 HECTARES	1998 HECTARES	1999 HECTARES	2000 HECTARES
SUBTOTALS						

COMPARISON OF AREA CONTROLLED BY YEAR

continued

	1995 HECTARES	1996 HECTARES	1997 HECTARES	1998 HECTARES	1999 HECTARES	2000 HECTARES
UGANDA SUBTOTALS	294					
KENYA SUBTOTALS	Unknown					
TANZANIA SUBTOTALS	Unknown					
RWANDA SUBTOTALS	Unknown					
GRAND TOTALS	294					

APPENDIX B: 1997 WATER HYACINTH CONTROL PROTOCOL

The Water Hyacinth Unit (WHU) intends to manage Water Hyacinth growth within the borders of Uganda, Lake Victoria waterways and tributaries so as to minimize non-target impacts and prevent environmental degradation.

1) **Area Selection**

WHU staff shall coordinate aquatic herbicide treatments (following approved EIA methods), as well as mechanical, physical and biological control operations in Water Hyacinth infested Lake Victoria waterways and tributaries as early in the season as is possible to avoid potential conflicts with nearby agricultural operations and to reduce cumulative pesticide usage. WHU will subdivided treatment areas into numbered application sites averaging 2 to 5 miles in length for shorelines, and 10 hectare areas in bays and open water areas.

2) **Permit Application**

WHU will obtain Restricted Use Permits (for aquatic herbicide use) from the National Environmental Management Authority and file timely Notices of Intent (NOI) for herbicide applications. WHU may write recommendations for cooperators who wish to apply restricted use herbicides. Contract applicators shall be responsible for obtaining Restricted Use Permits, writing recommendations, filing Notices of Intent, using equipment and pesticides legally, and filing monthly pesticide use reports with the WHU.

3) **Chemical Application Coordination**

- Regardless of pesticide permit requirements, NEMA and the Agricultural Commissioner shall establish the conditions of any proposed Water Hyacinth application. WHU staff will adopt the most restrictive conditions for that site (e.g. maximum wind speed, herbicide rates, environmental factors, and other parameters).
- The Agricultural Commissioner shall review NOIs for restricted use pesticide applications and, in permitting a treatment, notify WHU staff if additional provisions apply to that treatment. WHU staff shall consult with NEMA, the Ministry of Natural Resources and/or any other parties, including adjacent landowners, who might be affected.

4) **Water Quality Monitoring**

- Operational control operators shall use application equipment with volume and pressure capability to administer pesticides to heavily as well as lightly infested areas. The Agricultural Commissioner shall approve equipment before use within the country.
- For each site, operational control operators shall treat no more than 3 contiguous hectares. After treating 3 maximum hectares of contiguous mats, staff must then skip at least one adjacent site before treating another site. WHU staff may not treat skipped sites until the following week.
- Operational staff shall not apply herbicides within 0.8 km up or down stream of the Water Works Sites, or other water intake sites.

- Application Technique

  -WHU staff shall develop a chemical treatment strategy to minimize cumulative pesticide use over as many sites as is practicable.

  -Nursery areas shall be treated from the edges toward the outlet of the nursery.

  -For totally infested dead-end sloughs or bays greater than one hectare, staff shall treat no more than half the area at one time. Operational staff must prevent non-target damage by careful applications directly to Water Hyacinth plants, avoiding riparian or agricultural vegetation. Operational staff shall use drift control agents and stickers as recommended by label whenever conditions warrant. If at any time, off-site movement is uncertain, operational staff shall refrain from making the application.

5) **Spill Control**

- In boats, operational staff shall use undiluted herbicides from containers of 5 gallons or less, with no more than one container open at any given time.
- Operational staff shall securely fasten all herbicide containers together and attach them to a line and a float
- Each boat shall carry a marker buoy with an attached anchor line, and a tracer dye with which to mark, in the event of a spill, any herbicide and water movement from the spill site.
- If a spill occurs, operational staff shall immediately notify the Agricultural Commissioner and any appropriate agency listed in the emergency notification tree on page 26. Staff shall immediately provide, to the best of their ability, the exact location of the spill, and the identification and volume of all pesticide(s) spilled.

6) **Aerial Application**

The Agricultural Commissioner shall review NOIs for aerial applications and, if permitting a treatment, specify in writing the conditions which apply to that treatment. WHU staff shall consult with NEMA or any other parties, including adjacent landowners, who might be affected. Before initiating treatment, WHU staff shall provide the person supervising the treatment a list of contacts in the text of a treatment action plan to meet permit conditions.

7) **Mechanical Control Coordination**

The WHU's Mechanical Control Coordinator will supervise and insure proper reporting methods are followed to document the affects of the control effort. The 1997 program calls for the use of mechanical harvesting equipment at Owens Falls Dam, Port Bell and the Kagera River Boom Installation. Equipment operators have been trained during the 1996 period on the proper use and operations of the equipment's presently on site at the Owens Falls Dam, and equipment maintenance procedures have been established to minimize equipment down time. Training of field operations staff will be on a continuous basis as new staff and equipment are added to the program

8) **Physical Control Coordination**

The WHU will supervise the distribution of hand tools to the selected Fish Landing Sites along with the data monitoring protocol to insure the proper tracking of hyacinths removed via this method. In addition, the Local District Fisheries Officers will support the monitoring of activities at the Fish Landing Sites

9) **Biological Control Coordination**

The WHU Biological Control Coordinator will further develop and support the implementation of this control technique both in Lake Victoria and selected areas of Rwanda as funding develops. The biological control monitoring protocol is being established to properly document the results of this effort.

10) **Program Monitoring**

- Background - during 1996, a computer based mapping system was developed to track Water Hyacinth growth. Base map development was completed in January 1997, and baseline Water Hyacinth data is expected to be downloaded before the end of 1997. Semi-annual updates will be performed during 1997. Lake Victoria water analyses will be conducted in the treatment areas for residue levels of the herbicides, projected to be Weedar 64 and Rodeo. During the operational control program, fixed station samples will be taken weekly at the Gaba, Jinja and Entebbe Water Works if treatments using aquatic herbicides are within 2 kilometers of the intakes.

  Historically, Water Hyacinth control program applications have not been linked to any 2,4-D residues in water. In order to maintain compliance with the 100 PPB US Federal criteria allowed for 2,4-D, the WHU will arrange for a continuous monitoring program. Samples will be collected from 3 fixed water treatment stations and actual application areas in Lake Victoria waters before, during, and after treatments.

Gaba Water Works Intake- 3 times weekly, 8-9 a.m.

Jinja Water Works Intake- 3 times weekly, 8-9 a.m.

Entebbe Water Works Intake - 3 times weekly, 8-9 a.m.

Treatment Spot Checks

(Full routine monitoring, pre-treatment, during treatment, and post-treatment per 1997 protocol). If more than 3 contiguous hectares are sprayed, routine monitoring will be conducted.

Analysis Protocol

Two 15-ml water samples will be collected at each sampling site from a large 1-liter sample, placed in a plastic 20-ml screw capped vial and frozen until analysis. The laboratory will use a commercially available immunoassay system (Ohmicron, Newton, PA) to qualify and quantify 2,4-D in each sample according to Good Laboratory Practices (GLP), (see attached assay protocol and description). If any fixed station samples average over 20 PPB, the WHU will suspend operations until the source is identified or until operational spraying is proven not to be the source. In response to any post-treatment samples over 50 PPB, WHU will suspend operations until application adjustments reduce this to <50 PPB.

- Monitoring Responsibility - WHU will ensure provision of sufficient accurate monitoring data to account for the sensitivity of the application techniques in current use and document trends in chemical concentrations at the fixed station sites. Upon discovery, WHU will immediately notify all Task Force members of any results exceeding water quality criteria for 2,4-D.

PROTOCOL FOR MONITORING 1997 HERBICIDE APPLICATION APPLICATIONS

- **BACKGROUND**

During the 1997 In-Lake Herbicide Trials, water samples are being taken every 7 days and sent for analysis. Analysis of these samples will show the general movement of the herbicides in Lake Victoria waters and the 1997 Monitoring Protocol will be adjusted accordingly for sampling in high probability areas.

- **PROTOCOL FOR 1997**

The ability to control Water Hyacinth with Weedar 64 and Rodeo without any associated significant residues in Lake Victoria waters is currently under review. Daily intensive monitoring will be conducted in 1997 to determine if this sampling will be required in future years and to document compliance with allowable residue levels. To meet this need, two types of samplings will be conducted. Fixed stations at three locations and one spot check using 1997 protocols during operational applications.

a) Fixed Station: Fixed station monitoring at the locations listed will be conducted when herbicide applications are within 0.62 kilometers of the fixed station sites. The distance from fixed station sites may be modified following a review of herbicide movement documented in the In-Lake Herbicide Trials Report in annex 9.

   - Gaba Water Works Intake - samples to be taken Monday, Wednesday, and Friday in duplicate between 8 a.m and 9 a.m.
   - Jinja Water Works Intake - samples to be taken Monday, Wednesday, and Friday in duplicate between 8 a.m. and 9 a.m.

- Entebbe Water Works Intake - samples will be taken Monday, Wednesday, and Friday as above.

*Note: all samples will be composite and split into duplicate bottles.

Only samples from Mondays and Fridays at each location will be analyzed. All samples will be stored for thirty days for future analysis if needed.

b) Spot Checks*

- Full monitoring, pre-treatment and post-treatment per 1997 protocols.
- One during the first two weeks of operations.

*Note: if more than 3 contiguous hectares are sprayed, routine monitoring will be conducted (i.e. pre-treatment and post-treatment).

c) 1997 Herbicide Residue Analysis Protocols

- Sampling containers and sampling sites - at each fixed station or spot check site, two 15 ml water samples will be collected from a large (1 liter) sample, placed in a plastic 20 ml screw top vial and frozen until analysis.
- Analysis for 2,4-D & Glyphosate - a commercially available immunoassay system (i.e. Ohmicron, Newtown, PA) will be used to determine presence and level of 2,4-D in each water sample.
- Assay Protocol and Description - see attached.

d) Action Criteria

- Fixed Station - if any duplicate samples averaging over 20 PPB are taken, operations will be suspended until the source is identified, or until the incidence is shown not to be the result of operational spraying.
- Spot Monitoring - if any duplicate post-treatment samples averaging over 50 PPB are taken, operations will be suspended until adjustments are made to reduce the incidence to below 50 PPB.

- **RESPONSIBILITY FOR MONITORING**

The WHU will coordinate sample collection and receive for analysis the samples taken from the fixed stations. The WHU or other agency will conduct spot monitoring using WHU cooperative employees and will analyze samples within 48 hours. 10% of samples will be sent to a commercial analytical laboratory for confirmation of results.

- **REPORTING OF RESULTS OF MONITORING**

The WHU will report all results in writing to the Ministry of Agriculture, Animal Industry and Fisheries bi-weekly, or immediately if levels of 2,4-D exceed criteria.

APPENDIX C - 1997 WATER HYACINTH CONTROL OPERATION PLAN

It is the intent of the program to control the infestation of Water Hyacinth in the Lake Victoria while minimizing off-target impacts and preventing degradation of the existing water quality.

- **Area Selection**

  Approximately 50% of the Water Hyacinth present along the entire shoreline region of Uganda that is impacted, or as much as is physically and financially possible is targeted for treatment as early as approvals are obtained. The Lake area will be subdivided into application sites which vary in length from two (2) to five (5) kilometers.

- **Permit Application**

  The permit for each area and the Notices of Intent for each application will be obtained by the WHU.

- **Chemical Application Coordination**

  No chemical will be applied, regardless of permit requirement without first obtaining the concurrence of the Agricultural Commissioner for the area to be treated. On boundary waters, both Commissioners must give prior concurrence.

- **Water Quality Monitoring**

  Water quality monitoring shall be conducted in accordance with the established procedures. Monitoring will be conducted for both Weedar 64 and Rodeo.

- **Chemical Application**

1. Equipment: The application equipment must have sufficient volume and pressure to apply chemical control agents to large areas as well as fringe areas. Before any equipment is utilized, it must be approved by the Agricultural Commissioner or representative.

2. Site Application: Within each site selected, no more than 3 contiguous hectares at label rate shall be treated. After treating a maximum of 3 contiguous hectares at label rate, a minimum of one site must be left untreated before beginning another treatment area. The untreated sites may not be treated before two days have passed.

3. Prohibited Areas: For the 1997 season, no herbicide applications shall be made in the following areas: Within 0.62 kilometers of Entebbe, Gaba and Jinja Water Works and other areas as determined in the EIA.

4. Application Technique: All applications to nursery areas must be from the edges toward the outlet area of the nursery. In dead end sloughs larger than one hectare that are completely covered with hyacinth, no more than one-half of the area can be treated at one time. Care must be exercised to reduce non-target damage. Applications shall be directed to the target plant; riparian and agricultural vegetation shall be avoided. Drift and sticker control agents will be required in accordance with label requirements.

Drift will be prevented from reaching agricultural crops and riparian vegetation. At any time this cannot be assured, no treatment shall be made.

- **Spillage Control**

  All undiluted herbicides carried in the watercraft shall be in 5-gallon containers or smaller, with only one container of any one herbicide open at any given time. A marker buoy, with anchor line attached, and tracer dye shall be carried at all times to mark any herbicide spill and to monitor water movement at the spill site. All herbicide containers shall be securely fastened together and attached to a line and float. As soon as is possible, the applicator/monitor team shall provide notification to the Agricultural Commissioners and other appropriate agencies via the emergency notification procedure.

- **Aerial Application**

  Aerial application will be allowable in some predetermined areas of Lake Victoria. Any application will be coordinated with the WHU.

- **Emergency Notification**

  The applicator/monitoring team must report any spillage to the appropriate agencies as quickly as possible. The information shall include exact location of the spill, total volume spilled and identification of the herbicide spilled.

Emergency Numbers

Water Hyacinth Unit	
etc.	
etc.	
etc.	

- **Press Inquiries**

  All inquiries from the press will be answered by and shall be directed to:

  NAME
  ADDRESS
  PHONE NUMBER

APPENDIX D - 1997 WATER ANALYSIS

Samples Collected in the Field from _____ to _____. (dates)

LOCATION OF SAMPLE	SAMPLE	DATE COLLECTED	PPB 2,4-D or glyphosate

* = number falls below detection limits

Date analyzed:

Assay: Ohmicron 2.4-D ELISA Kit

Technician:

Internal Control: Expected - 35 PPB ± 7

Actual:

2,4-D/Glyphosate Data From Gaba Water Works

SAMPLE	DATE COLLECTED	PPB 2,4-D

* = number falls below detection limits

Date analyzed:

Assay: Ohmicron 2,4-D ELISA Kit

Technician:

Internal Control: Expected - 35 PPB ± 7

Actual:

2,4-D/Glyphosate Data From Entebbe Water Works

SAMPLE	DATE COLLECTED	PPB 2,4-D

2,4-D/Glyphosate DATA FROM Jinja Water Works

SAMPLE	DATE COLLECTED	PPB 2,4-D

* = number falls below detection limits

Date analyzed:

Assay: Ohmicron 2 4-D ELISA Kit

Technician:

Internal Control: Expected - 35 PPB ± 7

Actual:

APPENDIX E - REPORT

Summary

1997 will be the first year an operational control program has been initiated for the control of Water Hyacinth in Uganda in an effort to control the plant in Lake Victoria and adjacent areas. We are confident the operational control program will result in a reduction of the total Water Hyacinth infestation in Lake Victoria while establishing control protocols for other water bodies in Uganda and the region.

With continued support from other agencies, the Water Hyacinth Control Program will grow into a stronger program in 1998 and subsequent years until Water Hyacinth has been reduced to non nuisance levels in Lake Victoria. From case histories, it appears that after five years of vigorous control efforts, this weed should be under control.

ATTACHMENT 1

TREATMENT MATERIAL	YEAR	HECTARES TREATED NET/GROSS	AMOUNT USED GALLONS	km	HOURS
2,4-D (Weedar 64)	1997				
	1998				
	1999				
	1997				
	1998				
	1999				
Rodeo	1997				
	1998				
	1999				
All Surfactants	1997				
	1998				
	1999				
Totals All Herbicides	1997				
	1998				
	1999				

ANNEX 5

AQUATIC HERBICIDE LABELS
AND
MATERIAL SAFETY DATA SHEETS

Weedar® 64

Brand Herbicide

RHÔNE-POULENC

The 2,4-D Amine Weed Killer

ACTIVE INGREDIENT:
2,4-Dichlorophenoxyacetic acid, dimethylamine salt* 46.8%
INERT INGREDIENTS: 53.2%
*2,4-Dichlorophenoxyacetic acid equivalent 38.9% by weight or 3.8 pounds per gallon
*Isomer specific by AOAC Method No. 978.05

E.P.A. Reg. No. 264-2AA

E.P.A. Est. No. 264-MO-01

KEEP OUT OF REACH OF CHILDREN

DANGER PELIGRO

Si usted no entiendo la etiqueta, busque a alguien para que se la expliquè a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

For PRODUCT USE Information Call 1-800-334-9745

For EMERGENCY Information ONLY Call 24 Hours A Day 1-800-334-7577.

STATEMENT OF PRACTICAL TREATMENT

IF ON SKIN: Wash skin with plenty of soap and water. Get medical attention.

IF SWALLOWED: If patient is conscious and alert, give 2 to 3 glasses of water or milk to drink. If available, give one tablespoon of Syrup of Ipecac to induce vomiting. Alternatively, induce vomiting by touching back of throat with finger. Do not make an unconscious person vomit. Get medical attention.

IF IN EYES: Flush with water for at least 15 minutes. Get medical attention, PREFERABLY AN OPTHAMOLOGIST.

IF INHALED: Move to an uncontaminated area. Get medical attention.

NOTE TO PHYSICIAN

This product contains a phenoxy herbicidal chemical. There is no specific antidote. All treatments should be based on observed signs and symptoms of distress in the patient. Overexposure to materials other than this product may have occurred.

PRECAUTIONARY STATEMENTS

DANGER
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

Causes irreversible eye damage. Harmful if swallowed. May be fatal if absorbed through the skin. Avoid breathing vapors or spray mist. Do not get in eyes, on skin or on clothing.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear: coveralls over short-sleeved shirt and short pants, waterproof gloves, chemical-resistant footwear plus socks, chemical-resistant headgear for overhead exposure and protective eye wear. A chemical-resistant apron should also be worn when cleaning equipment, mixing or loading.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d) (4-6)], the handler PPE (personal protective equipment) may be reduced or modified as specified in the WPS.

For containers over 1 gallon but less than 5 gallons, mixers and loaders who do not use a mechanical system (probe and pump) to transfer the contents of this container must wear coveralls or a chemical-resistant apron in addition to the other required PPE. For containers of 5 gallons or more, a mechanical transfer system (probe and pump) must be used for transferring the contents of the container. If the contents of a non-refillable pesticide containers are emptied, the probe must be rinsed before removal. If the mechanical system is used in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4)] the handler PPE requirements may be reduced or modified as specified in the WPS.

USER SAFETY RECOMMENDATIONS

Users should: Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.

Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This product is toxic to aquatic invertebrates. Drift or runoff may adversely affect aquatic invertebrates and non-target plants. For terrestrial uses, do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters. Do not apply when weather conditions favor drift from treated areas. Do not use the same spray equipment for other purposes unless thoroughly cleaned.

Do not contaminate water used for irrigation or domestic purposes (except as specifically recommended on this label) especially in areas where grapes, cotton, tomatoes or other susceptible plants are grown.

Do not treat irrigation ditches in areas where water will be used to overhead (sprinkler) irrigate susceptible crops especially grapes, tomatoes, tobacco, and cotton.

MIXING AND LOADING: Most cases of ground water contamination involving phenoxy herbicides such as 2,4-D have been associated with mixing/loading and disposal sites. Caution should be exercised when handling 2,4-D pesticides at such sites to prevent contamination of ground water supplies. Use of closed systems for mixing or transferring this pesticide will reduce the probability of spills. Placement of the mixing/loading equipment on an impervious pad to contain spills will help prevent ground water contamination.

Do not apply WEEDAR® 64 Broadleaf Herbicide directly to, or permit to drift onto cotton, okra, grapes tomatoes, fruit trees, vegetables, flowers or other desirable crop or ornamental plants which are susceptible to 2,4-D herbicide. Do not apply near susceptible plants since very small quantities of the 2,4-D will cause severe injury during the growing or dormant periods. Crops contacted by WEEDAR® 64 Broadleaf Herbicide sprays or spray drift may be killed or suffer significant stand loss with extensive quality and yield reduction.

Do not apply when a temperature air inversion exists. Such a condition is characterized by little or no air movement and an increase in air temperature with an increase in height. In humid regions, a fog or mist may form. An inversion may be detected by producing a smoke column and checking for a layering effect. If questions exist pertaining to the existence of an inversion, consult with local weather services before making an application.

Use coarse sprays to minimize drift. Do not apply with hollow cone-type insecticide or other nozzles that produce line spray droplets. Drift from aerial or ground application may be reduced by: (1) applying as near to the target as possible in order to obtain coverage; (2) by increasing the volume of spray mix per acre, (3) by decreasing the pounds of pressure at the nozzle tips; and (4) by using nozzles which produce a coarse spray pattern; (5) by not applying when wind is blowing toward susceptible crops or valuable plants.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read entire label before using this label.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handle may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard conta requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses, and handlers of agricult pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains spe instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted e interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow entry into treated areas during the restricted entry interval (REI) of 48 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contac anything that has been treated such as plants, soil or water is: coveralls over short-sleeved shirt and short pants, waterproof gl chemical-resistant footwear plus socks, chemical-resistant headgear for overhead exposure and protective eye wear.

NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard (WP agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, f nurseries or greenhouses.

For ornamental turf uses (golf courses, cemeteries, parks and other turf grass areas), do not enter treatment areas until spray dried. Do not allow people (other than applicator) or pets on treatment area during application.

STORAGE AND DISPOSAL

STORAGE
Do not contaminate water, food or feed by storage or disposal. Store in original container in a dry secured storage area. Keep container tightly closed when not in use.

PESTICIDE DISPOSAL
Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law and may contaminate ground water. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL
Triple rinse or (equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

GENERAL CAUTIONS AND RESTRICTIONS

Do not apply WEEDAR® 64 Broadleaf Herbicide through any type of irrigation system.

Do not use in or near a greenhouse.

MIXING INSTRUCTIONS

Mix WEEDAR® 64 Broadleaf Herbicide only with water, unless otherwise directed on this label. Add about one-half the water to the mixing tank, then add WEEDAR® 64 with agitation and finally the rest of water with continuing agitation.

NOTE: Adding oil, wetting agent, or other surfactants to the spray may increase effectiveness on weeds but also may reduce selectivity to crops, resulting in crop damage.

COMPATIBILITY

If WEEDAR® 64 Broadleaf Herbicide is to be tank mixed with fertilizers or with other pesticides, compatibility should be tested prior t mixing. To test for compatibility, use a small container and mix a small amount (0.5 to 1 qt) of spray, combining all ingredients in th same ratio as the anticipated use. If any indications of physical incompatibility develop, do not use this mixture for spraying Indications of incompatibility usually will appear within 5 to 15 minutes after mixing.

Read and follow all directions and precautions on this label and on the labels of any products for which a tank mixture is bein considered.

APPLICATION PROCEDURES

Apply by air or ground equipment in sufficient gallonage to obtain adequate coverage, except as otherwise directed on this label.

Use 2 or more gallons of water per acre for aerial application and 10 or more gallons of water per acre for ground application.

GENERAL INFORMATION

INJURY TO CROPS FROM THIS HERBICIDE MAY OCCUR. IF YOU ARE NOT PREPARED TO ACCEPT SOME DEGREE OF CRC INJURY DO NOT USE THIS PRODUCT.

Crop varieties vary in response to 2,4-D and some are easily injured. Apply WEEDAR® 64 Broadleaf Herbicide only to varieties known be tolerant to 2,4-D. If you are uncertain concerning tolerant varieties or local use situations that may affect crop tolerance to 2,4- consult your seed company, state Agricultural Extension Service or qualified crop consultant for advice.

Be sure that use of this product conforms to all applicable laws, rules and regulations. Certain states have restrictions pertaining application distances from susceptible crops. The applicator should become familiar with these laws, rules or regulations and lo them exactly.

GENERAL WEED LIST

*beggarticks
bullthistle
coffeeweed
common cocklebur
common burdock
common evening primrose
common lambsquarters
hairy galinsoga
jimsonweed
*knotweed

Annual and Biennial Weeds

*mallow (venice or little)
marshelder
morningglory (common, ivy, woolly)
*musk thistle(***)
mustards (except blue mustard)
pepper weeds (except perennial)
**pigweeds (Amaranthus spp.)
prickly lettuce
ragweed (common or giant)
rough fleabane
*Russian thistle
Salsify (western or common)
*smartweeds (annual species)
sowthistles (annual or spiny)
sunflower
*vervains
vetches
wild carrot
wild lettuce
wild parsnips

Perennial Weeds

*bindweed (hedge, field, European)
blue lettuce
*Canada thistle
catnip
chicory
dandelion
*docks
*dogbanes
*goldenrod
*ground ivy
healall
*hoary cress
*ironweed
Jerusalem-artichoke
many flowered aster
**nettles (including stinging)
*orange hawkweed
plantains
sowthistle (perennial)
*vervains
*wild garlic
*wild onion

*These species may require repeated applications and/or use of the higher rate recommended on this product label even under ideal conditions for application.

**Control of pigweeds in the High Plains area of Texas and Oklahoma may not be satisfactory with this product.

***Not registered for control of musk thistle in California.

SPECIFIC USE DIRECTIONS

CEREAL GRAINS

CROP	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Wheat, Barley, Oats and Rye (not underseeded with legumes)		Apply after grain is fully tillered (usually 4 to 8 inches high) but not forming joints in the stem. **Do not spray grain in the boot to dough stage.**
Postemergence		
Annual and biennial broadleaf weeds	1/2 to 2 pints*	
Perennial broadleaf weeds	1 to 2 pints*	
Wheat, Barley, Oats and Rye (underseeded with legumes)	1/4 to 1/2 pint*	Apply after grain is 8 inches tall. **Do not spray grain in boot to dough stage.** Do not spray alfalfa or sweet clover unless the infestation is severe and injury to these legumes can be tolerated.
Emergency weed control in Wheat	3 pints	Apply when weeds are approaching bud stage, after the grain dough stage. **Do not spray during the boot to dough stage.** The 3 pints per acre application can product injury to wheat. Balance the severity of your weed problem against the possibility of crop damage. Where perennial weeds are scattered, spot treatment is suggested to minimize the extent of crop injury.
Perennial broadleaf weeds		

RESTRICTIONS AND LIMITATIONS FOR USE ON CEREAL GRAINS

For aerial application on grain, apply WEEDAR® 64 Broadleaf Herbicide in 3 to 10 gallons of water per acre.

For ground application a minimum of 10 to 15 gallons of water per acre is recommended for proper spray coverage.

Do not permit dairy animals or meat animals being finished for slaughter to forage treated grain fields within 2 weeks after treatment.

Do not feed treated straw to livestock if an emergency treatment as described above is applied.

*Use the lower rate if small annual and biennial weeds are the major problem. Use the higher rate if perennial weeds or annual biennial weeds are present which are in the hard-to-kill categories as determined by local experience. The higher rates increase the of grain injury and should be used only where the weed control problem justifies the grain damage risk. Do not apply WEEDAR grain in the seedling stage.

CORN AND SORGHUM

CROP	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
CORN (Field and Sweet)		
Preplant	1 to 2 pints	To control emerged broadleaf weed seedlings or existing cover crops prior to planting corn, apply 7 to 14 days before planting. Do not use on light, sandy soil, or where soil moisture is inadequate for normal weed growth. Use high rate for less susceptible weeds or cover crops such alfalfa.
Preemergence	2 to 3 pints	Apply 3 to 5 days after planting but before corn emerges. Do not use on light, sandy soils or where soil moisture is low.
Postemergence		Apply when weeds are small and corn is less than 8 inches tall (to top of canopy). When corn is over 8 inches tall, use drop nozzles and keep spray off foliage. Treat perennial weeds when they are in the bud to bloom stage. **Do not spray corn in the tassel to dough stage.** Corn treated with 2,4-D may become temporarily brittle. Winds or cultivation may cause stalk breakage during the period of time when the corn is brittle.
Annual broadleaf weeds	1/2 to 1 pint	
Perennial broadleaf weeds	1 to 1 1/2 pints	
Grain Sorghum (Milo)		
Postemergence	1 pint	Apply when sorghum is 6 to 15 inches tall. If sorghum is taller than 8 inches to top of the canopy, use drop nozzles and keep spray off the foliage. Do not **treat during the boot, flowering or dough stage.**

RESTRICTIONS AND LIMITATIONS FOR USE ON CORN AND SORGHUM

Do not forage or feed fodder for 7 days following application.

SOYBEANS (Preplant Only)*

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Postemergence	3/4 to 1 pint	Apply not less than 15 days prior to planting soybeans, when weeds are small and actively growing. Use the higher rate on larger weeds and when perennials are present.
	> 1 to 2 pints	Apply not less than 30 days prior to planting soybeans, when weeds are actively growing.
		In addition to those weeds found on the GENERAL WEED LIST, WEEDAR® 64 will suppress or control the following broadleaf weeds frequently encountered in reduced tillage soybean production systems: alfalfa*, bullnettle, smallflowered bittercress, Carolina geranium, smallflowered buttercup, common and rough cinquefoil, red clover*, horseweed or marestail, mousetail, wild mustard, field pennycress, cutleaf evening primrose, common purslane, speedwell, velvetleaf, and Virginia copperleaf. * These weeds are only partially controlled. Apply no more than 2.0 pints of WEEDAR® 64 in one season prior to planting soybeans. After applying, plant soybean seed as deep as practical or at least 1 1/2 to 2 inches deep. Adjust the planter press wheel, if necessary, to ensure that planted seed is completely covered. If desired, WEEDAR® 64 may be applied pre-plant to soybeans in tank mixtures with other herbicides such as Poast, Poast Plus, Roundup, Roundup D-Pak, Honcho, Gramoxone Extra, Prowl, Pursuit Plus, Scepter, Scepter 70 DG, Squadron and others that are registered for pre-plant soybean use. NOTE: Unacceptable injury to soybeans planted in fields previously treated with WEEDAR® 64 may occur and the extent of injury will depend on weather and agronomic factors such as the amount of weed vegetation and previous crop residue present that may be in effect between the time of application and the emergence of the soybean plant.

RESTRICTIONS AND LIMITATIONS FOR USE IN SOYBEANS (PRE-PLANT)

Do not apply WEEDAR® 64 when weather conditions such as temperature, air inversions, or wind favor drift from treated areas to susceptible plants.

Apply no more than 2.0 pints of WEEDAR® 64 per acre in one season prior to planting soybeans.

Only one application per growing season, regardless of the application rate used, is allowed.

Do not apply WEEDAR® 64 prior to planting soybeans if you are not prepared to accept the results of soybean injury including poss loss of stand and yield

Do not replant fields treated with WEEDAR® 64 in the same growing season with crops other than those labeled for 2,4-D pre-plant

Do not mow or cultivate weeds prior to treating with WEEDAR® 64 as poor control may result

Do not cut for feed treated hay, forage or fodder or graze treated soybeans to livestock

Do not apply WEEDAR® 64 pre-plant to soybeans in fields having a coarse-textured soil where the percent organic matter is < 1.0

Only one application of WEEDAR® 64 may be made prior to planting soybeans per growing season

Do not feed treated hay, forage, or fodder. Restrict livestock from grazing treated fields

*Not currently registered in California.

RICE, SUGARCANE, FALLOWLAND AND CROP STUBBLE

CROP	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Rice (Pre-plant use)	1 to 2 pints	Apply four or more weeks prior to planting rice. DO NOT USE IN CALIFORNIA.
Rice (Postemergence use)	1 to 2 1/2 pints	Apply when rice is in the late tillering stage of development at the time of first joint development. Do not apply after panicle initiation, after rice internodes exceed one-half inch, at early seedling, early panicle, boot or heading stages. Consult local university or Agricultural Extension Service specialists for more specific information on rates and timing of application.
Sugarcane		Apply before canes appear for control of emerged broadleaf weeds. Apply after cane emerges and through lay-by. DO NOT USE IN CALIFORNIA.
Preemergence	4 pints	
Postemergence	1 1/2 to 2 pints	
Fallowland and Crop Stubble		Use the lower rate when weeds are small (2 to 3 inches tall) and actively growing. Use the higher rate on older and drought-stressed plants.
Annual broadleaf weeds	1 to 2 pints	
Biennial broadleaf weeds	2 to 4 pints	Spray while musk thistles or other biennial species are in the seedling to rosette stage and before flower stalks become apparent. The lower rate can be used in the spring during rosette stage. Use the highest rate in the fall or after flower stalks have developed.
Perennial broadleaf weeds	2 to 6 pints	Spray weed in the bud to bloom stage or while in good vegetative growth. Do not disturb treated areas for at least 2 weeks after treatment, or until tops are dead.
Wild garlic and onion in crop stubble	4 to 6 pints	Apply to new regrowth of wild garlic or onion which occurs in the fall following harvest of small grains, corn or grain sorghum.

RESTRICTIONS AND LIMITATIONS FOR USE IN FALLOWLAND AND CROP STUBBLE

Do not plant any crop for 3 months after treatment or until chemical has disappeared from the soil.

RESTRICTIONS AND LIMITATIONS FOR USE IN RICE

Do not apply more than a total of 2 1/2 pints of WEEDAR® 64 to rice per growing season.

ESTABLISHED GRASS PASTURES, RANGELAND, AND CONSERVATION RESERVE PROGRAM AREAS

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds	2 pints	Apply when weeds are small and actively growing and prior to bud stage. Spray while musk thistles or other biennial species are in the seedling to rosette stage and before flower stalks become apparent. The lower rate can be used in the spring during rosette stage. Use the highest rate in the fall or after flower stalks have developed. Do not apply to newly seeded areas until grass is well established. Do not apply to grass in the early boot through milk stage if grass seed production is desired. Bentgrass and legumes may be injured by this treatment.
Biennial and perennial broadleaf weeds	2 to 4 pints	

RESTRICTIONS AND LIMITATIONS FOR USE IN PASTURES AND RANGELANDS

Do not graze (dairy) cattle in treated areas for 7 days after application.

Do not cut forage for hay within 30 days of application.

Do not permit dairy animals or meat animals being finished for slaughter to forage treated fields within 3 days of slaughter.

CONSERVATION RESERVE PROGRAM AREAS

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds In young grasses In established grasses	1/2 to 1 pint 1/2 to 2 pints	Apply to actively growing annual broadleaf weeds. Use 1/2 to 1 pint when weeds are small; use higher rates on older weeds. Do not apply to young grasses with fewer than 6 leaves or prior to tillering, as excessive injury may result. Do not apply more than 1 pint until grasses are well established as excessive injury may result.
Biennial and perennial broadleaf weeds In established grasses	2 to 4 pints	Treat when biennial weeds are in the seedling to rosette stage and before flower stalks become apparent. Treat perennial weeds in the bud to bloom stage. Apply to actively growing weeds.

RESTRICTIONS AND LIMITATIONS FOR USE ON CONSERVATION RESERVE PROGRAM AREAS

Use at least 2 gallons of water per acre by air and 5 gallons of water per acre by ground.

Do not harvest or graze treated Conservation Reserve Program areas.

Do not apply to grasses in the boot to dough stage if grass seed production is desired.

GRASSES FOR SEED PRODUCTION

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual and perennial broadleaf weeds	2 to 4 pints	Apply to established stands in spring from tiller to early boot stage. **Do not spray in boot stage.** New spring seedings may be treated with the lower rate after grass seedlings have at least 5 leaves. Perennial weed regrowth may be treated in the fall. DO NOT USE IN CALIFORNIA.

RESTRICTIONS AND LIMITATIONS FOR USE ON GRASSES FOR SEED PRODUCTION

Do not graze dairy animals or cut forage for hay within 7 days of application.

NON-CROPLAND

fencerows, roadsides, drainage ditches, and other non-crop areas

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds **Biennial and perennial broadleaf weeds**	2 to 4 pints 4 to 8 pints	Treat when weeds are young and actively growing. Perennial weeds should be near the bud stage, but not flowering at application. Do not use on susceptible southern grasses such as St. Augustine. Do not apply to newly seeded areas until grass is well established. Bentgrass, clover, legumes and dichondria may be injured by this treatment.

RESTRICTIONS AND LIMITATIONS FOR USE ON NON-CROPLAND

Do not graze dairy animals for 7 days following application.

Use sufficient gallonage for thorough and uniform coverage.

WEEDS IN ORNAMENTAL TURF AREAS

golf courses, cemeteries, parks, turfgrass, and other grass areas

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds	2 to 4 pints	Treat when weeds are young and actively growing. Perennial weeds should be near the bud stage, but not flowering at application. Do not use on susceptible southern grasses such as St. Augustine. Do not apply to newly seeded areas until grass is well established. Bentgrass, clover, legumes and dichondria may be injured by this treatment.
Biennial and perennial broadleaf weeds	4 pints	

RESTRICTIONS AND LIMITATIONS FOR USE ON ORNAMENTAL TURF AREAS

Use sufficient gallonage for thorough and uniform coverage.

Do not apply more than 2 broadcast applications per year per treatment site. This does not exclude spot treatments.

Do not allow people (other than applicator) or pets on treatment area during application.

Do not enter treatment areas until sprays have dried.

SPOT TREATMENT IN NON-CROP AREAS

Mix 2 to 3 fluid ounces of WEEDAR® 64 Broadleaf Herbicide in 3 gallons of water. Wet all weeds and stems thoroughly. For best resul treat when weeds are actively growing.

FORESTRY - TREE INJECTION

For controlling species such as alder, aspen, birch, blackgum, cherry, oak, sweetgum, and tulip poplar

Make injections as near to the root collar as possible, using one injection per inch of trunk dbh (4 1/2 feet). For resistant species su as hickory, injections should overlap. For best results, injections should be made during the growing season. May 15th throu October 15th.

For Dilute Injection: Mix 1 gallon of WEEDAR® 64 Broadleaf Herbicide in 19 gallons of water for dilute injections.

For Concentrate Injections: Use 1 to 2 ml of concentrate WEEDAR® 64 Broadleaf Herbicide per injection. The injection bit m penetrate the inner bark.

STONE FRUIT AND NUT ORCHARDS

WEEDS IN CROP	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds	3 pints	For control of weeds on the orchard floor, apply usir coarse sprays and low pressure in sufficient volum of water to obtain thorough wetting of weeds. Tre when weeds are small and actively growing. Do n use on light, sandy soil. DO NOT USE CALIFORNIA.

RESTRICTIONS AND LIMITATIONS FOR USE IN STONE FRUIT AND NUT ORCHARDS

Do not apply to bare ground as injury may result.

Do not apply immediately before irrigation and withhold irrigation for 2 days before and for 3 days after treatment.

Do not allow spray to drift onto or contact foliage, fruit, stems, trunks of trees or exposed roots as injury may result.

Do not apply to newly established or young orchards. Trees must be at least 1 year old and in vigorous condition.

Do not apply during bloom.

Do not graze or feed cover crops from treated orchards.

Do not make more than 2 applications per year.

Do not harvest stone fruit within 40 days of application.

Do not harvest nuts within 60 days of application.

WEEDS AND BRUSH IRRIGATION CANAL DITCHBANKS

(Seventeen Western States: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Nevada, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming).

For control of annual and perennial broadleaf weeds, apply 1 to 2 quarts of WEEDAR® 64 Broadleaf Herbicide per acre in approximately 20 to 100 gallons per acre. Treat when weeds are young and actively growing before the bud or early bloom stage. For harder-to-control weeds, a repeat spray after 3 to 4 weeks using the same rates may be needed for maximum results. Apply no more than two treatments per season.

For woody brush and patches of perennial broadleaf weeds, mix 1 gallon of WEEDAR® 64 in 150 gallons of water. Wet foliage thoroughly using about 1 gallon of solution per square rod.

SPRAYING INSTRUCTIONS

Apply with low pressure (10 to 40 psi) power spray equipment mounted on a truck, tractor, or boat. Apply while traveling upstream to avoid accidental concentration of chemical into water. Spray when the air is fairly claim, 5 mph or less. Do not use on small canals (less than 10 cfs) where water will be used for drinking purposes.

Boom spraying onto water surface must be held to a minimum and no cross-stream spraying to opposite banks should be permitted. When spraying shoreline weeds, allow no more than 2 foot overspray onto water with an average of less than 1 foot overspray to prevent introduction of greater than negligible amounts of chemical into the water.

Do not allow dairy animals to graze on treated areas for at least 7 days after spraying. Water within treated banks should not be fished.

AQUATIC WEED CONTROL

For use in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, rivers and streams that are quiescent or slow moving.

NOTICE TO APPLICATORS

State and Local Coordination: Before application, coordination and approval of local and state authorities may be required, either by letter of agreement or issuance of special permits for such use.

Fish Toxicity - Oxygen Ratio: Fish breathe oxygen in the water and a water - oxygen ratio must be maintained. Decaying weeds use up oxygen. To avoid fish kill from decaying plant material do not treat more than one half the lake or pond at one time. For large bodies of weed infested waters leave buffer strips of at least 100 feet wide and delay treatment of these strips for 4 to 5 weeks or until the dead vegetation has decomposed.

Wind Velocity - Ground or Surface Application: Do not apply when wind speeds are at or above 10 mph. **Air Application**: Do not apply when wind speeds are at or above 5 mph. The restrictions do not apply to subsurface applications used in weed control programs.

Irrigation: Delay the use of treated waters for irrigation for three weeks after treatment unless an approved assay shows that the water does not contain more than 0.1 ppm 2,4-D acid. Do not treat irrigation ditches in areas where water will be used to overhead sprinkler irrigate susceptible crops especially grapes, tomatoes and cotton.

Potable Water: Delay the use of treated water for domestic purposes for a period of three weeks or until such time as an approved assay shows that the water contains no more than 0.1 ppm 2,4-D acid.

Water Hyacinth *(Eichornia crassipe)* - Directions For Use

WEEDAR® 64 will control water hyacinth with surface and air applications.

Amounts to Use: 2 to 4 quarts (4 lb. acid equivalent per gallon) per acre. **Spray the weed mass only**. Use 4 quarts when plants are matured or when the weed mass is dense.

When To Apply: Spray when water hyacinth plants are actively growing. Repeat as necessary to kill regrowth and hyacinth plants missed in the previous operation.

How To Use - Surface Application: Use power sprayers operated with a boom or spray gun mounted on a boat, tractor or truck. Thorough wetting of foliage is essential for maximum control. Use 100 to 400 gal. A of spray mixture. Special precautions such as the use of low pressure, large nozzles and thickening agents should be taken to avoid spray drift in areas of sensitive crops. For DIRECTA SPRAY™ operation use WEEDAR® 64 with 1 pint of drift control agent in 50 to 100 gallons of water. For other applications follow the drift control agent label for mixing directions. **Air Application**: Use drift control spray equipment or thickening agents mixed into the spray solution. Apply 1.0 gallon per acre of WEEDAR® 64 through standard boom systems with a minimum of 5 gallons of spray mix per acre. For MICROFOIL® drift control spray systems, apply WEEDAR® 64 in 12 to 15 gallons spray mix per acre.

2,4-D Acid Equivalent	1/2 lb	1 lb	2 lbs	3 lbs.	4 lbs.
WEEDAR® 64	1 pt.	2 pts	2 qts.	3 qts	4 qts

Water Milfoil *(Myriophyllum spicatum)* - Directions For Use

For Eurasian Water Milfoil in programs conducted by the Tennessee Valley Authority in dams and reservoirs of the TVA system.

WEEDAR® 64 will control water milfoil with surface, subsurface and air applications.

How To Use: To control water milfoil when less than 5 gallons of concentrate per acre is recommended, dilute the concentrate with water to apply a minimum of 5 gallons of spray mix per acre. Do not treat within 1/2 mile of potable water intakes. Shoreline areas should be treated by sub-surface injection applied by boat to avoid aerial drift. Do not apply when weather conditions favor drift from target area. Do not contaminate water by cleaning of equipment washwaters.

Open Water Areas: To reduce contamination and prevent undo exposure to fish and other aquatic organism, do not treat water areas that are not infested with aquatic weeds.

Amounts To Use: Apply 2.5 to 10 gallons of WEEDAR® 64 per acre. The higher rate is used in areas of greater water exchange. These areas may require a repeat application.

When To Apply: For best results, apply in spring or early summer when milfoil starts to grow. This timing can be checked by sampling the lake bottom in areas heavily infested with weeds the year before.

Subsurface Application: Apply 2.5 to 10 gallons of WEEDAR® 64 per acre as a concentrate directly into the water through boat mounted distribution systems.

Surface Application: Apply 2.5 to 10 gallons of WEEDAR® 64 per acre in a minimum spray volume of 5 gallons mix per acre.

Air Application: Use drift control spray equipment or thickening agents mixed into the spray solution. Apply 2.5 to 10 gallons per acre of WEEDAR® 64 through standard boom systems with a minimum of 5 gallons of spray mix per acre. For MICROFOIL® drift control spray systems apply WEEDAR® 64 in 12 to 15 gallons spray mix per acre.

LIMITED WARRANTY AND DISCLAIMER

The manufacturer warrants that this product conforms to the chemical description on the label; that this product is reasonably fit for the purposes set forth in the directions for use when it is used in accordance with such directions; and that the directions, warnings and other statements on this label are based upon responsible experts' evaluation of reasonable tests of effectiveness, of toxicity to laboratory animals and to plants, and of residues on food crops, and upon reports of field experience. Tests have not been made on all varieties or in all states or under all conditions. THE MANUFACTURER NEITHER MAKES NOR INTENDS, NOR DOES IT AUTHORIZE ANY AGENT OR REPRESENTATIVE TO MAKE, ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, AND IT EXPRESSLY EXCLUDES AND DISCLAIMS ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

THIS WARRANTY DOES NOT EXTEND TO, AND THE BUYER SHALL BE SOLELY RESPONSIBLE FOR, ANY AND ALL LOSS OR DAMAGE WHICH RESULTS FROM THE USE OF THIS PRODUCT IN ANY MANNER WHICH IS INCONSISTENT WITH THE LABEL DIRECTIONS, WARNINGS OR CAUTIONS.

BUYER'S EXCLUSIVE REMEDY AND MANUFACTURER'S OR SELLER'S EXCLUSIVE LIABILITY FOR ANY AND ALL CLAIMS LOSSES, DAMAGES, OR INJURIES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, WHETHER OR NOT BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY IN TORT OR OTHERWISE SHALL BE LIMITED, AT THE MANUFACTURER'S OPTION TO REPLACEMENT OF, OR THE REPAYMENT OF THE PURCHASE PRICE FOR, THE QUANTITY OF PRODUCT WITH RESPECT TO WHICH DAMAGES ARE CLAIMED. IN NO EVENT SHALL MANUFACTURER OR SELLER BE LIABLE FOR SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT.

NOTICE TO BUYER

Purchase of this material does not confer any rights under patents governing this product or the use thereof in countries outside of the United Sates.

THIS SPECIMEN LABEL IS INTENDED FOR USE ONLY AS A GUIDE IN PROVIDING GENERAL INFORMA
REGARDING THE DIRECTIONS, WARNINGS AND CAUTIONS ASSOCIATED WITH THE USE OF
PRODUCT. AS WITH ANY AGRICULTURAL CHEMICAL, ALWAYS FOLLOW THE LABEL INSTRUCTIONS ON
PACKAGE BEFORE USING.

Form No. 95065
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Rhône-Poulenc Ag Company
P.O. Box 12014, 2 T.W. Alexander Drive
Research Triangle Park, North Carolina 27709

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EPA Approval: 6/3/9

RHÔNE-POULENC

WEEDAR(R) BRAND 64 HERBICIDE

MATERIAL SAFETY DATA SHEET **Date Prepared: 12/18/95 Supersedes Date: 9/27/95**

1. CHEMICAL PRODUCT AND COMPANY DESCRIPTION

RHONE-POULENC AG COMPANY
AGRICULTURAL CHEMICALS
2 T.W. Alexander Drive
Research Triangle Pk NC 27709

Emergency Phone Numbers:
FOR EMERGENCIES INVOLVING A SPILL, LEAK, FIRE, EXPOSURE OR ACCIDENT CONTACT: CHEMTREC (800-424-9300) OR RHONE-POULENC (800-334-7577).

For Product Information:
(800) 334-9745

Product Status:
FIFRA regulated use only.

EPA FIFRA Registration Number:
264-2

Chemical Name or Synonym:
2,4-D, DIMETHYLAMINE SALT

Molecular Formula:
$C_8H_6Cl_2O_3 \cdot C_2H_7N$

2. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS Reg Number	OSHA Hazard	Percentage
2,4-D DIMETHYLAMINE SALT	2008-39-1	Y	46.8
OTHER INGREDIENTS (TRADE SECRET)	**********	N	BALANCE

3. HAZARDS IDENTIFICATION

A. EMERGENCY OVERVIEW:

Physical Appearance and Odor:

 CONTINUED ON NEXT PAGE

3. HAZARDS IDENTIFICATION (CONTINUED)

dark brown to black / liquid, characteristic odor.

Warning Statements:
DANGER! CAUSES IRREVERSIBLE EYE DAMAGE. HARMFUL IF SWALLOWED OR ABSORBED THROUGH SKIN.

B. POTENTIAL HEALTH EFFECTS:

Acute Eye:
Causes corneal opacity, irreversible eye damage. Vapors and mists can cause irritation.

Acute Skin:
May cause slight transient irritation. Toxic if absorbed through skin. May produce symptoms similar to those from inhalation and ingestion. May cause decreased blood pressure, muscle weakness, muscle spasms.

Acute Inhalation:
Harmful if inhaled. May cause upper respiratory tract irritation, nausea, decreased blood pressure, muscle weakness, muscle spasms.

Acute Ingestion:
Harmful if ingested. May cause nausea, vomiting, abdominal pain, decreased blood pressure, muscle weakness, muscle spasms.

Chronic Effects:
This product contains ingredients that are considered by OSHA, NTP, IARC or ACGIH to be probable or suspected human carcinogens (see Section 11 - Chronic).

4. FIRST AID MEASURES

FIRST AID MEASURES FOR ACCIDENTAL:
Eye Exposure:
Hold eyelids open and flush with a steady, gentle stream of water for at least 15 minutes. Seek immediate medical attention.

Skin Exposure:
In case of contact, immediately wash with plenty of soap and water for at least 15 minutes. Seek medical attention. Remove contaminated clothing and shoes while washing. Clean contaminated clothing and shoes

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4. FIRST AID MEASURES (CONTINUED)

before re-use or discard if they cannot be thoroughly cleaned.

Inhalation:
Remove victim from immediate source of exposure and assure that the victim is breathing. If breathing is difficult, administer oxygen, if available. If victim is not breathing, administer CPR (cardio-pulmonary resuscitation). Seek medical attention.

Ingestion:
If victim is conscious and alert, give 2-3 glasses of water to drink and induce vomiting by touching back of throat with a finger. Do not induce vomiting or give anything by mouth to an unconscious person. Seek immediate medical attention. Do not leave victim unattended. Vomiting may occur spontaneously. To prevent aspiration of swallowed product, lay victim on side with head lower than waist. If vomiting occurs and the victim is conscious, give water to further dilute the chemical.

MEDICAL CONDITIONS POSSIBLY AGGRAVATED BY EXPOSURE:
Inhalation of product may aggravate existing chronic respiratory problems such as asthma, emphysema or bronchitis. Skin contact may aggravate existing skin disease.

NOTES TO PHYSICIAN:
All treatments should be based on observed signs and symptoms of distress in the patient. Consideration should be given to the possibility that overexposure to materials other than this product may have occurred.

Treat symptomatically. No specific antidote available.

This product contains a phenoxy herbicide. Myotoxic effects may include muscle fibrillations, myotonia, and muscular weakness. Ingestion of massive doses may result in persistent fall of blood pressure. Myoglobin and hemoglobin may be found in urine. Elevations in lactate dehydrogenase (LDH), SGOT, SGPT and aldolase indicate the extent of muscle damage. It has been suggested that overexposure in humans may affect both the central and peripheral nervous systems. The acute effects on the central nervous system resemble those produced by alcohol or sedative drugs. In isolated cases, peripheral neuropathy and reduced nerve conduction velocities have been reported although these observations may be related to other factors.

Gas-liquid chromatography for detecting and measuring chlorophenoxy compounds in blood and urine may be useful in confirming and assessing the magnitude of chlorophenoxy absorption.

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5. FIRE FIGHTING MEASURES

FIRE HAZARD DATA:

Flash Point:
Not Applicable

Extinguishing Media:
Recommended (small fires): dry chemical, carbon dioxide. Recommended (large fire): foam, water spray.

Special Fire Fighting Procedures:
Firefighters should wear NIOSH/MSHA approved self-contained breathing apparatus and full protective clothing. Dike area to prevent runoff and contamination of water sources. Dispose of fire control water later.

Unusual Fire and Explosion Hazards:
Under fire conditions, toxic, corrosive fumes are emitted.

Hazardous Decomposition Materials (Under Fire Conditions):
hydrogen chloride
oxides of nitrogen
oxides of carbon

6. ACCIDENTAL RELEASE MEASURES

Evacuation Procedures and Safety:
Wear appropriate protective gear for the situation. See Personal Protection information in Section 8.

Containment of Spill:
Dike spill using absorbent or impervious materials such as earth, sand or clay. Collect and contain contaminated absorbent and dike material for disposal.

Cleanup and Disposal of Spill:
Pump any free liquid into an appropriate closed container (see Section 7: Handling and Storage). Collect washings for disposal. Decontaminate tools and equipment following cleanup.

Environmental and Regulatory Reporting:
Do not flush to drain. Prevent material from entering public sewer

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6. ACCIDENTAL RELEASE MEASURES (CONTINUED)

system or any waterways. If spilled on the ground, the affected area should be removed to a depth of one or two inches and placed in an appropriate container for disposal. Dispose of as a hazardous waste. Spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies.

7. HANDLING AND STORAGE

Minimum/Maximum Storage Temperatures:
No Data Available

Handling:
Do not breathe vapors and mists. Do not get on skin or in eyes. Do not ingest.

Storage:
Store in an area that is away from food, feedstuffs, fertilizers and seed.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Introductory Remarks:
These recommendations provide general guidance for handling this product. Because specific work environments and material handling practices vary, safety procedures should be developed for each intended application. While developing safe handling procedures, do not overlook the need to clean equipment and piping systems for maintenance and repairs. Waste resulting from these procedures should be handled in accordance with Section 13: Disposal Considerations.

Assistance with selection, use and maintenance of worker protection equipment is generally available from equipment manufacturers.

Exposure Guidelines:
Exposure limits represent regulated or recommended worker breathing

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8. EXPOSURE CONTROLS/PERSONAL PROTECTION (CONTINUED)

zone concentrations measured by validated sampling and analytical methods, meeting OSHA requirements. The following limits (ACGIH, OSHA and other) apply to this material, where, if indicated, S=skin and C=ceiling limit:

2,4-D DIMETHYLAMINE SALT	Notes	TWA	STEL
RPI		5 mg/cu m	

Engineering Controls:
Where engineering controls are indicated by use conditions or a potential for excessive exposure exists, the following traditional exposure control techniques may be used to effectively minimize employee exposures: local exhaust ventilation at the point of generation.

Respiratory Protection:
When respirators are required, select NIOSH/MSHA approved equipment based on actual or potential airborne concentrations and in accordance with the latest OSHA standard (29 CFR 1910.134) and/or ANSI Z88.2 recommendations.

Under normal conditions, in the absence of other airborne contaminants, the following devices should provide protection from this material up to the conditions specified by OSHA/ANSI: Air-purifying (half-mask/full-face) respirator with cartridges/canister approved for use against pesticides.
Under conditions immediately dangerous to life or health, or emergency conditions with unknown concentrations, use a full-face positive pressure air-supplied respirator equipped with an emergency escape air supply unit or use a self-contained breathing apparatus unit.

Eye/Face Protection:
Eye and face protection requirements will vary dependent upon work environment conditions and material handling practices. Appropriate ANSI Z87 approved equipment should be selected for the particular use intended for this material.

Eye contact should be prevented through use of chemical safety glasses with side shields or splash proof goggles. An emergency eye wash must be readily accessible to the work area.

Skin Protection:
Skin contact must be prevented through the use of permeation resistant clothing, gloves and footwear, selected with regard for use conditions

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9. PHYSICAL AND CHEMICAL PROPERTIES (CONTINUED)

Freezing Point Range:
-6 C (21 F)

Boiling Point Range:
No Data Available

Vapor Pressure:
No Data Available

Vapor Density:
No Data Available

Molecular Weight:
266.12

10. STABILITY AND REACTIVITY

Chemical Stability:
This material is stable under normal handling and storage conditions described in Section 7.

Conditions To Be Avoided:
elevated temperatures

Materials/Chemicals To Be Avoided:
strong acids
strong oxidizing agents

The Following Hazardous Decomposition Products Might Be Expected:
Decomposition Type: thermal
hydrogen chloride
oxides of nitrogen
oxides of carbon

Hazardous Polymerization Will Not Occur.
Avoid The Following To Inhibit Hazardous Polymerization:
not applicable

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11. TOXICOLOGICAL INFORMATION

Acute Eye Irritation:
Toxicological Information and Interpretation
eye - eye irritation, rabbit.
Severe irritant.

Acute Skin Irritation:
Toxicological Information and Interpretation
skin - skin irritation, rabbit.
Under test conditions, this product caused minimal irritation to rabbit skin.

\cute Dermal Toxicity:
Toxicological Information and Interpretation
LD50 - lethal dose 50% of test species, 1544 mg/kg, rabbit.

Acute Respiratory Irritation:
No test data found for product.

Acute Inhalation Toxicity:
Toxicological Information and Interpretation
LC50 - lethal conctn. 50% of test species, > 2.06 mg/L/4 hr, rat.

Acute Oral Toxicity:
Toxicological Information and Interpretation
LD50 - lethal dose 50% of test species, 1161 mg/kg, rat.

Chronic Toxicity:
This product contains the following substances that are considered by OSHA, NTP, IARC or ACGIH to be "probable" or "suspected" human carcinogens.

Ingredient Name	Regulatory Agency Listing Carcinogen OSHA	IARC	NTP	ACGIH
CHLOROPHENOXY HERBICIDES	No	2B	No	No

Chlorophenoxy herbicides are listed as class 2B carcinogens (limited evidence for carcinogenicity in humans) by the International Agency for Research on Cancer (IARC). The Science Advisory Panel of USEPA has given a Class D classification (not classificable as to human carcinogenicity) and has required additional animal studies on 2,4-D. Various animal cancer tests have shown no reliable positive association between 2,4-D exposure and cancer. Recent results from a lifetime study in laboratory animals did not show evidence of carcinogenic effects caused by 2,4-D.

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12. ECOLOGICAL INFORMATION

Ecotoxicological Information:
For ecotoxicological data call the product information phone number listed in Section 1.

Chemical Fate Information:
For chemical fate data call the product information phone number listed in Section 1.

13. DISPOSAL CONSIDERATIONS

Waste Disposal Method:
Chemical additions, processing or otherwise altering this material may make the waste management information presented in this MSDS incomplete, inaccurate or otherwise inappropriate. Please be advised that state and local requirements for waste disposal may be more restrictive or otherwise different from federal laws and regulations. Consult state and local regulations regarding the proper disposal of this material.

Container Handling and Disposal:
Any containers or equipment used should be decontaminated immediately after use.
Consult state and local regulations regarding the proper disposal of container.

EPA Hazardous Waste - YES

14. TRANSPORTATION INFORMATION

For Transportation Regulatory Information call the Product Information phone number in Section 1.

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15. REGULATORY INFORMATION

FEDERAL REGULATIONS

TSCA Inventory Status:
This product is excluded from TSCA because it is solely for FIFRA regulated use.

SARA Title III Hazard Classes:

Fire Hazard	- NO
Reactive Hazard	- NO
Release of Pressure	- NO
Acute Health Hazard	- YES
Chronic Health Hazard	- YES

SARA Extremely Hazardous Substances (EHS)/CERCLA Hazardous Substances

Ingredient	CERCLA/SARA RQ	SARA EHS TPQ
UNLISTED HAZ. WASTE CHARACTERISTIC OF EP TOXICITY - 2,4-D	100 lbs	

STATE REGULATIONS:
This product does not contain any components that are regulated under California Proposition 65.

16. OTHER INFORMATION

National Fire Protection Association Hazard Ratings--NFPA(R):
2 Health Hazard Rating--Moderate
1 Flammability Rating--Slight
1 Reactivity Rating--Slight

National Paint & Coating Hazardous Materials Identification System--HMIS(R):
2 Health Hazard Rating--Moderate
1 Flammability Rating--Slight
1 Reactivity Rating--Slight

Reason for Revisions:
Conversion to ANSI MSDS format.

Key Legend Information:
NAV - Not Available
NAP - Not Applicable

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16. OTHER INFORMATION (CONTINUED)

ND - Not Determined
ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
TLV - Threshold Limit Value
PEL - Permissable Exposure Limit
TWA - Time Weighted Average
STEL - Short Term Exposure Limit
NTP - National Toxicology Program
IARC - International Agency for Research on Cancer

Disclaimer:
The information herein is given in good faith but no warranty, xpressed or implied, is made.

This sample label is current as of February 15, 1995. The product descriptions and recommendations provided in this sample label are for background information only. Always refer to the label on the product before using Monsanto or any other agrichemical product.

RODEO®

EMERGED AQUATIC WEED AND BRUSH HERBICIDE

BY Monsanto

Complete Directions for Use in Aquatic and Other Noncrop Sites.

EPA Reg. No. 524-343

AVOID CONTACT WITH FOLIAGE, GREEN STEMS, EXPOSED NONWOODY ROOTS, OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, SINCE SEVERE INJURY OR DESTRUCTION MAY RESULT.

RODEO is a registered trademark of Monsanto Company

1995-1 21061?1-1.CG

Read the entire label before using this product.

Use only according to label instructions.

Read "LIMIT OF WARRANTY AND LIABILITY" before buying or using. If terms are not acceptable, return at once unopened.

REFORMULATION IS PROHIBITED. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS

LIMIT OF WARRANTY AND LIABILITY

This Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY OR ANY OTHER EXPRESS OR IMPLIED WARRANTY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise.

Buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not expressly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil or treated vegetation.

THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACCURED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES.

Buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement.

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

Keep out of reach of children.

CAUTION!

HARMFUL IF INHALED.

Avoid breathing vapors or spray mist.

Remove contaminated clothing and wash clothing before reuse.

Wash thoroughly with soap and water after handling.

FIRST AID: IF INHALED, remove individual to fresh air. Seek medical attention if breathing difficulty develops.

In case of an emergency involving this product, Call Collect day or night, (314) 694-4000.

Environmental Hazards

Do not contaminate water when disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of SPILL or LEAK, soak up and remove to a landfill.

Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic and plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

ACTIVE INGREDIENT:	
*Glyphosate: N-(phosphonomethyl)glycine, in the form of its isopropylamine salt	53.8%
INERT INGREDIENTS	46.2%
	100.0%

*Contains 648 grams per litre or 5.4 pounds per U.S. gallon of the active ingredient glyphosate in the form of its isopropylamine salt. Equivalent to 480 grams per litre or 4 pounds per U.S. gallon of the acid glyphosate.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

For more product information call toll-free 1-800-332-3111.

Storage and Disposal

Do not contaminate water, foodstuffs, feed or seed by storage or disposal.

See container label for STORAGE AND DISPOSAL instructions.

GENERAL INFORMATION

This product is a water soluble liquid mixes readily with water and nonionic surfactant to be applied as a foliar spray for the control or destruction of many herbaceous and woody plants.

This product moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days but on most perennial brush species may not occur for 7 days or more. Extreme cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects are a gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the Weeds Controlled section of this label.

Unemerged plants arising from unaffected underground rhizomes or root crowns of perennial or biennial will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is achieved when treatment is made at late growth stages approaching maturity.

Always use the higher rate of this product per acre within the recommended range when vegetation is heavy or dense.

Prepare the desired volume of spray solution by mixing the amount of this product in water, shown in the following table:

Spray Solution

	AMOUNT OF RODEO®					
DESIRED VOLUME	3/4%	1%	1 1/2%	1 1/2%	5%	8%
1 gallon	1 oz.	1 oz.	1 oz.	2 oz.	6 oz.	10 1/2 oz.
25 gallons	1 1/2 pt.	1 qt.	1 1/2 qt.	1 1/2 qt.	5 qt.	2 gal.
100 gallons	3 qt.	1 gal.	1 1/2 gal.	1 1/2 gal.	5 gal.	8 gal.

2 tablespoons = 1 ounce

For use in knapsack sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill sprayer with the mixed solution and add the correct amount of surfactant.

WEEDS CONTROLLED

ANNUAL WEEDS

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "Directions for Use," "General Information" and "Mixing and Application Instructions" for labeled uses and specific application instructions.

Broadcast Application—Use 1 1/2 pints of this product per acre plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution if weeds are less than 6 inches tall. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus 2 or more quarts of an approved nonionic surfactant per 100 gallons of spray solution.

Hand-Held, High-Volume Application—Use a 3/4 percent solution of this product in water plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution and apply to foliage of vegetation to be controlled.

When applied as directed under the conditions described in this label, this product plus nonionic surfactant WILL CONTROL the following ANNUAL WEEDS:

Balsamapple**
Momordica charantia

Barley
Hordeum vulgare

Barnyardgrass
Echinochloa crus-galli

Bassia, fivehook
Bassia hyssopifolia

Bluegrass, annual
Poa annua

Bluegrass, bulbous
Poa bulbosa

Brome
Bromus spp.

Buttercup
Ranunculus spp.

Cheat
Bromus secalinus

Chickweed, mouseear
Cerastium vulgatum

Cocklebur
Xanthium strumarium

Corn, volunteer
Zea mays

Crabgrass
Digitaria spp.

Dwarfdandelion
Krigia cespitosa

Falseflax, smallseed
Camelina microcarpa

Fiddleneck
Amsinckia spp.

Flaxleaf fleabane
Conyza bonariensis

Fleabane
Erigeron spp.

Foxtail
Setaria spp.

Foxtail, Carolina
Alopecurus carolinianus

Groundsel, common
Senecio vulgaris

Horseweed/Marestail
Conyza canadensis

Kochia
Kochia scoparia

Lambsquarters, common
Chenopodium album

Lettuce, prickly
Lactuca serriola

Morningglory
Ipomoea spp.

Mustard, blue
Chorispora tenella

Mustard, tansy
Descurainia pinnata

Mustard, tumble
Sisymbrium altissimum

Mustard, wild
Sinapis arvensis

Oats, wild
Avena fatua

Panicum
Panicum spp.

Pennycress, field
Thlaspi arvense

Pigweed, redroot
Amaranthus retroflexus

Pigweed, smooth
Amaranthus hybridus

Ragweed, common
Ambrosia artemisiifolia

Ragweed, giant
Ambrosia trifida

Rocket, London
Sisymbrium irio

Rye
Secale cereale

Ryegrass, Italian*
Lolium multiflorum

Sandbur, field
Cenchrus spp.

Shattercane
Sorghum bicolor

Shepherdspurse
Capsella bursa-pastoris

Signalgrass, broadleaf
Brachiaria platyphylla

Smartweed, Pennsylvania
Polygonum pensylvanicum

Sowthistle, annual
Sonchus oleraceus

Spanishneedles*
Bidens bipinnata

Stinkgrass
Eragrostis cilianensis

Sunflower
Helianthus annuus

Thistle, Russian
Salsola kali

Spurry, umbrella
Holosteum umbellatum

Velvetleaf
Abutilon theophrasti

Wheat
Triticum aestivum

Witchgrass
Panicum capillare

*Apply 3 pints of this product per acre.

**Apply with hand-held equipment only.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

PERENNIAL WEEDS

Apply this product as follows to control or destroy most vigorously growing perennial weeds. Unless otherwise directed, allow at least 7 days after application before disturbing vegetation.

Add 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution to the rates of this product given in this list. See the "General Information," "Directions for Use" and "Mixing and Application" sections in this label for specific uses and application instructions.

NOTE: If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Reseal treatments may be necessary to control weeds regenerating from underground parts or seed.

When applied as recommended under the conditions described, this product plus surfactant WILL CONTROL the following PERENNIAL WEEDS:

Alfalfa
Medicago sativa

Alligatorweed*
Alternanthera philoxeroides

Anise/Fennel
Foeniculum vulgare

Artichoke, Jerusalem
Helianthus tuberosus

Bahiagrass
Paspalum notatum

Bermudagrass
Cynodon dactylon

Bindweed, field
Convolvulus arvensis

Bluegrass, Kentucky
Poa pratensis

Blueweed, Texas
Helianthus ciliaris

Brackenfern
Pteridium spp.

Bromegrass, smooth
Bromus inermis

Canarygrass, reed
Phalaris arundinacea

Cattail
Typha spp.

Clover, red
Trifolium pratense

Clover, white
Trifolium repens

Cogongrass
Imperata cylindrica

Cordgrass
Spartina spp.

Cutgrass, giant*
Zizaniopsis miliacea

Dallisgrass
Paspalum dilatatum

Dandelion
Taraxacum officinale

Dock, curly
Rumex crispus

Dogbane, hemp
Apocynum cannabinum

Fescue
Festuca spp.

Fescue, tall
Festuca arundinacea

Guineagrass
Panicum maximum

Hemlock, poison
Conium maculatum

Horsenettle
Solanum carolinense

Horseradish
Armoracia rusticana

Ice Plant
Mesembryanthemum crystallinum

Johnsongrass
Sorghum halepense

Reed, giant/ice plant—For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.

Spatterdock—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.

Sweet potato, wild—Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.

Thistle: Canada, artichoke—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.

Torpedograss—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.

Tufes, common—Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.

Waterhyacinth—Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.

Waterlettuce—For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.

Waterprimrose—Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.

Other perennials listed on this label—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached early head or early bud stage of growth.

WOODY BRUSH AND TREES

When applied as recommended under the conditions described, this product plus surfactant CONTROLS or PARTIALLY CONTROLS the following woody brush plants and trees:

Alder
Alnus spp.

Ash*
Fraxinus spp.

Aspen, quaking
Populus tremuloides

Bearclover, Bearmat
Chamaebatia foliolosa

Birch
Betula spp.

Blackberry
Rubus spp.

Broom:
French
Cytisus monspessulanus
Scotch
Cytisus scoparius

Buckwheat, California*
Eriogonum fasciculatum

Cascara*
Rhamnus purshiana

Catsclaw*
Acacia greggi

Ceanothus
Ceanothus spp.

Chamise
Adenostoma fasciculatum

Cherry:
Bitter
Prunus emarginata
Black
Prunus serotina
Pin
Prunus pensylvanica

Coyote brush
Baccharis consanguinea

Creeper, Virginia*
Parthenocissus quinquefolia

Dewberry
Rubus trivialis

Dogwood
Cornus spp.

Elderberry
Sambucus spp.

Elm*
Ulmus spp.

Eucalyptus, bluegum
Eucalyptus globulus

Hasardia*
Haplopappus squamosus

Hawthorn
Crataegus spp.

Hazel
Corylus spp.

Hickory
Carya spp.

Holly, Florida; Brazilian Peppertree
Schinus terebinthifolius

Honeysuckle
Lonicera spp.

Hornbeam, American
Carpinus caroliniana

Kudzu
Pueraria lobata

Locust, black*
Robinia pseudoacacia

Manzanita
Arctostaphylos spp.

Maple:
Red**
Acer rubrum
Sugar
Acer saccharum
Vine*
Acer circinatum

Monkey Flower*
Mimulus guttatus

Oak:
Black*
Quercus velutina
Northern pine
Quercus palustris
Post
Quercus stellata
Red
Quercus rubra
Southern red
Quercus falcata
White*
Quercus alba

Persimmon*
Diospyros spp.

Poison Ivy
Rhus radicans

Poison Oak
Rhus toxicodendron

Poplar, yellow*
Liriodendron tulipifera

Prunus
Prunus spp.

Raspberry
Rubus spp.

Redbud, eastern
Cercis canadensis

Rose, multiflora
Rosa multiflora

Russian-olive
Elaeagnus angustifolia

Sage: black, white
Salvia spp.

Sagebrush, California
Artemisia californica

Salmonberry
Rubus spectabilis

Salt cedar*
Tamarix spp.

Saltbush, Sea myrtle
Baccharis halimifolia

Sassafras
Sassafras albidum

Sourwood*
Oxydendrum arboreum

Sumac:
Poison*
Rhus vernix
Smooth*
Rhus glabra
Winged*
Rhus copallina

Sweet gum
Liquidambar styraciflua

Swordfern*
Polystichum munitum

Tallowtree, Chinese
Sapium sebiferum

Thimbleberry
Rubus parviflorus

Tobacco, tree*
Nicotiana glauca

Trumpetcreeper
Campsis radicans

Waxmyrtle, southern*
Myrica cerifera

Willow
Salix spp.

*Partial control

**See below for control or partial control instruction.

NOTE: If brush has been mowed or tops of trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

Apply the recommended rate of this product plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution when plants are actively growing and, unless otherwise directed, after full leaf expansion. Use the higher rate for larger plants and/or dense areas of growth. On vines, use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In arid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "Directions for Use" and "Mixing and Application Instructions" sections in this label for labeled use and specific application instructions.

Applied as a 5 to 8 percent solution as a directed application as described in the "HAND-HELD AND HIGH-VOLUME EQUIPMENT" section, this product will control or partially control all species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Kikuyugrass
Pennisetum clandestinum

Knapweed
Centaurea repens

Lantana
Lantana camara

Lespedeza: common, serices
Lespedeza striata
Lespedeza cuneata

Loosestrife, purple
Lythrum salicaria

Lotus, American
Nelumbo lutea

Maidencane
Panicum hematomon

Milkweed
Asclepias spp.

Muhly, wirestem
Muhlenbergia frondosa

Mullein, common
Verbascum thapsus

Napiergrass
Pennisetum purpureum

Nightshade, silverleaf
Solanum elaeagnifolium

Nutsedge: purple, yellow
Cyperus rotundus
Cyperus esculentus

Orchardgrass
Dactylis glomerata

Pampasgrass
Cortaderia jubata

Paragrass
Brachiaria mutica

Phragmites**
Phragmites spp.

Quackgrass
Agropyron repens

Reed, giant
Arundo donax

Ryegrass, perennial
Lolium perenne

Smartweed, swamp
Polygonum coccineum

Spatterdock
Nupnar luteum

Starthistle, yellow
Centaurea solstitialis

Sweet potato, wild*
Ipomoea pandurata

Thistle, artichoke
Cynara cardunculus

Thistle, Canada
Cirsium arvense

Timothy
Phleum pratense

Torpedograss*
Panicum repens

Tules, common
Scirpus acutus

Vaseygrass
Paspalum urvillei

Velvetgrass
Holcus spp.

Waterhyacinth
Eichornia crassipes

Waterlettuce
Pistia stratiotes

Waterprimrose
Ludwigia spp.

Wheatgrass, western
Agropyron smithii

*Partial control.

**Partial control in southeastern states. See specific recommendations below.

Alligatorweed—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.

Bermudagrass—Apply 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and when seed heads appear.

Bindweed, field/Silverleaf Nightshade/Texas Blueweed—Apply 5 to 7 1/2 pints of this product per acre as a broadcast spray west of the Mississippi River and 4 1/2 to 6 pints of this product per acre east of the Mississippi River. With hand-held equipment, use a 1 1/2 percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade, best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.

Brackenfern—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 to 1 percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.

Cattail—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early-to-full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.

Cogongrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.

Cordgrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 2 percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.

Cutgrass, giant—Apply 6 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7 to 10-leaf stage prior to retreatment.

Dogbane, hemp/Knapweed, Horseradish—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth. For best results, apply in late summer or fall.

Fescue, tall—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.

Guineagrass—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.

Johnsongrass/Bluegrass, Kentucky/Bromegrass, smooth/Canarygrass, reed/Orchardgrass/Ryegrass, perennial/Timothy/Wheatgrass, western — Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot-to-head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.

Lantana—Apply this product as a 3/4 to 1 percent solution with hand-held equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.

Loosestrife, purple—Apply 4 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution using hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.

Lotus, American—Apply 4 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.

Maidencane/Paragrass—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Repeat treatments will be required, especially to vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7 to 10-leaf stage prior to retreatment.

Milkweed, common—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.

Nutsedge: purple, yellow—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at maximum size. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.

Pampasgrass—Apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing.

Phragmites—For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 7 1/2 pints per acre as a broadcast spray or apply a 1 1/2 percent solution with hand-held equipment. In other areas of the U.S., apply 4 to 6 pints per acre as a broadcast spray or apply a 3/4 percent solution with hand-held equipment for partial control. For best results, treat during late summer or fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.

Quackgrass/Kikuyugrass/Muhly, wirestem—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height, 3 to 4-leaf stage of growth and actively growing. Allow 3 or more days after application before tillage.

Apply the product as follows to control or partially control the following woody brush and trees.

Alder/Blackberry/Dewberry/Honeysuckle/Oak, Post/Raspberry—For control, apply 4 1/2 to 6 pints per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.

Aspen, Quaking/Hawthorn/Trumpetcreeper—For control, apply 3 to 4 1/4 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment.

Birch/Elderberry/Hazel/Salmonberry/Thimbleberry—For control, apply 3 pints per acre of this product as a broadcast spray or as a 3/4 percent solution with hand-held equipment.

Broom: French, Scotch—For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment.

Buckwheat, California/Hasardia/Monkey Flower/ Tobacco, Tree—For partial control of these species, apply a 3/4 to 1 1/2 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Catsclaw—For partial control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Cherry: Bitter, Black, Pin/Oak, Southern Red/Sweet Gum/Prunus—For control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution with hand-held equipment.

Coyote brush—For control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Dogwood/Hickory/Salt cedar—For partial control, apply a 1 to 2 percent solution of this product with hand-held equipment or 6 to 7 1/2 pints per acre as a broadcast spray.

Eucalyptus, bluegum—For control of eucalyptus resprouts, apply a 1 1/2 percent solution of this product with hand-held equipment when resprouts are 6 to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to drought-stressed plants.

Holly, Florida/Waxmyrtle, southern—For partial control, apply this product as a 1 1/2 percent solution with hand-held equipment.

Kudzu—For control, apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications will be required to maintain control.

Maple, Red—For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 2 to 7 1/2 pints of this product per acre as a broadcast spray.

Maple, Sugar/Oak: Northern Pin, Red—For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed.

Poison Ivy/Poison Oak—For control, apply 5 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color.

Rose, multiflora—For control, apply 3 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects.

Sage, black/Sagebrush, California/Chamise/Tallowtree, Chinese—For control of these species, apply a 3/4 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results.

Saltbush, Sea myrtle—For control, apply this product as a 1 percent solution with hand-held equipment.

Willow—For control, apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment.

Other woody brush and trees listed in this label—For partial control, apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment.

AQUATIC AND OTHER NONCROP SITES

When applied as directed and under the conditions described in the "Weeds Controlled" section in this label, this product will control or partially control the labeled weeds growing in the following industrial, recreational and public areas or other similar aquatic and terrestrial sites.

Aquatic Sites—This product may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, rice levees, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas, and similar sites.

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions:

This product does not control plants which are completely submerged or have a majority of their foliage under water.

There is no restriction on the use of treated water for irrigation, recreation or domestic purposes.

Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.

NOTE: Do not apply this product within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 part per million as determined by laboratory analysis. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications.

For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.

Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment.

Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water.

When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill.

Other Noncrop-Type Sites—This product may be used to control the listed weeds in terrestrial noncrop sites and/or in aquatic sites within these areas.

Airports	Petroleum Tank Farms
Golf Courses	Pipeline, Power, Telephone & Utility Rights-of-Way
Habitat Restoration & Management Areas	Pumping Installations
Highways & Roadsides	Railroads
Industrial Plant Sites	Schools
Lumberyards	Storage Areas
Parking Areas	Similar Sites
Parks	

WILDLIFE HABITAT RESTORATION AND MANAGEMENT AREAS

This product is recommended for the restoration and or maintenance of native habitat and in wildlife management areas.

Habitat Restoration and Maintenance—When applied as directed, exotic and other undesirable vegetation may be controlled in habitat management areas. Applications may be made to allow recovery of native plant species, to open up water to attract waterfowl and for similar broad-spectrum vegetation control requirements in habitat management areas. Spot treatments may be made to selectively remove unwanted plants for habitat enhancement. For spot treatments, care should be exercised to keep spray off of desirable plants.

Wildlife Food Plots—This product may be used as a site preparation treatment prior to planting wildlife food plots. Apply as directed to control vegetation in the plot area. Any wildlife food species may be planted after applying this product, or native species may be allowed to reinfest the area. If tillage is needed to prepare a seedbed, wait 7 days after applying this product before tilling to allow for maximum effectiveness.

WIPER APPLICATIONS

For wick or wiper applications, mix 1 gallon of this product with 2 gallons of clean water to make a 33 percent solution. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended.

Apply this product 1 to 2 weeks after full green-up of bahiagrass or after the bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product, plus 2 quarts of an approved nonionic surfactant per 100 gallons of total spray volume in 10 to 25 gallons of water per acre.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45-day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression, sequential applications must be made prior to seedhead emergence.

Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the last application.

ANNUAL GRASS GROWTH SUPPRESSION

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of spray solution per acre. Mix 2 quarts of a nonionic surfactant per 100 gallons of spray solution. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

Product is protected by U.S. Patent No. 4,405,531. Other patents are pending. No license granted under any non-U.S. patent(s).

EPA Reg. No. 524-343

In case of an emergency involving this product,
Call Collect, day or night, (314) 694-4000.

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1995-1 21061T1-1/CG

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AGRICULTURAL PRODUCTS
ST. LOUIS, MISSOURI 63167 U.S.A.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands, a double application in opposite directions may improve results. See the "Weeds Controlled" section in this label for recommended timing, growth stage and other instructions for achieving optimum results.

CUT STUMP APPLICATION

Woody vegetation may be controlled by treating freshly cut stumps of trees and resprouts with this product. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut vegetation close to the soil surface. **Apply a 50 to 100 percent solution of this product to freshly cut surface immediately after cutting.** Delay in applying this product may result in reduced performance. For best results, trees should be cut during periods of active growth and full leaf expansion.

When used according to directions for cut stump application, this product will CONTROL, PARTIALLY CONTROL or SUPPRESS most woody brush and tree species, some of which are listed below:

Alder *Alnus spp.*	**Poplar*** *Populus spp.*
Coyote brush* *Baccharis consanguinea*	**Reed, giant** *Arundo donax*
Dogwood* *Cornus spp.*	**Salt cedar** *Tamarix spp.*
Eucalyptus *Eucalyptus spp.*	**Sweet gum*** *Liquidambar styraciflua*
Hickory* *Carya spp.*	**Sycamore*** *Platanus occidentalis*
Madrone *Arbutus menziesii*	**Tan oak** *Lithocarpus densiflorus*
Maple* *Acer spp.*	**Willow** *Salix spp.*
Oak *Quercus spp.*	

*This product is not approved for this use on these species in the state of California.

INJECTION AND FRILL APPLICATIONS

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

This treatment WILL CONTROL the following woody species:

Oak *Quercus spp.*	**Sweet gum** *Liquidambar styraciflua*
Poplar *Populus spp.*	**Sycamore** *Platanus occidentalis*

This treatment WILL SUPPRESS the following woody species:

Black gum* *Nyssa sylvatica*	**Hickory** *Carya spp.*
Dogwood *Cornus spp.*	**Maple, red** *Acer rubrum*

*This product is not approved for this use on this species in the state of California.

RELEASE OF BERMUDAGRASS OR BAHIAGRASS ON NONCROP SITES

RELEASE OF DORMANT BERMUDAGRASS AND BAHIAGRASS

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4 to 5-leaf stage.

WEEDS CONTROLLED

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

WEEDS CONTROLLED OR SUPPRESSED*

NOTE: C = Control
S = Suppression

WEED SPECIES	RODEO® FLUID OZ/ACRE 6	9	12	18	24	48
Barley, little *Hordeum pusillum*	S	C	C	C	C	C
Bedstraw, catchweed *Galium aparine*	S	C	C	C	C	C
Bluegrass, annual *Poa annua*	S	C	C	C	C	C
Chervil *Chaerophyllum tainturieri*	S	C	C	C	C	C
Chickweed, common *Stellaria media*	S	C	C	C	C	C
Clover, crimson *Trifolium incarnatum*	•	S	S	C	C	C
Clover, large hop *Trifolium campestre*	•	S	S	C	C	C
Speedwell, corn *Veronica arvensis*	S	C	C	C	C	C
Fescue, tall *Festuca arundinacea*	•	•	•	•	S	S
Geranium, Carolina *Geranium carolinianum*	•	•	S	S	C	C
Henbit *Lamium amplexicaule*	•	S	C	C	C	C
Ryegrass, Italian *Lolium multiflorum*	•	•	S	C	C	C
Vetch, common *Vicia sativa*	•	•	S	C	C	C

*These rates apply only to sites where an established competitive turf is present.

RELEASE OF ACTIVELY GROWING BERMUDAGRASS

NOTE: USE ONLY ON SITES WHERE BAHIAGRASS OR BERMUDAGRASS ARE DESIRED FOR GROUND COVER AND SOME TEMPORARY INJURY OR YELLOWING OF THE GRASSES CAN BE TOLERATED.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "Weeds Controlled" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner in annual lines). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer-term suppression of the following perennial species. Use lower rates for shorter-term suppression of growth.

Bahiagrass	Johnsongrass**
Dallisgrass	Trumpetcreeper*
Fescue (tall)	Vaseygrass

*Suppression at the higher rate only.
**Johnsongrass is controlled at the higher rate.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

BAHIAGRASS SEEDHEAD AND VEGETATIVE SUPPRESSION

When applied as directed in the "Noncrop Sites" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

MONSANTO PRODUCT NAME

RODEO® Emerged Aquatic Weed and Brush Herbicide

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ♣

Product Name: RODEO® Emerged Aquatic Weed and Brush Herbicide

Synonyms: None

EPA Reg. No.: 524-343

Company ID: Monsanto Company
800 North Lindbergh
St. Louis, MO 63167, U.S.A.

Phone #s: Emergency Phone Number (call collect): (314) 694-4000
Non-Emergency Information: 1-800-332-3111

Revisions: Sections containing a revision or new information are marked with a ♣

MSDS Number: S00010153 **Date: November, 1994** **Supersedes: March, 1993**

2. COMPOSITION INFORMATION ON INGREDIENTS ♣

Chemical Ingredients: *Active Ingredient:* Glyphosate, N-(phosphonomethyl) glycine, in the form of its isopropylamine salt ..... 53.8 %

Inert Ingredients: ..... 46.2 %

100.0%

Component	CAS Reg No	% by Wt
Glyphosate, isopropylamine salt	38641-94-0	53.8%

* NO Hazardous chemicals under the criteria of the OSHA Hazard Communication Standard (29 CFR §1910.1200)

See Section 8 for exposure limits.

3. HAZARDS IDENTIFICATION ♣

Emergency Overview:

Appearance & Odor: Colorless and odorless solution

Warning Statements:
- Keep out of reach of children.
- CAUTION!
- HARMFUL IF INHALED

Potential Adverse Health Effects:

Likely Routes of Exposure: Inhalation and skin contact

Eye Contact: No more than slightly irritating based on toxicity studies.

Skin Contact: No more than slightly toxic or irritating based on toxicity studies.

Ingestion: No more than slightly toxic based on toxicity studies. No significant adverse health effects are expected to develop if only small amounts (less than a mouthful) are swallowed.

Inhalation: No more than slightly toxic if inhaled based on toxicity studies.

Refer to Section 11 for toxicological information.

4. FIRST AID MEASURES ♣

If Inhaled: Remove individual to fresh air. Seek medical attention if breathing difficulty develops.

NOTE: For additional human emergency first aid or treatment guidance, call collect, anytime, day or night (314) 694-4000.

5. FIRE FIGHTING MEASURES

Flash Point: This material is not combustible as tested by the Tag Cup Test.

Auto Ignition Temperature: Not determined

Extinguishing Media: Use appropriate extinguishing media for exposure fire.

Special Fire Fighting Procedures: Firefighters and others that may be exposed to vapors, mists, dusts, or products of combustion should wear full protective clothing and self-contained breathing apparatus. Equipment should be thoroughly cleaned after use.

Unusual Fire or Explosion Hazards: None

6. ACCIDENTAL RELEASE MEASURES ♣

Observe all protection and safety precautions when cleaning up spills - See Exposure Controls/Personal Protection, Section 8.

Small Spills: For a spill less than one gallon on floor or other impervious surface, soak up with towels or other absorbent material and discard in the trash. Clean the spill area with soap and water and rinse the area thoroughly.

Large Liquid Spills on the floor or other impervious surface should be contained or diked and then absorbed with attapulgite, bentonite or other absorbent clays. Collect the contaminated absorbent, place in a metal drum and dispose of in accordance with the instructions provided under Disposal, Section 13 of this MSDS. Thoroughly scrub floor or other impervious surface with a strong industrial detergent and rinse with water.

Large spills that soak into the ground should be dug up, placed in metal drums and disposed of in accordance with instructions provided under DISPOSAL, Section 13 of this MSDS. Contact appropriate state agency when considering a land spreading disposal option.

Leaking containers should be separated from non-leakers and either the container or its contents transferred to a drum or other non-leaking container and disposed of in accordance with instructions provided under DISPOSAL, Section 13 of this MSDS. Any recovered spilled liquid should be similarly collected and disposed of.

7. HANDLING AND STORAGE ♣

Handling:

- Avoid breathing vapors or spray mist
- Remove contaminated clothing and wash clothing before reuse.
- Wash thoroughly with soap and water after handling.
- Do not contaminate water when disposing of equipment wash waters.
- Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

Storage:

- STORE ABOVE 10° F (-12° C) TO KEEP FROM CRYSTALLIZING.
- Crystals will settle to the bottom. If allowed to crystallize, place in a warm room at 68°F (20°C) for several days to redissolve and mix well before using.
- Do not contaminate water, foodstuffs, feed or seed by storage or disposal.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Personal Protective Equipment:

Eye Protection: RODEO® Emerged Aquatic Weed and Brush herbicide does not present significant eye irritation or eye toxicity requiring special protection. Avoid eye contact as good industrial practice.

Skin Protection: RODEO® Emerged Aquatic Weed and Brush herbicide does not present significant skin concern requiring special protection.

Respiratory Protection: For Handling of the Undiluted Product: Undiluted RODEO® Emerged Aquatic Weed and Brush herbicide is not likely to represent an airborne exposure concern during normal handling. In the event of an accidental discharge of the material during manufacture or handling which produces a heavy vapor or mist, workers should put on respiratory protection equipment. Consult respirator manufacturer to determine appropriate type of equipment. Observe respirator use limitations specified by NIOSH/MSHA or the manufacturer. Respiratory protection programs must comply with 29 CFR §1910.134.

For Application of Product Diluted in accordance with label instructions: Respirators are not required for applications of use - dilutions of RODEO® Emerged Aquatic Weed and Brush herbicide.

Ventilation: No special precautions are recommended.

Exposure Guidelines:

Exposure Limits	OSHA PEL	ACGIH TLV
RODEO®	None established	None established

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Colorless solution

Odor: Essentially odorless

pH: 4.6 - 4.8

Specific Gravity: 1.22 - 1.25 (water = 1)

Note: These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specification items.

10. STABILITY AND REACTIVITY

Chemical Stability: Stable for at least 5 years under normal conditions of warehouse storage. Heated facilities are not required.

Conditions to Avoid: Store above 10°F (-12°C) to keep from crystallizing.

Incompatibility with Other Materials: Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic and plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

Hazardous Decomposition Products: None known

Hazardous Polymerization: Does not occur. This product can react with caustic (basic) materials to liberate heat. This is not a polymerization but rather a chemical neutralization in an acid-base reaction.

11. TOXICOLOGICAL INFORMATION ♣

TOXICOLOGICAL DATA

Data from laboratory studies conducted by Monsanto with RODEO® Emerged Aquatic Weed and Brush herbicide are summarized below.

Oral - Practically Non-toxic, (Rat LD_{50} - >5,000 mg/kg)

Dermal - Practically Non-toxic, (Rabbit LD_{50} - >5000 mg/kg)

Inhalation - Slightly Toxic, (Rat 4-hr LC_{50} - > 1.3 mg/l, the highest atmospheric concentration achievable in this study); FIFRA Category III, Not DOT poisonous

Eye Irritation - Non irritating, - Rabbits (6 animals); 24-hr exp.; Draize Average: 0.0/110; EU: Corneal Opacity - 0.0, Iris - 0.0, Erythema - 0.0, Chemosis - 0.0

Skin Irritation - Practically Nonirritating - Rabbits (6 animals); 24-hr exp.; Draize Average: 0.1/8.0; EU: Erythema - 0.1, Edema - 0.0

In repeat dosing studies (6-months), dogs fed RODEO® Emerged Aquatic Weed and Brush herbicide exhibited slight body weight changes. Following repeated skin exposure (3-weeks) to RODEO® Emerged Aquatic Weed and Brush herbicide, skin irritation was the only effect in rabbits. No skin allergy was observed in guinea pigs following repeated skin exposure.

Additional toxicity information is available on glyphosate, the active herbicidal ingredient of RODEO® Emerged Aquatic Weed and Brush herbicide. Following repeated exposures (90-days) to glyphosate in their feed, decreased weight gains were noted at the highest test level in mice, while no treatment-related effects occurred in rats. Following repeated skin exposure (3 weeks) to glyphosate, slight skin irritation was the primary effect observed in rabbits. No skin allergy was observed in guinea pigs following repeated skin exposure. There was no evidence of effects on the nervous system, including delayed effects in chickens (repeat oral doses) or cholinesterase inhibition in rats (single oral doses). Reduced body weight gain and effects on liver tissues were observed with long-term (2-year) feeding of glyphosate to mice at high-dose levels. Reduced body weight gain and eye changes were observed at the high-dose level in one long-term (2 year) feeding study with rats, while no treatment-related effects occurred in a second study. No adverse effects were observed in feeding studies with dogs. Glyphosate did not produce tumors in any of these studies. **Based on the results from the chronic studies, EPA has classified glyphosate in category E (evidence of non-carcinogenicity for humans).** No birth defects were noted in rats and rabbits given glyphosate orally during pregnancy, even at amounts which produced adverse effects on the mothers. Glyphosate was fed continuously to rats at very high dose levels for 2 successive generations. Toxicity was reported in offspring from the high dose, a level which also produced adverse effects on the mothers. In a 3 generation study conducted at lower dose levels, no effects were seen on the ability of male or female rats to reproduce. Glyphosate has produced no genetic changes in a variety of standard tests using animals and animal or bacterial cells.

12. ECOLOGICAL INFORMATION

96-hr LC_{50} Bluegill: >1,000 mg/l, Practically Nontoxic
96-hr LC_{50} Trout: >1,000 mg/l, Practically Nontoxic
48-hr EC_{50} *Daphnia*: 930 mg/l, Practically Nontoxic
Oral LD_{50} Goat: 5,700 mg/kg, Practically Nontoxic

Brahman-cross heifers were given RODEO® Emerged Aquatic Weed and Brush herbicide, by gavage, at daily dosages of 0, 540, 830, 1290 and 2000 mg/kg for 7 consecutive days. Clinical signs of toxicity, including loss of appetite, diarrhea and death (1290 and 2000 mg/kg) were observed at 830 mg/kg or above. The no-effect level was considered to be 540 mg/kg/day.

For environmental toxicity information with Glyphosate, the active herbicidal ingredient of RODEO® Emerged Aquatic Weed and Brush herbicide, refer to the Glyphosate Material Safety Data Sheet.

13. DISPOSAL CONSIDERATIONS

Wastes resulting from the use of this product that cannot be used or chemically reprocessed should be disposed of in a landfill approved for pesticide disposal or in accordance with applicable Federal, State and local procedures.

Emptied container retains vapor and product residue. Observe all labeled safeguards until container is cleaned, reconditioned or destroyed.

Do not reuse container. Return emptied container per the Monsanto container return program. If not returned, triple rinse container, then puncture and dispose of in a sanitary landfill or by incineration or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

14. TRANSPORT INFORMATION ♣

Follow the precautions indicated in the Handling and Storage Section, Section 7 of this MSDS.

DOT Proper Shipping Name: Not Applicable
DOT Hazard Class/I.D. No.: Not Applicable
DOT Label: Not Applicable
U.S. Surface Freight Classification: Weed killing compound, N.O.I.B.N.

15. REGULATORY INFORMATION

SARA Hazard Notification:
Hazard Categories Under Criteria of SARA Title III Rules (40 CFR Part 370): Not applicable

Section 313 Toxic Chemical(s): Not Applicable

Hazardous Chemical(s) Under OSHA Hazard Communication Standard: Not Applicable

Reportable Quantity (RQ) under U.S. CERCLA: Not Applicable

TSCA Inventory: All components are on the US EPA's TSCA Inventory List

16. OTHER

Reasons for revision: New CMA Format; New name; Correct ingredient %s; update spill procedures

This Material Safety Data Sheet (MSDS) serves different purposes than and DOES NOT REPLACE OR MODIFY THE EPA-APPROVED PRODUCT LABELING (attached to and accompanying the product container). This MSDS provides important health, safety, and environmental information for employers, employees, emergency responders and others handling large quantities of the product in activities generally other than product use, while the labeling provides that information specifically for product use in the ordinary course.

Use, storage and disposal of pesticide products are regulated by the EPA under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) through the product labeling, and all necessary and appropriate precautionary, use, storage, and disposal information is set forth on that labeling. It is a violation of federal law to use a pesticide product in any manner not prescribed on the EPA-approved label.

Although the information and recommendations set forth herein (hereinafter "Information") are presented in good faith and believed to be correct as of the date hereof, Monsanto Company makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Monsanto Company be responsible for damages of any nature whatsoever resulting from the use of or reliance upon Information. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR THE PRODUCT TO WHICH INFORMATION REFERS.

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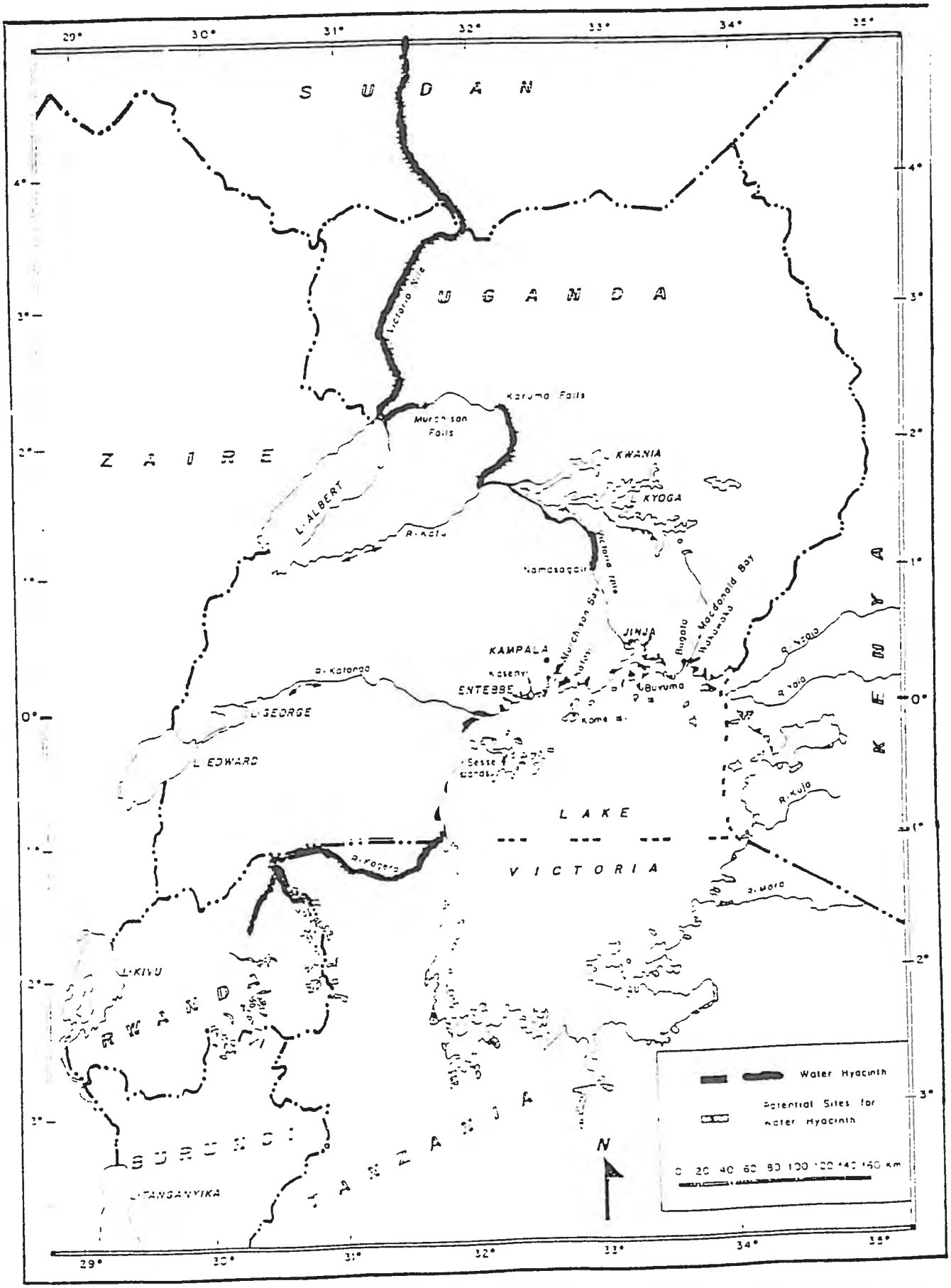
MSDSR.50

Printed on recycled paper (10% postconsumer waste)

ANNEX 6

MAPS


SUDAN
UGANDA
ZAIRE
KENYA
RWANDA
BURUNDI
TANZANIA
LAKE VICTORIA
Victoria Nile
Murchison Falls
Karuma Falls
L. ALBERT
R. Kafu
L. KWANIA
L. KYOGA
Namasagali
Victoria Nile
Murchison Bay
Macdonald Bay
JINJA
Bugala
KAMPALA
Kalangala
Kalangala
Kaseny
ENTEBBE
Buvuma
Kome Is.
R. Katonga
L. GEORGE
L. EDWARD
Sese Islands
R. Kagera
R. Nzoia
R. Yala
R. Kuja
R. Mara
L. KIVU
L. TANGANYIKA
N
Water Hyacinth
Potential Sites for Water Hyacinth
0 20 40 60 80 100 120 140 160 km
29°
30°
31°
32°
33°
34°
35°
4°
3°
2°
1°
0°

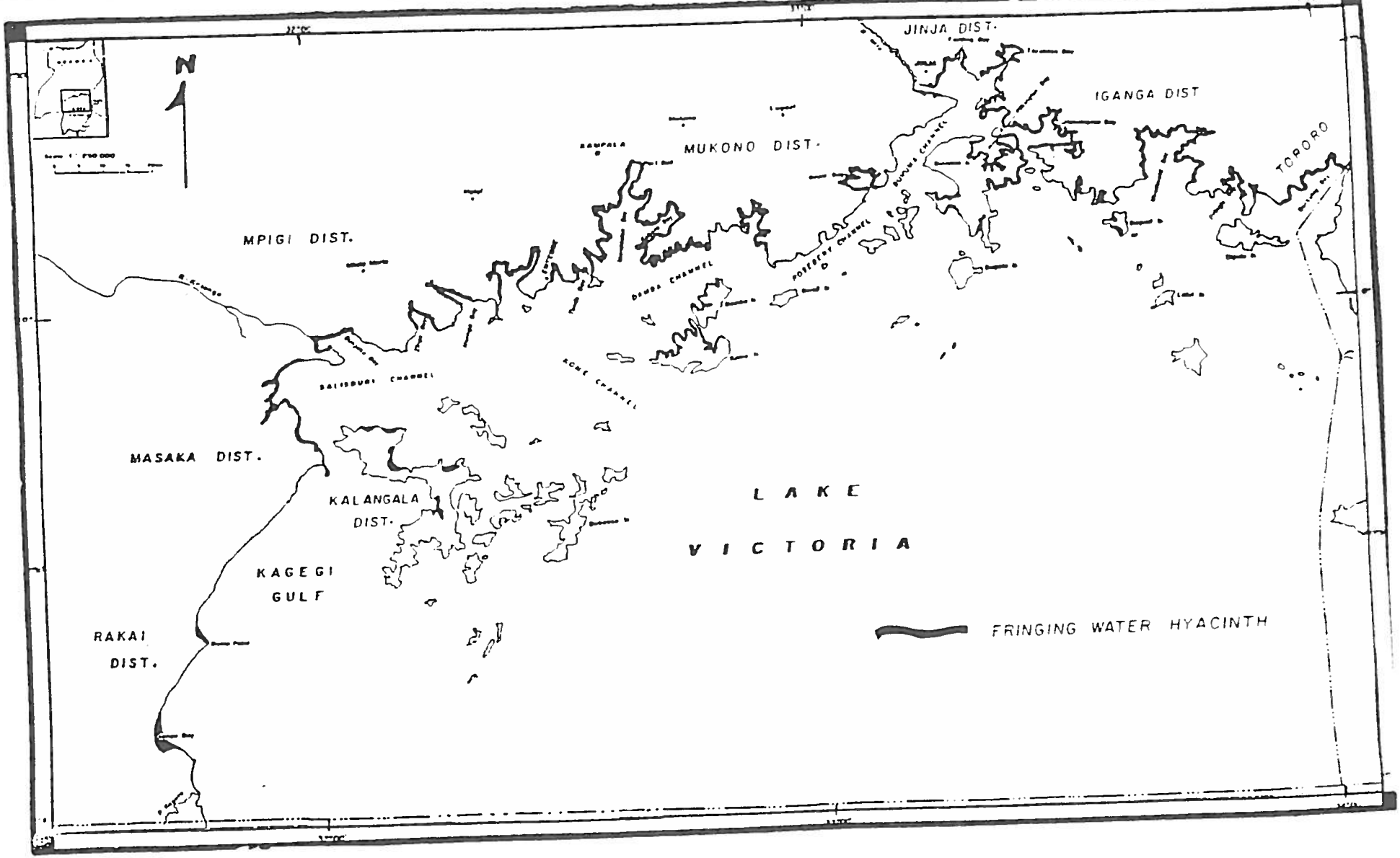


Fig. 2. The extent of fringing water hyacinth along the shores of Lake Victoria in Uganda.

ANNEX 7

COMMENTS AND RESPONSES ON THE DEIS

RESPONSES TO WRITTEN COMMENTS FROM DIRECTORATE OF WATER DEVELOPMENT (DWD) AND NATIONAL ENVIRONMENT AND MANAGEMENT AUTHORITY (NEMA) RECEIVED AT THE CORE EIA COMMITTEE MEETING.

DWD

COMMENT

1. Detailed arguments weighing the pros and cons of biological control have not been given. Results of the controlled experiments on the proposed agents by NARO field introduction of the agents on Lake Kyoga have not been reported in the text (unless I missed it). This should cover among other things detailed consideration of their life cycle in relation to other species and on the ecology of the Lake. In this respect the EIA is seriously deficient. This is important view of the past disastrous effects on the biodiversity of Lake Victoria of the introduction of the Nile Perch.

RESPONSE:

Comment noted and addressed in section 2.1.1

COMMENT:

2. The authors are commended on the full consideration that they have given to chemical control methods. Of the chemical agents 2,4-D is an agent which is primarily used in selective control of broad leafed plants in a terrestrial environment. It is believed to remain in sediments and could have a long-lasting effect if released slowly. It has a worrying toxicity and I see no reason to use it. Diquat and glyphosate both have been used extensively in aquatic situations and their efficacy is well known. There are some doubts about the toxicity of Diquat, but no such reservations about glyphosate. Throughout the document the evidence supports glyphosate as an extremely effective agent with little downside potential. Under the circumstances, we recommend use of glyphosate only. Why should we use three chemicals, all with different rates of application and different hazard sheets? Glyphosate is extremely effective. The EIA is also seriously deficient in the results of the efficacy tests done by NARO are not incorporated.

RESPONSE:

Comment noted. Diquat was excluded from the study because it was not certified. Toxicity of 2,4 -D has been addressed in section 5.1.12 and indicate that when used in accordance with label directions and precautions, there is no significant health hazard expected. Only two chemicals have been used in the study. Recommendation on the suitable chemical(s) to be used will be made in the Environmental Impact Statement. (EIS).

Comment on NARO efficacy tests has been noted, results have been attached as annex 7.

COMMENT:

3. There is a good case made in the document for spraying glyphosate, but I would suggest only spot spraying from boats along isolated shorelines. No persuasive case has been made for aerial spraying, given that the hyacinth is usually dispersed, except around Entebbe, Murchison Bay and Jinja, where is cannot be used anyway.

RESPONSE:

Comment noted. Recommendation on method to use will be made in the EIS

COMMENT:

4. Analysis is another matter worthy of discussion. Residues will need to be examined, as will water from the lake and drinking water. Methods will be necessary to detect parameters down to below 0.1ppb (EU limit for pesticides in drinking water). Methods of analysis for these substances are very difficult - GCMS for 2,4-D and Diquat and HPLC for glyphosate - and there is no laboratory in Uganda capable of doing this. So how is it proposed to build the capacity for water quality monitoring is? Glyphosate gets round this, by the way, as the authors state. It is so quickly inactivated by contact with the silica in water that nothing is there to be analyzed. Have analysis costs been included in the costs for the chemical treatment?

RESPONSE:
Comment is noted and addressed in 2.4

COMMENT:

5. Mechanical treatment is given short shrift: it is expensive, and it is time consuming. Therefore it is second best. However, it is acknowledged that for other considerations it will have to be used in most places where the hyacinth is likely to be. There include around Entebbe, in Murchison Bay and at the Owen Falls in Jinja, as well as in the areas where hyacinth has invaded the shoreline close to centers of population. The authors also concede that the effects of rotting vegetation from chemical treatment on water quality will be such that it is better that it is mechanically removed anyway. So mechanical treatment will be necessary to a much larger extent than the authors have accepted.

RESPONSE:
Comments noted.

COMMENT

6. None of the benefits of mechanical treatment have been examined in detail. There will be the socio-economic benefits of the employment of large numbers of Ugandans on physical removal operations, thereby improving their economic status. And there is the benefit that will be gained from properly composting the hyacinth, producing an important fertilizer that will enhance soil condition rather than the depletion that comes from the use of artificial fertilizers.

RESPONSE:
Comment noted, addressed in 5.1.16 and 5.1.17.

COMMENT:

7. I would like to see a reworking of costs and a cost/benefit analysis of glyphosate spraying and mechanical treatment. As has been said before, the latter will provide employment and a beneficial product, and the former will have disposal costs of hyacinth attached to it and/or a medium term degradation of inshore fisheries from the death of invertebrate species due to rotting vegetation.

RESPONSE:
Comment noted, addressed in 2.4, and 5.1.17

WRITTEN RESPONSES TO COMMENTS FROM NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

1. **Section .... Introduction:**

"Toxicology and herbicide residue data has been cited from available reference data and results from herbicide applications in the United States"

Executive Summary:- "This Environmental Impact Assessment includes a thorough review of available data on the affected environment...."

Comment:

Reading through the document, it appears that information revealing potential adverse impacts of the chemicals may not have been accessible to the study. An example of such information revealing potential adverse impacts of one of the candidate chemicals (Glyphosate) is contained in an available document, "Journal of Pesticide Reform/Fall 1995. Vol. 15, No. 3 received by NEMA after the report under review was compiled.

It must be noted that concern for potential adverse impacts of the herbicides has been raised by NEMA and other interested parties during previous meetings and in written comments on the initial draft documents. This concern was also raised during the workshop of 10th July, 1996 convened to review the Scoping document.

RESPONSE:
Comment noted. Information revealing potential adverse impacts of the chemical was obtained from attached Material Safety Data Sheets and from Scientific studies quoted in the Reference section. The material quoted in the journal above had no scientific peer review.

2. **Section 1.2.1: Approach:**

"The emergency program is expected to consist of herbicide applications, **by aircraft** and boat, approximately 2,000 hectares of water hyacinth with a goal of reducing current biomass by 90% **within six months of initiation.**

Application of chemicals over a sixth months period would have necessitated a further discussion of risks and potential cumulative impacts associated with extended use of the chemicals. This is not highlighted in the report.

RESPONSE:
Comment noted. Addressed in section 5.1.3.2

3. **Section 2.1: Emergency Action Plan Pp. 10:**

"Aquatic herbicides will be applied by aircraft and boat to kill hyacinth in open water areas, in bays, and along shorelines areas. The areas where aquatic herbicides are applied will be selected to ensure any potential impact on water use and quality is minimized."

Comment:

The identified potential areas for this exercise should be stated in the Draft document at this stage so that the potential impact of herbicides application and/or mechanical control program in these locations can be assessed, and the appropriate mitigation measures proposed.

RESPONSE:
Comment noted, addressed in EAP document in Annex 2.

4. **Section 2.1.1**

"Chemical spraying can reduce large populations of water hyacinth to smaller numbers in a relatively short time."

Comment:

To allay the concern about potential cumulative impact of the chemicals, it would be appropriate to give an indication of how short this period might be. It must be noted that the Kajansi studies suggest a need for repeated spraying to achieve control of the weed. Thus, a "reduction of populations …… in a relatively short time" could only be possible with repeated spraying and the impact of such repeated spraying must be a related factor to consider.

RESPONSE:
Comment noted. Addressed in 2.1.1 and 5.1.3.2

5. **Section 2.1.2: Chemical Control. Pp. 11**

"This method is generally the most effective for reducing water hyacinth infestations quickly, and most widely used strategy in the world".

Comment:

Caution must be exercised because the fact that the chemical is used worldwide may not necessarily imply that it can be suitable in Lake Victoria. Recommendations associated with EIAs are often highly site specific, taking into account factors such as differences in uses of the site, nature of the site and surroundings, risks involved in the different sites etc. As an example, the risks involved in using chemicals in Lake Victoria may not necessarily be similar to those involved in using the same chemicals elsewhere. Proposals to use the chemicals in Lake Victoria must therefore be weighed against associated risks such danger to fish exports.

RESPONSE:
Comment noted. In-Lake trials are expected to provide specific recommendations relating to Lake Victoria environment.

6. **Pp. 2 Par. 2:**

"Water quality monitoring will be performed to measure herbicide residues. The residue monitoring program would be reviewed prior to the start of **each year's control efforts".**

Comment:

If the chemical control program is envisaged to last years, the implications must be adequately weighed before chemical use is recommended and approved for use?

RESPONSE:
Comment noted, addressed in 5.1.3.2

7. **Section 2.1.3: Mechanical/Physical Control: Pp. 12 last sentence:**

"Water hyacinth mechanically or physically removed will be transported away from the lake system to designated disposal sites."

Comment:

Criteria for designation of these sites should be included in the draft EIS. In addition, the planned mode of disposal of the harvested weed must be described. Is it going to be just "open air" dumping? And if so what are the envisaged environmental impacts and associated mitigation measures? Post harvest handling and disposal of the harvested weed needs further description.

RESPONSE:
Comment noted, addressed in 2.1.3

8. **Section 2.1.4: Chemical Control Pp. 12 Last Sentence**

"Aquatic herbicides will not be used in areas where lake water is used for domestic, agricultural or industrial uses and in areas where local villages use lake water for general domestic uses".

Comment:

While concern is shown for these categories of water uses and users, silence is maintained on the issue of potential danger to fish and fisheries. Why would water for agriculture and industrial use be of greater concern than the fish in the water?

RESPONSE:
Comment noted, addressed in 5.1.4

9. **Section 5.1.3.2:**

"When water hyacinth is killed by herbicides. ... About 75% of the dry weight rots aerobically on the water surface and the other 25% becomes blown around the lake ..."

Comment:

Potential negative water quality impacts due to rotting/decomposing water hyacinth after spraying is portrayed in this section to be insignificant (The section actually implies an almost 0% water hyacinth left to cause likely negative water quality impacts due to decomposing water hyacinth). There might be need to further substantiate this information, especially given that a contradictory view is presented in page 41 first paragraph which states, "A potential temporary impact to aquatic life could result from herbicide induced die-offs of water hyacinth causing oxygen deficits in shallow, quiescent sloughs". The later view seems to recognize the potential for creation of anoxic conditions due to possible decomposition of the water hyacinth in which case mitigation should be identified.

RESPONSE

Comment noted, addressed in 5.1.3.2

10 **Section 5.1.8: Chemicals:**

"Potential impacts from the use of herbicides..... in front of Owen Falls Dam site may include temporary clogging of generating turbines".

Comment:

Previous meetings involving UEB Officials have indicated a reluctance to have the dam site sprayed. Has their consent been obtained as far as this proposal is concerned?

RESPONSE:
Documents gives potential impacts in the event that the dam is sprayed but does not recommend or discourage spraying of the dam. ????OR SHOULD IT???

General Comments:

(a) It would be more appropriate to adopt a water hyacinth control program that, among things, would achieve control of the weed without causing adverse decline in the fishing industry in all its forms (internal/artisanal and export oriented fishing), while permitting access to and from fish landing sites.

(b) A description of the behavior of the 3 candidate chemicals shows differences in persistence in water, efficacy in controlling the weed etc. In light of this, it would be more appropriate if the study prioritized and made a recommendation on the best chemical to start with if chemical control is adopted, other that the present situation which seems to discuss all the three herbicides on an equal rating.

RESPONSE:
Comments noted.

Conclusion:

d)It is apparent from the results presented that the element of **analysis of risks** associated with each of the proposed control methods has to be used in weighing the options to be eventually approved for the control of the weed.

RESPONSE:
Comment noted. The analysis of risk for each option has been summarized in the matrix table of alternatives.

In Page 48, Section on Toxicity, it is stated that "the ability of a chemical to produce carcinogenic (tumor-promoting), teratogenic (causing birth defects) and mutagenic (promoting changes in genetic material) effects may occur at much lower residual levels than drinking water standards. The specific research on herbicide effects is somewhat incomplete and controversial".

The question therefore is. are we at this stage going to recommend the use of a method on which available information is controversial. and has direct implications of risk to health and to the fisheries?

Pp. 54: "the decision to use pesticides to control water hyacinth in Lake Victoria is based in significant part on the cost of alternative. and the time required to implement them".

Looking at the methods from the point of view of costs involved. whereas mechanical control is said to be very costly. it does not at the same time risk the country losing income from fish exports. On the other hand. whereas chemical control way be cheaper. the risks involved with respect to fish exports may more than offset the cheapness of the method.

If chemical control is preferred from the point of view of the short time it requires to have effect. it must be noted that the Kajansi study seems to point at repeated spraying to have this "short time" idea work. But what are the overall impacts and risks of repeated spraying?

RESPONSE:
Comments noted and addressed.

WRITTEN RESPONSES TO COMMENTS FROM NARO FISHERIES RESEARCH INSTITUTE.

COMMENT 1
Executive Summary : Pg 2 Para. 1
'The action plan .....water hyacinth'

Comment:
This statement could be interpreted to preclude partial integration By using only two of the three: or selection of only one of the three control methods.

Proposal: Amend to read:
"The action plan would reduce water hyacinth infestation through the use of an integrated control program incorporating an appropriate combination of chemical. mechanical and biological control

methods in a given infestation situation in various parts of Lake Victoria and surrounding water bodies, while ..... water hyacinth.

COMMENT 2
Page 3: 1.2.1 Approach: Paragraph One. Comment: Uganda Electricity Board (UEB) is a key stake holder although it is not mentioned specifically.

Proposal :
UEB should be mentioned.

COMMENT 3
"The emergency program is expected to consist of herbicide applications by aircraft and boat to approximately 2,000 hectares of water hyacinth with a goal of reducing current biomass to 90% within six months of initiation."

Comment
This statement does not appear derived from the Emergency Action Plan (EAP) as given in Section 9, Annex 2. There appears to be no basis given in the text on which a decision to spray 2,000 ha of water hyacinth was based.

Proposals
i) Paragraph 2 under approach should be amended to reflect the strategy in the EAP; otherwise it should be made independently of the EAP strategy.

ii) Application of herbicides should be based on carefully evaluated and reasoned plan. This consideration should be reflected in the demarcation of the total area expected to be sprayed.

COMMENT 4
Page 4 paragraph 1.2.1.1

Comment
This paragraph erroneously attributes execution of "Herbicide trials" to NARO/FIRI.

Proposal
The paragraph should be amended to include the full complement of participating institution/ministries as follows:-

MAAIF - NARO
Ministry of Natural Resources
Government Chemist
Makerere University
Ministry of Health

COMMENT 5
1.2.1.2
In intermediate objective no. 2 it is not clear what "region" means.
Proposal
It is essential to state this objective precisely.

The numbering used for "Intermediate objectives" 1.2.1.2 and "long-term objectives 1.2.1.3 put the two sections under 1.2.1 i.e. "Emergency program objectives"

COMMENT 6
The three sections would seem to be at par

Proposal

Numbering should be reviewed.

COMMENT 7
Emergency action plan
Sentence number two states: "Aquatic herbicides will be applied by aircraft and boat to kill water hyacinth in open water areas, in bays and along shoreline areas. The areas where aquatic herbicides are applied will be selected to ensure any potential impact on water use and quality is minimised".

Comment
Proposed use of aircraft to apply herbicides wherever water hyacinth occurs does not appear to include any consideration of potential health and economic impacts and how they would be mitigated. For instance location of gardens and homesteads along the shoreline may require specific precautions; so might the proportion of the large mats that would be treated at anyone time. For that matter, selection of methods of herbicide application might itself require an EIA!

Intermediate plan: the word 'region' in the second sentence appears not to have been defined. Hence it has no specific meaning.

COMMENT 8
Page 11 paragraph one: last sentence "Biological control is planned for those areas least receptive to chemical spraying ....."

Comments
i) This statement implies use of chemicals as the main control method adopted. The basis for this selection should be highlighted in the EIA for evaluation.

ii) The statement appear to be inappropriate as the criterion for selecting where to use biological agents to control water hyacinth.

COMMENT 9
2.1.2 Chemical Control

Comments
i) This section should be re-oriented to reflect results of Chemical Verification Trials at Kituza and Kajjansi.

ii) Paragraph two on page 12 starts: Water quality monitoring will be performed to measure herbicide residues. The residue monitoring program would be reviewed prior to the start of each year's control effort, by the Water Hyacinth Unit and oversight agencies."

Comment
The above indicates this EIA is putting the case of multiple herbicide application. Note that 'Chemical Verification Trials' were based on a single herbicide application event. The impact of multiple herbicide application would therefore need study before the strategy can be evaluated.

COMMENT 10
Page 12 - 2.1.4 General location of the proposed actions.

Comment:
The EIA does not appear to take into account all the interests of all stake holders. For instance the introductory statement under 2.1.4. does not mention some stake holders including fish consumers, exporters and fishermen; possible environmental impacts apart from those on water use and quality.

Proposal
This would be a serious oversight as the above examples are considered among the most important elements of the aquatic resource and resource users. It should be redressed.

COMMENT 11
2.3 No action plan - The no action plan should be explored more looking for and taking into account up-to-date information on the dynamics of areal cover and biomass; and movement of water hyacinth. For instance:-

i) the impact of successional growth involving hippograss and other macrophytes on shoreline resident water hyacinth.

ii) the fate of water hyacinth entering Lake Victoria in various environmental scenarios in the lakes in Uganda

COMMENT 12
Page 14 - paragraph two - starts:

The "no action" alternative would allow ..... rate of spread of approximately 30% increase in plant population per year.

Comment
This statement calls for substantiation so that it may be evaluated.

COMMENT 13
Page 18 - Top paragraph: It is stated that Lake George drains into the Katonga River. This claim appears erroneous. It should be checked out.

COMMENT 14
5.1.3 Water Quality

Chemical Control

Comment
NARO did not analyse for background/baseline herbicides residues in Lake Victoria as stated in this section. Results quoted in this section refer to analysis in Pan Lake at Kajjansi.

COMMENT 15
5.1.3.2 - Effects of dying water hyacinth and organic sedimentation to the lake bottom.

Comments
i) Information in paragraph one should be substantiated.

ii) It may be more useful to discuss impact of :-

Page 15 - Physical Control:
The 150,000kg given as the biomass per ha is erroneous. Average biomass determined by FIRI research team is 560,000kg or 560 ton per ha. Note special areas like Owen Falls Dam where compaction increases biomass rate.

COMMENT 16
2.5 Identification of preferred action

Page 16 Biological:

Comment
The way this section is put appears to differ from the general principle that biological control is expected to be the long-term control strategy expressed in the Emergency Action Plan.

Proposal
This control strategy should be propagated wherever water hyacinth occurs.

COMMENT 17
3.0 Affected environment

Paragraph one: The commonest fishing gear in Lake Victoria is the gillnet. It should be highlighted.

TELEGRAMS: AQUATIC
TELEPHONE: 220376.
FAX: 221436.

IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTE NO.

AQUATIC WATER HYACINTH PROGRAM LIMITED
RECEIVED
07 NOV 1996
KAMPALA

THE REPUBLIC OF UGANDA

THE DIRECTORATE OF
WATER DEVELOPMENT
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KAMPALA, UGANDA

(19)

October 28, 1996

D/1M.
Please respond

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY
RECEIVED

The Executive Director,
National Environment Management Authority (NEMA)
KAMPALA

Attn: Dr. Aryamanya-Mugisha, Henry

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR WATER HYACINTH CONTROL PROGRAMME

Reference is made to your letter NEMA/96/WH of 21 October 1996 on the above subject. Having read the main document, together with the hazard data sheets for the three proposed herbicides and taken advice from our Consultant Chemist on the Water Resources Assessment Project (also Chairman of the British Standards Institution Water Quality Committee); the following are our comments:

1) Detailed arguments weighing the pros and cons of biological control have not been given. Results of the controlled experiments on the proposed agents by NARO field introduction of the agents on Lake Kyoga have not been reported in the text (unless I missed it). This should cover among other things detailed consideration of their life cycle in relation to other species and on the ecology of the Lake. In this respect the EIA is seriously deficient. This is important view of the past disastrous effects on the biodiversity of Lake Victoria of the introduction of the Nile perch.

2) The authors are commended on the full consideration that they have given to chemical control methods. Of the chemical agents 2,4 - D is an agent which is primarily used in selective control of broad leaved plants in a terrestrial environment. It is believed to remain in sediments and could have a long-lasting effect if released slowly. It has a worrying toxicity and I see no reason to use it. Diquat and glyphosate both have been used extensively in aquatic situations and their efficacy is well known. There are some doubts about the toxicity of Diquat, but no such reservations about glyphosate. Throughout the document the evidence supports glyphosate as an extremely effective agent with little downside potential. Under the circumstances, we recommend use of glyphosate only. Why should we use three chemicals, all with different rates of application and different hazard sheets? Glyphosate is extremely effective. The EIA is also seriously deficient in that the results of the efficacy tests done by NARO are not incorporated.

3) There is a good case made in the document for spraying glyphosate, but I would suggest only spot spraying from boats along isolated shorelines. No persuasive case has been made for aerial spraying, given that the hyacinth is usually dispersed, except around Entebbe, Murchison Bay and Jinja, where it cannot be used anyway.

4) Analysis is another matter worthy of discussion. Residues will need to be examined, as will water from the lake and drinking water. Methods will be necessary to detect parameters down to below 0.1ppb (EU limit for pesticides in drinking water). Methods of analysis for these substances are very difficult - GCMS for 2,4 - D and Diquat and HPLC for glyphosate - and there is no laboratory in Uganda capable of doing this. So how is it proposed to build the capacity for water quality monitoring is? Glyphosate gets round this, by the way, as the authors state. It is so quickly inactivated by contact with the silica in water that nothing is there to be analysed. Have analysis costs been included in the costs for the chemical treatment?

5) Mechanical treatment is given short shrift: it is expensive, and it is time consuming. Therefore it is second best. However, it is acknowledged that for other considerations it will have to be used in most places where the hyacinth is likely to be. These include around Entebbe, in Murchison Bay and at the Owen Falls in Jinja, as well as in the areas where hyacinth has invaded the shoreline close to centres of population. The authors also concede that the effects of rotting vegetation from chemical treatment on water quality will be such that it is better that it is mechanically removed anyway. So mechanical treatment will be necessary to a much larger extent than the authors have accepted.

6) None of the benefits of mechanical treatment have been examined in detail. There will be the socio - economic benefits of the employment of large numbers of Ugandans on physical removal operations, thereby improving their economic status. And there is the benefit that will be gained from properly composting the hyacinth, producing an important fertilizer that will enhance soil condition rather than the depletion that comes from the use of artificial fertilizers.

7) I would like to see a reworking of costs and a cost/ benefit analysis of glyphosate spraying and mechanical treatment. As has been said before, the latter will provide employment and a beneficial product, and the former will have disposal costs of hyacinth attached to it and/or a medium term degradation of inshore fisheries from the death of invertebrate species due to rotting vegetation.

8) Finally, there are many spelling and grammatical errors in the document which needs to be checked.

I suggest that you call a meeting of the Core Scoping Committee to discuss this document to clarify on aspects of the report which are not clear.

ENOCH DRIBIDU
MEMBER, CORE SCOPING COMMITTEE

COMMENTS FROM NEMA ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE EMERGENCY WATER HYACINTH CONTROL PROGRAMME PREPARED BY AQUATICS UNLIMITED.

1. **Section ...Introduction:**

"Toxicology and herbicide residue data has been cited from available reference data and results from herbicide applications in the United States"

Executive Summary: "This Environmental Impact Assessment includes a thorough review of available data on the affected environment..."

Comment:

Reading through the document, it appears that information revealing potential adverse impacts of the chemicals may not have been accessible to the study. An example of such information revealing potential adverse impacts of one of the candidate chemicals (Glyphosate) is contained in an available document, "Journal of Pesticide Reform/Fall 1995. Vol.15, No.3 received by NEMA after the report under review was compiled.

It must be noted that concern for potential adverse impacts of the herbicides has been raised by NEMA and other interested parties during previous meetings and in written comments on the initial draft documents. This concern was also raised during the workshop of 10th July convened to review the scoping document.

2. **Section 1.2.1: Approach.**

"The emergency programme is expected to consist of herbicide applications, <u>by aircraft</u> and boat, approximately 2,000 hectares of water hyacinth with a goal of reducing current biomass by 90% <u>within six months of initiation</u>

Comment: Application of chemicals over a sixth months period would have necessitated a further discussion of risks and potential cumulative impacts associated with extended use of the chemicals. This is not highlighted in the report.

3. **Section 2.1: Emergency Action Plan Pp 10.**

"Aquatic herbicides will be applied by aircraft and boat to kill hyacinth in open water areas, in bays, and along shoreline areas. The areas where aquatic herbicides are applied will be selected to ensure any potential impact on water use and quality is minimized".

Comment: The identified potential areas for this exercise should be stated in the Draft document at this stage so that the potential impact of herbicide application and / or mechanical control programme in these locations can be assessed, and the appropriate mitigation measures proposed.

4. **Section 2.1.1**

"Chemical spraying can reduce large populations of water hyacinth to smaller numbers in a relatively short time".

Comment: To allay the concern about potential cumulative impact of the chemicals, it would be appropriate to give an indication of how short this period might be. It must be noted that the Kajansi studies suggest a need for repeated spraying to achieve control of the weed. Thus, a "reduction of populations .....in a relatively short time" could only be possible with repeated spraying and the impact of such repeated spraying must be a related factor to consider.

5. **Section 2.1.2: Chemical Control. pp 11**

"This method is generally the most effective for reducing water hyacinth infestations quickly, and most widely used strategy in the world".

Comment: Caution must be exercised because the fact that the chemical is used worldwide may not necessarily imply that it can be suitable in Lake Victoria. Recommendations associated with EIAs are often highly site specific, taking into account factors such as differences in uses of the site, nature of the site and surroundings, risks involved in the different sites etc. As an example, the risks involved in using chemicals in Lake Victoria may not necessarily be similar to those involved in using the same chemicals elsewhere. Proposals to use the chemicals in Lake Victoria must therefore be weighed against associated risks such danger to fish exports.

6. **Pp. 2 Para 2:** "Water quality monitoring will be performed to measure herbicide residues. The residue monitoring programme would be reviewed prior to the start of <u>each year's control efforts".</u>

Comment:

If the chemical control programme is envisaged to last years, the implications must be adequately weighed before chemical use is recommended and approved for use ?

7. **Section 2.1.3: mechanical / physical control: Pp 12 last sentence:**

"Water hyacinth mechanically or physically removed will be transported away from the lake system to designated disposal sites".

Comment: Criteria for designation of these sites should be included in the draft EIS. In addition, the planned mode of disposal of the harvested weed must be described. Is it going to be just "open air" dumping ? and if so what are the envisaged environmental impacts and associated mitigation measures ? Post harvest handling and disposal of the harvested weed needs further description.

8. **Section 2.1.4: Chemical control pp 12 last sentence.**

"Aquatic herbicides will not be used in areas where lake water is used for domestic, agricultural or industrial uses and in areas where local villages use lake water for general domestic uses".

Comment: While concern is shown for these categories of water uses and users, silence is maintained on the issue of potential danger to fish and fisheries. Why would water for agriculture and industrial use be of greater concern than the fish in the water ?

9. **Section 5.1.3.2:** "When water hyacinth is killed by herbicides,... about 75% of the dry weight rots aerobically on the water surface and the other 25% becomes blown around the lake...."

Comment: Potential negative water quality impacts due to rotting /decomposing water hyacinth after spraying is portrayed in this section to be insignificant (The section actually implies an almost 0 % water hyacinth left to cause likely negative water quality impacts due to decomposing water hyacinth) . There might be need to further substantiate this information, especially given that a contradictory view is presented in page 41 first paragraph which states, " A potential temporary impact to aquatic life could result from herbicide induced die-offs of water hyacinth causing oxygen deficits in shallow, quiescent sloughs". The latter view seems to recognize the potential for creation of anoxic conditions due to possible decomposition of the water hyacinth in which case mitigation should be identified.

10. **Section 5.1.8 Chemicals:**

"Potential impacts from the use of herbicides ... in front of Owen Falls Dam site may include temporary clogging of generating turbines".

Comment: Previous meetings involving UEB Officials have indicated a reluctance to have the dam site sprayed. Has their consent been obtained as far as this proposal is concerned ?

General Comments:

a) It would be more appropriate to adopt a water hyacinth control programme that, among other things, would achieve control of the weed without causing adverse decline in the fishing industry in all its forms (internal/artisanal and export oriented fishing), while permitting access to and from fish landing sites.

b) A description of the behaviour of the 3 candidate chemicals shows differences in persistence in water, efficacy in controlling the weed etc. In light of this, it would be more appropriate if the study prioritized and made a recommendation on the best chemical to start with if chemical control is adopted, other than the present situation which seems to discuss all the three herbicides on an equal rating.

Conclusion:

d) It is apparent from the results presented that the element of analysis of risks associated with each of the proposed control methods has to be used in weighing the options to be eventually approved for the control of the weed.

In Page 48, section on toxicity, it is stated that "the ability of a chemical to produce carcinogenic (tumor-promoting), teratogenic (causing birth defects) and mutagenic (promoting changes in genetic material) effects may occur at much lower residual levels than drinking water standards. The specific research on herbicide effects is somewhat incomplete and controversial".

The question therefore is, are we at this stage going to recommend the use of a method on which available information is controversial, and has direct implications of risk to health and to the fisheries ?

PP 54: "the decision to use pesticides to control water hyacinth in Lake Victoria is based in significant part on the cost of alternative, and the time required to implement them".

Looking at the methods from the point of view of costs involved, whereas mechanical control is said to be very costly, it does not at the same time risk the country losing income from fish exports. On the other hand, whereas chemical control may be cheaper, the risks involved with respect to fish exports may more than offset the cheapness of the method.

If chemical control is preferred from the point of view of the short time it requires to have effect, it must be noted that the Kajansi study seems to point at repeated spraying to have this "short time" idea work. But what are the overall impacts and risks of repeated spraying ?

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18 DEC 1996
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WATER HYACINTH PROGRAM

15 December, 1996

Mr Tom. Moorehouse
Aquatics Unlimited
KAMPALA

EIA - Water Hyacinth Control: Comments on Draft Document

Enclosed please find my comments on the above document. Somehow I failed to get them off to you earlier. I have just realised they were still undelivered! Better late than never. I regret any inconvenience this lateness may cause you.

Regards

Tim Twongo

cc Justine Ecaat
NEMA

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AQUATICS UNLIMITED
RECEIVED
21 OCT 1996
KAMPALA
WATER HYACINTH PROGRAM

30 September 1996

Mr. Thomas G. Moorhouse
Technical Coordinator
Aquatics Unlimited
P. O. Box 7057
KAMPALA

Dear Mr. Moorhouse

WATER HYACINTH CONTROL (ENVIRONMENTAL IMPACT ASSESSMENT)

I am enclosing herewith a copy of our comments on the Draft Environmental Impact Assessment (EIA) that were discussed with you in my office in the course of last week.

We would request that you incorporate responses to these comments in the EIA report. In the meantime we had agreed that a draft of EIA be ready for review by us in two weeks and that we call a scoping meeting sometime next week.

I should therefore be grateful if you could let us have a copy of the up-dated report of EIA for our prior review.

Yours sincerely

Prof. J. Y. Okedi
EXECUTIVE DIRECTOR

Encl.

Comments from NEMA on the Draft Environmental Impact Statement for the Water Hyacinth Control Programme.

These comments are supplementary to comments made during earlier meetings on this subject, including the comments appended to the draft EIS as record of comments from previous meetings.

1. Page 2 Para.3 states that draft EIS is being circulated to Core Scoping Committee. PP4 Second last Para, second last sentence states it is being circulated to Expanded Scoping Committee.... Are the two the same commitee ?

2. Proposed action and alternatives

2.1 The description of the proposed mechanical control option in **section 2.1.3** is grossly inadequate. In order to come up with mitigation measures, the exact mode of operations for the mechanical control programme needs to be described.

How for example is the harvested weed to be disposed and where? Will it be disposed immediately at the shores or will it be transported to some other place ?

There is no mention whether trucks will be used to haul away the huge masses of the harvested weed, or some other method shall be used.

What mode of disposal of the hearvested weed is planned ? Is it going to be just "open air" dumping ? and if so what are the envisaged environmental impacts and associated mitigation measures ?

- This section needs to describe the various phases of the mechanical control programme: in-lake operations, shoreline handling operations and post harvest handling and disposal of the harvested weed.

If the sites for disposal of the weed are already identified, these too must be described. If they are not yet known (which is implied by the Draft EIS not mentioning anything about this nor describing them), what where the recommendations in the control programme to ensure that disposal of the harvested weed does not harm the envronment ?

How will the weed reach the disposal sites and what measures are proposed to ensure that in transporting the weed, the operations will not actually simply distribute and propagate its spead to other areas or make other water points vulnerable to invasion by the potential scattering of the weed during transportation. The risk of solving the problem in Lake Victoria and causing it elsewhere must be mitigated.

3. Environmental impacts: (Ref. Section 5.0 of the draft EIS)

In light of the above inadequacies in describing proposed actions with respect to proposed mechanical control programme, it will be very difficult to predict the likely environmental impacts of the mechanical control programme if the information above is not included in the section for proposed actions. No wonder then that in the environmental impacts section, there

is no mention made of the likely environmental consequences of the mechanical control programme at source (lake and lake sides), at the dumping sites, and enroute to the dumping sites. The same observation goes for Section 7 - Environmental Mitigation and monitoring plan.

4. Section 5.1.5

Because this will be a public document, and therefore to make the public get the point clearly and to understand the comparison being made, it would be better if the "known tolerance levels of fish" and key aquatic invertebrates to 2,4-D, are specified, as well as what is reasonably expected to be the residual levels from the spraying programme. Otherwise to most readers the last sentence of the paragraph will be mainly speculative.

Section 5.1.10.1

"An accidental spill of herbicide from an application boat does not pose a serious threat to water quality". This is a very difficult statement to comprehend, especially given that very small dozes of chemical are recommended for use, then why not bother about a spill ? A further explanation may help.

Moreover, this apparently contradicts the fact that "Spray boat operators would be equiped with a list of emergency notification telephone numbers so that downstream water purveyors could be alerted to a spill. This actually indicates some concern about potential danger of a spill, and yet it is earlier stated it does not pose a serious threat. How about those other downstream water users without telephones (who may actually be the majority), what mechanism is proposed to allert them of spills ?

Pp 30 para 4 sentence 2 "Diquat residues are not expected to be present in amounts toxic to aquatic life as a result of the selected plan". It would be better to precisely indicate these residue levels here and what the toxic levels are, for ease of comparison, and also to substantiate the statement for better understanding.

Additonal comments arising out of ameeting between Officials from Aquatics Unlimited and NEMA Officials on 20th September 1996:

Apart from re-emphasising some of the concerns above, the meeting also raised the following additional issues:

- The need to address the potential synergistic and cumulative impacts of the chemicals was noted, especially in isolated bays where flush-out of the chemicals may not be fast enough.

- the chemical properties of the candidate chemicals for the proposed control programme needs to be described in the project description section, and their likely environmental impacts need to be described in the impacts section.

- the likely environmental consequences resulting from the rotting of the water hyacinth after spraying, and the associated chemical reactions resulting from the rotting eg; deoxygenation of water need to be stated.

- in the Draft EIS, the was need to discuss the integration of spraying and mechanical harvesting as an alternative to mere spraying and-let-rot approach, although fears were raised on the cost implications of this.

ANNEX 8

KAJJANSI POND AND KITUZA LAB TRIALS REPORT

REPORT ON VERIFICATION STUDY ON CHEMICAL CONTROL OF WATER HYACINTH

FINAL DRAFT

Chemical Verification Sub- Committee,
National Task Force on Control and Management
of the Water Hyacinth.

OCTOBER, 1996

Executive Summary

The water hyacinth *Eichhornia crassipes* poses an urgent national problem whose control requires a co-ordinated and integrated approach. The noxious weed covers about 80% of the shoreline of Lake Victoria in Uganda; 55% of that of Lake Kyoga; a considerable proportion of the northern shores of Lake Albert; as well as the banks of about 500 km of River Nile in Uganda. In 1995 water hyacinth covered an estimated area of 2,300 ha of the inshore of Lake Victoria - Uganda; 600 ha of Lake Kyoga and about 550 ha along the Nile. In the meantime, the socio-economic and ecological burden due to the infestation becomes more evident, requiring urgent alleviation.

In order to explore more control options for the noxious weed, the National Technical Committee on the management of Water Hyacinth (NTCWH) mandated a multidisciplinary Sub-Committee to make a verification study on three herbicides namely Glyphosate, Diquat and 2,4-D Amine used in other countries e.g. the United States of America, to control water hyacinth.

The study, whose main goal was to verify the efficacy, safety and environmental friendliness of the candidate herbicides in Uganda, was conducted under semi-laboratory conditions at Kituza Research Centre in Mukono District as well as in newly excavated ponds which constituted isolated semi-natural ecosystems at Kajjansi on Kampala-Entebbe road.

The Kituza phase determined the application rates for optimum efficacy for each herbicide. The experiments at Kajjansi established the background levels of the herbicides in the experimental environment, assessed the impact of the three

chemicals on water quality and aquatic life and evaluated the potential of their persistence in the environment if used to control water hyacinth in a single application event.

Efficacy

The following application levels for optimum efficacy were recommended: Diquat (Reglone)- 2kg of active ingredient (a.i) per ha (10.0L ha^{-1}); Glyphosate (Round up) - 2.8kg a.i per ha (8.0L ha^{-1}) and 2,4-D Amine - 2kg a.i (2.8L ha^{-1}). Application of each of the three herbicides elicited regrowth by sprouting in the following order of decreasing intensity 2.4 - D, Diquat, Glyphosate.

Glyphosate was recommended as the most potentially efficacious of the three herbicides followed by diquat, if applied professionally on water hyacinth.

Environmental friendliness

Herbicides residues

Trace to non-detectable background residues of the candidate herbicides were found in the experimental environment (water, bottom sediments, water hyacinth and fish muscle). After spraying, residues of the three herbicides were detected in water, sediments, water hyacinth and fish muscle in minute quantities far below toxic or tolerance levels and hence unlikely to have adverse environmental effects after a single application event.

The minute quantities of herbicide found in the water soon afte spraying attested to careful application such that most of th chemicals remained on the water hyacinth.

Water quality: No adverse effects related to herbicide application were detected in the physical and chemical attributes of the water. However, a significant increase in the biomass of phytoplankton was observed in the pond sprayed with Glyphosate in weeks one and two. The increase was probably due to the release of available phosphorus as Glyphosate disintegrated.

Algae and zooplankton: Preliminary results indicate no adverse effects on abundance of algae and zooplankton attributed to application of the three herbicides in the trials. However, in view of the succession growth characteristic of some microbiota notably species of algae and rotifers, more conclusive deductions would require longer sampling period.

Macrofauna: No adverse effects attributed to the use of the three herbicides in the trials were discern with respect to abundance of macrofauna. However, lack of replicates in the experiments did not permit statistical testing.

Fish: The behaviour and survival of the three Tilapias *Oreochromis niloticus* (Nile tilapia), *Oreochromis leucosticus* and *Tilapia zillii* tested in the pond experiments were not observed to be adversely affected by use of the three herbicides in the trials. No fish mortality was observed after herbicide application.

Public health and awareness

While public awareness meetings and door-to-door sensitisation regarding safety precautions in matters relating to use of

herbicides, and in order to exchange perceptions on their use were undertaken with some of the Kajjansi communities, insufficient medical tests on the people handling the herbicides and on community residents were undertaken.

Detailed evaluation - single herbicide

The planned detailed evaluation of a single recommended herbicide with respect to efficacy and impact on water quality and biota in a semi-self contained natural environment like Pan Lake at Kajjansi was not realised due to unavoidable circumstances.

Recommendations

Based on the results of the laboratory-scale and pond (semi-natural environment) experiments, Glyphosate was recommended as the most suitable herbicide for large scale evaluation/use in the control of water hyacinth.

Regrowth after herbicide application should be carefully evaluated as it would suggest repeated use of herbicides to sustain water hyacinth control as is the case in Florida - USA. The evaluation would benefit from detailed larger scale experiments in a small, closed natural system like Pan Lake.

The significance of the surge in algal biomass in the first and second week of spraying with Glyphosate should be fully evaluated if use of this herbicide is recommended for Lake Victoria which is already adversely impacted by nutrient enrichment.

If massive herbicide application is sanctioned, comprehensive public health and awareness programmes should accompany the exercise, supervised by the Ministry of Health.

In the event that multiple herbicide application is contemplated, it would be essential to conduct appropriate studies to rule out probable attendant environmental impacts such as accumulation of herbicide residues via the food chain.

List of scientific personnel

1	Dr	T. Twongo	Fisheries Ecologist - Team Leader
2	Dr	M.K. Magunda	Soil Scientist
3	Mr	M.P.E. Wetala	Weed Scientist
4	Mr	S.V. Matagi	Limnologist
5	Ms	R. Mugidde	Limnologist
6	Dr	Y.S. Kizito	Limnologist (Invertebrates)
7	Mr	A.B. Lugudo	Analytical Chemist
8	Prof	J.T. Nyangababo	Analytical Chemist
9	Dr	T. Rushedge	Public Health
10	Dr	E.F. Agaba	Public Health
11	Mr	J. Ecaat	Environmentalist

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1. INTRODUCTION

Infestation with water hyacinth in Uganda has in the last five years attained epidemic proportions along the shores of Lakes Victoria, Kyoga, Albert and on the River Nile. Large mats of the noxious weed have closed important landing sites, numerous domestic water sources, transportation routes, fishing grounds; and various serious impacts due to the water weed have translated into costly expenses to the country. There is, therefore, need to develop an effective program to control and manage proliferation of this pest in Uganda.

Three control methods namely: biological, mechanical and chemical have been used in an integrated approach in several countries of the world including the United States of America, Australia, Nigeria and Sudan. While biological control has already been initiated in this country and some mechanical control capability has been acquired, suggestions to initiate the chemical control of water hyacinth arouse health and environmental concerns regarding the environmental friendliness of the chemicals in aquatic habitats. Lakes and rivers in Uganda are the direct source of potable water taken largely untreated and of fish which is a major source of animal protein and income for most lakeside communities as well as the whole country through export. It is, therefore, essential that verification of the effectiveness, safety and environmental friendliness of candidate chemicals for the control of water hyacinth be undertaken before they are integrated into the management of the weed.

Accordingly, the Chemical Verification Sub-Committee of the National Technical Committee on the Control and management of Water Hyacinth was commissioned to carry out a comparative study of three herbicides namely 2,4-D, glyphosate and diquat detailed in Table 1, with respect to their:

i. effectiveness (efficacy) to kill water hyacinth;
ii. environmental friendliness; and
ii. safety to humans.

The studies were scheduled to proceed through three stages:

i. experimentation in semi-laboratory conditions to determine optimum application rate for each herbicide;

ii. experimentation in small ponds with semi-natural ecosystems, to select the most suitable herbicides of the three based on efficacy and environmental friendliness;

iii. experimentation to evaluate further the efficacy and environmental friendliness of the selected herbicide in stable and virtually isolated natural ecosystems.

iv. Emphasis was to be placed on promoting public awareness and relevant aspects of public health in the above activities.

1.1 Laboratory Experiment

The main objective of the experiment was to determine the most suitable rates of application for each of the three candidate herbicides.

1.2 Pond Experiments

The main objectives of the pond experiments were:

i. to assess on a larger scale the efficacy of the three candidate herbicides on water hyacinth;

ii. to determine the effects of the herbicides on the water environment and aquatic biodiversity when sprayed on water hyacinth.

The experiments were to be accompanied by a public awareness campaign particularly among the communities around the experimental area of Kajjansi, to sensitise them about the objectives of the studies and the safety precautions that would be expected of them during various stages of the studies. Specifically, the experiments were to:

i. determine the efficacy of the herbicides on water hyacinth;

ii. assess the effects of the herbicides on water quality;

iii. assess effects of spraying with the herbicides on aquatic micro and macro biota (algae, zooplankton and macrofauna); and on fish;

iv. determine persistence of herbicide residues in the water, water hyacinth, bottom sediments and fish;

v. recommend the most suitable herbicide for control of water hyacinth.

2. MATERIALS AND METHODS

2.1 Laboratory experiments

Experiments to compare the efficacy of the candidate herbicides detailed in Table 1 under laboratory conditions were conducted at Kituza Experimental Station in Mukono District. The herbicides were tested on well established water hyacinth four weeks after transplanting into sealed polythene tubes placed into holes about one metre deep; in a split plot randomised complete block design setting with three replications. The growth medium (water) was spiked

with about 50 gm of NPK fertilizer to enhance the nutrient status. The herbicides were applied at three different rates, as detailed in Table 2, using a knapsack sprayer with a flood-jet nozzle.

Common name	Chemical name	Commercial name and Formulation	Manufacturer
glyphosate glycine	N-phosphonomethyl	Roundup 36% soluble liquid	Monsanto bought from Rhone Poulenc Kampala
2,4-D	2,4-Dichloro phenoxy acetic acid	2,4-D Amine 72% a.e. aqueous salt solution	bought from Rhone Poulenc Kampala
diquat	9,10 dihdro-8a, 10a diazoniaphenanthre	Reglone 20% miscible liquid	ICI bought from Twiga chemicals Kampala

Table 1. Details of the herbicides tested in the study.

Herbicide	Application Rates: Kg a.i. ha or (L ha⁻¹)		
	1	2	3
Roundup (36% glyphosate)	2 (5.6)	3 (8.3)	4 (11.1)
2,4-D - Amine (72% 2,4-D)	2 (2.8)	4 (5.6)	6 (8.3)
Reglone (20% Diquat)	1 (5.0)	2 (10.0)	3 (15.0)

Table 2. Application rates of herbicides used in the study.

2.2 Pond Experiments

In an effort to verify the most suitable herbicide to be used in the chemical control of water hyacinth, small ponds designated A,B,C & D were constructed adjacent to Pan Lake (a man made lake about 4 ha) at Kajjansi on Kampala-Entebbe road. The Ponds (12.50 to 17.0 m long by 9.0 to 13.0 m wide

and about 3 m deep) were excavated using a traxi cavator, filled with water from Pan Lake and planted with water hyacinth from the same lake. Mud from the bottom of Pan Lake was then introduced into each pond to facilitate quick stabilisation. The water depth in the ponds varied between 1.6 and 2.5 m (Table 3). Each of the ponds was spiked with about 5 kg of NPK to enhance the poor nutrient status of the water. They were left undisturbed to stabilize for at least two months before the first pre-herbicide application water quality analyses were made. The second pre-herbicide application samples were taken in May 1995 six months later. The ponds were assumed to have developed stable ecosystems.

2.3 Herbicide application

Herbicides described in Table 2 were applied on Water hyacinth from 2 Jeckto sprayers, each operated by two applicants and connected to a locally assembled boom whose length was varied from 9.6m to 13.4m depending on the total swath length required to spray a given pond. Each sprayer

Pond No.	Pond area (m^2)	Pond water depth (m)	Hyacinth area (m^2)	Application rates in Kg a.i ha or (L ha^{-1})
A	155	2.2	93	NIL
B	112	1.6	88	2 (10.0L ha^{-1})
C	137	1.8	137	2 (1.8L ha^{-1})
D	201	2.5	201	2.8 (8.0L ha^{-1})

Table 3. Experimental dimensions and herbicides rates used in the experiments at Kapsabet. A = Control; B = Diquat; C = 2, 4-D; D = Glyphosate (Round-up).

supplied two flood-jet nozzles with a spray output of 1. litres per minute. The herbicides were applied at a spra

volume of 200 L ha^{-1}, on water hyacinth covering about half of each pond (Table 3). The walking speed of the applicants was synchronised and varied so as to deliver, per hectare, 8.0 L of Glyphosate, 2.6 L of 2-4,D and 10.0 L of Diquat, the pre-selected application rates.

2.4 Water quality studies

Pre-herbicide application water quality (baseline) data collection was done on 9 January and 6 May 1996. On the 27 May 1996 herbicides were sprayed on ponds B, C and D. Two hours after spraying, physical variables of the matter were measured and samples taken for chemical analyses. There after, water samples were taken weekly until 24 June 1996. The samples were taken from the surface, middle, and bottom using a Van Dorn water sampler. Water transparency was measured with a Secchi disc. Temperature, dissolved oxygen, conductivity and pH were measured using a Hydrolab (SVR2-SU SONDE model

Both field and laboratory analyses were done on water samples collected according to standard methods for examination of water and waste water (APHA, 1992).

2.5 Studies on biota

2.5.1 Algae and zooplankton

Samples were collected in duplicate from the edge of the mat using a tube sampler to cover the entire water column. Chlorophyll-a concentrations were done as in Stainton et al. 1974. Samples for phytoplankton analyses were preserved in formalin and Lugol's iodine. Samples for zooplankton study were reduced in volume by filtering through a 60 micron net and preserved in 5% formalin. Plankton examination and study was done with the aid of appropriate microscopes.

2.5.2 Water hyacinth and sediments

Water hyacinth plants and bottom sediments for herbicides residue analysis were sampled on the 7, 14, 21, and 28 day after herbicide application.

2.5.3 Macrofauna

Water hyacinth mats were sampled using 0.25m^2 quadrat randomly thrown within one meter of the edge of the mat to the open water while benthos was sampled using a ponar grab with a maximum grab area of 0.05 m^2. Water hyacinth roots and debris were sprinkled with ethanol to flush out the macrofauna which were then hand sorted. Benthos was washed in a large sieve with a mesh of 400 microns before the organisms were picked and preserved in 10% formalin for further analyses in the laboratory.

2.5.4 Fish

Three species of Tilapia namely *Oreochromis niloticus* (40), *Oreochromis leucosticus* (50) and *Tilapia zillii* (40) specimens from a nearby Aquaculture Experimental Station were stocked into each of the three ponds and left to acclimatize for a month before herbicide application.

Behavioural data on fish before and after herbicide application were collected by a single observer for about fifteen minutes at each pond in the morning and afternoon. Emphasis was placed on fish mobility, schooling behaviour, swimming posture as well as on the general impression on the health of the fish. Observations were made daily for the first three days following herbicide application, and there after, once a week until 24th June (28 days after

application of herbicides) when regular observations were discontinued due to absence of abnormal behaviour. Fish samples were collected using gillnets set overnight and inspected regularly so as to avoid capture of more samples than necessary. This was essential to avoid depleting the limited stocks in the ponds. Samples for herbicide residue analysis were stored at about 4 degree Celsius until processing/analysis

2.6 Herbicide residue analysis

Herbicide residue analyses was done using Gas Liquid Chromatography (GLC) and Anode Stripping Voltammetric (ASV) methods in two laboratories - the Government Chemist and the Chemistry Department of Makerere University. All samples for residue analysis were stored at about 4 degrees Celsius immediately after collection and thereafter.

2.6.1 Anode stripping voltammetric method

Extraction and clean up:

i **Water** - a sample of water was allowed to percolate through an anion - exchange, Dower 1 - X 8 resin, packed in a column, at a rate of 30-50 ml hr^{-1}. This was followed by 20 ml of de-ionized water and the percolates were discarded.

The column was eluted at the same rate with 50 ml of 0.1 M hydrochloric acid. The first 10ml were discarded and the next 40 ml of elute collected in the measuring cylinder. The resin was not used again.

To the 40 ml eluate was added 2 ml sulphuric acid (1+1), 1 ml of potassium bromide and 1 ml of sodium nitrite solution. The mixture was shaken and left for 15 minutes, then 1ml of ammonium sulphamate solution added to destroy excess of

nitrite, The reaction mixture was then portioned into electrolysis cell, purged with nitrogen and measurements performed in anode stripping voltammetry mode.

ii. **Solid Samples** - a sample of plant material , sediment, soil or fish, of known weight was ground well to fine powder. This was then blended with chloroform or hexane or dichloromethane together with some water, and then centrifuged at 10,000 rpm for 30 min. The aqueous layer was concentrated by rotary evaporation. The analysis was done following the procedure in (I) above.

2.7 Public awareness and health

Meetings were held with members of some of the communities around Kajjansi; to inform them about the chemical verification exercise and to solicit their views on how they regarded the use of herbicides. Some door to door visits were also made for the same purpose.

2.8 General constraints

Replication of pond experiments was not practical due to limited suitable area for pond construction at Pan Lake site. Unlike ponds C and B, ponds A and D received sizeable quantities of runoff during rain events.

3.0 RESULTS AND DISCUSSION

3.1 Efficacy - laboratory experiments

3.1.1 **Reglone (diquat)** showed fast activity, scorching the laminae of the water hyacinth within a few hours after application. Most of the herbicide activity lasted for about

two weeks after application. At the application rate of 10 and 15L ha^{-1}, complete kill of above water biomass of the weed was achieved 8 weeks after application; there was no complete kill at the rate of 5.0 L ha^{-1}.

3.1.2 **2,4-D amine (2,4-D)** was slower than Reglone with major herbicide activity lasting 4 weeks after application. Results indicated erratic behaviour whereby complete kill of the weed was recorded at the lowest rate of 2.8 L ha^{-1} and not at the higher rates of 5.6 and 8.3 L ha^{-1}.

3.1.3 **Roundup (glyphosate)** was slow, major herbicide activity taking 4 weeks after application. At the application rate of 8.3 and 11.1 L ha^{-1} complete kill of above water biomass the weed was achieved in four weeks while at 5.6 L ha^{-1}, it was achieved after 8 weeks.

3.1.4 Regrowth

Extensive regrowth by sprouting occurred in all experimental units sprayed with 2,4-D. Regrowth in units sprayed with Reglone was fastest where 5.0 L ha^{-1} was applied. Little regrowth was noted in units sprayed with glyphosate (roundup).

3.2 Efficacy - Ponds Experiments

3.2.1 Reglone (diquat)

1 week: 98% of laminae desiccated; petioles basically green;

2 weeks: as above; some petioles turning light yellow;

4 weeks: about 78% of laminae shrunk; most petioles brittle;

6 weeks: mats at openwater margin dead; otherwise little change;

8.5 weeks: 25% of above water biomass collapsed; all laminae dead; other petioles looking live;

12 weeks: 65% of above water biomass collapsed; 35% indicated recovery in parts;

14 weeks: 50% of mat rotting; about 2% regrowth of sprayed mat noted

16 weeks: 80% above water biomass rotting. Sprouting regrowth in about 20% of sprayed area.

3.2.2 2-4, D Amine

1 week 100% petioles twisted, drooping and yellow; laminae green or yellow;

2 weeks 50% of the laminae dead; 50% wilted but green;

4 weeks 60% of laminae dead, 40% still green; most petioles looked brown;

6 weeks most laminae looked dead; most petioles were brittle

8.5 weeks 80%of laminae and 70% of petioles looked dead; regrowth by sprouting covered 20% of the dead mats at the openwater fringe.

12 weeks All above water biomass looked dead; Regrowth sprouted to cover about 40% of sprayed area. Dense feeding marks of biological control weevils noted.

14 weeks Regrowth covered about 70% of sprayed area and was flowering.

16 weeks Regrowth covered about 80% of sprayed area.

3.2.3 Roundup (glyphosate)

1 week: 25% of laminae yellow, the rest green and look healthy

2 to 4 weeks: little change

6 weeks: 75% of laminae dusty green

8.5 weeks: 30% of laminae dying, the rest dusty brown; petioles light brown

12 weeks: 70% laminae desiccated; petioles dark brown some green

14 weeks: 100% laminae dead; most petioles light brown; regrowth covered about 40% of sprayed area.

16 weeks: regrowth covered about 60% of sprayed area.

3.2.4 Recommended herbicide rates

The following application rates were recommended for the experiments in the ponds: Reglone (diquat) 10.0 Lha-1; 2,4-D Amine (2,4-D) 2.8 Lha-1; Roundup (glyphosate) 8.0 Lha-1.

3.2.5 Weight loss

Water hyacinth sprayed with herbicides lost weight very slowly (Table 4). Application of the systemic herbicides glyphosate and

	Pond A (Control)	Pond B (Diquat)	Pond C (2-4,D)	Pond D (Glyphosate)
IB (Kg)	2,166.3	3,291.2	5,945.8	9,149.4
Date	Fresh biomass		(Kg m⁻²)	
6.5.96	26.1	37.4	43.4	41.4
29.5.96	25.4	35.4	41.4	39.4
3.6.96	25.4	32.4	34.6	35.4
10.6.96	24.4	29.4	3[illegible] 4	33.4
17.6.96	25.4	34.6	3[illegible] 6	27.1
24.6.96	24.4	34.5	[illegible] 4	27.4
FB (Kg)	2,025.2	3,036.0	4,521.[illegible]	[illegible] 2.0
Wt loss (%)	6.5	7.8	24.0	3.7

Table 4 Changes in fresh biomass of water hyacinth after herbicide application. IB = initial biomass; FB = final biomass.

2,4-D appear to have contributed to significantly faster weight lost that spraying with the contact diquat. Loss in weight of 6.5 recorded for the control pond A could have been caused by spreading out of the water weed due to wind effect acting on the intact laminae.

3.3 Discussion on efficacy

Diquat: This was the fastest acting herbicide in laboratory experiments where total kill of above water biomass was achieved in 8 weeks at the recommended application rate of 10L ha^{-1}. However, complete wetting during herbicide application was essential as demonstrated by some patchy recovery in the pond experiments during week 12. Diquat was also accompanied by considerable regrowth during week 14 even from part of what had appeared to be dead biomass

2,4-D Amine: This herbicide was judged slower acting than diquat. The recommended application rate of 2.8L ha^{-1} achieved maximum kill during week 9 after herbicide application. However, treatment with 2.4-D was accompanied by the most extensive regrowth in the pond experiments and in the laboratory scale experiments where sprouting occurred at all herbicide rates.

Glyphosate: This herbicide was rated to exhibit the slowest control activity for water hyacinth. However, Glyphosate recorded the highest efficacy of the three herbicides tested, attaining complete kill at all application rates used in the laboratory experiments, accompanied by no regrowth up to week 9 when observations stopped. Although pond experiments did not demonstrate similar degree of efficacy due to poor herbicide coverage caused by drift (available experimental site did not permit

replication of experimental ponds) Glyphosate caused total mortality of the above water biomass 14 weeks after application. However regrowth set in after 12 weeks, emphasising the need for optimum wetting in the use of herbicides to control water hyacinth.

Regrowth: The phenomenon of regrowth would be a crucial consideration when deciding to utilise herbicides especially in a water environment vital as a source of potable water and fisheries. Results of the verification experiments indicate two types of regrowth namely when the herbicide fails to overpower all the vegetative buds of the weed and secondly when insufficient herbicide is applied or no herbicide reaches some of the target. The latter is almost inevitable in a setting like that in the lakes of Uganda with long and convoluted shorelines. In both cases the result would be extensive sprouting of the weed enhanced by the enriched environment of rotting hyacinth biomass. In a vast environment like Lake Victoria this kind of regrowth would have to be repeatedly sprayed with herbicide to sustain control. It would appear that this scenario is partly responsible for the annual herbicide application to control water hyacinth in Florida- USA.

3.4 Water quality studies

3.4.1 Secchi, transparency, colour, turbidity, total suspended solids

Ponds A, B & C showed progressive increases in Secchi transparency while pond D had the reverse (Figure 1). Average Secchi transparency was higher in ponds B & C after herbicides application. Pond B was as transparent as pond C throughout the study. In pond D average Secchi transparency decreased three fold after spraying with herbicides. This could partly be

explained by a three fold increase in algal biomass (as chlorophyll-a concentrations) occurred between week one and two after herbicide application followed by a decline in week three. To the contrary, algal growth in ponds B and C seem to have been inhibited during weeks one and two as evidenced by a decline in chlorophyll-a concentrations until the third week after herbicides were applied. Initially, ponds A & D had higher colour, turbidity and total dissolved solids compared to ponds B & C where the three parameters fluctuated at low levels. In general, total suspended solids progressively decreased throughout the study in all ponds. Ponds A & D showed a marked decrease in colour and turbidity, especially, during the second week after herbicide application. High colour in the ponds was attributed to the colloidal clay particles and humic acids. Decaying organic matter and silt seem to have been the major contributors to turbidity and total suspended solids compared to algal biomass as evidenced by the inverse relationship of these in pond D during weeks one and two after herbicide application. Reduction in colour, turbidity and total suspended solids in all ponds including the control pond A seem to be an artefact of dilution by the heavy March-May rains.

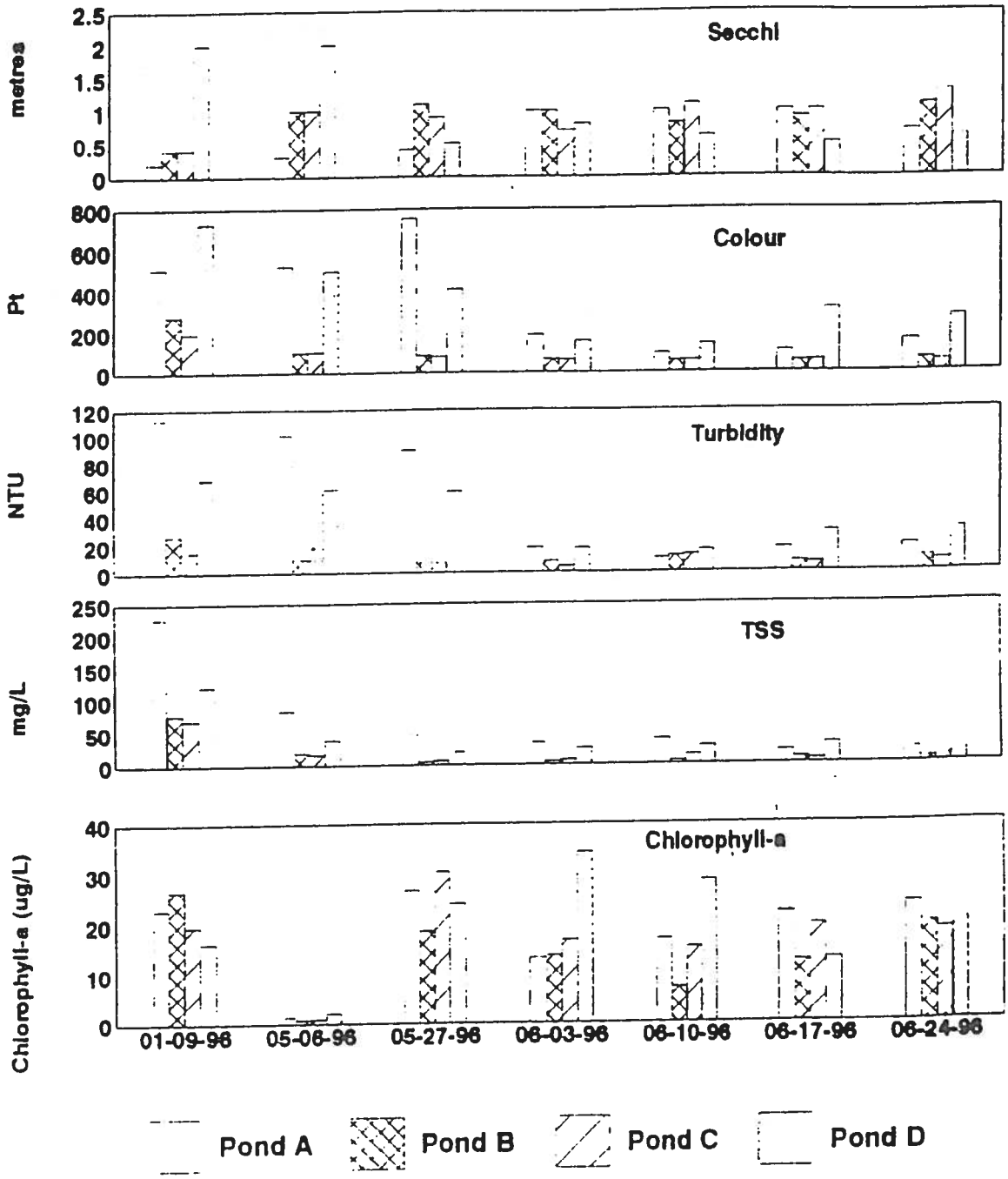

Figure 1. Secchi, colour, turbidity, total suspended solids and chlorophyll-a in ponds A,B,C & D during the study.

3.4.2 Temperature

Water temperatures were of the same order of magnitude in all the ponds (Figure 2.). Maximum temperatures were recorded during the day herbicides were sprayed in ponds B & C. Average post-spray temperatures did not differ significantly in all ponds (Figure 3). Peak temperature values on the day of spray could be a result of relatively high colour and turbidity on that day.

3.4.3 Oxygen

At the beginning of the study ponds A and C were anoxic (less 4mg l^{-1}) and remained so throughout. Severe anoxia was observed in all the ponds weeks prior to herbicide application following heavy rains and entry of run-off into the ponds. Spraying didn't appear to affect dissolved oxygen concentrations as control pond A had similar average values as the other three ponds

3.4.4 pH

pH remained below seven in all the ponds. It decreases throughout the study and highest values were recorded in pond A and least in pond D. Spraying did not appear to affect pH as control pond A showed similar trends as ponds B,C & D.

3.4.5 Conductivity

All ponds were quite different in terms of electrical conductance suggesting different levels of mineral concentrations which makes them not ideal for these chemical verification experiments. Experimental ponds ought to have been as identical as possible with herbicide type as the only variable. This was, of course, not practical in a semi-natural set-up where each pond would be

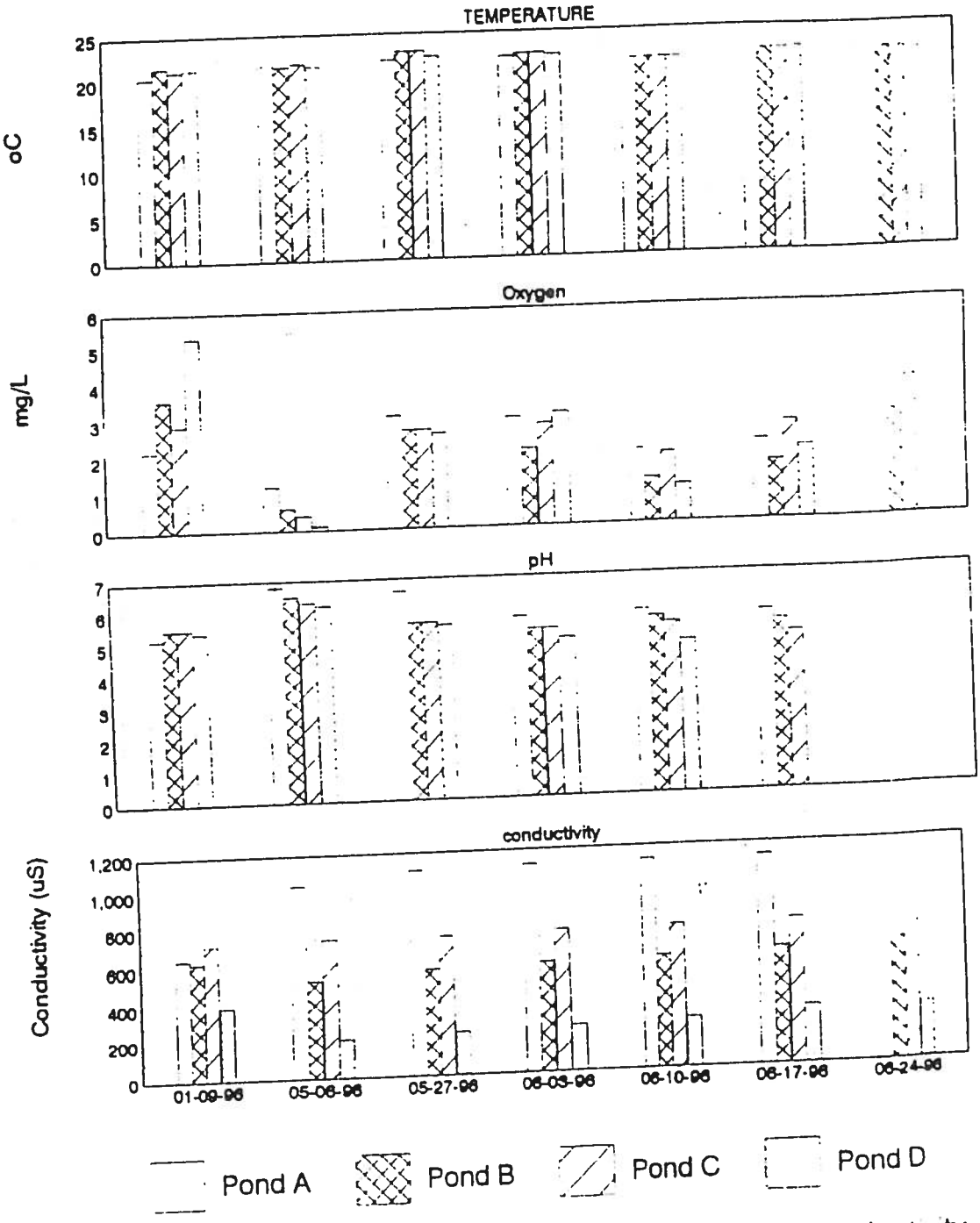

Figure 2. Daily mean temperatureS, oxygen, conductivity and pH in ponds A, B, C, & D during the study period.

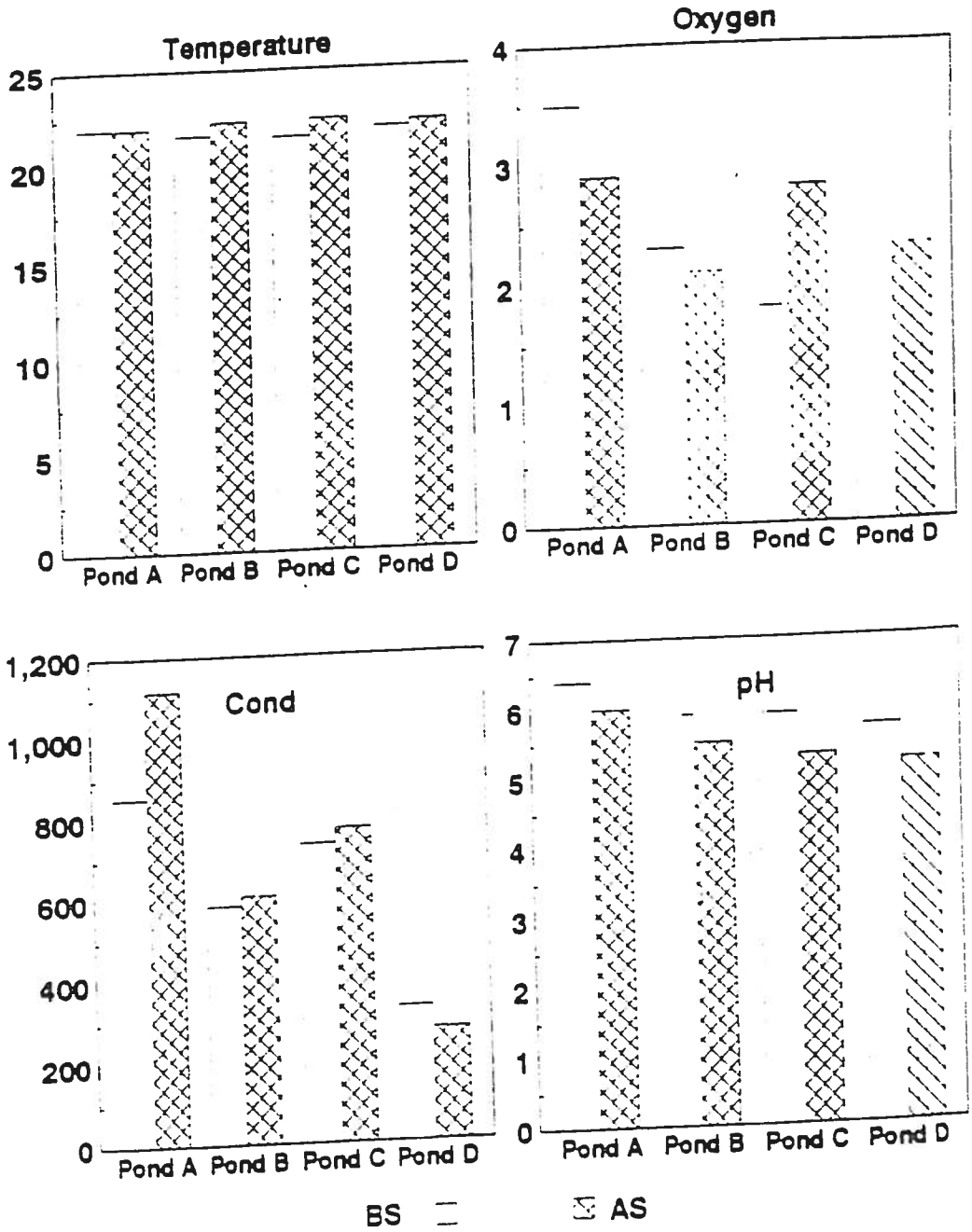

Figure 3. Average temperature, oxygen, pH and conductivity before (BS) and after spray (AS) in the ponds A, B, C & D.

expected to have some peculiar environmental characteristics. Pond D had the most dilute ionic concentration, while pond A had conductivity which were four times higher than in D and twice higher than in pond C.

3.4.6 Biological oxygen demand (BOD)

BOD was in the range 5 to 16mg L^{-1} in all the ponds. BOD decreased to a minimum during the third week after spray (Figure 4).
Average pre-herbicide application values were 2 to 3 times higher than their corresponding post-spray values (Figure 5) suggesting reduction in biodegradable matter or inhibition of bio-degradation processes. Given a decrease in total suspended solids and turbidity the former seems more likely. Changes in BOD seemed not to be related to herbicides application since the control pond A exhibited similar trends as ponds B, C & D.

3.4.7 Chemical Oxygen demand (COD)

In general, levels of COD declined following herbicide application, reaching a minimum during the third week after spraying as did BOD (Figure 5). The observed values were low compared to those in literature of contaminated waters and were in the range 2 to 25mg L^{-1}. Initial mean COD values were 21mg L^{-1} in pond A and B and 17.7 and 19.2mg L^{-1} in ponds C and D, respectively.
On the day of herbicide application, highest COD values were measured in pond C, followed by pond B and A, while pond D had the lowest. About 45-46% drop in COD values was recorded in ponds B and C and no change in pond D the week immediately after herbicide. Chemical oxygen demand was 72-75% lower in Pond B and C three weeks after herbicide application. The forth week after spray saw a rise in COD to about 60% of the initial value suggesting a recovery processes in the ponds. In pond D changes in COD were gradual with a 20% and 35% decrease during week three

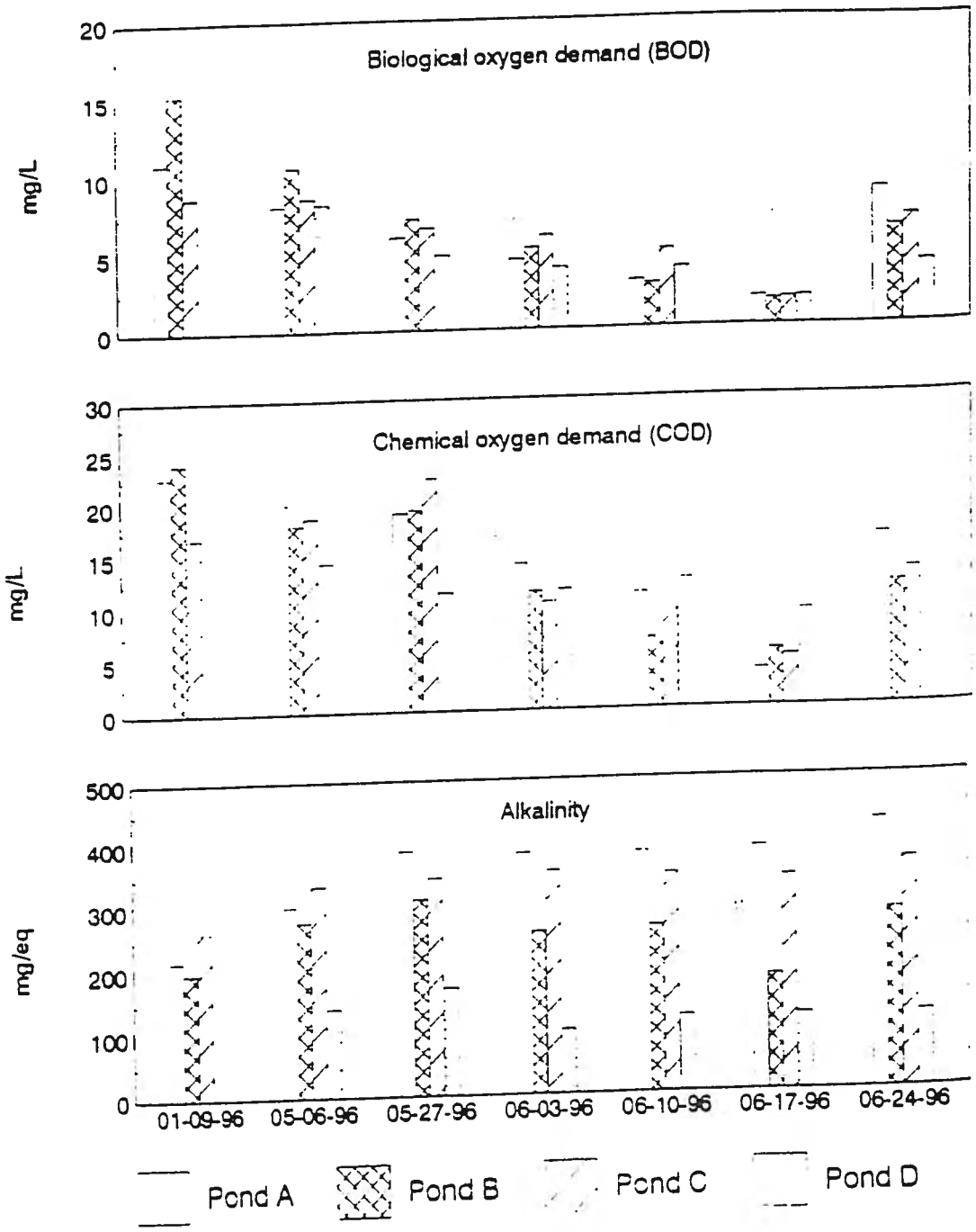

Figure 4. Biological oxygen demand (BOD), chemical oxygen demand (COD) and alkalinity in the ponds during the study period.

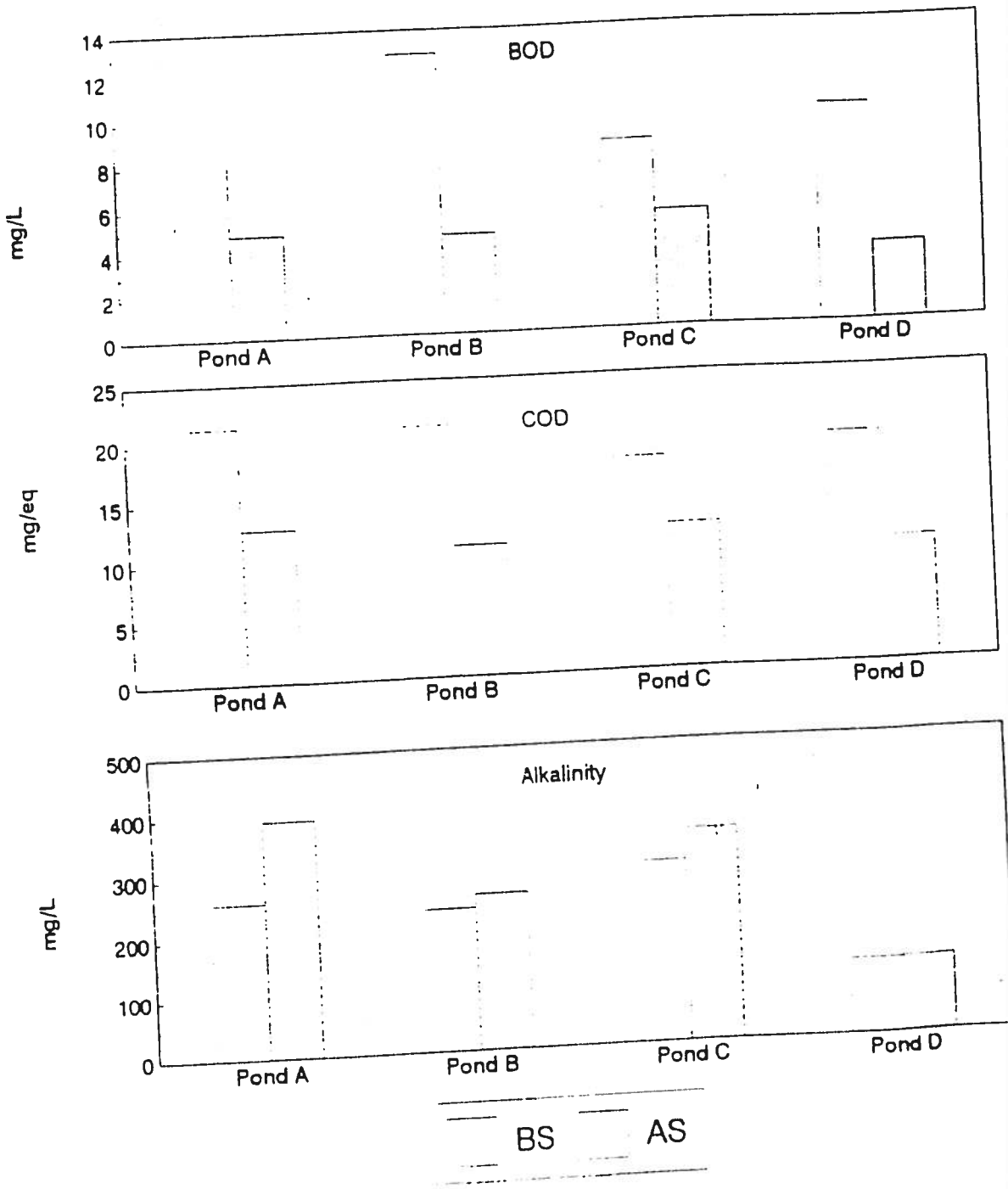

Figure 5. Average biological oxygen demand (BOD), chemical oxygen deman (COD) and alkalinity in the ponds before spray (BS) and after spray (AS).

and four after spray. A general decrease in COD from week two to three after spray may be explained by dilution of pond waters by the incoming rain and possibly by sedimentation of adsorbed chemical components.

3.4.8 Alkalinity

The alkalinity values were in the range 26 to 480mg L^{-1} at all stations and varied insignificantly within stations. In all ponds highest alkalinity values were recorded on the day herbicides were applied. The average values of ponds A, B, & C after spraying were higher than those before spraying, while pond D values remained fairly constant after spray (Figure 4). The mean average alkalinity values of the control pond A were 50% higher at the end of the study.

3.4.9 Sulphate

Sulphate concentrations were highest in the control pond A with a 30% increase in mean values at the end of the study (Figure 6, & 7,). Means values in pond B and C were close before and after spray while pond D had a 60% increase in mean sulphate concentrations after spraying with herbicides. Fluctuation in sulphate concentrations may partly be explained by variability in oxygen concentrations in the ponds. Chloride concentrations were highest at the time of herbicide application and decreased there after. Chloride values in ponds B and C decreased on the average while pond D showed no significant difference (Figure 7). Iron measurements were relatively high in the control pond A compared to B, C & D. Iron concentrations decreased in ponds B & C after spraying with herbicides. Only pond D had higher post spray average values than pre spray. The recorded iron concentrations were high and are

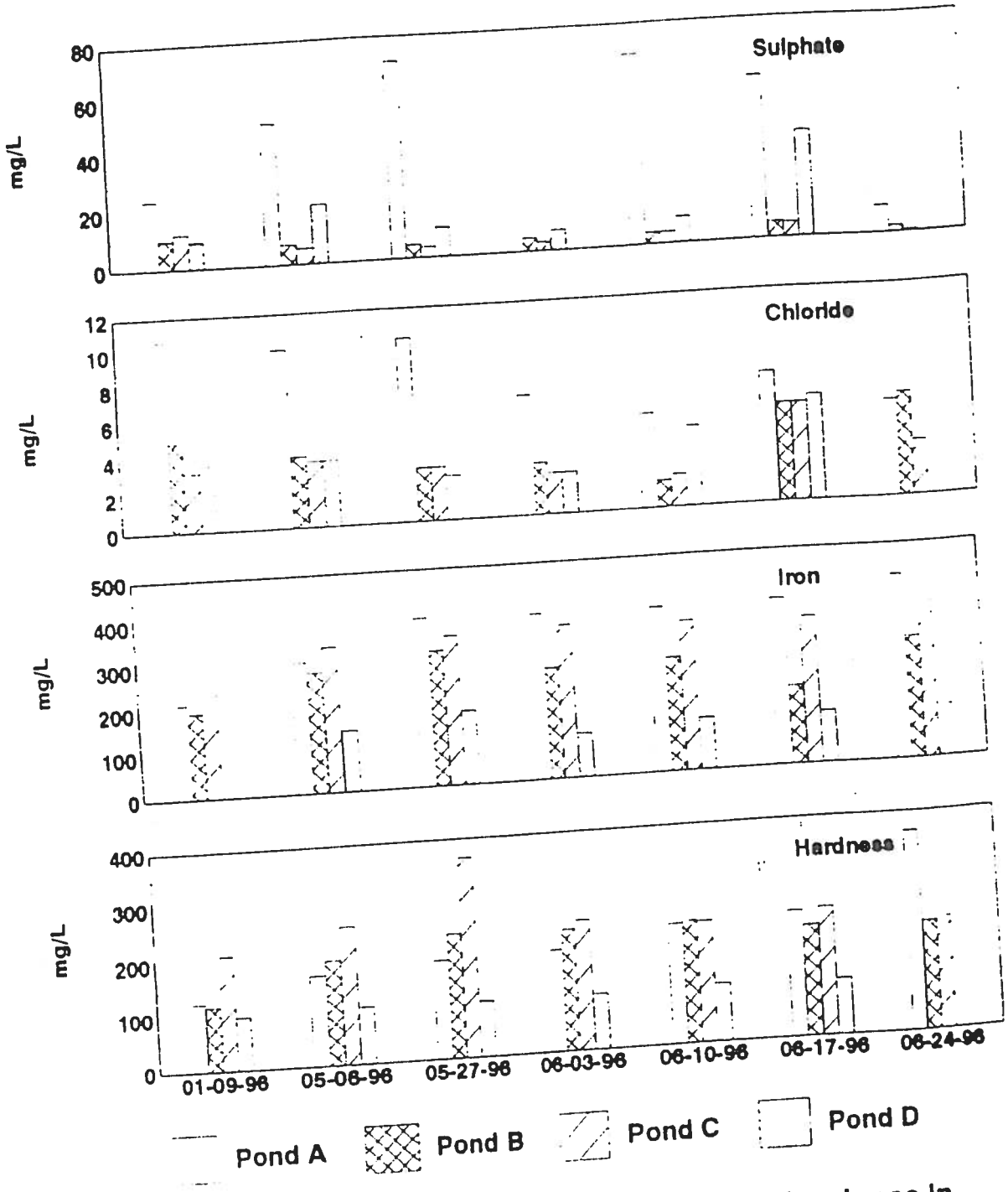

Figure 6. Sulphate, chloride, iron and total hardness in ponds A, B, C & D during the study.

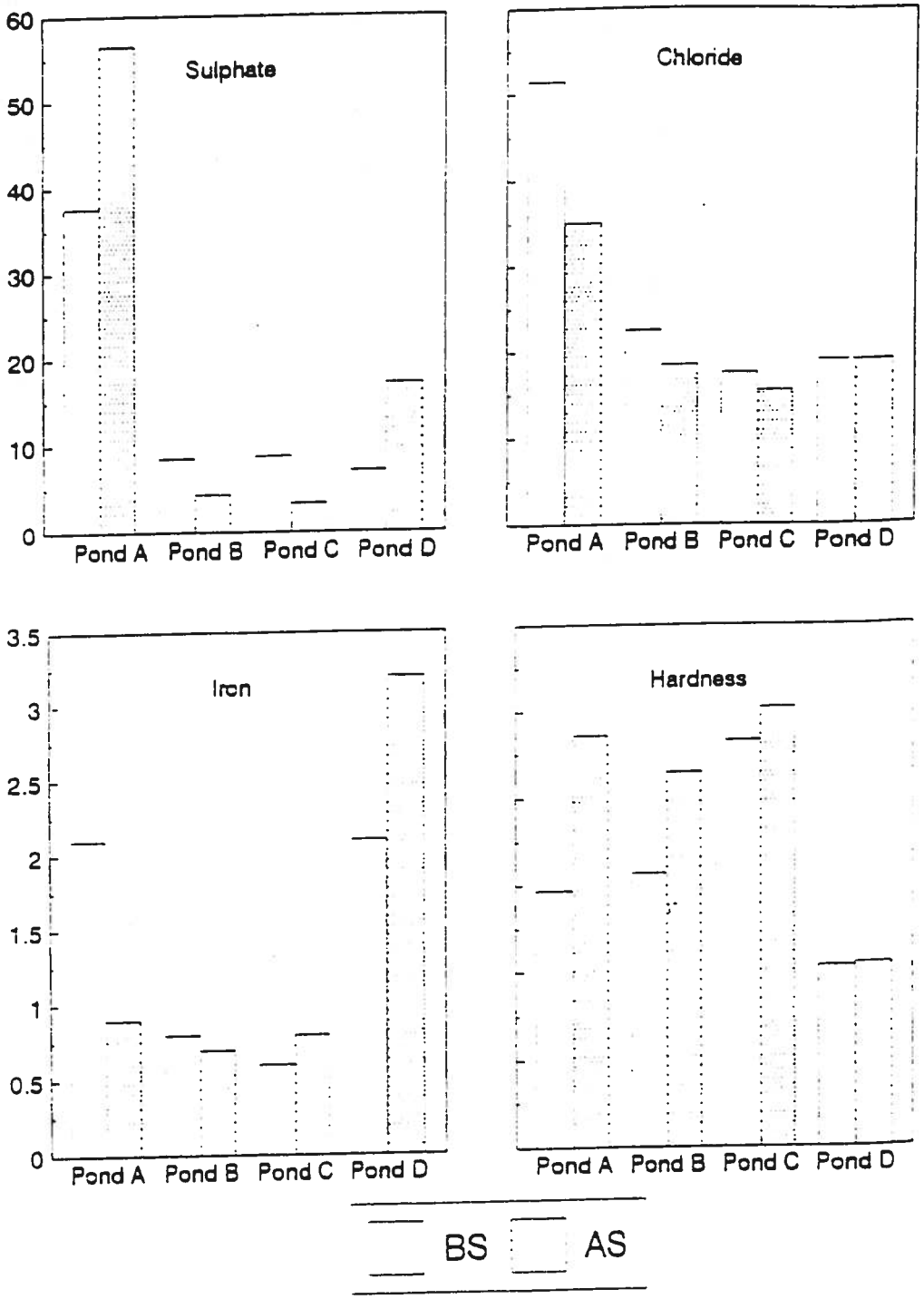

Figure 7. Sulphate, chloride, iron and hardness in the ponds before (BS) and after spray (AS) during the study period.

attributed to anoxic conditions that prevail in the ponds and favour their release into solution.

3.4.10 Orthophosphate (SRP), Total dissolved P, & Total P

Daily concentrations of SRP, TDP and TP for all stations over the study period are presented in Figure 8. SRP, TDP & TP concentrations showed a similar downward trend in all experimental ponds. However, on 27 May 1996, the control pond A showed an increase in SRP and TDP. Comparison of pre spray and post spray average values shows a four fold decrease in SRP in ponds B, C & D. Control pond A had significantly higher SRP concentrations than B,C & D showed increases in average values at the end of the study. Comparison of pre and post spray average values show a twenty two fold decrease in average TDP in pond D, two and one fold decrease in ponds C and B respectively. Contrary, control pond A showed a two fold increase.

Total P concentrations were high, probably related to fertilisation before start of experiment. The relatively low pH, always below 6,(Figure 2) in ponds B, C & D favoured precipitation of P into the sediment, despite the low oxygen concentrations and hence the decrease in TDP concentrations. Pond A had a relatively high pH, above or about 6 compared to other ponds which favoured release of P. TP progressively decreased in all the ponds. Pond B & D showed a 4 fold, while Pond D had an eight & control pond A had a seven fold decrease. This suggest loss of P to the sediment given the pH range and to the plants (algae and Hyacinth).

3.4.11 Ammonium (NH_4-N, nitrate, organic nitrogen and total nitrogen (total N)

Fluctuations in the various components of nitrogen were in the same order of magnitude in all the ponds with no apparent

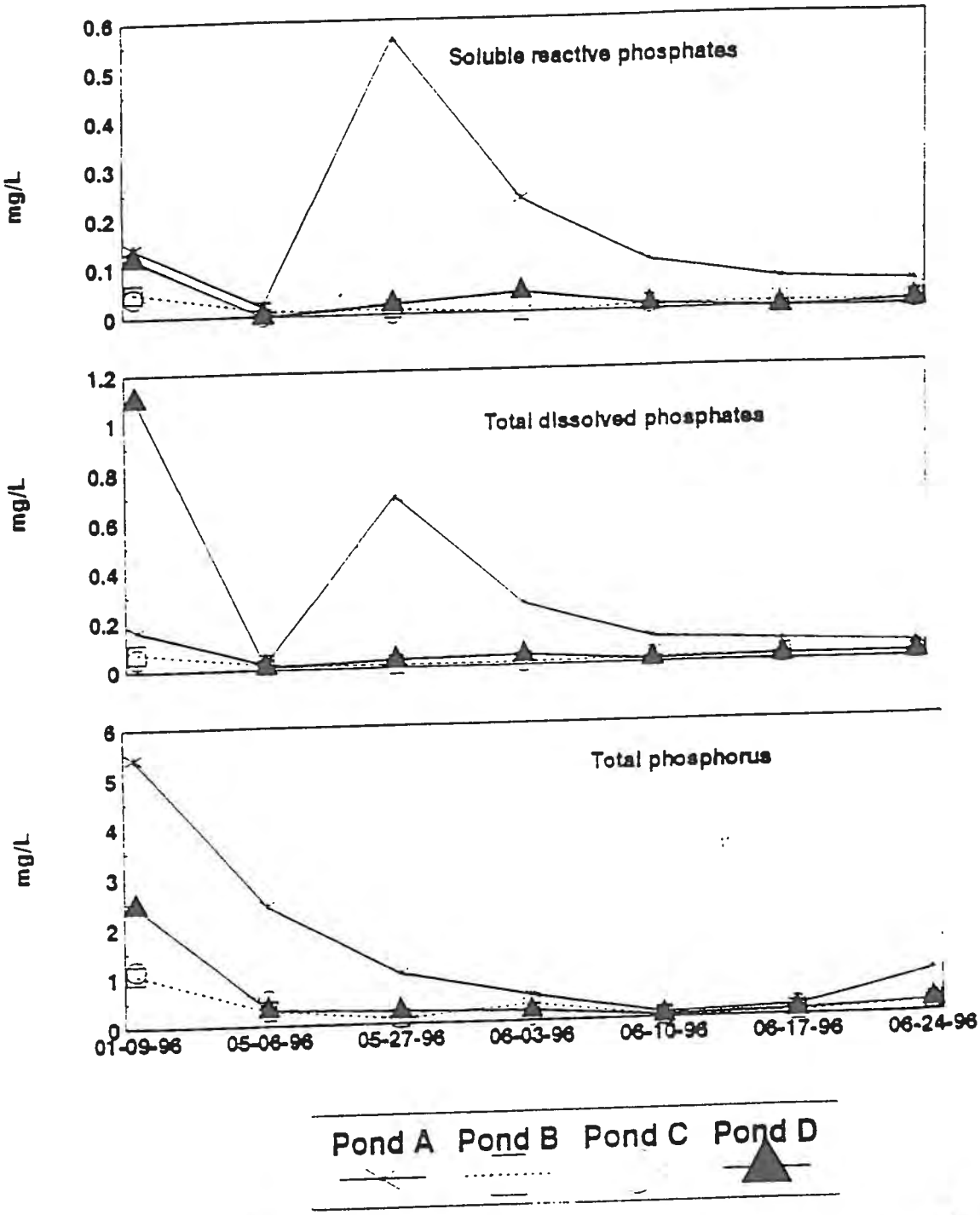

Figure 8. Values of soluble reactive phosphate, total dissolved phosphate, total phosphorus in ponds A, B, C & D.

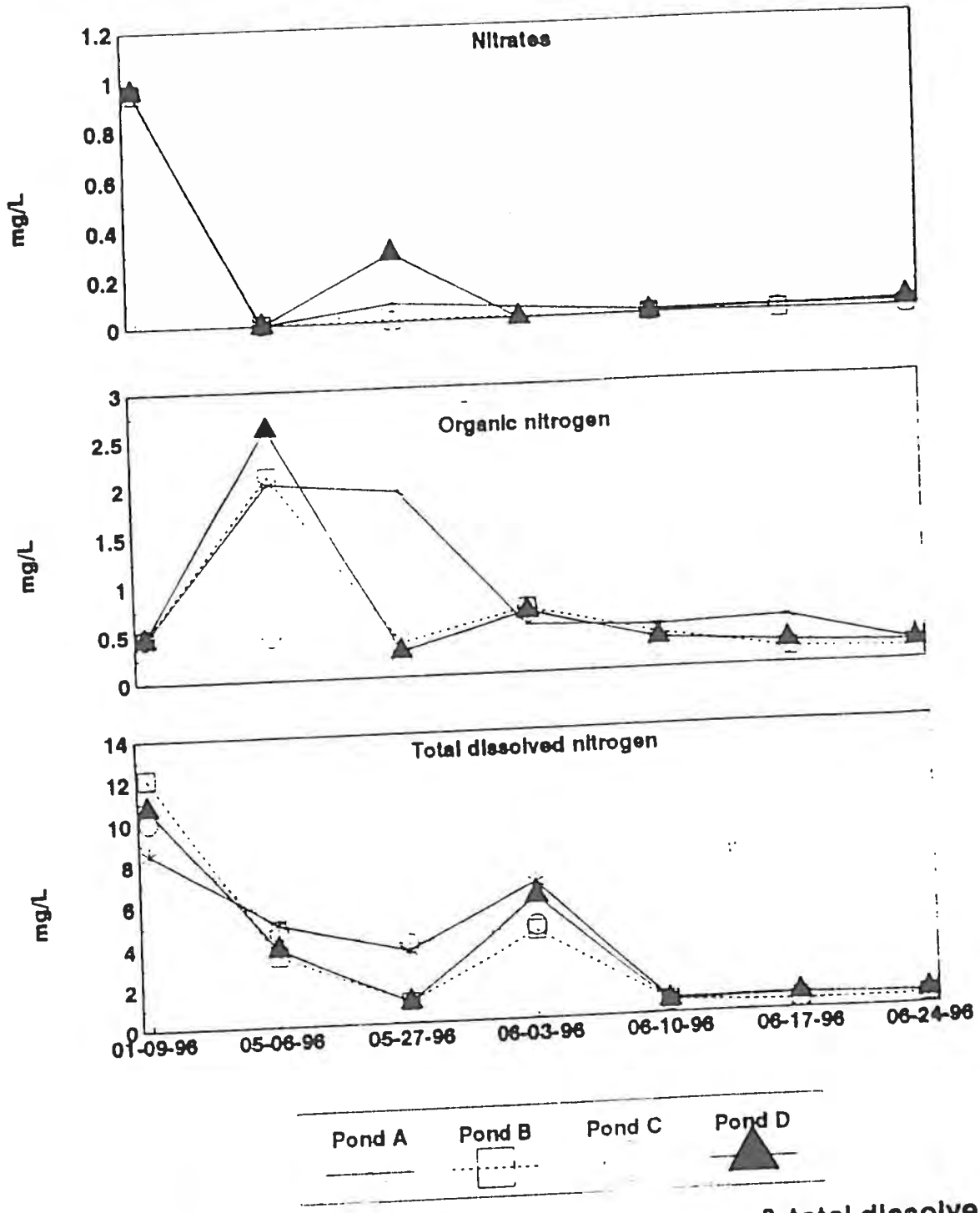

Figure 9. Values of nitrates, organic nitrogen & total dissolved nitrogen in ponds A, B, C & D.

relationship to spraying dates (Figure 9). Total nitrogen concentrations were high in all ponds but ought to have been higher if it were to meet the N:P demand and supply ration i.e. the observed excess P in the ponds favours a draw down on N. Total nitrogen decreased two to three fold in ponds B, C, and D and about 25% in the control pond A. Organic nitrogen was the most important component of the total nitrogen. Given low oxygen and light levels denitrification processes are likely to dominate and consequently lower nitrogen concentrations in the ponds.

3.5 Impact on biota

3.5.1 Algae and zooplankton

Preliminary results indicate no adverse effects on abundance of algae and zooplankton attributed to application of the three herbicides in the trials. However, in view of the successional growth characteristic of some microbiota notably species of algae and rotifers, more conclusive deductions would require longer sampling period.

3.5.2 Macrofauna

Data on abundance of macrofauna recovered from the roots and rhizomes of water hyacinth (Table 5) and from the bottom sediments (Table 6) before and after application of the herbicide is given as number of organisms per m^2. The number of macro invertebrates recorded in the experimental ponds before herbicides were applied are generally lower than those recovered after. This was probably due to the fact that in May 1995, pond fauna had not yet stabilised. On the other hand pre-herbicide application sampling in January 1996 followed prolonged total cover of the experimental ponds by water hyacinth due to unavoidable circumstances which halted the experiments for some

time. However, while rigorous comparison of the macrofauna data from the herbicide trials is not possible due to lack of replication inspection of data from the control and sprayed ponds does not reveal adverse effects on the abundance of the macro-invertebrates attributed to the use of the three herbicides in the trials.

Macrofauna	Chironomid				Odonata				Oligochitae				Gastropoda			
PONDS	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
DATE					Pre-herbicide Application											
9.1.95	8	0	8	32	0	8	0	8	0	0	16	0	8	8	4	8
6.5.96	0	0	0	0	8	8	0	0	0	0	8	0	0	0	8	0
					Post-herbicide Application											
27.5.96	0	0	64	0	48	0	0	0	0	0	16	0	16	0	0	0
28.5.96	0	0	0	0	0	16	0	0	0	0	0	0	0	16	0	0
3.6.96	16	0	0	0	16	0	0	16	32	0	16	0	0	0	0	0
10.6.96	16	0	0	0	16	0	0	16	0	0	0	16	0	0	0	0
17.6.96	0	0	0	0	0	0	0	0	0	16	16	64	16	0	0	0
24.6.96	0	0	0	0	0	0	0	0	0	32	0	32	0	0	0	0

Table 5. Effect of herbicide application on relative abundance of major macrofauna in the roots of water hyacinth in the experimental ponds at Kajjansi.

Macrofauna	Chironomid				Oligochitae				Gastropoda			
PONDS	A	B	C	D	A	B	C	D	A	B	C	D
DATE					Pre-herbicide Application							
6.5.96	0	0	0	0	0	0	0	0	0	0	41	0
					Post-herbicide Application							
27.5.96	163	0	32	653	0	0	0	0	0	41	0	0
28.5.96	82	122	163	490	0	0	0	0	0	0	41	0
3.6.96	449	163	1061	857	41	0	0	41	0	0	0	0
10.6.96	775	122	857	1224	0	41	41	0	0	41	0	41
17.6.96	122	748	245	0	0	0	0	0	0	0	0	0
24.6.96	558	354	585	0	14	14	0	0	27	0	14	41

Table 6. Effect of herbicide application on relative abundance of major macrofauna in the bottom mud in the experimental ponds at Kajjansi.

3.5.3 Fish

The behaviour and survival of the three Tilapias (*Oreochromis niloticus* (Nile tilapia), *Oreochromis leucostictus* and *Tilapia zillii*) tested in the pond experiments were not observed to have been adversely affected by use of the three herbicides in the trials. No fish mortality was registered after herbicide application.

3.6 Herbicides residues

3.6.1 Residues reference values

Standard persistence and toxicological characteristics of the candidate herbicides are shown in Table 7. More data on tolerance levels from literature are given in Table 8 below. The "potable water tolerance" implies that when residues (in water) exceed the indicated level then the herbicide in question is likely to impart health problems on those drinking the water. "Fish tolerance level" implies that fish health could be endangered when herbicide residues exceed the indicated tolerance limits. Tolerance limits could therefore be considered as the maximum permissible herbicide levels (in the water environment) which, if exceeded, could lead to toxicity of the herbicide to man or fish.

The LC_{50} values (Table 7) imply that the levels in water would have to exceed the indicated values to cause 50% fish mortality; the levels have to persist for 96 hours and lead to the 50% fish kill. The test organisms (Table 8) were young fish.

3.6.2 Residues in experimental ponds

The residue levels in different samples, as a function of time (hours and days after spraying) are given in Tables 9, 10, 11, and 12. Results of residue analysis for water hyacinth, water sediment in fish from the control pond (A) are summarised in Table 13.

FISH AND AQUATIC INVERTEBRATES[1]			
HERBICIDE/TEST ORGANISM	96-h LC_{50} (mg L^{-1})	ACUTE[2] ORAL LD_{50} (RATS) [MG/KG]	$t^1/_2$[3] (d)
1. DIQUAT G. fasciatus Black bullhead	> 100 170	231	7
2. GLYPHOSATE Rainbow trout Channel catfish Bluegill	130 130 135	5600	21
3. 2,4-D Rainbow trout Bluegill Lake trout	2.0 [illegible].5 45.0	375	14

Table 7. Persistence and toxicological characteristics of the candidate herbicides. Source: [1]Handbook of acute toxicity of chemicals to fish and aquatic invertebrates (1980); [2]The pesticide manual (1987).

Herbicides	Portable Water (mg L^{-1})	Toxicity to fish (mg L^{-1})
2,4-D	0.10	1.00
Diquant	0.01	0.20
Glyphosate	0.50	

Table 8. Tolerance Levels for the candidate herbicides. Source : Joseph et al. 1986.

3.6.2.1 Water

The initial residues were very low for all the herbicides (diquat, 2,4-D, and glyphosate) and dissipation / decay was fast. The initial deposit was on average 0.98 mg L^{-1} X 10^{-3} (high concentration) and 0.02 mg L^{-1} X 10^{-3} (low concentration). Only a level of 0.02 mg L^{-1} X 10^{-3} is found even after three days; thereafter there was a steady decrease. These levels were very low when compared with the tolerance levels (Table 8).

3.6.2.2 Water hyacinth

Residue levels were not detected in water hyacinth samples from control pond. Herbicide residues detected in the weed from sprayed ponds were very low and dissipation was fast.

3.6.2.3 Fish

The herbicide residues were not detected in fish from the control pond. Residues were sometimes present in fish from sprayed ponds (Table 11) but the herbicides dissipated so fast that 14 after spraying 2,4-D and glyphosate could no longer be detected. Comparison with the reference values (Tables 7 & 8) clearly shows that the recorded values were meagre.

3.6.2.4 Sediments

As can be seen from the data (Table 9) the levels of the three herbicides in the sediments are very low and dissipate fast with levels of 0.005 mg L^{-1} X 10^{-3} on the 7th day dropping to 0.001 mg L^{-1} X 10^{-3} on the 28th day after spraying. This is a 5-fold decline from the initial deposition.

METHOD /DAA	DIQUAT		2, 4 - D		GLYPHOSATE	
GLC	CONTROL	SPRAYED	CONTROL	SPRAYED	CONTROL	SPRAYED
		SURFACE BOTTOM	SURFACE BOTTOM			SURFACE BOTTOM
0	ND	0.98 0.98	ND	0.02 ND	ND	0.06 0.05
1	ND	0.98 0.98	ND	0.02 ND	ND	0.09 0.08
2	ND	0.90 0.89	ND	ND ND	ND	0.08 0.08
3	ND	ND ND	ND	0.009 0.009	ND	0.02 0.01
14	ND	0.05 0.05	ND	ND ND	ND	ND ND
21	ND	TR TR	ND	TR TR	ND	ND ND
28	ND	ND TR	ND	ND ND	ND	ND ND
ASV						
0	TR	0.13 0.10	TR	0.56 0.40	TR	0.37 0.30
1	TR	0.14 0.10	TR	0.47 0.40	TR	0.34 0.30
2	TR	0.11 0.20	TR	0.25 0.20	TR	0.24 0.10
3	TR	0.10 0.20	TR	0.18 0.10	TR	0.23 0.10
14	TR	0.09 0.10	TR	0.15 0.20	TR	0.18 0.20
21	TR	0.06 0.10	TR	0.27 0.20	TR	0.10 0.10
28	TR	0.02 0.10	TR	0.10 0.10	TR	0.08 0.10

Table 9. Herbicide residues in water [mg/L x 10^{-3}] from the experimental ponds. DAA = days after application of herbicide; ND = no herbicide detected ; TR = trace

METHOD	DAA	DIQUAT	2, 4-D	GLYPHOSATE
GLC	7	ND	0.302	MS
	14	ND	0.090	MS
	21	0.120	0.050	MS
	28	ND	0.010	MS
ASV	7	0.001	0.001	0.005
	14	0.001	0.001	0.001
	21	0.001	0.003	0.004
	28	TR	0.004	0.003

Table 10. Herbicide residues in water hyacinth [mg/Kg x 10^{-3}] from the experimental ponds. DAA = days after application; ND = no herbicide detected MS = missing data.

METHOD/DAA		DIQUAT			2,4-D			GLYPHOSATE		
		Z	N	L	Z	N	L	Z	N	L
GLC	3	NFC	NFC	NFC	1.14	0.96	0.34	0.02	NFC	0.15
	10	NFC	ND	0.21	NFC	NFC	0.71	0.02	0.02	TR
	14	3.6	ND	NFC	ND	NFC	NFC	ND	TR	NFC
	21	NFC	0.04	0.05	NFC	NFC	TR	ND	ND	ND
	28	ND	NFC	0.02	ND	ND	ND	ND	ND	ND

Table 11 Herbicide residues in fish [mg/Kg x 10^{-3}] from the experimental ponds. ND = no herbicide detected; NFC = no fish caught; TR = trace; Z = *Tilapia zillii*; N : *Oreochromis niloticus*; L : *Oreochromis leucostictus*.

METHOD	DAA	DIQUAT	2, 4-D	GLYPHOSATE
GLC	7	ND	0.302	0.052
	14	ND	0.090	0.028
	21	0.120	0.050	0.006
	28	ND	0.010	ND
ASV	7	0.001	0.005	0.07
	14	0.008	0.004	0.06
	21	0.004	0.003	0.005
	28	0.004	0.001	0.005

Table 12. Herbicide residues in Sediments [mg/Kg x 10^{-3}] from the experimental ponds. ND = no herbicide detected.

3.6.3 Discussion on residues

In general the level of herbicide residues recovered in water, fish and sediments for all the herbicides tested were minute and very low when compared to tolerance levels from the literature (Tables 7 and 8). Residue levels in the water hyacinth were equally low and declined/decomposed rapidly. The low levels in the water hyacinth plants exemplifies the fact that very small quantities of herbicide are applied and most of this remains on the foliage if applied professionally. The level of herbicide residues detected in the samples is not likely to have adverse environmental effects resulting from a single application event. It is, however, not possible to predict from these results the effects on the environment and biota that may arise from possible herbicide accumulation in the event of repeated application of the herbicides.

DAA	Diquat			2,4-D			Glyphosate		
a									
	Whh	Sdt		Whh	Sdt		Whh	Sdt	
7	ND	ND		ND	ND		ND	ND	
14	ND	ND		ND	ND		ND	ND	
21	-	-		-	-		-	-	
28	-	-		-	-		-	-	
b									
	Z	N	L	Z	N	L	Z	N	L
3	NFC	NFC	NFC	ND	ND	TR	0.43	NFC	ND
7	ND	ND	ND	NFC	NFC	ND	ND	ND	ND
14	ND	ND	ND	ND	NFC	NFC	ND	ND	NFC
21	-			NFC	NFC	ND	-	-	ND
28				ND	ND	ND	-	-	ND

Fig 13. Herbicide residues in water hyacinth (Whh), bottom sediments (Sdt) and fish (Z,N,L) from the control pond. GLC analysis). DAA = days after herbicide application; Z = Tilapia Zillii, N = Oreochromia niloticus; L = Oreochromis leucostictus.

4.0 Recommendations

1. Based on the results of the laboratory-scale and pond (semi-natural environment) experiments, Glyphosate was recommended as the most suitable herbicide for large scale evaluation/use in the control of water hyacinth.

2. Regrowth after herbicide application should be carefully evaluated as it would suggest repeated use of herbicides to sustain water hyacinth control as is the case in Florida - USA. The evaluation would benefit from detailed larger scale experiments in a small, closed natural system like Pan Lake.

3. The significance of the surge in algal biomass in the first and second week of spraying with Glyphosate should be fully evaluated if use of this herbicide is recommended for Lake Victoria which is already adversely impacted by nutrient enrichment.

4. If massive herbicide application is sanctioned, comprehensivepublic health and awareness programmes should accompany the exercise, supervised by the Ministry of Health.

5. In the event that multiple herbicide application is contemplated, it would be essential to rule out probable attendant environmental impacts such as accumulation of herbicide residues via the food chain.

ANNEX 9

IN- LAKE TRIAL RESULTS

IN-LAKE HERBICIDE TRIALS
RESULTS & CONCLUSION REPORT

WAZIMENYA BAY
LAKE VICTORIA, UGANDA

WATER HYACINTH CONTROL PROGRAM

May 1997

PREPARED BY:
AQUATICS UNLIMITED

IN COOPERATION WITH

MINISTRY OF AGRICULTURE, ANIMAL INDUSTRY AND FISHERIES (MAAIF)
WATER HYACINTH UNIT

FUNDED UNDER GRANT FROM THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID) WITH ADDITIONAL FUNDING FROM UNITED NATIONS DEVELOPMENT PROGRAM (UNDP)

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List of In-Lake Herbicide Trials Participants

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EXECUTIVE SUMMARY

Water hyacinth, Eichhornia crassipes, has become a serious environmental nuisance and socio-economic burden since its arrival in Uganda's Lake Victoria at the start of the decade. The weed pest has been present since the late 1980's in Uganda's other water bodies, namely Lakes Kyoga and Albert and the Rivers Victoria Nile, Albert Nile, and Kagera. Without implementation of control efforts to bring waterhyacinth to a maintenance control level, the weed is expected to continue its unchecked growth, leading to progressively more serious long term consequences for the nation.

The Government of Uganda recognized this threat and embarked on a program of control by establishing a National Technical Committee for the Control of Waterhyacinth (NTCWH) whose task was to develop an integrated strategy to control the weed. It was learned by the Committee that many countries in the world use herbicides in successful integrated control programs against the weed and it therefore recommended that this method be explored through a chemical verification process. The verification study identified three herbicides for testing by a multi-disciplinary team of scientists to proceed through a three step process that began with semi laboratory trials followed by trials in small man made ponds, and ended with studies taking place in Lake Victoria. The In - Lake Trials evaluated two aquatic herbicides approved for use in the United States aquatic environment (United States Environmental Protection Agency) and were granted Temporary Certificates for trial purposes by the Ugandan Agriculture Chemicals Board.

This report presents the results of the In-Lake herbicide trials that occurred during the period February 10 through March 13, 1997. It was found that no adverse effects were realized when the herbicides 2,4 D (WEEDAR 64) and Glyphosate (RODEO) were used in accordance with the manufacturer's label. The level of control achieved was greater than 90% during the 30 day period.

It is felt that these trials prove that these herbicides can be used safely as part of an integrated water hyacinth control program in Lake Victoria when properly applied and used in accordance with label directions.

1. INTRODUCTION

Water hyacinth infestations have attained epidemic proportions along the shores of Lakes Victoria, Kyoga, Albert, Uganda's River Nile and the region's River Kagera over the last five years. Large migratory mats and resident shoreline populations of the noxious weed have disrupted or closed important landing sites, numerous domestic water sources, transportation routes, fishing grounds, disrupted and threatened hydroelectric power, in addition to impacting other areas, all of which translate to serious social, economic, and environmental costs to the country. In light of this aquatic weed infestation, the need to develop an effective program to control and manage the proliferation of this pest in Uganda and the region was becomming imparative.

The major control methods; biological, mechanical and chemical have been used in an integrated approach in numerous countries around the world including the United States of America, Australia, Nigeria and Sudan. While biological control has already been initiated in Uganda and other parts of the region, and some mechanical control capability has been acquired, suggestions to initiate chemical control of water hyacinth arouse health and environmental concerns with regard to the safety of chemicals in the aquatic habitat. Lakes and rivers in Uganda are the direct source of potable drinking water, consumed largely untreated by many. These waters are also a major source of animal (fish) protein and generate local and foreign income for the country as well as other countries sharing waterbodies with Uganda. It was, therefore, deemed essential to verify the effectiveness, safety and environmental friendliness of candidate herbicides before this method could be considered a tool for the integrated management and control of waterhyacinth.

Accordingly, the Chemical Verification Sub-Committee of the National Technical Committee on the Control and Management of Water Hyacinth was commissioned to carry out a comparative study of three herbicides; 2, 4-D, Glyphosate and Diquat detailed in Table 1, with respect to their:

(i) effectiveness (efficacy) to kill water hyacinth;
(ii) environmental friendliness; and
(iii) safety to humans.

The studies were scheduled to proceed through three stages:

(i) experimentation in semi-laboratory conditions to determine the optimum application rate for each herbicide;
(ii) experimentation in small ponds with semi-natural ecosystems, to select the most suitable herbicides of the three based on efficacy and environmental friendliness;
(iii) experimentation to further evaluate the efficacy and environmental friendliness of the selected herbicide in stable and virtually isolated natural ecosystems.

1.1 LABORATORY EXPERIMENT

The main objective of the experiment was to determine the most suitable rates of application for each of the three candidate herbicides: 2,4 D, Diquat, and Glyphosate. These studies were conducted by the NTCWH Chemical Varification Sub-Committee and in general found that labelled rates of these herbicides provided control of water hyacinth.

1.2 POND EXPERIMENTS

The main objectives of the pond experiments were to:
(i) assess on a larger scale the efficacy of the herbicides on water hyacinth;
(ii) assess the effects of the herbicides on water quality;
(iii) assess effects of spraying with the herbicides on aquatic micro and macro biota (algae, zooplankton and macrofauna); and on fish;
(iv) determine persistence of herbicide residues in the water, water hyacinth, bottom sediments and fish; and
(v) recommend the most suitable herbicides for the control of water hyacinth.

The experiments were to be accompanied by a public awareness campaign particularly among the communities around the experimental area of Kajjansi, to sensitize them about the objectives of the studies, and the safety precautions that would be expected of them during various stages of the studies.

1.3 IN-LAKE HERBICIDE TRIALS

The main objectives of the In - Lake herbicide Trials were to:

(i) evaluate the efficacy of the herbicides 2, 4 D and Glyphosate on water hyacinth;

(ii) assess the effects of the herbicides on water quality;

(iii) assess effects of spraying herbicides on aquatic micro and macro biota (e g. algae, phytoplankton, zooplankton and macrofauna); and on fish;

(iv) analyze the persistence of herbicide residues for In - Lake water and bottom sediments, In-land soils, water, and fish;

(v) recommend the suitability of both herbicides for control of water hyacinth; and

(vi) incorporate the findings of the trials into the Environmental Impact Assessment for the Control of Water Hyacinth.

The experiments were to be accompanied by a public awareness campaign particularly among the communities around Wazimenya Bay, and more specifically Mubanda, Butere, and Busoke village, to sensitize the public about the objectives of the studies and the safety precautions that would be expected of them during various stages of the trial. Refer to Annex A, In Lake Herbicide Trial Protocol, for details on the trials.

2. MATERIALS AND METHODS

2.1 LABORATORY EXPERIMENTS

For a full report on the Laboratory and Pond Experiments, please refer to the Report on Verification Study on the Chemical Control of Water Hyacinth, October 1996 (Final Draft), Chemical Verification Sub- Committee, National Task Force on Control and Management of the Waterhyacinth.

2.2 POND EXPERIMENTS

For a full report on the Laboratory and Pond Experiments, please refer to the Report on Verification Study on the Chemical Control of Water Hyacinth, October 1996 (Final Draft),

Chemical Verification Sub- Committee. National Task Force on Control and Management of the Waterhyacinth.

2.3 IN LAKE HERBICIDE TRIALS - JUSTIFICATION, SITE SELECTION, AUTHORITY, AND SITE ESTABLISHMENT

After completion of Pond experiments at Kajansi. In-Lake herbicides trials were recognized as the next appropriate step in completing the chemical verification process to evaluate herbicides for use in an Operational Waterhyacinth Control Program. Two herbicides approved by the United States Environmental Protection Agency for use in aquatic ecosystems for the control of water hyacinth were granted Temporary Certificates from the Ugandan Agricultural Chemical Board. The herbicides were Glyphosate (RODEO) and 2.4 D (WEEDAR 64). Diquat (REWARD) was not granted a certificate for the reason that the manufacturer does not recommend the use of Diquat in areas where whole fish is used for the production of fish protein concentrate or fish meal. Though residues would not have reasonably been expected to accumulate in fish tissue. the Board opted to decline a certificate for this herbicide at this time.

Potential sites were then investigated for suitability in carrying out In-Lake experiments. On November 19. 1996 an In - Lake trial site visit was organized by the Water Hyacinth Unit and Aquatics Unlimited to Wazimenya Bay. Ntenjeru sub-county. Mukono District approximately 10 km. southeast of the municipality of Gaba for the purpose of determining the appropriateness of this site for the In-Lake Herbicide Trials (See Figure 1. Map of Wazimenya Bay). Present for that survey were members from Ministry of Agriculture. Animal Industries and Fisheries (MAAIF) - Fisheries Department and Water Hyacinth Unit. MAAIF - Crop Protection. National Agriculture Research Organization - Fisheries Research Institute (NARO - FIRI). National Environmental Management Authority (NEMA). Directorate of Water Development (DWD)- Water Resources Management. National Water & Sewerage Corporation (NW&SC). The Agricultural Policy Secretariat. Makerere University - Kampala (MUK) and Aquatics Unlimited. It was determined by the group that Wazimenya Bay would be a suitable location to conduct trials as there were no large settlements. the bay was relatively isolated. there was not much human activity in the bay, and there was resident shoreline hyacinth mats typical of the Lake Victoria infestation in quantities sufficient for carrying out the experiments.

On 8th January, 1997 the National Environmental Management Authority of Uganda approved the In - Lake Herbicide Trials through their authority under Sections 7(1) (f) and 20 of the National Environmental Statute. The Trials were then scheduled to take place 30 days later between February 10, 1997 and March 13, 1997. Refer to Annex A, In Lake Herbicide Trial Protocol, for details on the trials.

On January 22, 1997 five test plots were delineated using poles placed on the lakeside edge of the shoreline infestation. Each plot was measured 200 meters in length and approximately 10 meters in width, for an average size of 0.2 Ha/plot. Sign boards were made to identify each trial plot (i.e A through E) as well as to warn persons of experiments to be undertaken. Two plots were established per herbicide for duplication purposes and one plot kept as a control plot with no herbicide application to be made. Average depth of water at the edge of each plot was approximately 0.75 meters. Wazimenya Bay in its entirety covers in excess of 1000 Ha and is made up of many small inlets or smaller bays, typical of much of the shoreline of Lake Victoria. The plots were established along the western or northern side of one of these smaller bays in the northernmost portion of Wazimenya Bay adjacent to the villages of Busoke and Mubanda to ensure, among other things, that conditions such as wind or water currents would be somewhat similar between plots. In addition, 5 cages of approximately 1.25 cubic meters each were constructed from wire in order to hold a total of 5 Tilapia for the fish tissue residue analysis segment of the trial. Tilapia were repeatedly placed in cages starting January 25, 1997 in order to allow them to adjust to conditions prior to the actual herbicide treatment. Problems occurred with the caged fish that is discussed later in this report.

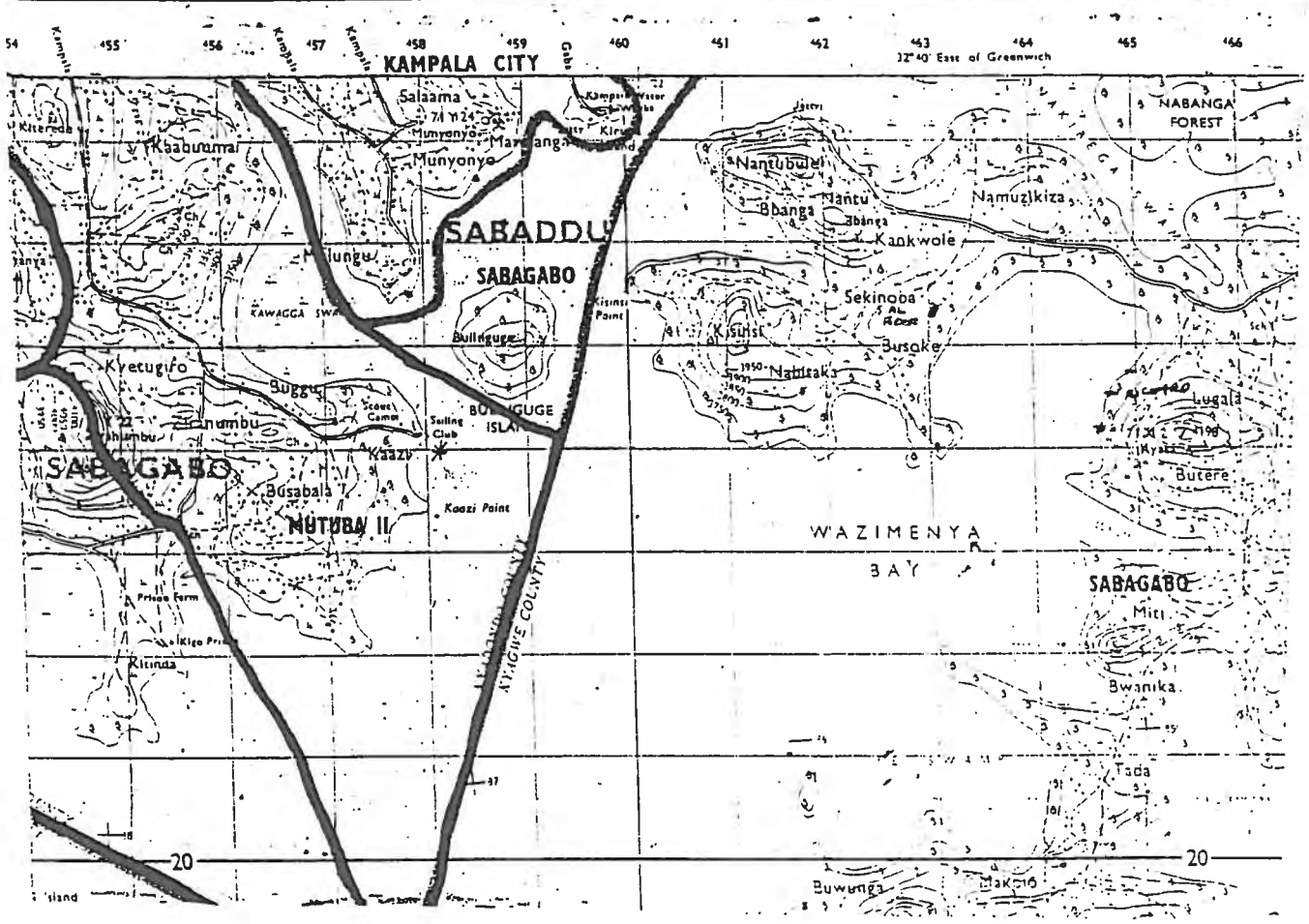

Figure 1: Map of Wazimenya Bay

2.4 HERBICIDE APPLICATION: IN - LAKE TRIALS

The herbicide concentrations for both herbicides were used at the highest rates as directed by the manufacturer's label under the section Directions for Use. In the case of 2, 4 D, the label states, "Use the higher labeled rate when plants are matured or when the weed mass is dense" and for Glyphosate, " Use the higher rate when more rapid visual effects are desired ". The condition of mature weeds, dense weed mass, and the need for rapid visual effects did, indeed, exist at the time prior to herbicide application. In addition, the highest legal herbicide rates would provide a greater chance of detecting residues in fish and water. These herbicides were applied on the plots at the rates described in Table 1.

Table 1. Herbicides volumes applied on a per hectare basis, Wazimenya Bay, In -Lake Herbicide Trials, February 1997.

Herbicide	Liters/Ha	Kg/Ha Active Ingredient	Plot
2,4 D (WEEDAR 64)	9.3 L/Ha	4.47 Kg/Ha	B + C
Glyphosate (RODEO)	7.0 L/Ha	4.56 Kg/Ha	A + D
None	None	None	E

Filtered lake water was used to dilute herbicides in the mixing tank at a rate of 375 liters/1.86 liters of 2,4 D (for plot size 0.2 Ha) and 140 liters/1.4 liters of Glyphosate. The Glyphosate mix had 0.35 liters (0.25 % of 140 liters) of surfactant (surface active agent - a substance added to a liquid to increase its spreading or wetting properties by reducing its surface tension) added to assist in penetration of the herbicide through the leaf surface and 2 ounces of a defoaming agent to prevent the mixture from developing excess foam and air bubbles which can cause uneven and interrupted spray streams. The surfactant used was INDUCE, active ingredients are 90% propriety blend of Alkyl Aryl Polyoxyalkane Ether, Free Fatty Acids. The defoaming agent used was FOAMBUSTER, active ingredient 10% Dimethyl Polysiloxane, 90% water and non-ionic emulsifiers.

Table 2. Details of herbicides applied during In - Lake Herbicide Trials, Wazimenya Bay, February 1997.

Common name	Chemical name	Commercial name and Formulation - Active Ingredient	Manufacturer
Glyphosate	N-(phosphonomethyl) glycine	RODEO, 53.8% in form of its isopropylamine salt	Monsanto
2, 4-D Amine	2, 4-Dichlorophenoxy-acetic acid	WEEDAR 64, 46.8% in form of its dimethylamine salt	Rhone-Poulenc

Herbicides described in the Tables 1 and 2 were applied on February 11, 1997 between 9:00 AM and 11:30 AM. Herbicide application was carried out from a wooden canoe using a petrol powered, 8 HP, 15 gallon per minute (maximum delivery rate) water delivery pump mounted with a 375 liter mixing tank. Spraying was made with an adjustable hand operated spray gun at a pressure of 150 PSI using a
#8 spray tip for Glyphosate and a #12 tip for 2,4 D.

The herbicide applications were made under the supervision of Mr. Thomas J. McNabb , a licensed Agricultural Pest Control Advisor (Aquatics Unlimited) and Mr. Lawrence Mwebesa (MAAIF - Crop Protection). The herbicide applications were carried out by two qualified Pesticide Applicators (Aquatics Unlimited's Mr. Thomas J. McNabb & Mr. David Najera) and by Mr. Lawrence Mwebesa (MAAIF - Crop Protection).

Weather conditions on the day of spraying were initially lightly foggy with no wind to sunny with light wind (less than 8 Km/hr) from the north. Weather conditions remained mostly sunny and dry for the 30 days after spraying with temperatures in the low 20's and highs in the low to mid 30's °C.

2.5 SAMPLE PARAMETERS STUDIED

2.5.1 HERBICIDE RESIDUE

Herbicide residues samples (e.g. In-Lake water and soil, In-Land water and soil, fish tissue) were collected in duplicate to allow for analyses at both Makerere University's (Kampala, Uganda (MUK)) Chemistry Department as well as at an independent laboratories located in the United States. The US laboratory, North Coast Laboratories, located in Arcata, California, was chosen for their professionalism, integrity, and capability to test for both Glyphosate and 2,4-D residues in water and in soil. The laboratory, Analysis Research Consulting Incorporated (ANRESCO) San Francisco, California, USA was selected for their ability to test fish tissue for 2,4-D. Glyphosate analysis was not carried out in the USA as Polarographic assays are no longer common practice and a laboratory to carry out the tests could not be found in the USA.

Samples collected for analysis at MUK's Chemistry Department were placed in coolers then transferred to Kampala and stored at the Department of Chemistry until analyzed.

Samples collected for analysis in the USA were collected in 1 liter brown glass bottles in the case of 2,4-D to prevent the degradation of samples by photolysis (a chemical reaction produced by exposure to light or ultraviolet radiation) and 125 ml glass bottles in the case of Glyphosate. Waterproof sample labels were fixed to the bottles and were used to identify samples by writing in waterproof ink a code identifying the day, plot, and location of sample. Immediately after collection, samples were placed in a cooler containing ice packs and then transferred to a freezer and kept just above the freezing point, approximately 4°Celsius to await next day air shipment. Prior to placing samples in the freezer, security seals were placed over the caps and remained on the bottles until opened by laboratory technicians at North Coast Laboratories, USA. The day after sample collection, chilled samples were removed from the freezer and placed in coolers containing ice packs, styrofoam packing chips, bubblewrap packing material, and newspaper to prevent breakage, insulate samples, and to keep samples as cool as possible. North Coast Laboratory Chains of Custody forms were filled out by Aquatics Unlimited staff to identify samples, residue tests required, and to document persons handling samples. These Chains of Custody Forms were placed in water tight plastic bags and placed inside the cooler. Coolers were

then wrapped in strong packing tape and forwarded by courier (Federal Express) directly to North Coast Laboratories. Samples were usually received by the laboratory within 72 hours after shipping. 1 to 2 Tilapia were harvested per plot and immediately placed into plastic bags coded with date and plot. then placed into coolers containing ice packs. One chilled or frozen whole fish or a fish fillet per plot were then provided to MUK - Chemistry Department. Duplicate fish samples were forwarded with water and soil samples to North Coast Laboratories who then express delivered the fish samples to ANRESCO for analysis.

2.5.1.1 IN - LAKE WATER SAMPLES

Pre-treatment lake water samples were collected for Herbicide Residue Analysis (baseline - Day 0) on February 10. 1997 at 5 meters into the waterhyacinth plot. at the edge of the mat or 0 meters. 30 meters and 100 meters perpendicular to the plot edge at a depth of less than 25 cm. from the lake surface. On the 11th February. the herbicides Glyphosate were sprayed on Plots A and D. 2.4 D on plots B. C. Plot E was kept as a Control Plot and was not sprayed. Two hours after spraying (treatment day - 2 hr.). water samples were collected for herbicide residue analyses. Thereafter. water samples were collected on Day 1 . 2. 7. 14. 21. and Day 30 corresponding to February 12. 13. 18. 25. March 4 and 13. 1997. respectively. See Section 2.5.1 Herbicide Residues for handling procedures.

2.5.1.2 IN - LAKE SEDIMENT SAMPLES

In - Lake sediment samples were taken by bottom dredge and placed in 8 ounce glass jars. Sample points were five meters inside the waterhyacinth plot and at 30 meters perpendicular to the plot. After collecting pre-treatment samples on Day 0. samples were thereafter collected on Day 1. Day 14. and Day 30. See Section 2.5.1.1. In-Lake Water for corresponding dates and Section 2.5.1 Herbicide Residues for handling procedures.

2.5.1.3 IN - LAND WATER SAMPLES

For sample collection. bore holes were dug by hand tools approximately 5 meters in land from the plot area. Holes were dug to water table depth. usually 1 meter. After collecting pre-treatment

samples on Day 0, samples thereafter were collected on Day 7, and Day 30. See Section 2.5.1.1, In-Lake Water Samples for corresponding dates and Section 2.5.1 Herbicide Residues for handling procedures.

2.5.1.4 IN - LAND SOIL SAMPLES

Bore holes created and used to collect samples for In- Land Water were also used for the collection of In-Land Soil to detect any movement of the herbicide through the water table. Soils at the bottom of each hole were collected in a 8 ounce glass jar by hand. After collecting pre-treatment samples on Day 0, samples thereafter were collected on Day 7, and Day 30. See Section 2.5.1.1, In-Lake Water Samples for corresponding dates and Section 2.5.1 Herbicide Residues for handling procedures.

2.5.1.5 FISH TISSUE SAMPLES AND OBSERVATIONS

Attempts to keep various Tilapia species caged in 1.25 cubic meter wire cages either on the lake bottom or suspended above it proved unfeasible. On January 22, 1997 poles were driven into the lake bottom approximately 2 to 3 meters in front of each plot. A length of rope was then secured to each cage and tied off to the pole. Another rope attached to the cage held 20 liter Jerry Cans to provide buoyancy for the cage in order to keep it from resting on the lake bottom. Beginning January 25, 1997, local fishermen were contracted to catch a minimum of three Tilapia per plot for placement in the fish cages. The average fish survival time in the cages was under 48 hours. Repeated attempts to improve and modify catching techniques, transport methods, holding time of the fish prior to placement in the cages, cage placement in the water column, cage mesh size and type,... failed to keep fish from dying within a couple of days. Within 24 hours all fish began to develop sores around the eyes, mouth and sides. This was attributed primarily to the fish colliding with the sides of the cages causing scratching and bruising which allowed susceptibility to infection, resulting in fish death after a short period. During water quality sampling it was determined that low oxygen levels existed around the fish cages which we feel created conditions of stress and contributed to the fish attempting to escape from the cages and thus colliding with the cage sides as mentioned above. It should be noted that numerous attempts were made with the

placement of approximately 50 fish in the cages over a two week period prior to Pre-Treatment sampling which resulted in minimal survival rates.

Fish collection for pre-treatment samples (Day 0) were taken from the cages in a weakened state 0r close to death. The inability to keep fish alive in the cages resulted in resorting to the capture of Tilapia by cast or throw nets. This was successfully accomplished by hiring a local fisherman to repeatedly and accurately throw a net along the edge of each plot until the desired number of fish were harvested. Fish were collected on Days 7 and 21 by this method.

In addition, behavioral observation of fry (juvenile fish) in and around the plots after herbicide application were noted while observing efficacy of herbicides for all plots. Emphasis was placed on fish mobility and swimming posture.

2.5.2 HERBICIDE RESIDUE ANALYSIS PROCEDURES

2.5.2.1 SUMMARY OF RESIDUE ANALYSES METHODS, MAKERERE UNIVERSITY:

Refer to the report from the lead scientist (Professor Nyangababo) for herbicide residue studies. Appendix B, for procedures.

2.5.2.2 SUMMARY OF RESIDUE ANALYSES METHODS, NORTH COAST LABORATORIES, USA:

Herbicide residue analyses were conducted by North Coast Laboratories following US-EPA approved methods. The following is a summary of those methods:

2,4-D WATER MATRIX

Samples for analysis were salted and acidified so the protonated acid herbicides could be extracted into ether. The herbicides were then hydrolyzed to the free acids under basic conditions and the extract was reduced in volume by rotoevaporation. The extract was reacidified, salted with the

analytes extracted into ether. Volume reduction of the Na_2SO_4 dried extract is accomplished by the microsnydering and then the extract is derivatized by diazomethane. The analytes are taken up in hexane and analyzed by GC-ECD (US-EPA-8151 Methods).

2,4-D SOIL MATRIX

Samples for analysis were acidified to about pH 1. The protonated acid herbicides were then extracted into acetone ether solvent. The extract was then reduced in volume and then the herbicides are hydrolyzed to the free acids under basic conditions, cleaned up with hexane if necessary, re-extracted into MTBE, and derivatized using diazomethane solution. The methylated extracts are then analyzed using a dual column system with ECDs (US-EPA-8151 Methods).

GLYPHOSATE WATER MATRIX

Samples for analysis were filtered and analyzed on an HPLC post column system using a fluorescence detector (US-EPA 547 NCL Method).

GLYPHOSATE SOIL MATRIX

A 5.0 gram soil sample was extracted with 0.5 M KOH and the glyphosate was chelated using an iron from Chelex resin. It was eluted with acid and the eluant was cleaned using a anion exchanged resin. Then the extract was roto evaporated to dryness and re - dissolved in acid. The sample is filtered and analyzed on a HPLC post-column system using a fluorescence detector (US-EPA 547 NCL Method).

2,4-D FISH TISSUE MATRIX: ANRESCO LABORATORIES, USA

Fish tissue samples were solvent extracted and the extract was derivatized with diazomethane. The methyl ester of the 2, 4-D is chromatographed on an FTX-5 capillary GC column with detection by an OIC ELCD in the chlorinated mode.

GLYPHOSATE FISH TISSUE MATRIX: NOT ANALYZED IN THE US (SEE SECTION 2.5.1., HERBICIDE RESIDUE)

HERBICIDE RESIDUE QUALITY ASSURANCE

To ensure that sound laboratory and quality control practices were maintained througnout the analyses process. introduction of spikes. blanks and lab control samples were included among samples tested in the USA. Spikes are additional samples which have a quantity of herbicide placed into a sample by a laboratory manger. but unknown to the technician. Blanks are samples which contain no herbicide. lab control samples are those samples which contain a known residue. Laboratory managers can then monitor results obtained from spikes. blanks. and control samples to evaluate technician performance and maintain the highest level of confidence and integrity possible for analyzing and reporting results.

2.5.3 WATER QUALITY SAMPLES

Water quality parameters were measured and samples collected for chemical analyses at pre-treatment followed by sample collection as described in Section 2.5.1.1 Water Residues. In - Lake Water. The samples for chemical analyses were taken by hand from less than 0.50 meters below the water surface with a label coded 0.5 liter plastic bottle and placed immediately in a cooler containing ice packs. These samples were transferred on the day of collection to National Water and Sewerage Corporation laboratories in Bugolobi and kept cool until analyzed.

The following Water Quality parameters were tested:

i. Water transparency was measured with a Secchi disc.
ii. Temperature. and Dissolved Oxygen were measured in the field using a hand held Orion Model 810 DO multimeter:
iii. pH was measured using a Hach EC10 pH multimeter. Both meters were calibrated prior to use and checked before and after every sample collection exercise.
iv. <u>Phosphorus. Reactive</u> (0.00 to 5.00 mg/L PO_4^{3-}) was measured by the Hach PhosVer 3 method and Test' N Tube Procedure using PhosVer 3 Phosphate Powder Pillows:

v. Phosphorus, Total (0.00 to 3.50 mg/L PO_4^{3-}) was measured by the Hach PhosVer 3 with Acid Persulfate Digestion and Test' N Tube Procedure using Potassium Persulfate Powder Pillows;

vi. Nitrite, LR (0 to 0.300 mg/L NO_2^--N) was measured by the Diazotization Method using NitriVer 3 Nitrite Reagent Powder Pillows; and

vii. Nitrate, MR (0 to 4.5 mg/L NO_3^--N) via the Cadmium Reduction Method using NitraVer 5 Nitrate Reagent Powder Pillows and a Hach DREL/2010 Spectrophotometer.

2.5.4 BIOTA - PHYTOPLANKTON, ZOOPLANKTON, AND CHLOROPHYLL-a

2.5.4.1 PHYTOPLANKTON SAMPLES

Water samples for phytoplankton analysis were collected with an integrated 0.5 liter water sampler from 2 points per plot, 5 meters into the waterhyacinth mat and at the edge or 0 meters from the plot. After each sample collection the water was placed into plastic sample bottles and fixed with Lugol's Iodine to preserve the algal cells. Pre-Treatment and Post-Treatment samples were collected on the samples days presented in section 2.5.1.1 Water Residues, In- Lake Water. Samples were placed in coolers containing ice packs followed by storage at Makerere University pending sample analysis. In the laboratory, 1 ml from each sample was placed in a Sedgewick Rafter Cell (a counting chamber). The chamber was then placed under a microscope, where algal cells were identified and counted.

2.5.4.2 ZOOPLANKTON SAMPLES

Water samples for Zooplankton analysis were collected with an integrated 0.5 liter water sampler from 2 points per plot, 5 meters into the waterhyacinth mat and at the edge or 0 meters from the plot, for all five plots. Samples for zooplankton study were reduced in volume by filtering through a 60 micron net and immediately preserved in 5% formaldehyde solution. Pre and Post Treatment samples were collected on the samples days presented in Section 2.5.1.1 Water Residues, In-Lake Water. Samples were placed in coolers containing ice packs and then placed in storage at Makerere University pending sample analysis. Plankton examination and study was carried out with the aid of an inverted microscope on sedimented whole samples. Identification of taxon was made while counting.

2.5.4.3 CHLOROPHYLL a SAMPLES

Water samples for Chlorophyll - a analysis were collected with an 0.5 liter plastic bottle just under the lake surface from 3 points per plot, 5 meters into the waterhyacinth mat, at the edge or 0 meters from the plot, and 30 meters perpendicular to the plot for all five plots. Pre and Post Treatment samples were collected on the samples days presented in Section 2.5.1.1 Water Residues, In-Lake Water. Samples were placed in coolers containing ice packs and then placed in storage at the Fisheries Research Institute, Jinja pending sample analysis. Chlorophyll -a concentrations were analyzed per Stainton et al. 1974.

2.5.5 MACROFAUNA SAMPLES

Two primary niches for macrofauna were sampled in four locations per plot; namely macrofauna that inhabit the benthic niche and those that inhabit the root systems and debris niche of a waterhyacinth mat. Those locations specifically were Bottom Sediments (5 meters inside the weed plot and 1 meter inside the weed plot) and below water hyacinth biomass (waterhyacinth roots and debris) 5 meters inside the weed plot and 1 meter inside the weed plot. Two samples were collected from each location, were collected pre-treatment (baseline - Day 0), 2 Hours (2 Hr.) post treatment and thereafter as described in Section 2.5.1.1 Water Residues, In - Lake Water. All samples were transported to the Fisheries Research Institute (FIRI) in Jinja for storage until analyzed.

2.5.5.1 MACROFAUNA BIOMASS SAMPLES (BELOW WATER LINE)

Macrofauna from the root mass and debris were sampled at each location by using a $0.25m^2$ quadrant randomly thrown onto the waterhyacinth mat at the abovementioned locations. Plant mass was pulled from within the quadrant and placed immediately into a wash basin, the petioles and leaves cut away from the root system, and the remaining contents of the basin (roots, debris, and water) placed into a plastic bag and transported to the FIRI laboratory. In the lab waterhyacinth roots and debris were then sprinkled with ethanol to flush out macrofauna which were then handsorted by genus and counted.

2.5.5.2 BENTHIC MACROFAUNA SAMPLES

Benthic macrofauna were sampled at each location by collecting benthic material using a ponar grab with a maximum grab area of 245 cm^2. The contents of the grab were then placed into a plastic bag, transported and stored at the FIRI lab for analysis. In the lab benthos were washed in a large sieve with a mesh of 400 microns before the organisms were picked and preserved in 10% formalin for further identification and counting.

2.5.6 HERBICIDE EFFICACY SAMPLES

Herbicide efficacy, or effectiveness, was recorded pre treatment and thereafter as described in the timeline of Section 2.5.1.1 Water Residues, In - Lake Water. Visual observations of the waterhyacinth plots were made to document general and specific appearance of treated and untreated waterhyacinth in addition to health of surrounding aquatic and terrestrial vegetation and crops. Efficacy was rated on a scale of 0 to 10 (0 being 0% healthy plants and 10 being 100% healthy plants), zero equivalent to complete necrosis (death) and 10 to a healthy plant. Several 35 mm color photographs were taken of each plot to document and support herbicide efficacy evaluations.

2.5.7 PUBLIC AWARENESS CAMPAIGN

On 25 November, 1996 the Water Hyacinth Unit and Aquatics Unlimited visited with Mukono District Center, LC III, and LC I officials to seek their cooperation and assistance for In-Lake Herbicide Trials. Through their support, public sensitization programs were organized and held at two schools in Mubanda and Butere villages (Wazimenya Bay communities) on November 29, 1996 for the purpose of educating the villagers on GoU efforts for controlling waterhyacinth, and the need to conduct In-Lake herbicide trials. Following introductions and discussion on the government's efforts, a video developed by the University of Florida - Center for Aquatic Plants presenting integrated control efforts in the USA that was dubbed into Luganda was shown to the participants. A question and answer session then took place which addressed the concerns raised by the participants, particularly with respect to herbicides. The meetings concluded with the communities agreeing to support activities related to the herbicide trials.

Prior to the herbicide application, fliers (handouts) in Luganda and English were distributed to the adjacent villages with suggestions to follow during the 30 day trial period. Signs were placed in front of each plot identifying the area as a herbicide trial site, requesting that persons stay away from the area, and identifying the Ministry responsible for the exercise. In addition, local leaders supported efforts by patrolling the area and reminding persons not to carry out certain activities within the treated areas during the 30 day trial period.

On February 19, 1997, eight days after the herbicide application, members of the Parliamentary Sessional Committee on Agriculture, a member from the Sessional Committee on Natural Resources, several reporters and film crews, the Water Hyacinth Unit and Aquatics Unlimited proceeded to Wazimenya Bay from Monyoyo Boat Landing in the FIRI vessel MPUTA. Members were briefed on the exercise and encouraged to ask questions related to the exercise. Footage of the outing appeared on UTV and in The New Vision. Regional Countries were informed of herbicide trial activities prior to actual commencement through the Lake Victoria Fisheries Organization inaugural Council of Ministers meeting that was held in Kampala Uganda on 19th December 1996. Additionally, several articles appeared in The Monitor, The New Vision, and The East African Newspapers.

2.5.8 GENERAL CONSTRAINTS

On several occasions during the 30 day sample collection period migratory mats invaded the In-Lake trial site area making it difficult, in some cases impossible, to access plots to make observations, collect data, or to collect samples. Every attempt was made to reach plots, but decisions were made on occasions to abandon efforts to reach heavily infested plots. See Table 6, Waterhyacinth coverage around plots on various test days.

The In Lake Herbicide Trials sample collection period was restricted to thirty days (February 10 to March 13, 1997) due to the emergency nature of the waterhyacinth control program, financial constraints, and the need to complete the herbicide verification and Environmental Impact Assessment processes. The verification studies in the Laboratory at Kituza Experimental Station began in late 1995 followed by those in ponds at Pan - Lake, Kajansi in January 1996 (herbicide application occurred on May 27, 1996). Therefore, trials have actually been in progress for 17

months at the time of writing, and the entire process should be viewed as having not taken place in any great haste, but as having moved forward methodically and scientifically. Formulations of the selected herbicides have been in use for many years in Uganda. In addition, 2,4-D has been used in aquatic plant control projects for over 50 years and Glyphosate has been in use for approximately the past 25 years. These herbicides are NOT new but have been tested in Uganda to obtain in-country data on their associated environmental impacts, and make determinations as to their usefulness in the water hyacinth control program.

Table 3. Waterhyacinth coverage around plots on various test days. The presence of migratory water hyacinth mats during sample collection has been recorded as follows: None = no migratory hyacinth mats in the vicinity of sample collection points, Scattered = upto 75% coverage in vicinity of sample collection points, Present = greater than 75 % coverage in vicinity of sample collection points.

DATE	DAY	PLOT	DISTANCE FROM EDGE OF PLOT		
			0 METERS	30 METERS	100 METERS
10/2/97	P	A	present	present	present
		E	present	present	present
		B	scattered	scattered	scattered
		C	scattered	scattered	scattered
		D	scattered	scattered	scattered
11/2/97	2 hr.	A	none	none	none
		E	none	none	none
		B	none	none	none
		C	none	none	none
		D	none	none	none
12/2/97	1	A	none	none	none
		E	none	none	none
		B	none	none	none
		C	none	none	none
		D	none	none	none
13/2/97	2	A	scattered	scattered	scattered
		E	scattered	scattered	scattered
		B	present	present	present
		C	present	present	present
		D	present	present	present
18/2/97	7	A	present	present	present
		E	none	scattered	present
		B	present	present	present
		C	present	present	present
		D	none	scattered	present
25/2/97	14	A	scattered	present	present
		E	none	scattered	scattered
		B	none	none	none
		C	none	none	none
		D	none	none	none
04/3/97	21	A	present	scattered	scattered
		E	present	present	present
		B	present	present	present
		C	present	present	present
		D	present	present	present
13/3/97	30	A	scattered	scattered	scattered
		E	present	present	present
		B	scattered	none	none
		C	scattered	none	none
		D	scattered	none	none

3.0 RESULTS AND DISCUSSION: IN LAKE HERBICIDE TRIALS

3.0.1 HERBICIDE RESIDUES

Standard toxicological characteristics of the candidate herbicides are shown in Table 4. The LC_{50} values are residue concentration levels that would have to persist for 96 hours in order to be lethal to 50% of a population. Acute Oral LD_{50} levels refer to a single orally administered dose of a substance that is lethal to 50 % of a animal test population.

Maximum Contaminant Levels (MCL) is the level considered protective of a person who in theory may drink water or eat fish at that level of contamination everyday of his or her life. Data on MCL levels are given in Table 5.

Theoretical persistence of the aquatic herbicides 2, 4 D and Glyphosate are presented in Table 6. Various methods of dissipation or degradation are responsible for the persistence of the herbicides as shown in the table, and water temperature plays an important role in this process since colder waters slow down biological activity.

Table 4. Toxicological characteristics of the candidate herbicides. Source: WSSA Herbicide Handbook, 7th Edition, 1994 (Weed Science Society of America).

FISH AND INVERTEBRATES1		
HERBICIDE/TEST ORGANISM	96-HOUR LC_{50} (mg L^{-1}) Fish Only	ACUTE ORAL LD_{50} (RATS) [mg/kg]
GLYPHOSATE - RODEO		
Rainbow trout	>1,000	>5000
Carp	>10,000	
Bluegill sunfish	>1,000	
Daphnia	48 hr LC50 - 930	
2, 4-D - WEEDAR 64		
Rainbow trout	250*	
Bluegill sunfish	524*	1,161**
Daphnia	48 hr. LC50 - 184*	

*Values are provided for 2,4 D dimethylamine salt technical

** Rhone Poulenc AG Company, Material Safety Data Sheet for WEEDAR 64, 1995

Table 5. Maximum Contaminant Levels (MCL -USA) for the candidate herbicides. Source: United States Government Printing Office Access, 1997.

Herbicide	Potable Water ($\mu g\ L^{-1}$)[1]	Fish/Shellfish ($mg\ Kg^{-1}$)[4]
2, 4-D	70[2]	1.00/1.00[5]
Glyphosate	700[3]	0.25/3.0[6]

Notes:

1. 1 $\mu g\ L^{-1}$ is equal to 1 mg/L x 10^{-6} or 1 part per billion (ppb).
2. USEPA - 40 CFR 141.61 (c) (9), Federal Register, December 30, 1992. Revised as of 30/12/96
3. USEPA - 40 CFR 141.61 (c) (27), Federal Register, January 17, 1994. Revised as of 30/12/96
4. 1 mg/kg =1 mg/L x 10^{-3} or 1 part per million (ppm).
5. USEPA - 40 CFR 180.142 (f), Federal Register, revised as of July 1, 1996.
6. USEPA - 40 CFR 180.364 (b), Federal Register, revised as of July 1, 1996.

Table 6. Persistence of aquatic herbicides in water vary due to differences in environmental conditions. Source: WSSA Herbicide Handbook, 7th Edition, 1994 (Weed Science Society of America).

Herbicides	Method of Disappearance	Half life in water in days*	Typical half live in days for ponds**
Glyphosate	Microbial Adsorption	14 days	< 2 days
2,4 D	Microbial Photolysis Plant Metabolism	7–48 days	< 5 days

Notes: * distilled water
**warm water ponds

3.0.1.1 IN-LAKE WATER SAMPLES

Makerere University - Kampala

2,4-D: 2, 4-D concentrations in water from in and near the treatment plots ranged from a maximum of 175$\mu g\ L^{-1}$ (175ppb) to a minimum of < 0.01 $\mu g\ L^{-1}$ (0.01 ppb). Maximum levels appeared two hours after application. Samples taken 5 meters inside the mat (treatment plot)

initially exceeding the MCL's and within 24 hours levels were below the MCL in all plots for the remainder of the trial period. Refer to Appendix B for further details.

GLYPHOSATE : Glyphosate concentrations in water ranged from a maximum of 245μg L^{-1} (245ppb) to a minimum of < 0.01 μg L^{-1} (0.01 ppb). Maximum levels appeared two hours after application. Samples taken 5 meters inside the mat were at all times below the MCL in all plots. Refer to Appendix B for further details.

North Coast Laboratories, USA

A total of 160 water residue samples were scheduled for collection and 192 residue sample analyses were to be conducted. The reason for higher residue analyses (192) vs. water residue samples collected (160) is due to double sampling at Plot E, the control plot, for 2,4 D and Glyphosate. Because migratory mats blocked access to plots and minor sample bottle breakage occurred, fewer samples were actually analyzed. The total number of samples analyzed for herbicide residues in water was 156. Herbicide residue levels from North Coast Laboratories are discussed below and presented in Table 7.

2,4 - D: 2,4-D concentrations ranged from non-detectable to 560 μg L^{-1} (560 ppb). The highest level appeared two hours after application with the sample taken 5 meters inside the treated plots (Table 10), which coorisponds to the highest 2, 4-D concentrations detected at Makerere University. Analysis reveals that the Maximum Contaminant Level (MCL) for drinking water of 70 μg L^{-1} (70 ppb) was never exceeded outside the treatment area (e.g. edge, 30, and 100 meters), and within 48 hours residue levels were nearing the MCL inside the treatment area.. Residue levels of 2,4-D could periodically be detected directly inside (5 meters in) the treated plots to levels of 1.0 μg L^{-1} (1.0 ppb), the minimum laboratory detection level for 2,4-D water residues.

GLYPHOSATE: Glyphosate concentrations in water ranged from non detectable to 500 μg L^{-1} (500 ppb). The highest level appeared two hours after application from a sample taken 5 meters inside the treatment area (Table 10), which again cooresponds to the highest glyphosate concentrations detected at Makerere University. Analysis reveals that for collected samples the Maximum Contaminant Level (MCL) for drinking water of 700 μg L^{-1} (700 ppb) was never

exceeded either inside or outside the treatment area (e.g. 5 meters inside, edge, 30, and 100 meters). Glyphosate residues on Day 2 (48 hours after application) were not detected inside (5 meters in) or outside the treatment areas and they remained undetectable for the balance of trial period. The minimum laboratory detection limit for Glyphosate residues in water samples is 5.0 $\mu g\ L^{-1}$ (5.0 ppb).

Table 7. Herbicide residues for In Lake water collected from herbicide plots in Wazimenya Bay, Lake Victoria following treatment of water hyacinth with maximum rates of 2, 4-D and Glyphosate. Residues reported in μg L^{-1} (ppb).

		Time after treatment							
Plot	**Site**	**0**	**2hrs**	**1day**	**2**	**7**	**14**	**21**	**30**
A(Glyphosate)	0	-	140	69	0	-	0	0	0
	1	-	42	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
D(Glyphosate)	0	0	500	0	0	0	-	0	-
	1	-	17	0	0	0	0	0	0
	2	-	0	0	0	0	-	0	0
	3	-	0	0	0	0	0	0	0
B(2, 4-D)	0	0	160	14	120	5	2	0	0
	1	-	33	2	0	0	0	0	-
	2	-	0	0	-	0	0	0	0
	3	0	2	0	-	0	0	0	0
C(2, 4-D)	0	0	560	52	-	-	0	0	2
	1	0	43	0	-	-	0	0	0
	2	0	7	0	-	-	0	0	0
	3	-	2	0	-	-	0	0	0
E(Control)									
Glyphosate	0	-	0	0	0	0	0	0	0
	1	0	0	0	-	0	0	0	0
	2	-	0	0	0	0	0	0	0
	3	0	0	0	0	0	-	0	0
2, 4-D	0	0	0	0	0	0	0	0	0
	1	-	0	0	-	0	0	0	0
	2	0	0	0	0	0	0	0	0
	3	-	0	0	0	0	-	0	0

Site 0 = inside treated plots, 1 = edge of treated plot, 2 = 30 meters from treated plot and 3 = 100 meters from treated plot - = no data collected.

3.0.1.2 IN-LAKE SEDIMENT SAMPLES

Makerere University - Kampala

2, 4 D: 2, 4-D concentrations ranged from a maximum of 0.002 mg kg^{-1} (0.002 ppm) to a minimum of < 0.001 mg kg^{-1} (0.001 ppm). Maximum levels appeared on the day of application with samples taken 5 meters inside the mat. Residues were detected on Day 14 five meters inside the treatment area and on the treatment area edge.

GLYPHOSATE : Glyphosate concentrations ranged from a maximum of 0.001 mg kg^{-1} (0.001 ppm) to a minimum of < 0.001 mg kg^{-1} (0.001 ppm). Maximum levels appeared on the day of application with samples taken 5 meters inside the treatment area and appeared on Day 14 five meters inside the treatment area and on the plot edge. Refer to Appendix B for further details.

North Coast Laboratories, USA

A total of 40 sediment residue samples were scheduled for collection from which 48 residue sample analyses were to be conducted. The reason for higher residue analyses (48) vs. sediment residue samples collected (40) is due to double sampling in Plot E, the control plot, for 2,4-D and Glyphosate. Because migratory mats occasionally blocked access to plots and some sample bottle breakage occurred, the total number of samples analyzed for herbicide residues in water was 38.

2,4 - D: 2,4-D was non detectable in the samples during the trial period. (See Table 8). The minimum laboratory detection limit for 2,4-D in soil residues is 1.0 μg g^{-1} (1.0 ppb).

GLYPHOSATE: Glyphosate was non detectable for all samples during the trial period (See Table 11). The minimum laboratory detection limit for Glyphosate in soil residues is 0.05 μg g^{-1} (0.05 ppb).

Table 8. Herbicide residues for In-Lake sediments collected from herbicide plots in Wazimenya Bay, Lake Victoria, Uganda, following treatment of water hyacinth with maximum rates of Glyphosate and 2, 4-D. Residues reported in μg L^{-1} (ppb).

		Time after treatment (days)			
Plot	**Site**	**0**	**1**	**14**	**30**
A(Glyphosate)	0	-	-	0	0
	1	-	0	0	0
D(Glyphosate)	0	0	0	0	0
	1	0	0	-	0
B(2, 4-D)	0	-	0	0	0
	1	0	0	0	0
C(2, 4-D)	.0	0	-	0	0
	1	0	-	0	0
E(Control)					
Glyphosate	0	-	0	0	0
	1	-	0	0	0
2, 4-D	0	-	0	0	0
	1	-	0	0	0

Site 0 = Inside treated plots and 1 = outside edge of treated plots - = indicates no sample analysis available.

3.0.1.3 IN-LAND WATER SAMPLES

Makerere University - Kampala

2,4 D: 2,4-D was non detectable for all samples during the trial period. Refer to Appendix B for further details.

GLYPHOSATE: Glyphosate was non detectable for all samples during the trial period. Refer to appendix B for further details.

North Coast Laboratories, USA

A total of 15 water residue samples were scheduled for collection from which 18 residue sample analyses were to be conducted. The reason for higher residue analyses (18) vs. water residue samples collected (15) is due to double sampling Plot E, the control plot, for 2,4-D and glyphosate. Because migratory water hyacinth mats periodically blocked access to plots or sample bottle breakage occurred, the total number of samples analyzed for herbicide residues in the In-Land water was 14.

2,4-D: 2,4-D was not detected in the In-Land water samples except on one occasion. The only detected sample (27 $\mu g\ L^{-1}$) occured seven days after application in Plot B (See Table 9). The MCL for that one detectable sample fell within the allowable level for drinking water of 70 $\mu g\ L^{-1}$ (70 ppb), but it was believed that this one detection was an anomoly. The discovery of 2, 4-D in this one In-Land water sample was not expected and it is highly unlikely that movement of the herbicide occurred through the water table; 2,4-D was not detected in Plot C. Prior to Day 7 sampling, local villagers observed that Plot B borehole had dried out and no water would be available for sample collection. Local leaders took it upon themselves to dig another hole so that the scientists would have water to collect, but dug a large diameter hole closer to the lake edge (approximately 1 meter) than the 5 meters In-Land described in the design. The new bore hole was at a point where the herbicide application occurred very close to the lake edge. After collecting the water sample from the new borehole, villagers were requested by Aquatics Unlimited to deepen the original hole so that Day 30 samples could be collected per the design. The detection of 2,4-D in this instance should be viewed with some unknown factors in mind, and in retrospect, the sample should probably not have been taken. Unknown circumstances and events that occurred prior to digging the new hole are likely to have contributed to residue detection. The minimum laboratory detection limit for 2,4-D water residues is 1.0 $\mu g\ L^{-1}$ (1.0 ppb).

GLYPHOSATE: Glyphosate concentrations were non detectable for all samples during the trial period. (See Table 12). The minimum laboratory detection limit for Glyphosate residues in water is 0.05 $\mu g\ L^{-1}$ (0.05 ppb).

Table 9. Herbicide residues for In - Land water and soil from herbicide plots in Wazimenya Bay, Lake Victoria following treatment of water hyacinth with maximum rates of Glyphosate and 2, 4-D. Residues reported in µg L^{-1} (ppb).

		Time after treatment (days)		
Plot	**Material**	**0**	**7**	**30**
A (Glyphosate)	Soil	-	0	0
	Water	0	0	0
D (Glyphosate)	Soil	0	-	0
	Water	0	-	-
B (2, 4-D)	Soil	0	0	0
	Water	0	27	0
C (2, 4-D)	Soil	0	-	0
	Water	-	0	-
E(Control)				
Glyphosate	Soil	0	0	0
Glyphosate	Water	0	0	0
2, 4-D	Soil	0	0	0
2, 4-D	Water	0	0	0

- = No data analysis available

3.0.1.4 IN-LAND SOIL SAMPLES

Makerere University - Kampala

2,4 D: 2,4-D was non detectable for all samples during the trial period. Refer to Appendix B for further details.

GLYPHOSATE: Glyphosate was non detectable for all samples during the trial period. Refer to see Appendix B for further details.

North Coast Laboratories, USA

A total of 15 soil residue samples were scheduled for collection from which 18 residue sample analyses were to be conducted. The reason for higher residue analyses (18) vs. soil residue samples collected (15) is due to double sampling Plot E. the control plot. for 2,4-D and glyphosate. Because migratory mats blocked access to plots or sample bottle breakage occurred, the total number of samples analyzed for herbicide residues in the In-Land water was 16.

2,4-D: 2,4-D was non detectable for all samples during the trial period (See Table 9). The minimum laboratory detection limit for 2,4 D soil residues is 1 $\mu g\ g^{-1}$ (1 ppb).

GLYPHOSATE: Glyphosate was non detectable for all samples during the trial period. (See Table 9). The minimum laboratory detection limit for Glyphosate in soil residues is 0.05 μg^{-1} (0.05 ppb).

3.0.1.5 FISH TISSUE SAMPLES AND OBSERVATIONS

FISH TISSUE RESIDUE ANALYSIS

Problems associated with collecting fish tissue were discussed earlier in Section 2.5.1.5, Fish. Pre-treatment day had a total of three fish collected. Day 2 had four fish collected. and Day 21 had four fish collected. On Day 2, plot C was infested with waterhyacinth and fish from that plot were not harvested. Day 21 was actually collected on Day 28 because waterhyacinth mats prevented fisherman from catching fish on that day. On Day 28 fish capture was attempted at plot C but after several hours of attempting to catch fish the effort was abandoned. Local fisherman stated that this section of shoreline was historically unproductive and capture was made more difficult by clear skies coupled with a high mid day sun which they claimed was not conducive to the presence of fish.

All pre-treatment fish samples were inadvertently sent to the ANRESCO Laboratories in the US for analysis. Therefore, samples were not immediately available for sampling at MUK. After realization of this problem, the fish samples were then sent back by courier to Uganda by

ANRESCO Laboratories so that duplicate analyses could be conducted in Uganda. Due to delays while in transport, samples were received in a highly decomposed state. This decomposed state did not prevent the ability to analyze the samples, but the bacterial activity related to the decomposed fish would break down both 2,4-D and glyphosate in the fish tissue. Also, the samples were returned as a composite (all samples were ground into a single sample) for one sample analysis.

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2,4-D: 2,4-D was not detectable in fish for Day 2 and Day 21 samples. However pre-treatment samples returned from the USA for analysis at MUK tested positive for 2,4-D at trace levels. The positive result for this sample was not expected since application of samples had not yet occurred (pre-treatment). The sample was most likely contaminated either at ANRESCO or MUK Laboratories during handling, or the decaying fish may have produced some chemical interference that showed up as 2, 4-D. See Appendix B for further details.

GLYPHOSATE: Glyphosate was not detectable for Day 2 and Day 21 samples. Pre-treatment samples returned from the USA for analysis at MUK tested positive for Glyphosate at a level of 0.02 mg kg^{-1} (0.02 ppm). The positive result for this sample was not expected since application of samples had not yet occurred (pre-treatment), and was likely contaminated at ANRESCO Laboratories or at MUK laboratory during handling, or the decaying fish may have produced some chemical interference that showed up as glyphosate.. See Appendix B for further details.

ANRESCO Laboratories, USA

A total of 18 fish residue analyses were scheduled. A total of 11 fish tissue were analyzed.

2,4-D: 2,4-D was non detectable in fish tissue samples during the trial period. Fish fry were visible at most times in all sample points at all plots. Behavior and mobility were normal at all times. No dead fish were ever observed. The minimum detection limit for 2,4-D in fish tissue is 0.05 mg/kg (0.05 ppm or 50 ppb). See Table 10 for results.

GLYPHOSATE: See section 2.5.1, Herbicides Residue for a discussion on Glyphosate and fish residues.

COMPARISON OF RESULTS: Results obtained by Ugandan and USA labs followed a similar trend of rapid dissipation over the 30 day sampling period although maximum residues reported by the labs differed. This may be attributed to holding time of the sample prior to analysis or to temperature of the samples during the holding time. Power outages of up to 6 hours cut power to refrigerators at MUK on several occasions that may have lead to microbial degradation and/or lower levels of residues being detectable.

Table 10. Herbicide residues for Fish Tissue from herbicide plots in Wazimenya Bay, Lake Victoria following treatment of water hyacinth with maximum rates of Glyphosate and 2, 4-D. Residues reported in mg kg $^{-1}$ (ppm). North Coast Laboratories, USA.

		Time after treatment (days)		
Plot	**Material**	**0**	**7**	**21**
A (Glyphosate)	Tilapia	-	-	-
D (Glyphosate)		-	-	-
B (2,4 D)	Tilapia	0	0	0
C (2,4 D)		-	-	-
E (Glyphosate)	Tilapia	-	-	-
E (2,4 D)		0	0	0

- = No data analysis available

FISH OBSERVATIONS

A total of 30 observations were to be made during the trial, but due to migratory mats fewer observations were possible. As discussed previously, fish would not survive in the cages which resulted in observing fish in and around the plots. As a result, fish were not restricted in movement and were free to travel in and out of plots representing a more normal and natural event. Fish fry (juveniles) observed during the trial period were found behaving normally, displaying typical swimming posture and mobility at all points within the plots.

3.0.2 WATER QUALITY SAMPLES

Parameters sampled and tested for were Secchi depth, water temperature, pH, dissolved oxygen, Phosphorus and Nitrogen. Most parameters were sampled or tested during the trial period with several waterhyacinth mat obstructions preventing sample collections on certain dates. It should be noted that many environmental factors can influence water quality results. These include algae blooms, wind and water generated water currents, storm and rain events, air pollution and the resulting deposition of dust, soil, or ash particles from cooking, grassland fires, garbage incineration, and smoke stack emissions, or discharge of effluents to name but a few sources. The presence of migratory water hyacinth is another source to influence water quality and was recorded during the trials (See Table 3). The results presented below, however, are reported to be in agreement with those tested for during routine sampling exercises conducted by Uganda's National Water and Sewerage Corporation at Gaba II Water Works. See Appendix C for a detailed report by the lead scientist (Mr. Samuel Matagi) for Water Quality Studies.

3.0.2.1 SECCHI DEPTH SAMPLES

Secchi Depth varied between a minimum of 0.100 meter to a maximum of 1.64 meters; the mean levels varied from a minimum of 0.59 meters to a maximum of 1.23 meters. Secchi Depth readings increased as distances increased away from the plots into open water. Secchi Depth was not likely to have been affected by limited herbicide treatments or decaying vegetation, but would have been influenced more by natural conditions such as algae blooms, storm events, wind induced currents or upwellings, and migratory waterhyacinth mats.

3.0.2.2 WATER TEMPERATURE SAMPLES

Water temperatures were constant throughout the trials fluctuating between a minimum 24.3 C to a maximum of 29.1 C. The minimum mean was 26.2 C and the maximum mean was 26.8 C. No significant difference was observed between plots, however temperatures were observed to be cooler 5 meters into the mat and increased at distances away from the plots into open waters. Temperatures are not likely to have been affected by the limited herbicide treatments or decaying

vegetation, but would have been influenced more by natural conditions such as solar radiation, cloudy or hazy conditions, wind induced currents or upwellings or migratory water hyacinth mats.

3.0.2.3 pH SAMPLES

pH values varied widely within and between plots from a minimum of pH 4.72 to a maximum of pH 8.64. No significant differences were observed between plots and the control plot, however sample points 5 meters into the plot generally had lower pH readings and pH increased into the open water areas. Migratory hyacinth mats and decomposition of treated and untreated hyacinth were also likely contributors to widely varying pH values.

3.0.2.4 DISSOLVED OXYGEN SAMPLES

Dissolved Oxygen (DO) fluctuated within plots during the trial period ranging from a minimum 0.4 mg/L (0.4 ppm) to a maximum of 7.2 mg/L (7.2 ppm). The mean DO levels ranged from a minimum of 3.0 mg/L (3.0 ppm) to a maximum mean of 5.3 mg/L (5.3 ppm). DO levels usually increased with greater distance from the plot edge into open water areas. DO levels did not differ significantly between treated plots and the control plot. Migratory water hyacinth mats were probably the most influential factor affecting DO readings, but waves or wind induced currents and upwellings could also have played a factor. Migratory hyacinth mats block sunlight thereby reducing phytoplankton oxygen production. In addition, naturally occurring decomposition or herbicide induced decomposition also cause reductions in DO levels. See Table 3 for information related to the presence of migratory hyacinth mats on sample days.

The effects of various levels of waterhyacinth management schedules on dissolved oxygen concentrations. Source: Benefits of Maintenance Control of Waterhyacinth, Aquatics Magazine, Joyce et.al.,

Percent of Area Covered Prior to Control	Average Dissolved Oxygen Concetrations mg/l
0	10.3
5	9.3
25	4.0
50	1.6
100	1.3
100	2.0
Unsprayed	

3.0.2.5 PHOSPHORUS, REACTIVE (PO_4^{3-}) AND PHOSPHORUS, TOTAL (PO_4^{3-}) SAMPLES

Reactive Phosphorus concentrations ranged between 0.01 mg/L (0.01 ppm) to a maximum of 0.42 mg/L (0.42 ppm) the trial period. The mean levels for Reactive P ranged from a minimum of 0.01 mg/L (0.01 ppm) to a maximum mean of 0.075 mg/L (0.075 ppm). Differences were observed within plots and Reactive P concentrations levels usually decreased with greater distance from the plot edge into open water areas. Migratory water hyacinth mats were probably the most influential factor affecting Phosphorus readings, but weather, water currents and upwellings could also have played a factor. No significant differences were observed between plots and the control plot.

Total Phosphorus concentrations ranged between a minimum of 0.01 mg/L (0.01 ppm) to a maximum of 1.33 mg/L (1.33 ppm) during the trial period. The mean levels for Total P ranged from a minimum of 0.15 mg/L (0.15 ppm) to a maximum mean of 0.36 mg/L (0.36 ppm). No significant differences were observed between plots and the control plot, but differences did appear

within plots. Total P concentrations levels usually decreased with greater distance from the plot edge into open water areas. Migratory water hyacinth mats were probably the most influential factor affecting Total P readings, but waves or wind induced currents and upwellings could also have played a factor.

3.0.2.6 NITRITE, LR (NO_2^-) AND NITRATE, MR (NO_3^-) SAMPLES

Nitrite concentrations ranging from between a minimum of 0.00 mg/L (0.00 ppm) to a maximum of 0.16 mg/L (0.16 ppm) were observed during the trial period. The mean levels for Nitrite ranged from a minimum of 0.00 mg/L (0.00 ppm) to a maximum mean of 0.003 mg/L (0.003 ppm). No significant differences were observed between plots and the control plot, however differences were seen within plots. Nitrite concentration levels usually decreased with greater distance from the plot edge into open water, although these decreases were marginal. As stated above, many environmental factors can influence nitrite levels.

Nitrate concentrations ranging from between a minimum of 0.02 mg/L (0.02 ppm) to a maximum of 0.110 mg/L (0.110 ppm) were observed during the trial period. The mean levels for Nitrate ranged from a minimum of 0.07 mg/L (0.07 ppm) to a maximum mean of 0.082 mg/L (0.082 ppm). Nitrate concentration levels fluctuated slightly between plots, though no significant differences were observed between plots and the control plot or within plots. As stated above, many environmental factors can influence nitrite levels.

3.0.3 BIOTA

3.0.3.1 PHYTOPLANKTON SAMPLES

Major phyla represented and reported during the phytoplankton sampling exercise were Blue Green Algae, Green Algae, and Diatoms. Blue Green Algae (Cyanobacteria) dominated the three phyla with Microcystis spp. in most abundance, followed in decreasing abundance by Anabaenopsis spp., and Mersimopedia spp. Diatom (Bacillariophyta) were the next most important phyla represented, with Nitzschia spp. being most dominant, followed by Navicula spp., and Cocconeis spp. Green Algae (Chlorophyta) phyla were found in relatively low numbers throughout the trial period. It

should also be observed that there was a continuous presence of phytoplankton in the plots for the duration of the trials. See Appendix D for full report by the lead scientist (Professor Stephen Byarujali) responsible for Phytoplankton studies.

It was observed from pre-treatment and post-treatment counts, that at each sampling site for all plots, there were predominantly higher phytoplankton counts at the edge of the water hyacinth mat as opposed to 5 meters inside the hyacinth mat where sunlight blocked plankton production. It was also suggested that lower numbers of phytoplankton in the hyacinth mats could be a result of herbicide application having reduced phytoplankton population numbers, yet the control plot exhibited similar population numbers and distribution, therefore it would, indeed, be difficult to draw this conclusion. Horizontal water movements and the ability that movement plays in transporting herbicide exposed algal cells out of the plot, in addition to the effect a large water body plays in diluting herbicides, were factors also suggested as potentially influencing the sampling exercise. Herbicides were diluted by lake water (See Table 7, and Section 3.0.1.1), but were also broken down or made biologically unavailable through photolysis, plant metabolism and microbial action in the case of 2,4-D, or through adsorption or microbial action in the case of Glyphosate (See Table 6). It should also be noted that weather patterns, migratory waterhyacinth mats (See Table 3), water currents, water temperature and seasonal changes can also be important variables in phytoplankton population and distribution.

Lituratue shows that these herbicides have no influence on phytoplankton at the levels detected in water, 2 hours post-treatment.

It was stated by the lead scientist of the phytoplankton study that no conclusion or recommendation could be made on the effect herbicides have on phytoplankton communities since the trial could not control natural factors. Herbicides would have obvious effects in isolated and controlled experiments where natural influences could be limited or reduced. This kind of experiment could reveal different results, but these would be for conditions unlike those present in Lake Victoria. Nevertheless, the fact that phytoplankton were present throughout the study period and that there was no noticeable effect cannot be ignored.

3.0.3.2 CHLOROPHYLL-a SAMPLES

Chlorophyll - a levels fluctuated within plots and between plots over the thirty day trial period. Glyphosate treated plots saw values vary from a minimum of 9.04 $\mu g\ L^{-1}$ (9.04 ppm) to a maximum of 43.7 $\mu g\ L^{-1}$ (43.7 ppm) with mean concentrations ranging from a minimum of 10.43 $\mu g\ L^{-1}$ (10.43 ppm) to a maximum of 37.5 $\mu g\ L^{-1}$ (37.5 ppm). Values for 2,4-D treated plots ranged from a minimum of 3.48 $\mu g\ L^{-1}$ (3.48 ppm) to a maximum of 61.86 $\mu g\ L^{-1}$ (61.86 ppm) with mean concentrations ranging from a minimum of 6.06 $\mu g\ L^{-1}$ (6.06 ppm) to a maximum of 45.87 $\mu g\ L^{-1}$ (45.87 ppm). The control plot, E, which had no herbicide applied, varied from a minimum of 5.56 $\mu g\ L^{-1}$ (5.56 ppm) to a maximum of 34.75 $\mu g\ L^{-1}$ (34.75 ppm) with mean concentrations ranging from a minimum of 5.56 $\mu g\ L^{-1}$ (5.56 ppm) to a maximum of 34.75 $\mu g\ L^{-1}$ (34.75 ppm). It is interesting to note that minimum values for all the plots occurred on Day 7, a day that began with fog and saw migratory hyacinth mats invade the trials site (see Table 3). For a full report by the lead scientist (Dr. Timothy Twongo) on Chlorophyll-a studies, see Appendix E.

The variability of the Chlorophyll-a results suggest that factors related to environmental conditions (e.g. wind and water currents, water hyacinth mats, light duration and penetration, ...) were a greater influence to Chlorophyll-a concentrations than herbicides residues which dissipated to very low levels within 72 hours.

3.0.3.3 ZOOPLANKTON SAMPLES

Major zooplankton Orders identified and quantified were, in order relative abundance, Copepoda, Rotifera, and Cladocera. The presence, distribution and relative abundance of these zooplankton remained continuous during the 30 Day trial period. See Appendix F for full report by the lead scientist responsible (Dr. Yusuf Kizito) for Zooplankton studies.

The lead scientist responsible for zooplankton studies has noted that the constant mixing of lake water was responsible for the continuous presence of zooplankton throughout the period, and adds that the results should not be misinterpreted to mean that application of herbicides have no significant toxic effects. It was also expressed that herbicide toxicity on zooplankton is more appropriately assessed in the laboratory where conditions can be more easily controlled and

dilution of herbicide concentrations can be prevented. These values are reported in the literature and are many times higher then concentrations of herbicides found 2 hours post-treatment.

Continuous mixing of lake water through natural means certainly assists in the dissipation of herbicides as does the methods of degradation mentioned in the previous section, 3.0.3.1 Phytoplankton. It is agreed that toxicity tests are more appropriate in the laboratory and have, indeed, been carried out by herbicide manufacturers, independent laboratories, and government agencies in many countries on a variety of zooplankton including Daphnia, a species in the Order-Cladocera. Cladocera, a major Order present in Lake Victoria were collected, identified and counted during the herbicide trials in Wazimenya Bay. Referring to Section 3.0.1 Herbicide Residues, Table 4 - Toxicological characteristics of the candidate herbicides, it can be seen that 48 hour LC_{50} levels for Daphnia (Order - Cladocera) are 930 mg/L (930 ppm) for RODEO - Glyphosate and 184 mg/L (184 ppm) for WEEDAR 64 - 2, 4-D technical. Section 3.0.1.1 In-Lake Water Samples reveals that the highest herbicide residue levels occurred 2 hours after application at 500 $\mu g\ L^{-1}$ (500 ppb) for Glyphosate and 560 $\mu g\ L^{-1}$ (560 ppb) for 2,4 D. These 2 hour maximum levels are far below those levels specifically toxic to Daphnia, and those levels expected toxic to zooplankton in general.

3.0.4 MACROFAUNA SAMPLES

Macrofauna were primarily identified for the following classes, families, genus' or groups: Odonata, Oligochaeta, Leeches, Ephemeroptera, Chironomidae, Caridina, Bivalvia, and Gastropoda.

For a full report by the lead scientist (Dr. Timothy Twongo) responsible for macrofauna diversity and abundance studies, refer to Appendix G.

3.0.4.1 MACROFAUNA BIOMASS SAMPLES (BELOW WATER LINE)

Macrofauna abundance and distribution in the roots and debris (below water biomass) 5 meters into the treatment area and at 1 meter into the treatment area varied between plots, and over the 30

day trial period. No adverse effect to macrofauna diversity and abundance can be attributed to the use of either herbicide.

Macrofauna population and distribution studies can be effected by season, macrofauna breeding cycles, weather or storm events, and a number of other variables. It would therefore require comparison to long term surveys to identify any negative consequences related to herbicide use in the control of waterhyacinth. It should be realized, however, that any changes in macrofauna populations would not be unexpected after the application of herbicides since macrofauna found in the water hyacinth roots and debris are occupying a niche that is a target for control. As plants pass through the phases of necrosis, conditions previously suited to some macrofauna - waterhyacinth associations would become less desirable to some species because of the changing physical landscape of the habitat. Water quality parameters were observed not to change significantly and herbicide residues dissipated rapidly, thereby ruling out declines due to these factors. When plants reach the final stages of necrosis and are swept away by winds, water currents, or collapse on the water surface, the hyacinth mats would have become a habitat that no longer resembles the original mat; macrofauna composition, diversity and abundance would be required to adjust to the changed environment. Some species would be expected to benefit since they may previously have been occupying a niche considered marginal when their habitat of preference was a waterhyacinth free environment, while others would be expected to decline for the opposite reason.

Prior to the invasion of water hyacinth to the region's water bodies, this water hyacinth niche did not exist as such and lake waters no doubt had a much different biotic composition and structure. Therefore, any declines that can be interpreted in the results, or that may appear in any approved future control program should be reviewed in relation to the migration of macrofauna to more suitable habitats.

3.0.4.2 BENTHIC MACROFAUNA SAMPLES

Macrofauna population and distribution in benthic sediments 5 meters into the treatment area and 1 meter into the treatment area varied between plots and over the 30 day trial period. No adverse

effect to macrofauna can be attributed to the use of either herbicide. Refer to the discussion in Section 3.0.4.1 for views related to macrofauna.

3.0.5 HERBICIDE EFFICACY

Herbicide efficacy data was collected through visual observation and photographs. On some days all plots were not accessible, but at least one treated plot and the control plot was visited on every sampling day. Plots treated with the same herbicide showed similar effects during the trials. Special attention was made to observe any changes to other aquatic, semi aquatic, or terrestrial flora and crops adjacent to the plots. Refer to the Appendix H for a full report by the lead scientist (Mr. Lawrence Mwebesa) responsible for Efficacy studies.

3.0.5.1 2, 4-D AMINE - WEEDAR 64

The observations presented below for herbicide efficacy have been combined for Plots B and C, since these were replicated plots with similar levels of control.

OBSERVATIONS

Pre-treatment: Plants 100% healthy, slight browning on some plants related probably to Mayfly damage. Browning of some individual Papyrus plants. Hippograss brown at bases, stems and leaves green above.

Day 1: Plants 90 % healthy. Weakened petiole, bending approximately 30 to 45 degrees. Browning or yellowing of leaf. Surrounding vegetation no change.

Day 2: Plants 80% healthy. Petioles wilting or bending 45 to 90 degrees. Browning of leaves and petioles, scorching appearance on leaves. Hippograss bases brown, tops green - No change. Papyrus and phragmites showing no change in appearance. Plot C was not visited due to blockage by water hyacinth mat.

Day 7: Plants 40 to 50 % healthy. 50% leaves brown, 50% yellow, all plants wilting. Petioles yellowing. Surrounding vegetation - No change. Plot C viewed from distance, water hyacinth mat blocking, majority brown or yellow. No change to surrounding vegetation.

Day 14: Plants 40 to 50 % healthy. Majority of plants yellow or brown and desiccated. Leaves curling. Visible elongated petioles weaving through mat. Plants mostly upright. Hippograss brown at bases, green stems and leaves, No change. Papyrus and Phragmites, No change.

Day 21: Plants 30 % healthy. Plants leaves mostly brown and curled, desiccated petioles. Some green leaves and petioles evident, but growth elongated and uncontrolled from base of plants. No change to surrounding vegetation.

Day 30: Plants 20% healthy. Most leaves and petioles brown or yellow, plant withering and desiccated. Some evidence of irregular growth from buds at bases of plants, but leaves and petioles deformed and irregular. Some flowers visible in treated plots. Surrounding vegetation normal.

Day 40: Plants 10% healthy. Plants mostly brown and desiccated. Upper canopy entirely effected. Lower canopy of plants (primarily buds) showing abnormal growth - 10% of lower canopy showing unusual growth. Stems collapsing on water surface. All other vegetation normal, only waterhyacinth effected by the treatments. No observation possible at plot C due to waterhyacinth mat blockage.

3.0.5.2 GLYPHOSATE - RODEO

The observations presented below for herbicide efficacy have been combined for Plots A and D, since these were replicated plots with similar levels of control.

OBSERVATIONS:

Pre-treatment: Plants 100% healthy, slight browning on some plants related probably to Mayfly damage. Browning of some individual Papyrus plants. Hippograss brown at bases, stems and leaves green above.

Day 1: Plants 90 % healthy. Drooping petiole, bending approximately 30 to 40 degrees. Leaf. yellowing and curling, surrounding vegetation no change.

Day 2: Plants 90% healthy. Petioles wilting or bending 45 to 90 degrees. Browning of leaves margins. Hippograss bases brown, tops green - No change. Papyrus and phragmites showing no change in appearance.

Day 7: Plants 50 to 60 % healthy. Majority of plants wilting yellowing and browning. Petioles yellowing or brown. Buds at base of plant browning. Surrounding vegetation - No change.

Day 14: Plants 40 to 50 % healthy. Majority of plants yellow, brown and desiccated. Petioles yellow or mainly brown. Plants mostly upright with leaves absent on some plants. Hippograss brown at bases, green stems and leaves - No change. Papyrus and Phragmites - No change.

Day 21: Plants 20 to 30 % healthy. Plant leaves mostly brown, leaves dropping off petioles. Leaves and petioles mostly desiccated. Some yellow petioles visible. No change to surrounding vegetation.

Day 30: Plants 20% healthy. Outer portions of mat disintegrating. Most leaves and petioles brown or yellow, plant withering and desiccated. No daughter plants visible. Surrounding vegetation normal.

Day 40: Plants 0 to 10 % healthy. Plants mostly brown and desiccated. 40 % of leaves dropping off petioles. Plants losing buoyancy. Plot width reduced due to weakened plants floating

away. All other vegetation normal. No observation possible at plot D due to waterhyacinth mat blockage.

3.0.5.3 CONTROL - NO TREATMENT

OBSERVATIONS:

Pre-treatment: Plants 100% healthy. Mostly green, some slight damage due to Mayfly damage.

Day 1: Plants 100% healthy. Some slight damage probably due to Mayfly damage.

Day 2: Plants 100% healthy. Some slight Mayfly damage at mat fringe.

Day 7: Plants 100% healthy. Mostly green and healthy.

Day 14: Plants 100% healthy. Healthy green plants.

Day 21: Plants 100% healthy. Green healthy tall plants.

Day 30: Plants 100% healthy. Healthy tall plants.

Day 40: Plants 100% healthy. Green healthy plants.

The herbicides 2,4-D and Glyphosate both exhibited high levels of efficacy during the 40 day observation period. Clear skies, warm temperatures, and the lack of rain played an important role in the speed at which the herbicides were absorbed, translocated, and ultimately disrupted the growth of the water hyacinth during the period. Some regrowth in the 2,4-D plots was observed, but this growth was not that of a healthy plant, but rather that of plants growing in the erratic and irregular behavior typical of this herbicide's mode of control. Reduction of plant biomass and increased wind and wave action would probably destroy all the remaining plants in the treated plots.

FINAL CONCLUSION

Based on the results reported in this In-Lake Herbicide Trial, it can be concluded that the herbicides WEEDAR 64 (2,4 D) and RODEO (Glyphosate) had no significant impacts on the aquatic ecosystem in and around the treatment areas. No observable negative impacts were reported as a result of either the application of the herbicide or the resulting decomposition of the water hyacinth mats. It is recommended that the potential use of these two aquatic herbicides be incorporated into the Environmental Impact Assessment currently being conducted for the control of water hyacinth in Lake Victoria. The benefits associated with the use of aquatic herbicides in an integrated water hyacinth control program in Lake Victoria would reduce environmental impacts associated with the continued growth of water hyacinth, with no adverse environmental impacts.

In comparing the efficacy of the two candidate herbicides, WEEDAR 64 (2,4-D) provided quicker knock down of the vegetation while RODEO (Glyphosate) provided a greater degree of control from post treatment Day 14 through Day 40. Due to the various water use restrictions associated with Weedar 64, Rodeo would provide a greater degree of flexibility (during dry periods) for use in an operational control program.

The aquatic herbicides RODEO and WEEDAR 64 can be used in an integrated water hyacinth control program without adverse environmental impacts on humans or the aquatic environment if properly applied and used in accordance with the manufacturers label directions.

4.0 Recommendations

1. The In-Lake Herbicide Trials should be incorporated into the Environmental Impact Assessment (EIA) to allow review by the GoU, stakeholders, and the public in order to present the merits of limited herbicide use in an integrated water hyacinth control program.

2. Should the reviewers of the EIA concur and find no significant impact with regards to the use of approved and tested aquatic herbicides, and thus approves the controlled use of these aquatic herbicides, selected target areas should be identified to greatly reduce the water hyacinth bio-mass in Lake Victoria.

3. An operational control program incorporating the use of aquatic herbicides must be developed prior to any application to ensure proper application techniques, site selection and the associated evaluation and monitoring procedures;

4. Prior to any herbicide application, spray crews must show proof of experience in aquatic herbicide application, either in the form of an approved certification or training with an emphasis or classification in aquatic herbicide application;

5. Water hyacinths treated with aquatic herbicides may require re-treatment between Post Treatment Days 30 and 60 to insure 100% control in the selected treatment areas. If rainfall occurs within six hours of a glyphosate application, the entire area may require re-treatment.

END

ANNEX A

IN - LAKE HERBICIDE TRIALS PROTOCOL

IN LAKE HERBICIDE TRIALS

WAZIMENYA BAY
LAKE VICTORIA, UGANDA

WATER HYACINTH CONTROL PROGRAM

10 FEBRUARY 1997

PREPARED BY:

AQUATICS UNLIMITED

IN COOPERATION WITH

MINISTRY OF AGRICULTURE, ANIMAL INDUSTRY AND FISHERIES (MAAIF)
WATER HYACINTH UNIT

FUNDED UNDER GRANT FROM THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT (USAID)

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Information Package
5th February, 1997

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Section 1

In-Lake Herbicide Trials Participant Contact Numbers and Boat Assignments

AQUATICS UNLIMITED
WATER HYACINTH CONTROL PROGRAM

In-Lake Herbicide Trials
Participant Contact Number and Boat Assignments

5 February 1997

Boat 1:

Mr. Matagi: Water Quality (P. 2hr. 1. 2. 7. 14. 21. 30) (-5. 0. 30. 100)
National Water & Sewage Corporation (Tel: 257548):

Prof. Nyangababo: Residues (P. 2hr. 1. 2. 7. 14. 21. 30)
Makerere University (Tel: 540992)

Fisheries Research Institute (FIRI) Technician X 2 for Assistance

Ms. Bugaari: Assistant
Aquatics Unlimited (Tel: 41-250550)

Boat 2:

Dr. Twongo: Macro Chlorophyll (a) (P. 2hr. 1. 2. 7. 14. 21. 30) 1 meter in and edge
FIRI (Tel: 043-20484):

Dr. Kizito: Zooplankton (P. 1. 2. 7. 14. 21. 30)
Makerere University (Tel: 14-531902)

Dr. Byarugali: Phytoplankton (P. 1. 2. 7. 14. 21. 30)
Makerere University (Tel: 540764/5)

FIRI Assistants from Dr. Twongo (three)

Mr. Agaba: Assistant
Aquatics Unlimited (Tel: 41-250550)

Boat 3:

Mr. Mwebesa: Efficacy
Ministry of Agriculture, Animal Industry and Fisheries (Tel. 042-20115 (O) or 042-20333 (H)

Mr. Moorhouse: Coordinator
Aquatics Unlimited (Tel: 41-250550)

In-Lake Herbicide Trials
Participant Contact Number and Boat Assignments
Page Two

Mr. Etyang: Assistant
Water Hyacinth Unit (Tel: 042-20563):

Mr. McNabb: Advisor (Pre-treatment)
Aquatics Unlimited

Dr. McNabb: Observer (Pre-treatment)
Michigan State University

Boat 4: (Application Boat)

Mr. Najera: Herbicide Applicator
Aquatics Unlimited (Tel: 41-250550)

Mr. Mwebesa: Observer (Treatment Only)
Ministry of Agriculture, Animal Industry and Fisheries (Tel: 042-20115)

Section 2

In-Lake Herbicide Trials Design
(Test Plot Data, Calculations & Area Map)

In Lake Herbicide Trials Design
Water Hyacinth Control Program

Wazimenya Bay
Lake Victoria, Uganda

Objectives, Test Plot Data, Herbicide Data, Calculations & Area Map

7 February, 1997

Prepared By:

Aquatics Unlimited &
University of Florida, Center for Aquatic Plants

In cooperation with

Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)
Water Hyacinth Unit

Kampala Uganda

In-Lake Herbicide Trials
Lake Victoria Water Hyacinth Control Program

The In-Lake Herbicide Trials will be carried out during the week of 10 February, 1997 in cooperation with the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Water Hyacinth Unit, Aquatics Unlimited and participating scientists from Uganda and the United States. The Ugandan National Environmental Management Authority (NEMA) approved the In Lake Herbicide Trials through their authority under Sections 7 (1) (f) and 20 of the National Environmental Statute on 8th January, 1997.

1: Objectives: To determine relative efficacy of Rodeo (glyphosate) and Weedar 64 (2,4-D) on water hyacinth and to measure residues of herbicides in water, sediments, fish tissue, and to monitor herbicide effects to biota and macrofauna in and adjacent to the treatment sites. The Temporary Certificate of Registration of an Agricultural Chemical for the aquatic herbicides Rodeo (Glyphosate) and Weedar 64 (2,4-D) have been received as approved by the Agricultural Chemical Control Board (Uganda) and dated 15th October, 1996.

2: Site Location: A protected bay (Wazimenya Bay-Lake Victoria) has been selected and approved by GoU agencies (site inspection completed by GoU agencies during the week of November 18, 1996) where a 20-40 meter fringe of water hyacinth is growing fixed to the shoreline. The water depth on the outside of the fringe is a minimum of 0.75 m deep allowing operation of a boat/outboard motor (see Figure 1 for site map details).

3: Application Equipment: A work boat will be used to carry the herbicide pump and 375 liter tank spray equipment along the outside edge of the water hyacinth mat. The pump speed/pressure and output (liters/hectare of tank mix) will be pre set to minimize spray drift. Boat speed will be calibrated against width of the sprayed area and pump output (liters of mix per hectare) to be certain the desired application rate is applied. The herbicide application will be made by a Licensed Aquatic Weed Control Operator from the United States.

4: Test Plot Data: There are five test plots number A through E approximately 0.20 Ha each in size. Four of the plots are for the evaluation of the environmental affects of the herbicide applications while the fifth plot is a control. Plots A & D will be treated with Rodeo, and plots B & C will be treated with Weedar 64. Plot E is the control.

The treatments will be replicated (two plots for each herbicide, four plots total) and will be applied to approximately 0.2 ha for each herbicide at the rate specified below. The herbicide application system will reach approximately 10 meters into the water hyacinth mat.

Average Plot size = 2,000 m^2 divided by 10 m wide = 200 m long
10 m wide (distance spray will carry)
<200 m long = equals 0.2 hectare

Plot A: This plot starts on the boarder of Busoke and Mubanda Villages. The shoreline vegetation is primarily made up of Papyrus, Phragmites and fern. The plot will be treated with Rodeo.

Plot E: This plot is located approximately 150 meters NE along the shoreline from Plot A. The shoreline vegetation is made up primarily of Hippo Grass. This plot is the control with no treatment.

Plot B: This plot is located approximately 150 meters NE along the shoreline from Plot E. The shoreline vegetation is primarily made up of Hippo Grass. The plot will be treated with Weedar 64.

Plot C: This plot is located approximately 150 meters NE along the shoreline from Plot B. The shoreline vegetation is primarily made up of Papyrus, Hippo Grass and Fern. The plot will be treated with Weedar 64.

Plot D: This plot is located approximately 200 meters E along the shoreline from Plot C. The shoreline vegetation is primarily made up of Papyrus with some Fern. The plot will be treated with Rodeo.

5: Herbicide Calculations:

Herbicide Rates:

- Weedar 64: Weedar 64 is the trade name of 2,4-D amine manufactured and labeled for aquatic use in the U.S. by Rhone-Poulenc. The United States Environmental Protection Agency (EPA) herbicide Registration Number is 264-2AA (EPA Reg. No.). The Uganda Agricultural Board Temporary Registration Certificate Number is UgC/96/00039/He/Tempo. Weedar 64 will be used at the high labeled rate of 2.24 to 4.49 kg/ha as the label for controlling water hyacinth (Eichornia crassipe) states "Use 4 qts. (4 lbs active ingredient (a.i.)) when plants are matured or when the weed mass is dense". Weedar 64 contains 3.8 (rounded to 4 in label use rate calculations) pounds of 2,4-Dichlorophenoxyacetic acid equivalent per gallon (1.81 kg/3.78 liters). The herbicide use rates of Weedar 64 for the In-Lake Herbicide Trials are determined as follows:

Herbicide Volume Calculations (Weedar 64)

4 quarts per acre = (4 qts/1.057 quarts per liter) = 3.78 liters per acre.
3.78 L/acre x 2.47 acres per hectare = 9.34L/ha.
9.34 L/ha x 0.20 ha (plot size) = 1.86L of Weedar 64 per test plot.

Herbicide Active Ingredient (a.i.) Calculations (Weedar 64)

4 lbs a.i. per acre = 4lbs/2.2 pounds per kilogram = 1.81 kg/acre
1.81 kg/acre x 2.47 acre per hectare = 4.47 kg/ha a.i.
4.47 kg/ha x 0.20 ha (plot size) = 0.89 kg a.i. per test plot.

- Rodeo: Rodeo is the aquatic labeled form of glyphosate registered for aquatic use in the U.S. by Monsanto. The United States Environmental Protection Agency (EPA) herbicide Registration Number is 524-343 (EPA Reg. No.). The Uganda Agricultural Board Temporary Registration Certificate Number is UgC/96/00038/He/Tempo. Rodeo will be used at the high labeled rate of 5 to 6 pints per acre as the label for controlling water hyacinth (Eichornia crassipe) states "Use the higher rate when more rapid visual effects are desired". Rodeo contains 5.4 pounds per U.S. gallon of the active ingredient glyphosate in the form of its isopropylamine salt, equivalent to 4 pounds per U.S. gallon of the acid glyphosate. Surfactant at 0.25% volume will be added to the tank mix to aid the penetration of glyphosate into the water hyacinth. The herbicide use rates of Weedar 64 for the In-Lake Herbicide Trials are determined as follows:

Herbicide Volume Calculations (Rodeo)

6 pints per acre = 0.75 gallons = 3 quarts per acre = 3 qts/1.057 quarts per liter = 2.83 liters per acre.
2.83 L/acre x 2.47 acres per hectare = 6.99 L/ha.
6.99 L/ha x 0.20 ha (plot size) = 1.40 liters of Rodeo per test plot.

Herbicide Active Ingredient (a.i.) Calculations (Rodeo)

5.4 pounds a.i./gallon x 0.75 gallons (use rate of 6 pints per acre) = 4.07 lbs
4.07 lbs a.i. per acre = 4.07 lbs/2.2 pounds per kilogram = 1.85 kg/acre
1.85 kg/acre x 2.47 acres per hectare = 4.56 kg/ha a.i.
4.56 kg/ha x 0.20 ha (plot size) = 0.91 kg a.i. per test plot.

Tank Mix:

- Weedar 64 (2,4-D amine): Fill tank with 374 liters of water, add 1.86 liters of 2,4-D amine, agitate and apply. Pump output rates will be adjusted and calibrated to compensate for boat speed during the equipment test run.

- Rodeo (Glyphosate) Add 140 liters of water to tank, then add 0.35 liters of surfactant (0.25%), then add 1.4 liters of Rodeo, mix and apply. Pump output rates will be adjusted and calibrated to compensate for boat speed during the equipment test run.

6: Applicator and mixing safety equipment:

- Weedar 64 (2,4-D amine) per label directions
  - coveralls
  - rubber gloves/boots
  - goggles or other eye protection
  - rubber apron when mixing

- Rodeo (glyphosate) per label directions
  - no safety equipment required, however, standard industrial hygiene is recommended, i.e. do not get on skin, wash hands after use, etc.

7: Preparation & Application Procedures:

- Each plot has boundaries established by the placement of stakes at the edge of the water hyacinth mat fringe (treatment area = 200m x 10m approximate). Three stakes outline the final test plot outer edge area and are marked by surveyors tape delineating each treatment area.
- The work boat will be fitted with the application equipment and tested prior to the trial date.

Preparation Procedures:

- Prime pump by adding lake water to the priming port
- Attach hoses to the proper fittings and insure proper seal
- Check to insure chemical intake valve and spray nozzles are in the off position
- Start pump
- With pump running, bleed air from hoses and pump by opening and closing the nozzle several times, then allow pressure to build
- Once desired pressure is realized, slowly open spray nozzle and adjust to the required pressure to reach the inside of the treatment area
- Adjust nozzle valve to provide even distribution over the treatment area with a spray pattern that will provide even coverage of the area. Do not exceed a 30 degree spray angle
- Perform test run in non target area to properly calibrate boat speed and coverage as outlined above

Application Procedures:

- Tank mix the herbicides as outlined above
- Work with the wind to keep it at your back
- Cover treatment area from open water area spraying in
- Check tax mix level frequently to ensure proper dosage rates are being applied
- Close chemical intake valve when pump is not in use
- Upon completion of plot A, treat replica plot D that requires the same herbicide
- Upon completion of plots with specific herbicide use, flush the tank and pump system with water for a minimum of one minute.

8: Water Use Restrictions:

- Weedar 64 (2,4-D amine)
  - Do not use water in treated plots for domestic use (potable or bathing) or irrigation of food crops for 21 days after application. (mcl = 0.1 ppm)

- Rodeo (glyphosate)
  - Do not use the water in the treated plots for drinking for 48 hours following application. (mcl = 0.7 ppm)

9: Typical water loading under water hyacinth: The average water depths beneath a floating fringe of water hyacinth is typically 1 meter deep, and is used in the following calculations. Using this average depth, a theoretical calculation can be made for estimating the herbicide load in water beneath the sprayed vegetation.

Assuming one hectare, 1 meter deep sprayed with Weedar 64 (2,4-D) and Rodeo (glyphosate), the calculations in Table 1 assume no plant coverage, i.e. herbicide applied and mixed directly in the water, and 80% interception of the spray by plants.

Table 1. The mcl (maximum contaminate level), rate of herbicide used for hyacinth control, and theoretical loading of 1 meter of water with and without plants.

	mcl (ppm)	rate (kg/ha)	no plants (ppm)	with plants
2,4-D amine	0.1	4.47	0.447	0.08
Glyphosate	0.7	4.56	0.456	0.09

The maximum contamination level is established by the U.S. Environmental Protection Agency as the maximum level of a contaminant in potable water. Concentrations of a contaminant at or below the mcl are considered safe for human consumption. Although theoretical values in Table 1 suggest that following the spraying of water hyacinth, herbicide levels are near the mcl levels, theoretical values cannot be used to waive the water use restrictions, rather, the water must be analyzed to determine mcl levels in order to waive water use restrictions (see herbicide labels).

10: Toxicity of Weedar 64 (2,4-D amine) and Rodeo (glyphosate): The acute toxicity's of these herbicides are listed in Table 2.

Table 2. Acute toxicity's (generally 96 hour LC or LD_{50}) of aquatic herbicides typically used for water hyacinth control.

Herbicide	Theoretical max. in water	Rat	Fish	daphnia
2,4-D amine ppm	0.447	300-1000 mg/kg	27-1000 ppm	6.4
glyphosate (Rodeo) ppm	0.456	>5000 mg/kg	100-200 ppm	930

11: Physicians Guide to Treatment: (From herbicide label)

- Weedar 64 (2,4-d amine) - no specific antidote, treat based upon symptoms of victim. If swallowed, induce vomiting, if on skin or in eyes, wash with soap and flush with water.

- Rodeo (glyphosate) - considered essentially non-toxic, if inhaled and breathing is labored seek medical attention, call 314/694-4000 for emergency treatment advice, 24 hours a day. Glyphosate is classified as a category E compound by EPA, (evidence of non- carcinogenicity for humans).

- Emergency Medical Protocol - An Emergency Medical Protocol has been prepared and distributed with the general information package to all of the participants. See this document for further information.

12: Residue studies in water adjacent to plants: As noted in Figure 1 (area map), water residue samples be collected 5 meters from the sprayed edge, at sprayed plant edges, 30 m and 100 meters from plants on Day 0 (per-treatment), 2 hour and day 1, 7, 14, 21 & 30 post treatment (these sampling times correspond to the Lab and Pond trials carried out by the NTCWH Chemical Verification Sub-Committee). Single samples will be collected from a water depth of 0.5 meters from the water surface. Typical herbicide half-lives in water are indicated in Table 3 and the data suggests that 8 days of sampling is sufficient to detect the maximum herbicide residues as well as the rapid dissipation and degradation (30 day sampling is being done per the request of NEMA).

Table 3. Persistence of aquatic herbicides in water. Times vary due to differences in environmental conditions.

Herbicide	Method of Disappearance	Half-life in Water (days)	Typical Half-live (ponds)**
Glyphosate	Microbial Adsorption	14*	<2 days
2,4-D	Microbial Photolysis Plant Metabolism	7-48	<5 days

* distilled water ** warm water ponds

Dissipation of 2,4-D is mostly by microbial degradation. A small amount of photodecomposition and breakdown by tolerant plants also occurs. Complete decomposition usually takes about 2 weeks in water and can be as short as 1 week in rich, warm natural waters. 2,4-D breaks down into naturally occurring compounds, including carbon dioxide, water, ammonia and chlorine.

Glyphosate is usually not applied directly to water for weed control, but when it does enter the water it is bound tightly to dissolved and suspended particles and to bottom sediments and made inactive. Glyphosate is broken down into carbon dioxide, water, nitrogen, and phosphorus over a period of several months.

13: Monitoring Procedures & Parameters: (See Sampling Protocol)

- **Water Quality & Sediment Residue**
- **Biota** (Chlorophyll -a, Zooplankton & Phytoplankton)
- **Sediment Analysis**
- **Macrofauna**
- **Fish**
- **Soil Sampling**
- **In-Land Soil and Water**
- **Vegetation Evaluations-Observations**

13: Public Sensitization: A public sensitization campaign for the In-Lake Trials has been carried out to educate the public in and around the selected trial bay area of the planned activities for the chemical verification studies as well as further document their views on the use of aquatic herbicides for the water hyacinth control program. The program involved local leaders at the RDC, CAO, LC5, and LC3 level to foster support for the program and for their assistance and approval in calling meetings at two local villages (Mubanda and Butere) for the purposes of educating the local LC's and residents on GoU efforts, waterhyacinth control strategies, and the need to carry out herbicide trials. Cooperation for the trials was stressed and precautionary measures during the trial period were discussed in order that no outside influences would effect the results of the trials. Safety precautions were also discussed and provided in a handout both in Luganda and English version. Visits to the district center were made to gain support at the district level followed by meetings at schools in both the villages of Mubanda and Butere where school children as well as parents, LC 1, LC2 were brought together and made aware of GoU efforts in controlling waterhyacinth, and the proposed In-Lake Herbicide trials. A video of control efforts in the United States was shown to the participants (Dubbed Luganda Version of a University of Florida - Center of Aquatic Plants video tape). Questions related to control efforts and herbicide use were raised by the participants and

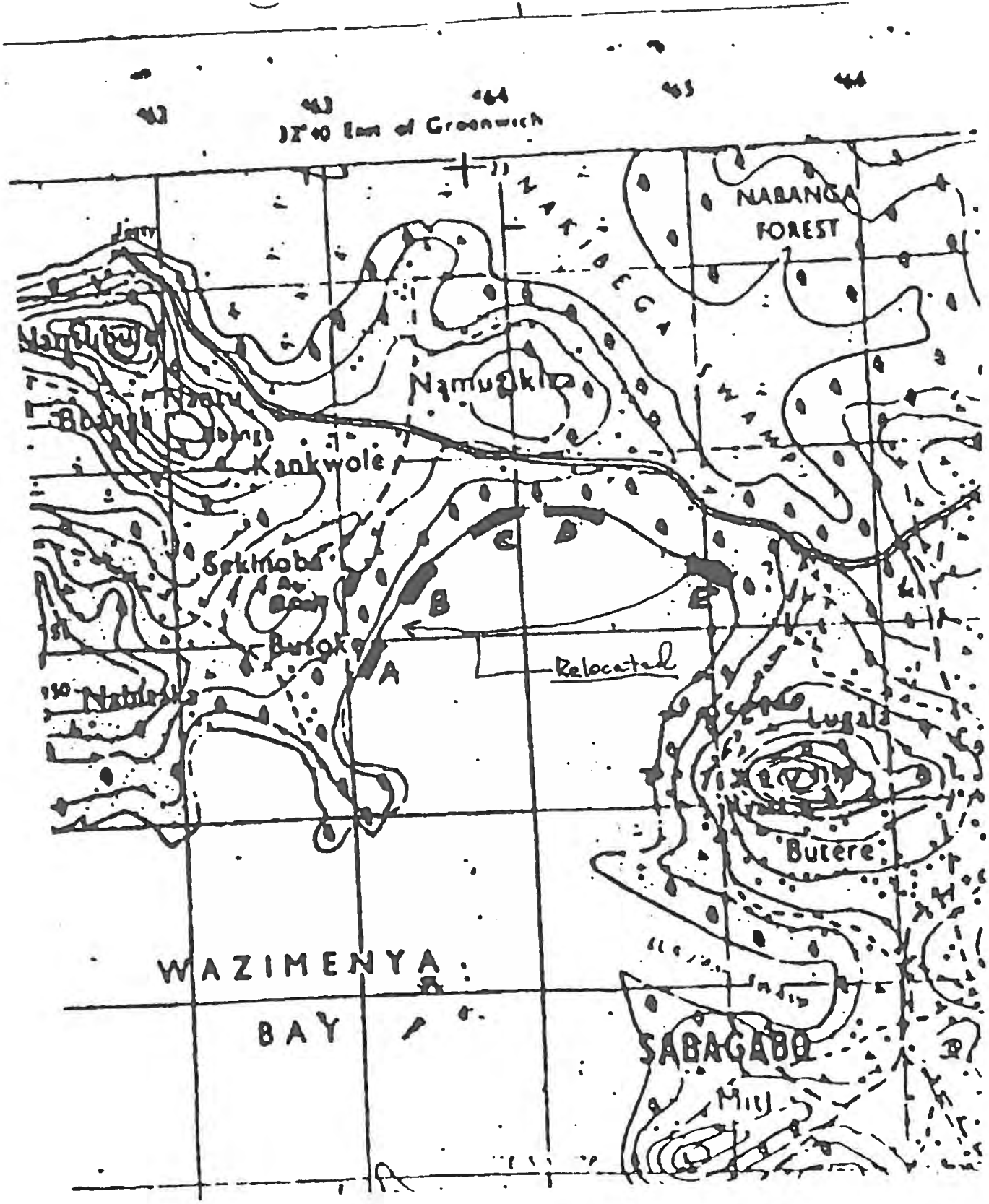
support for the exercise was given. During the week of 3 February 1997 fliers detailing precautions were taken to the villages for distribution. These precautions are requests to keep out of the treatment areas to prevent outside influences from effecting the results of the trials.

14: Efficacy:

The two herbicides tested have been evaluated under numerous conditions, including in small tanks/ponds by the NTCWH Chemical Verification Sub-Committee in Uganda during 1996. On large plots, 0.5-1.0 hectares, visual evaluations are usually sufficient because control is usually >80% by 2 weeks post-treatment. Control with glyphosate usually takes 4-6 weeks after treatment.

15: Reporting of Results: A final report on the results of the In Lake Herbicide Trials will be produced, and is expected to be completed within sixty days from the trial date.

Questions in regards to this Trial Design can be directed to Mr. Dick Nyeko, Coordinator, Water Hyacinth Unit (MAAIF) in Entebbe at 256-42-20578/63 or Mr. Thomas Moorhouse, Aquatics Unlimited (AU) in Kampala at 256-41-250-550.



In Lake Herbicide Trials (02-97)

Section 3

In-Lake Herbicide Trials Sampling Protocol
(Revised 5 February 1997)

In-Lake Herbicide Trials
Lake Victoria Water Hyacinth Control Program

Sampling Protocol
Wazimenya Bay, Uganda

Revised February 05, 1997

International Conference Center, P.O. Box 7057, Suite 235 • Kampala, UGANDA • Office (256) 41-250550 • Fax (256) 41-257824
827 Arnold Drive, Suite 80 • Martinez, California 94553 USA • Phone (510) 370-9175 • Fax (510) 370-9179

In-Lake Herbicide Trial
Sampling Protocol

The following schedule outlines sampling parameters and their associated analytical procedures in accordance with the National Environmental Management Authority (NEMA) approved In-Lake Herbicide Trials, Lake Victoria Water Hyacinth Control Program. The Uganda scientists who will collaborate with Aquatics Unlimited are listed under each of their respective sections.

Test Plots: There will be two plots each for the herbicides to be tested, Rodeo and Weedar-64 plus one control plot for a total of 5 plots located in Wazimenya Bay.

Water Quality and Herbicide Residues:

- Sampling days: Pre-Treatment water quality and herbicide residue sampling will be followed by post-treatment sampling at 2 hours and days 1, 2, 7 14, 21, 30.

- Sample points per plot: There will be four sample points per plot at 5 meters (5m) or ½ distance (½ d) into sprayed plots, 0 meters (edge), 30 meters, 100 meters.

- Total samples: 160 samples
- Samples per day: 20
- Scientists: Water Quality: Samuel Matagi, Chemist/Analyst, National Water and Sewerage Corp.
  Herbicide Residues: Prof. Nyangababo
- Parameters to be Analyzed: Water quality analysis will be conducted for N, P, DO, Temperature, Transparency and pH.

- Methods:

Herbicide residual: Samples will be collected in 1 liter plastic containers, labeled for date, time, plot number and location. The collected samples will be frozen and shipped weekly via courier to North Coast Laboratories in the United States for analysis. Additional samples will be collected as indicated above and will be analyzed by Prof. Nyangababo at Makerere University, Uganda.

Water Quality: N, P & pH will be analyzed on site using a HACH DREL/2010 Water Quality Laboratory. Temperature and Dissolved oxygen will be determined on site using a VWR select Orion model 810 DO meter and a 20 cm standard secchi disk will be used to determine transparency.

In-Lake Herbicide Trial
Sampling Protocol

Biota (Chlorophyll-a)

- Sampling days: Pre-Treatment sampling will be followed by post-treatment sampling at 2 hours and days 1, 2, 7 14, 21, 30.

- Sample points per plot: There will be two transects per plot and two sample points per transect, or a total of 4 samples per plot. Sample points will be 1 meter into treatment area from water edge and 30 meters out.

- Total samples: 160 samples
- Samples per day: 20
- Scientists: Dr. Timothy Twongo, MAAIF, Fisheries Research Institute
- Parameters to be Analyzed: Chlorophyll a.

- Methods: Water samples will be collected just under the water surface and analysis will be conducted in Uganda.

Phytoplankton and Zooplankton

Additional parameters for phytoplankton and zooplankton have been requested and will be collected and analyzed by Dr. S. M. Byarujali (MUK) and Dr. Yusuf Kizito (MUK), respectively. There will be one transect per plot and 2 points per transect at 1 meter into the plot and 30 meters from the plot. One sample will be collected per sample point Samples per day will be 10 for a total of 80 samples each for phyto and zooplankton.

Sediment Analysis

- Sampling days: Pre-Treatment sampling will be followed by post-treatment sampling at Days 1, 14 and 30.

- Sample points per plot: There will be one sample point per plot at 5 meters (5m) or ½ distance (½ d) into sprayed plots.

- Total samples: 20 samples
- Samples per day: 5
- Scientists: Prof. Nyangababo
- Parameters to be Analyzed: Herbicide residue.

- Methods: Samples will be collected with a Bottom Sampling Dredge, packaged in 0.5 liter glass jars, frozen and shipped to the United States for analysis.

In-Lake Herbicide Trial
Sampling Protocol

Macrofauna

- Sampling days: Pre-Treatment sampling will be followed by post-treatment sampling at 2 hours and days 1, 2, 7 14, 21, 30.

- Sample points per plot: There will be one transect per plot and 2 points per transect at 1 meter into plots and at 30 meters from plot to open water. 3 samples will be collected per point. Macrofauna samples will be collected from water hyacinth roots and from bottom sediments.

- Total samples: 360 samples (120 root samples, 240 benthic samples)
- Samples per day: 45 samples (15 root samples, 30 benthic samples)
- Scientists: Dr. Timothy Twongo - MAAIF, Fisheries Research Institute

- Parameters to be Analyzed: Water hyacinth and sediment Macrofauna.

- Methods: Water hyacinth mats will be sampled using a 0.25 square meter quadrant randomly thrown within five meters from the edge of the mat while benthos will be sampled using a ponar grab. Water hyacinth roots and debris will be sprinkled with ethanol to flush out the Macrofauna that will be hand sorted, counted and preserved in 10% formalin. Benthos sediments will be washed in a sieve with a mesh of 400 microns and the organisms will be hand sorted, counted by the field technicians on each of the sample collection dates outlined above.

Fish

- Sampling days: Pre-Treatment observations will be followed by post-treatment observations at days 1, 7, 14, 21 and 30. Fish will be removed for analysis at pre-treatment followed by days 2 and 21.

- Sample points per plot: There will be one fish cage per plot with five fish each for observation. One fish from each cage will be removed for tissue analysis at pre-treatment and on days 2 and 21. The cages will be located at the plot edges.

- Total samples: 30 samples
- Observations per day: 5
- Samples sent for Analysis: 15

In-Lake Herbicide Trial
Sampling Protocol

- Scientists: Dr. Timothy Twongo, and Prof. Nyangababo
- Parameters to be Analyzed: Herbicide residue in tissues.

- Methods: Fish cages will be constructed and stocked with Tilapia. The cages will be placed on the edge of each treatment area and monitored for behavior changes during the 30 day sampling period. One fish from each cage will be filleted and frozen and shipped to the certified lab in the US for herbicide residue analysis pretreatment and on days two and on day 21. Prof. Nyangababo will also analyze in Uganda.

In-Land Soil and Water Sampling

- Sampling days: Pre-Treatment sampling will be followed by post-treatment samples at days 7 and 30.

- Sample points per plot: There will be one sample point per plot located 5 meters inland to collect both ground water and soil samples.

- Total samples: 30 samples
- Samples per sampling day: 10
- Scientists: Prof. Nyangababo
- Parameters to be Analyzed: Herbicide residue.

- Methods: As requested by NEMA, a bore hole will be drilled 5 meters inland from the waters edge at each treatment site to collect water and soil samples for herbicide residue analysis. The samples will be shipped to the certified lab for analysis. Prof. Nyangababo will also analyze for residue in Uganda

Vegetation Evaluations-Observations

- Observation days: Pre-Treatment observations will be followed by post-treatment observations at days 1, 2, 7 14, and 30.

- Observation points per plot: General observation of the plot will be made.

- Total Observations: 25
- Observations per day: 5
- Scientists: Mr. Mwebesa - MAAIF, Crop Protection

In-Lake Herbicide Trial
Sampling Protocol

Methods. The water hyacinths within and outside of the treatment areas as well as shoreline vegetation will be visually observed on each of the sampling dates (pre-treatment, days 1, 7, 14 & 30). Observations will be made and the vegetation will be rated appearance relationship (as per verification report, Kajjansi trials) to the vegetation in and around the general control plot that will be located within the same bay as the treatment area. 35 mm film prints of the sites will be collected and kept on file for reference and documentation of any vegetative state changes.

List of Analytical Equipment and Materials to be Used:

- **HACH:** DREL/2010 Water Quality Laboratory. Includes a 2010 spectrophotometer, conductivity/TDS meter, ph meter, instrument and reagent cases, plus reagents and apparatus for performing up to 27 test.

  The DREL is a self-contained, portable testing system. Calibrations for over 120 commonly performed analysis are permanently stored in the DR/2010 spectrophotometer ready-only memory.

  A Pour through assembly will enable testing of multiple samples and speeds measurement of multiple samples, eliminates errors caused by using unmatched sample cells and improves accuracy when high sensitivity is required

- **VWR Scientific:** VWR select Orion model 810 DO meter with 3m cable electrode including the probe Maintenance Kit and Manual. Meter includes features such as automatic temperature compensation, communication capability, 50 point datalogging, barometric pressure compensation, salinity correction, selectable resolution, adjustable stand, and one or two point calibration.

- **Neutralized Buffered formalin Solution**: 1 Liter 10% formalin solution for use in histological applications to fix and store tissue specimens.

- **Denatured Proprietary Ethanol (Anhydrous):** 1 Liter used for flushing action in the Macrofauna analysis.

- **Wind Meter:** Pocket wind meter has one scale which reads 2 - 10 mph in 1\ 2 mph increments. A second scale reads 10 - 66 mph in 2 mph increments.

- **Bottom sampling dredge:** Aquatic Ecosystem Stainless steel dredge features a bottom sensing closure which eliminates the need for a messenger weight. Dredge is a convenient sediment collecting device for mud, sand, ooze and light gravel.

In-Lake Herbicide Trial
Sampling Protocol

- **Secchi disk:** Aquatic Ecosystem 20 cm disk standard for measuring the relative visibility of water.

- **Water sampler**: Aquatic Ecosystem collects samples from depths between one and twenty meters. Its inner collection chamber allows DO samples to be fixed prior to removal.

- **Palmer counting cell** Aquatic Ecosystem design for counting samples of phyto plankton and zoo plankton.

- **Plankton Net:** Kecton Industries, Inc. with conical graduated tube at end (38.1 cm X 12.7 cm diameter). Minute plankton are collected and can be observed in the clear 50 ml conical graduated tube at the end of the net.

- **Sieve, 400 microns:** Cole-Parmer brass frame and stainless steel wire cloth. Benthos sediments will be washed in the sieve.

- **Fluorescent dye tracers:** 0.25 liter (rhodamine wts, red dye) Biodegradable and nontoxic, dye rapidly diffuse to help determine water flow.

- **Miscellaneous items:**

Items below will be utilized in the water quality testing program.

1) Potassium test reagents: 100/pkg. x 2
2) Nitrogen Nitrate 2 - 50/pkg.
3) Nitrogen Nitrite 2 - 50/pkg.
4) Phosphorus Reactive 2 - 50/pkg
5) Phosphorus Total 2 - 50/pkg.
6) Temperature Pocket Pal Tester
7) 1 - Graduated Cylinder Plastic 250 ml
8) 1 - Cylinder Brush
9) Tube brush
10) Sample bottle (for grab samples) 500ml, 12/pkg.
11) Mixing bottle 10 ml. 6/pk
12) Beaker 50 ml
13) Mixing bottle 25 ml
14) Membrane filters (0.45 um and 0.8 um pore size)
15) Acatone, concentrated NhHOH, grinding tubes

Questions in regards to this Protocol can be directed to Mr. Thomas Moorhouse, Aquatics Unlimited (AU) in Kampala at 256-41-250-550. AU is located in Suite 235 of the International Conference Center, Kampala Uganda.

Section 4

In-Lake Herbicide Trials Sample Labeling Scheme and Data Record Sheets

AQUATICS UNLIMITED
WATER HYACINTH CONTROL PROGRAM

IN-LAKE HERBICIDE TRIALS
SAMPLE LABELING SCHEME AND SAMPLE DATA FORMS

10 February 1997

WATER QUALITY AND RESIDUE : (Water Quality Sampling Data Form Attached)

PLOT	TIME OF SAMPLING	SAMPLE LOCATION
A	P = 0	1/2d or 5m = 0
B	2hr = 1	Edge/0m = 1
C	Day 1 = 2	30m = 2
D	Day 2 = 3	100m = 3
E	Day 7 = 4	
	Day 14 = 5	
	Day 21 = 6	
	Day 30 = 7	

EXAMPLE: A21 = PLOT A. DAY 1. EDGE

CHLOROPHYLL(a) (Sampling Data Form Attached)

PLOT	TIME OF SAMPLING	SAMPLE LOCATION
A	P = 0	1m = 0
B	2hr = 1	30m = 2
C	Day 1 = 2	
D	Day 2 = 3	
E	Day 7 = 4	
	Day 14 = 5	
	Day 21 = 6	
	Day 30 = 7	

SEDIMENT ANALYSIS: (Sampling Data Form Attached)

PLOT	TIME OF SAMPLING
A	P = 0
B	Day 1 = 1
C	Day 14 = 2
D	Day 30 = 3
E	

IN-LAKE HERBICIDE TRIALS
SAMPLE LABELING SCHEME AND SAMPLE DATA FORMS
PAGE TWO

MACROFAUNA (M), ZOOPLANKTON (Z), PHYTOPLANKTON (P) (Sampling Data Form Attached)

PLOT	TIME OF SAMPLES	SAMPLE TYPE	SAMPLE LOCATION
A	P = 0	Debris = A	1m = 0
B	2hr = 1	Benthos = B	30m = 2
C	Day 1 = 2		
D	Day 2 = 3		
E	Day 7 = 4		
	Day 14 = 5		
	Day 21 = 6		
	Day 30 = 7		

INLAND SOIL AND WATER RESIDUE: (Sampling Data Form Attached)

PLOT	TIME OF SAMPLING	SAMPLE TYPE
A	P = 0	Soil = S
B	Day 7 = 1	Water = W
C	Day 30 = 2	
D		
E		

FISH ANALYSIS: (Sampling Data Form Attached)

PLOT	TIME OF SAMPLING
A	P = 0
B	Day 2 = 1
C	Day 21 = 2
D	
E	

OBSERVATIONS: (Sampling Data Form Attached)

Visual observations at locations 1 on all of the sample days Separate record forms

IN-LAKE HERBICIDE TRIALS AQUATICS UNLIMITED SAMPLING DATA FORM

WATER HYACINTH CONTROL PROGRAM

Water Quality			**Date**						
Sample Day:			**Time:**						
Water Quality Residual						**Water Quality Analysis**			
Location	**0**	**1**	**2**	**3**		**0**	**1**	**2**	**3**
A-Rodeo					Ph				
WQ Residual					Temp				
Sediment					Secchi				
Inland Sample: Sedi					Do				
Inland Sample: Water					Nitri-N				
					Nitra-N				
					Tp				
					Rp				
B-Weedar 64					Ph				
WQ Residual					Temp				
Sediment					Secchi				
Inland Sample: Sedi					Do				
Inland Sample: Water					Nitri-N				
					Nitra-N				
					Tp				
					Rp				
C-Weedar 64					Ph				
WQ Residual					Temp				
Sediment					Secchi				
Inland Sample: Sedi					Do				
Inland Sample: Water					Nitri-N				
					Nitra-N				
					Tp				
					Rp				
D-Rodeo					Ph				
WQ Residual					Temp				
Sediment					Secchi				
Inland Sample: Sedi					Do				
Inland Sample: Water					Nitri-N				
					Nitra-N				
					Tp				
					Rp				
E-Control					Ph				
WQ Residual					Temp				
Sediment					Secchi				
Inland Sample: Sedi					Do				
Inland Sample: Water					Nitri-N				
					Nitra-N				
					Tp				
					Rp				
Wind									
Weather Conditions									
Waves									
Cooler Number									
Ship Date									
Chain of Custody									

IN LAKE HERBICIDE TRIALS

AQUATICS UNLIMITED
WATER HYACINTH CONTROL PROGRAM

SAMPLING DATA FORM

Biota		**Date:**		
Sample Day:		**Time:**		
Location		**1m**		**30m**
Plot	**No. of Samples**			
A-Rodeo				
Macrofauna				
Benthos				
Chlorophyll (a)				
Fish				
Zooplankton				
Phytoplankton				
B-Weedar 64				
Macrofauna				
Benthos				
Chlorophyll (a)				
Fish				
Zooplankton				
Phytoplankton				
C-Weedar 64				
Macrofauna				
Benthos				
Chlorophyll (a)				
Fish				
Zooplankton				
Phytoplankton				
D-Rodeo				
Macrofauna				
Benthos				
Chlorophyll (a)				
Fish				
Zooplankton				
Phytoplankton				
E-Control				
Macrofauna				
Benthos				
Chlorophyll (a)				
Fish				
Zooplankton				
Phytoplankton				

Residue Analysis:				
Sample Day:		**Time**		
Location	**0**	**1**	**2**	**3**
A-Rodeo				
Sediment Sample				
Water Sample				
Inland Soil Sample				
Inland Water Sample				
Fish Tissue Sample				
B-Weedar 64				
Sediment Sample				
Water Sample				
Inland Soil Sample				
Inland Water Sample				
Fish Tissue Sample				
C-Weedar 64				
Sediment Sample				
Water Sample				
Inland Soil Sample				
Inland Water Sample				
Fish Tissue Sample				
D-Rodeo				
Sediment Sample				
Water Sample				
Inland Soil Sample				
Inland Water Sample				
Fish Tissue Sample				
E-Control				
Sediment Sample				
Water Sample				
Inland Soil Sample				
Inland Water Sample				
Fish Tissue Sample				

IN-LAKE HERBICIDE TRIALS

AQUATICS UNLIMITED
WATER HYACINTH CONTROL PROGRAM

SAMPLING DATA FORM

Fish Observations	**Date:**
Sample Day:	**Time:**
	Location 1
Plot	
A-Rodeo	
B-Weedar 64	
C-Weedar 64	
D-Rodeo	
E-Control	
Shipping Date	
Cooler Number	
Chain of Custody	

IN-LAKE HERBICIDE TRIALS

AQUATICS UNLIMITED
WATER HYACINTH CONTROL PROGRAM

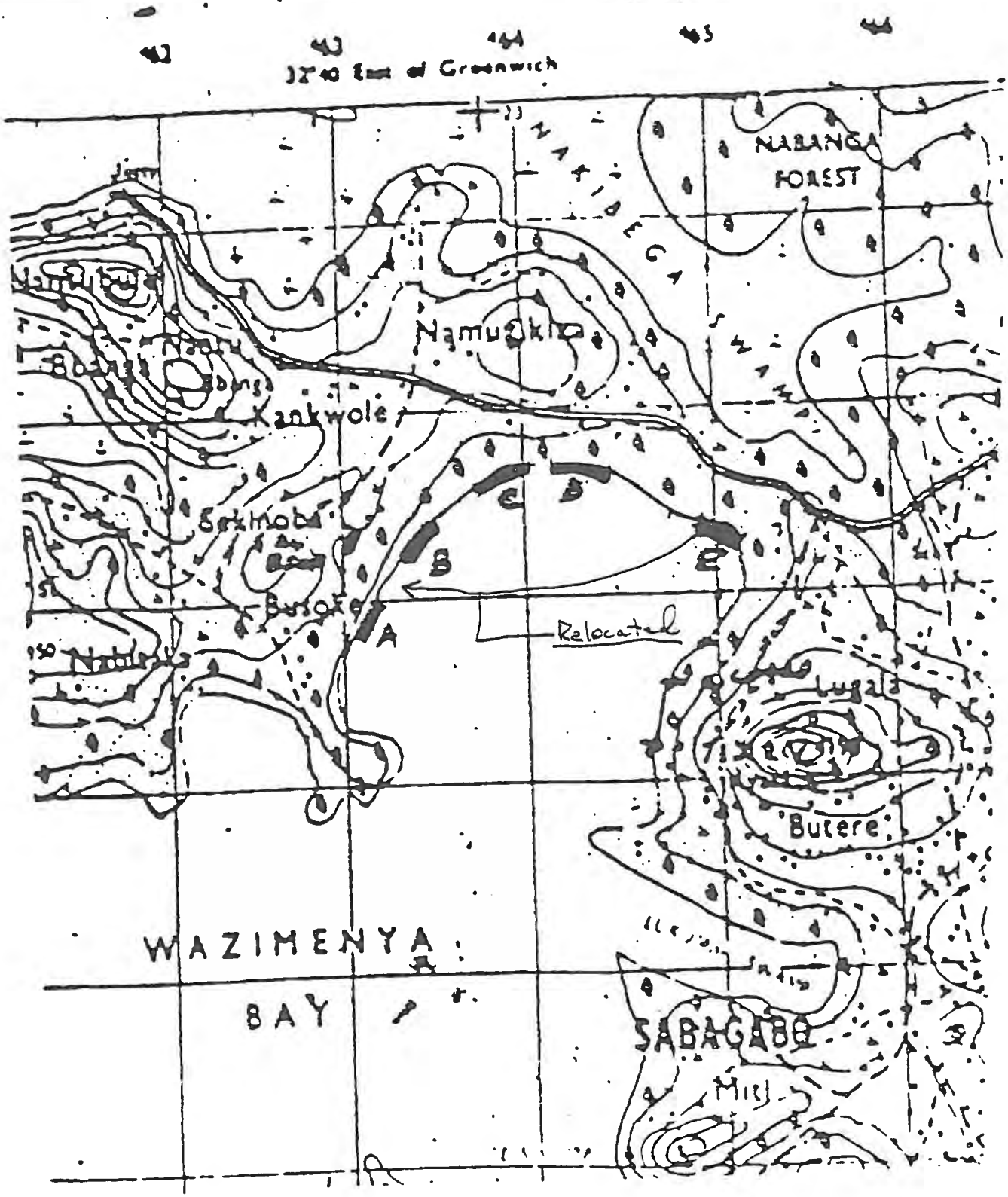
SAMPLING DATA FORM

Efficacy:	
Sample Day:	**Time:**
Plot	**Location 1**
Observations	
A-Rodeo	
B-Weedar 64	
C-Weedar 64	
D-Rodeo	
E-Control	
Evaluation Scale 1-10 (10-Best)	
A-Rodeo	
B-Weedar 64	
C-Weedar 64	
D-Rodeo	
E-Control	
Photos	
A-Rodeo	
B-Weedar 64	
C-Weedar 64	
D-Rodeo	
E-Rodeo	

Section 5

Pest Control Recommendation

Site Map



In Lake Herbicide Trials (02-97)

9/89

Pest Control Recommendation

1. Operator of the Property: Government of Uganda C/o MAAIF
2. Recommendation Expiration Date: 31st March, 1997

Address: Fisheries Department | City: Entebbe | County: Uganda

3. Location to be Treated: Test Plots (4) in Wazimenya Bay - Lake Victoria

4. Commodity to be Treated: Shoreline Test Plots
5. Acres or Units to be Treated: Approx. 1 Ha

6. Method of Application: ☐ Air ☐ Ground ☐ Fumigation ☒ Other Boat
7. Pest(s) to be Controlled: Water Hyacinth

8. Name of Pesticide(s)	Rate Per Acre or Unit	Dilution Rate	Volume Per Acre or Unit
Weedar 64	9.33 l/Ha	1:200	3%
Roden	7.00 l/Ha	1:100	1%

9. Hazards and/or Restrictions:
- ☐ 1. Highly toxic to bees
- ☐ 2. Toxic to birds, fish and wildlife
- ☒ 3. Do not apply during irrigation or when run off is likely to occur
- ☐ 4. Do not apply near desirable plants
- ☒ 5. Do not allow to drift onto humans, animals, desirable plants or property
- ☐ 6. Keep out of lakes, streams and ponds
- ☐ 7. Birds feeding on treated area may be killed
- ☒ 8. Do not apply when foliage is wet (dew, rain, etc.)
- ☒ 9. May cause allergic reaction to some people
- ☒ 10. This product is corrosive and reacts with certain materials (see label)
- ☐ 11. Closed system required
- ☐ 12. Restricted use pesticide (California and/or Federal)
- ☐ 13. Hazardous area involved (see map and warnings)
- ☐ 14. Other (see attachment)

10. Schedule, Time or Conditions: February, 1997

11. Surrounding Crop Hazards: Matooke, Cassava, Sugar Cane

12. Proximity of Occupied Dwellings, People, Pets or Livestock: Small villages around treatment area.

Handout from MAAIF - Precautions.

13. Non-Pesticide Pest Control, Warnings and Other Remarks: Post treatment area.

Notify Shoreline Residents

Notify Authorities

14. Criteria Used for Determining Need for Pest Control Treatment:
- ☐ Sweep Net Counts
- ☒ Field Observation
- ☒ History
- ☐ Leaf or Fruit Counts
- ☐ Pheromone or Other Trap
- ☐ Other
- ☐ Preventive
- ☐ Soil Sampling

15. Crop and Site Restrictions:
- ☐ 1. Worker reentry interval ____ days
- ☐ 2. Do not use within ____ days of harvest/slaughter
- ☒ 3. Posting required ☒ Yes ☐ No 30 days
- ☒ 4. Do not irrigate for at least 21 days after application
- ☒ 5. Do not apply more than 3 application(s) per season
- ☐ 6. Do not feed treated foliage or straw to livestock
- ☐ 7. Plantback restrictions (see label)
- ☒ 8. Other (see attachment)

16. I certify that alternatives and mitigation measures that would substantially lessen any significant adverse impact on the environment have been considered and, if feasible, adopted.

Adviser Signature: [signature] | Date: 30th January, 1997

Adviser License Number: AA03036

Employer: Aquatics Unlimited

Employers Address: 827 Arnold Dr. Suite 80 Martinez, CA 94553

N

W (See map attached)

(See notification attached

S

33-92 (Est/2-90)

TOTAL P

Section 6

NEMA In-Lake Herbicide Trials Approval

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

East African Development Bank Building 5th Floor,
4 Nile Avenue, P.O. Box 22255, Kampala, Uganda
Tel: 256-41-236817/251064/251065 251068
Fax: 256-41-257521/232680
E-Mail: nema@imul.com
E-Mail: nema@starcom.co.ug

NEMA/96/WH

8th January 1997

AQUATICS UNLIMITED
RECEIVED
09 JAN 1997
KAMPALA
WATER HYACINTH PROGRAM

The Permanent Secretary,
Ministry of Agriculture, Animal Industry and Fisheries,
P.O. Box 102,
Entebbe

IN-LAKE HERBICIDE TRIALS FOR EIA ON WATER HYACINTH CONTROL PROGRAMME

Reference is made to your letter Ref. C/MIN/411 dated 6th January, 1997 submitting the names of the Ugandan scientists who are going to participate in the in-lake herbicide trials.

NEMA is pleased to note that the conditions which were set for the in-lake herbicide trials to begin have now been fulfilled, and these included:

(i) **the scope of the work**: in a letter to NEMA dated 6th November, 1996 from Dr. Thomas MacNabb, and in the revised In-lake herbicide trials design dated 3rd December 1996, Aquatics Unlimited indicated their acceptance to include biological/biodiversity parameters in the assessment, including sampling of fish and other benthos in the sediments, as well as other macrofaunas besides other parameters such as water quality; and

(ii) **involvement and inclusion of Ugandan Scientists** in the in-lake herbicide trials exercise. In our earlier communication to you dated 9th December, 1996, NEMA required the inclusion of the following scientists in the team, namely, **Dr. T. Twongo** of FIRI for analysis of chemical residues in fish, **Dr. Y. Kizito** of Zoology Department, Makerere University for plankton analysis and, **Mr. Vivian Matagi** for water quality analysis. Other Ugandan Scientists to participate in this exercise are as indicated in your communication of 6th January, 1997 referred to above.

I however wish to emphasize that these scientists are expected to be facilitated to be able to participate fully at all stages and steps of the in-lake herbicide trials exercise, and to be able to execute their assigned tasks satisfactorily.

I also wish to reiterate that the in-lake herbicide trials to be conducted at Wazimenya Bay are part of the process to complete an Environmental Impact Assessment (EIA) process that started with laboratory tests at Kitusa and pond trials at Kajansi. The EIA is required by law before

a decision is made whether or not to approve the use of the chemicals under trial as part of the water hyacinth control programme.

The findings of the in-lake herbicide trials shall therefore be incorporated into the Environmental Impact Statement being prepared by Aquatics Unlimited. This Environmental Impact Statement, when finalized, shall be a public document and shall be subjected to a public hearing and review by all interested parties.

As part of the process, NEMA also expects that public awareness campaigns to inform people on the precautionary measures to be taken during the trials shall continue throughout the process of in-lake herbicide trials.

As indicated in our letter of even ref. dated 9th December, 1996, NEMA brings to your attention the involvement of another Ugandan scientist, Dr. Francis Ejobi of Faculty of Veterinary Medicine, Makerere University, who will be undertaking independent toxicological analysis on fish as part of his PhD research programme. Dr. Ejobi will finance his research work.

Lastly, in view of the above, and by virtue of the powers conferred upon the Authority under Sections 7 (1) (f) and 20 of the National Environment Statute, the execution of the in-lake herbicide trials at the above site is approved, subject to the in-lake herbicide trials design submitted to NEMA, other requirements of the Environmental Impact Assessment process and conditions thereto issued by NEMA.

Aryamanya Mugisha Henry
for: EXECUTIVE DIRECTOR

c.c. H.E. the Vice President and
Minister of Agriculture, Animal Industry & Fisheries
ENTEBBE.

" The Hon. Minister
Ministry of Natural Resources
KAMPALA.

" The Hon. Minister of State
Ministry of Natural Resources
KAMPALA.

" The Permanent Secretary
Ministry of Natural Resources
KAMPALA.

" The Solicitor General
Ministry of Justice
KAMPALA.

" The Senior Private Secretary to
Rt. Hon. Prime Minister
Prime Minister's office
KAMPALA.

" The Commissioner
Fisheries Department
Ministry of Agriculture, Animal Industry and Fisheries
ENTEBBE.

" **Mr Moorhouse**
Aquatics Unlimited
KAMPALA..

Section 7

Temporary Certificate of Registration of an Agricultural Chemical for Rodeo dated 14/10/96

FORM C

MINISTRY OF AGRIC.
P. O. BOX 102, ENTEBBE

THE CONTROL OF AGRICULTURAL CHEMICALS STATUTE, 1989

(regulation 11)

TEMPORARY CERTIFICATE OF REGISTRATION OF AN AGRICULTURAL CHEMICAL

NUMBER...UgC/00038/He/Tempo.

It is hereby certified that the agricultural chemical described herein has been temporarily registered under the control of Agricultural Chemicals Statute and Regulations made thereunder and is subject to conditions specified herein -

1. Approved common name.....GLYPHOSATE ISOPROPYLAMINE SALT.....

2. Trade name under which the chemical is traded in Uganda.....RODEO,S.L.....

(GLYPHOSATE 53.8%).....

3. Condition(s) under which agricultural chemical is registered.....TEMPORARY.....

REGISTRATION TO CONTROL WATER HYACINTH.....

.....

[either that-

(a) it is for the emergency control of infestation in.....LAKE VICTORIA..... area, or / and,

(b) it is for the carrying out of Laboratory tests, experiments and field tests .....

IN LAKE VICTORIA.....;or

(c) the applicant is required to produce technical information regarding the use for which chemical is to be used; or any other condition.]

4. Registration Number.....UgC/96/00038/He/Tempo.....

5. Registered in the name of P.S, MAAIF.....of (address) BOX 102,EBBTel.No.20805..

6. Date of Registration.....15th OCTOBER,1996.....

7. Certificate expires on 14/10/1997.(ONE YEAR)..... from the date of Registration.

Chairman,
Agricultural Chemicals Board.

Secretary,
Agricultural Chemicals Board.

This sample label is current as of February 15, 1995. The product descriptions and recommendations provided in this sample label are for background information only. Always refer to the label on the product before using Monsanto or any other agrichemical product.

RODEO®

EMERGED AQUATIC WEED AND BRUSH HERBICIDE

BY Monsanto

Complete Directions for Use in Aquatic and Other Noncrop Sites.

EPA Reg. No. 524-343

AVOID CONTACT WITH FOLIAGE, GREEN STEMS, EXPOSED NONWOODY ROOTS, OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, SINCE SEVERE INJURY OR DESTRUCTION MAY RESULT.

RODEO is a registered trademark of Monsanto Company

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Read the entire label before using this product.

Use only according to label instructions.

Read "LIMIT OF WARRANTY AND LIABILITY" before buying or using. If terms are not acceptable, return at once unopened.

REFORMULATION IS PROHIBITED. SEE INDIVIDUAL CONTAINER LABEL FOR REPACKAGING LIMITATIONS.

LIMIT OF WARRANTY AND LIABILITY

This Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY OR ANY OTHER EXPRESS OR IMPLIED WARRANTY IS MADE. This warranty is also subject to the conditions and limitations stated herein.

Buyer and all users shall promptly notify this Company of any claims, whether based in contract, negligence, strict liability, other tort or otherwise.

Buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, the state conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil or treated vegetation.

THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES, OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES.

Buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement.

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

Keep out of reach of children.

CAUTION!

HARMFUL IF INHALED.

Avoid breathing vapors or spray mist.

Remove contaminated clothing and wash clothing before reuse.

Wash thoroughly with soap and water after handling.

FIRST AID: IF INHALED, remove individual to fresh air. Seek medical attention if breathing difficulty develops.

In case of an emergency involving this product,
Call Collect, day or night, (314) 694-4000.

Environmental Hazards

Do not contaminate water when disposing of equipment wastewaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of SPILL or LEAK, soak up and remove to a landfill.

Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, aluminum, fiberglass, plastic and plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, ignited cigarette or other ignition source.

ACTIVE INGREDIENT:	
*Glyphosate (N-phosphonomethyl glycine) in the form of its isopropylamine salt	53.8%
INERT INGREDIENTS	46.2%
	100.0%

*Contains 648 grams per litre or 5.4 pounds per U.S. gallon of the active ingredient glyphosate in the form of its isopropylamine salt. Equivalent to 480 grams per litre or 4 pounds per U.S. gallon of the acid, glyphosate.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

For more product information, call toll-free 1-800-332-3111.

Storage and Disposal

Do not contaminate water, foodstuffs, feed or seed by storage or disposal.

See container label for STORAGE AND DISPOSAL instructions.

GENERAL INFORMATION

This product is a water-soluble liquid mixes readily with water and nonionic surfactant to be used as a foliar spray for the control or destruction of many herbaceous and woody plants.

This product moves through the plant from the point of foliage contact to and into the root system. Visible effects on most annual weeds occur within 2 to 4 days but on most perennial brush species may not occur for 7 days or more. Extreme cool or cloudy weather following treatment may slow the activity of this product and delay visual effects of control. Visible effects are a gradual wilting and yellowing of the plant which advances to complete browning of above-ground growth and deterioration of underground plant parts.

Unless otherwise directed on this label, delay application until vegetation has emerged and reached the stages described for control of such vegetation under the "Weeds Controlled" section of this label.

Unemerged plants arising from unattached underground rhizomes or root stocks of perennial brush will not be affected by the spray and will continue to grow. For this reason best control of most perennial weeds or brush is obtained when treatment is made at late growth stages approaching maturity.

Always use the higher rate of this product per acre within the recommended range when vegetation is heavy or dense.

Do not treat weeds or brush under poor growing conditions such as drought stress, disease or insect damage, as reduced control may result. Reduced results may also occur when treating weeds or brush heavily covered with dust.

Reduced control may result when applications are made to any weed or brush species that have been mowed, grazed or cut, and have not been allowed to regrow to the recommended stage for treatment.

Rainfall or irrigation occurring within 6 hours after application may reduce effectiveness. Heavy rainfall or irrigation within 2 hours after application may wash the product off the foliage and a repeat treatment may be required.

When this product comes in contact with soil (on the soil surface or as suspended soil or sediment in water) it is bound to soil particles. Under recommended use situations, once this product is bound to soil particles, it is not available for plant uptake and will not harm off-site vegetation where roots grow into the treatment area or if the soil is transported off-site. Under recommended use conditions, the strong affinity of this product to soil particles prevents this product from leaching out of the soil profile and entering ground water. The affinity between this product and soil particles remains until this product is degraded, which is primarily a biological degradation process carried out under both aerobic and anaerobic conditions by soil microflora.

This product does not provide residual weed control. For subsequent residual weed control, follow a label-approved herbicide program. Read and carefully observe the cautionary statements and all other information appearing on the labels of all herbicides used.

Buyer and all users are responsible for all loss or damage in connection with the use or handling of mixtures of this product or other materials that are not expressly recommended in this label. Mixing this product with pesticides or other materials not recommended in this label may result in reduced performance.

ATTENTION

AVOID DRIFT. EXTREME CARE MUST BE USED WHEN APPLYING THIS PRODUCT TO PREVENT INJURY TO DESIRABLE PLANTS AND CROPS.

Do not allow the herbicide solution to mist, drip, drift or splash onto desirable vegetation since minute quantities of this product can cause severe damage or destruction to the crop, plants or other areas on which treatment was not intended. The likelihood of plant or crop injury occurring from the use of this product is greatest when winds are gusty or in excess of 5 miles per hour or when other conditions, including lesser wind velocities, will allow spray drift to occur. When spraying, avoid combinations of pressure and nozzle type that will result in splatter or fine particles (mist) which are likely to drift. AVOID APPLYING AT EXCESSIVE SPEED OR PRESSURE.

NOTE: Use of this product in any manner not consistent with this label may result in injury to persons, animals or crops, or other unintended consequences. When not in use, keep container closed to prevent spills and contamination.

MIXING AND APPLICATION INSTRUCTIONS

APPLY THESE SPRAY SOLUTIONS IN PROPERLY MAINTAINED AND CALIBRATED EQUIPMENT CAPABLE OF DELIVERING DESIRED VOLUMES. HAND-GUN APPLICATIONS SHOULD BE PROPERLY DIRECTED TO AVOID SPRAYING DESIRABLE PLANTS. NOTE: REDUCED RESULTS MAY OCCUR IF WATER CONTAINING SOIL IS USED, such as WATER FROM PONDS AND UNLINED DITCHES.

MIXING

This product mixes readily with water. Mix spray solutions of this product as follows: fill the mixing or spray tank with the required amount of water while adding the required amount of this product (see "Directions for Use" and "Weeds Controlled" sections of this label). Near the end of the filling process add the required surfactant and mix well. Remove hose from tank immediately after filling to avoid siphoning back into the water source. During mixing and application, foaming of the spray solution may occur. To prevent or minimize foam, avoid the use of mechanical agitators; place the filling hose below the surface of the spray solution; terminate by-pass and return lines at the bottom of the tank and if needed use an approved anti-foam or defoaming agent.

Keep by-pass line on or near bottom of tank to minimize foaming. Screen size in nozzle or line strainers should be no finer than 50 mesh. Carefully select nozzle to avoid spraying a fine mist. For best results with conventional ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

When using this product, mix 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution. Use a nonionic surfactant labeled for use with herbicides. The surfactant must contain 50 percent or more active ingredient.

Always read and follow the manufacturer's surfactant label recommendations for best results.

These surfactants should not be used in excess of 1 quart per acre when making **broadcast** applications.

Colorants or marking dyes approved for use with herbicides may be added to spray mixtures of this product. Colorants or dyes used in spray solutions of this product may reduce performance, especially at lower rates or dilutions. Use colorants or dyes according to the manufacturer's label recommendations.

Clean sprayer and parts immediately after using this product by thoroughly flushing with water and dispose of rinsate according to labeled use or disposal instructions.

Carefully observe all cautionary statements and other information appearing in the surfactant label.

APPLICATION EQUIPMENT AND TECHNIQUES

AERIAL EQUIPMENT

See the supplemental label for use of this product by air in California.

Use the recommended rates of this product and surfactant in 3 to 20 gallons of water per acre as a broadcast spray, unless otherwise specified. See the "Weeds Controlled" section of this label for specific rates. Aerial applications of this product may only be made as specifically recommended in this label.

AVOID DRIFT — DO NOT APPLY DURING INVERSION CONDITIONS, WHEN WINDS ARE GUSTY OR UNDER ANY OTHER CONDITION WHICH WILL ALLOW DRIFT. DRIFT MAY CAUSE DAMAGE TO ANY VEGETATION CONTACTED TO WHICH TREATMENT IS NOT INTENDED. TO PREVENT INJURY TO ADJACENT DESIRABLE VEGETATION, APPROPRIATE BUFFER ZONES MUST BE MAINTAINED.

Coarse sprays are less likely to drift, therefore, do not use nozzles or nozzle configurations which dispense spray as fine spray droplets. Do not angle nozzles forward into the airstream and do not increase spray volume by increasing nozzle pressure.

Drift control additives may be used. When a drift control additive is used, read and carefully observe the cautionary statements and all other information appearing in the additive label.

Ensure uniform application—To avoid streaked, uneven or overlapped application, use appropriate marking devices.

Thoroughly wash aircraft, especially landing gear, after each day of spraying to remove residues of this product accumulated during spraying or from spills. PROLONGED EXPOSURE OF THIS PRODUCT TO UNCOATED STEEL SURFACES MAY RESULT IN CORROSION AND POSSIBLE FAILURE OF THE PART. LANDING GEAR ARE MOST SUSCEPTIBLE. The maintenance of an organic coating (paint) which meets aerospace specification MIL-C-38413 may prevent corrosion.

BOOM EQUIPMENT

For control of weed or brush species listed in this label using conventional boom equipment—Use the recommended rates of this product and surfactant in 3 to 50 gallons of water per acre as a broadcast spray, unless otherwise specified. See the "Weeds Controlled" section of this label for specific rates. As density of vegetation increases, spray volume should be increased within the recommended range to ensure complete coverage. Carefully select correct nozzle to avoid spraying a fine mist. For best results with ground application equipment, use flat fan nozzles. Check for even distribution of spray droplets.

HAND-HELD and HIGH-VOLUME EQUIPMENT

Use Coarse Sprays Only

For control of weeds listed in this label using knapsack sprayers or high-volume spraying equipment utilizing handguns or other suitable nozzle arrangements—Prepare a 3/4 to 2 percent solution of this product in water, add a nonionic surfactant and apply to foliage of vegetation to be controlled. For specific rates of application and instructions for control of various annual and perennial weeds, see the "Weeds Controlled" section in this label.

Applications should be made on a spray-to-wet basis. Spray coverage should be uniform and complete. Do not spray to point of runoff.

This product may be used as a 5 to 8 percent solution for low-volume directed sprays for spot treatment of trees and brush. It is most effective in areas where there is a low density of undesirable trees or brush. If a straight stream nozzle is used, start the application at the top of the targeted vegetation and spray from top to bottom in a lateral zig-zag motion. Ensure that at least 50 percent of the leaves are contacted by the spray solution. For flat fan and cone nozzles and with hand-directed mist blowers, mist the application over the foliage of the targeted vegetation. Small, open-branched trees need only be treated from one side if the foliage is thick or there are multiple root sprouts, applications must be made from several sides to ensure adequate spray coverage.

Prepare the desired volume of spray solution by mixing the amount of this product in water, shown in the following table

Spray Solution

	AMOUNT OF ROUNDUP					
DESIRED VOLUME	3.4%	1%	1.5%	1.5%	5%	8%
1 gallon	1 oz.	1 oz.	1 oz.	2 oz.	6 oz.	10 oz.
25 gallons	1 pt.	1 qt.	1 qt.	1 qt.	5 qt.	2 gal.
100 gallons	3 qt.	1 gal.	1 gal.	1½ gal.	5 gal.	8 gal.

2 tablespoons = 1 ounce

For use in knapsack sprayers, it is suggested that the recommended amount of this product be mixed with water in a larger container. Fill sprayer with the mixed solution and add the correct amount of surfactant.

WEEDS CONTROLLED

ANNUAL WEEDS

Apply to actively growing annual grasses and broadleaf weeds.

Allow at least 3 days after application before disturbing treated vegetation. After this period the weeds may be mowed, tilled or burned. See "Directions for Use," "General Information" and "Mixing and Application Instructions" for labeled uses and specific application instructions.

Broadcast Application—Use 1 1/2 pints of this product per acre plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution if weeds are less than 6 inches tall. If weeds are greater than 6 inches tall, use 2 1/2 pints of this product per acre plus 2 or more quarts of an approved nonionic surfactant per 100 gallons of spray solution.

Hand-Held, High-Volume Application—Use a 3/4 percent solution of this product in water plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution and apply to foliage of vegetation to be controlled.

When applied as directed under the conditions described in this label, this product plus nonionic surfactant WILL CONTROL the following ANNUAL WEEDS:

Balsamapple**
Momordica charantia

Barley
Hordeum vulgare

Barnyardgrass
Echinochloa crus-galli

Bassia, fivehook
Bassia hyssopifolia

Bluegrass, annual
Poa annua

Bluegrass, bulbous
Poa bulbosa

Brome
Bromus spp.

Buttercup
Ranunculus spp.

Cheat
Bromus secalinus

Chickweed, mouseear
Cerastium vulgatum

Cocklebur
Xanthium strumarium

Corn, volunteer
Zea mays

Crabgrass
Digitaria spp.

Dwarfdandelion
Krigia cespitosa

Falseflax, smallseed
Camelina microcarpa

Fiddleneck
Amsinckia spp.

Flaxleaf fleabane
Conyza bonariensis

Fleacane
Erigeron spp.

Foxtail
Setaria spp.

Foxtail, Carolina
Alopecurus carolinianus

Groundsel, common
Senecio vulgaris

Horseweed/Marestail
Conyza canadensis

Kochia
Kochia scoparia

Lambsquarters, common
Chenopodium album

Lettuce, prickly
Lactuca serriola

Morningglory
Ipomoea spp.

Mustard, blue
Chorispora tenella

Mustard, tansy
Descurainia pinnata

Mustard, tumble
Sisymbrium altissimum

Mustard, wild
Sinapis arvensis

Oats, wild
Avena fatua

Panicum
Panicum spp.

Pennycress, field
Thlaspi arvense

Pigweed, redroot
Amaranthus retroflexus

Pigweed, smooth
Amaranthus hybridus

Ragweed, common
Ambrosia artemisiifolia

Ragweed, giant
Ambrosia trifida

Rocket, London
Sisymbrium irio

Rye
Secale cereale

Ryegrass, Italian*
Lolium multiflorum

Sandbur, field
Cenchrus spp.

Shattercane
Sorghum bicolor

Shepherdspurse
Capsella bursa-pastoris

Signalgrass, broadleaf
Brachiaria platyphylla

Smartweed, Pennsylvania
Polygonum pensylvanicum

Sowthistle, annual
Sonchus oleraceus

Spanishneedles*
Bidens bipinnata

Stinkgrass
Eragrostis cilianensis

Sunflower
Helianthus annuus

Thistle, Russian
Salsola kali

Spurry, umbrella
Holosteum umbellatum

Velvetleaf
Abutilon theophrasti

Wheat
Triticum aestivum

Witchgrass
Panicum capillare

*Apply 3 pints of this product per acre.

**Apply with hand-held equipment only.

Annual weeds will generally continue to germinate from seed throughout the growing season. Repeat treatments will be necessary to control later germinating weeds.

PERENNIAL WEEDS

Apply this product as follows to control or destroy most vigorously growing perennial weeds. Unless otherwise directed, allow at least 7 days after application before disturbing vegetation.

Add 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution to the rates of this product given in this list. See the "General Information," "Directions for Use" and "Mixing and Application" sections in this label for specific uses and application instructions.

NOTE: If weeds have been mowed or tilled, do not treat until regrowth has reached the recommended stages. Fall treatments must be applied before a killing frost.

Repeat treatments may be necessary to control weeds regenerating from underground parts or seed.

When applied as recommended under the conditions described, this product plus surfactant WILL CONTROL the following PERENNIAL WEEDS:

Alfalfa
Medicago sativa

Alligatorweed*
Alternanthera philoxeroides

Anise/Fennel
Foeniculum vulgare

Artichoke, Jerusalem
Helianthus tuberosus

Bahiagrass
Paspalum notatum

Bermudagrass
Cynodon dactylon

Bindweed, field
Convolvulus arvensis

Bluegrass, Kentucky
Poa pratensis

Blueweed, Texas
Helianthus ciliaris

Brackenfern
Pteridium spp.

Bromegrass, smooth
Bromus inermis

Canarygrass, reed
Phalaris arundinacea

Cattail
Typha spp.

Clover, red
Trifolium pratense

Clover, white
Trifolium repens

Cogongrass
Imperata cylindrica

Cordgrass
Spartina spp.

Cutgrass, giant*
Zizaniopsis miliacea

Dallisgrass
Paspalum dilatatum

Dandelion
Taraxacum officinale

Dock, curly
Rumex crispus

Dogbane, hemp
Apocynum cannabinum

Fescue
Festuca spp.

Fescue, tall
Festuca arundinacea

Guineagrass
Panicum maximum

Hemlock, poison
Conium maculatum

Horsenettle
Solanum carolinense

Horseradish
Armoracia rusticana

Ice Plant
Mesembryanthemum crystallinum

Johnsongrass
Sorghum halepense

Kikuyugrass
Pennisetum clandestinum

Knapweed
Centaurea repens

Lantana
Lantana camara

Lespedeza: common, serices
Lespedeza striata
Lespedeza cuneata

Loosestrife, purple
Lythrum salicaria

Lotus, American
Nelumbo lutea

Maidencane
Panicum hematomon

Milkweed
Asclepias spp

Muhly, wirestem
Muhlenbergia frondosa

Mullein, common
Verbascum thapsus

Napiergrass
Pennisetum purpureum

Nightshade, silverleaf
Solanum elaeagnifolium

Nutsedge: purple, yellow
Cyperus rotundus
Cyperus esculentus

Orchardgrass
Dactylis glomerata

Pampasgrass
Cortaderia jubata

Paragrass
Brachiaria mutica

Phragmites**
Phragmites spp

Quackgrass
Agropyron repens

Reed, giant
Arundo donax

Ryegrass, perennial
Lolium perenne

Smartweed, swamp
Polygonum coccineum

Spatterdock
Nuphar luteum

Starthistle, yellow
Centaurea solstitialis

Sweet potato, wild*
Ipomoea pandurata

Thistle, artichoke
Cynara cardunculus

Thistle, Canada
Cirsium arvense

Timothy
Phleum pratense

Torpedograss*
Panicum repens

Tules, common
Scirpus acutus

Vaseygrass
Paspalum urvillei

Velvetgrass
Holcus spp

Waterhyacinth
Eichornia crassipes

Waterlettuce
Pistia stratiotes

Waterprimrose
Ludwigia spp

Wheatgrass, western
Agropyron smithii

*Partial control

**Partial control in southeastern states. See specific recommendations below.

Alligatorweed—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/4 percent solution with hand-held equipment to provide partial control of alligatorweed. Apply when most of the target plants are in bloom. Repeat applications will be required to maintain such control.

Bermudagrass—Apply 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and when seed heads appear.

Bindweed, field/Silverleaf Nightshade/Texas Blueweed—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray west of the Mississippi River and 4 1/2 to 6 pints of this product per acre east of the Mississippi River. With hand-held equipment, use a 1 1/2 percent solution. Apply when target plants are actively growing and are at or beyond full bloom. For silverleaf nightshade best results can be obtained when application is made after berries are formed. Do not treat when weeds are under drought stress. New leaf development indicates active growth. For best results apply in late summer or fall.

Brackenfern—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 to 1 percent solution with hand-held equipment. Apply to fully expanded fronds which are at least 18 inches long.

Cattail—Apply 4 1/2 to 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and are at or beyond the early to full bloom stage of growth. Best results are achieved when application is made during the summer or fall months.

Cogongrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray. Apply when cogongrass is at least 18 inches tall and actively growing in late summer or fall. Allow 7 or more days after application before tillage or mowing. Due to uneven stages of growth and the dense nature of vegetation preventing good spray coverage, repeat treatments may be necessary to maintain control.

Cordgrass—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 2 percent solution with hand-held equipment. Schedule applications in order to allow 6 hours before treated plants are covered by tidewater. The presence of debris and silt on the cordgrass plants will reduce performance. It may be necessary to wash targeted plants prior to application to improve uptake of this product into the plant.

Cutgrass, giant—Apply 6 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment to provide partial control of giant cutgrass. Repeat applications will be required to maintain such control, especially where vegetation is partially submerged in water. Allow for substantial regrowth to the 7 to 10 leaf stage prior to retreatment.

Dogbane, hemp/Knapweed/Horseradish—Apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud to flower stage of growth. For best results, apply in late summer or fall.

Fescue, tall—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot to head stage of growth. When applied prior to the boot stage, less desirable control may be obtained.

Guineagrass—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and when most have reached at least the 7-leaf stage of growth.

Johnsongrass/Bluegrass, Kentucky/Bromegrass, smooth/Canarygrass, reed/Orchardgrass/Ryegrass, perennial/Timothy/Wheatgrass, western—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the boot to head stage of growth. When applied prior to the boot stage, less desirable control may be obtained. In the fall, apply before plants have turned brown.

Lantana—Apply this product as a 3/4 to 1 percent solution with hand-held equipment. Apply to actively growing lantana at or beyond the bloom stage of growth. Use the higher application rate for plants that have reached the woody stage of growth.

Loosestrife, purple—Apply 4 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution using hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost.

Lotus, American—Apply 4 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treat when plants are actively growing at or beyond the bloom stage of growth. Best results are achieved when application is made during summer or fall months. Fall treatments must be applied before a killing frost. Repeat treatment may be necessary to control regrowth from underground parts and seeds.

Maidencane/Paragrass—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Repeat treatments will be required, especially to vegetation partially submerged in water. Under these conditions, allow for regrowth to the 7 to 10-leaf stage prior to retreatment.

Milkweed, common—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached the late bud-to-flower stage of growth.

Nutsedge: purple, yellow—Apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment to control existing nutsedge plants and immature nutlets attached to treated plants. Apply when target plants are in flower or when new nutlets can be found at the zone tips. Nutlets which have not germinated will not be controlled and may germinate following treatment. Repeat treatments will be required for long-term control.

Pampasgrass—Apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing.

Phragmites—For partial control of phragmites in Florida and the counties of other states bordering the Gulf of Mexico, apply 7 1/2 pints per acre as a broadcast spray or apply a 1 1/2 percent solution with hand-held equipment. In other areas of the U.S., apply 4 1/2 to 6 pints per acre as a broadcast spray or apply a 3/4 percent solution with hand-held equipment for partial control. For best results, treat during late summer or fall months when plants are actively growing and in full bloom. Due to the dense nature of the vegetation, which may prevent good spray coverage and uneven stages of growth, repeat treatments may be necessary to maintain control. Visual control symptoms will be slow to develop.

Quackgrass/Kikuyugrass/Muhly, wirestem—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment when most quackgrass or wirestem muhly is at least 8 inches in height (3 to 4 leaf stage of growth) and actively growing. Allow 3 or more days after application before tillage.

Wiper applications can be used to control or suppress annual and perennial weeds listed on this label. In heavy weed stands, a double application in opposite directions may improve results. See the "Weeds Controlled" section in this label for recommended timing, growth stage and other instructions for achieving optimum results.

CUT STUMP APPLICATION

Woody vegetation may be controlled by treating freshly cut stumps of trees and resprouts with this product. Apply this product using suitable equipment to ensure coverage of the entire cambium. Cut vegetation close to the soil surface. **Apply a 50 to 100 percent solution of this product to freshly cut surface immediately after cutting.** Delay in applying this product may result in reduced performance. For best results, trees should be cut during periods of active growth and full leaf expansion.

When used according to directions for cut stump application, this product will CONTROL, PARTIALLY CONTROL or SUPPRESS most woody brush and tree species, some of which are listed below.

Alder *Alnus spp.*	**Poplar*** *Populus spp.*
Coyote brush* *Baccharis consanguinea*	**Reed, giant** *Arundo donax*
Dogwood* *Cornus spp.*	**Salt cedar** *Tamarix spp.*
Eucalyptus *Eucalyptus spp.*	**Sweet gum*** *Liquidambar styraciflua*
Hickory* *Carya spp.*	**Sycamore*** *Platanus occidentalis*
Madrone *Arbutus menziesii*	**Tan oak** *Lithocarpus densiflorus*
Maple* *Acer spp.*	**Willow** *Salix spp.*
Oak *Quercus spp.*	

*This product is not approved for this use on these species in the state of California.

INJECTION AND FRILL APPLICATIONS

Woody vegetation may be controlled by injection or frill application of this product. Apply this product using suitable equipment which must penetrate into living tissue. Apply the equivalent of 1 ml of this product per 2 to 3 inches of trunk diameter. This is best achieved by applying 25 to 100 percent concentration of this product either to a continuous frill around the tree or as cuts evenly spaced around the tree below all branches. As tree diameter increases in size, better results are achieved by applying dilute material to a continuous frill or more closely spaced cuttings. Avoid application techniques that allow runoff to occur from frill or cut areas in species that exude sap freely after frills or cutting. In species such as these, make frill or cut at an oblique angle so as to produce a cupping effect and use undiluted material. For best results, applications should be made during periods of active growth and full leaf expansion.

This treatment WILL CONTROL the following woody species:

Oak *Quercus spp.*	**Sweet gum** *Liquidambar styraciflua*
Poplar *Populus spp.*	**Sycamore** *Platanus occidentalis*

This treatment WILL SUPPRESS the following woody species:

Black gum* *Nyssa sylvatica*	**Hickory** *Carya spp.*
Dogwood *Cornus spp.*	**Maple, red** *Acer rubrum*

*This product is not approved for this use on this species in the state of California.

RELEASE OF BERMUDAGRASS OR BAHIAGRASS ON NONCROP SITES

RELEASE OF DORMANT BERMUDAGRASS AND BAHIAGRASS

When applied as directed, this product will provide control or suppression of many winter annual weeds and tall fescue for effective release of dormant bermudagrass or bahiagrass. Make applications to dormant bermudagrass or bahiagrass.

For best results on winter annuals, treat when weeds are in an early growth stage (below 6 inches in height) after most have germinated. For best results on tall fescue, treat when fescue is in or beyond the 4 to 6 leaf stage.

Rate recommendations for control or suppression of winter annuals and tall fescue are listed below.

Apply the recommended rates of this product in 10 to 25 gallons of water per acre plus 2 quarts nonionic surfactant per 100 gallons of total spray volume.

WEEDS CONTROLLED OR SUPPRESSED*

NOTE: C = Control
S = Suppression

WEED SPECIES	RODEO FLUID OZ/ACRE 6	9	12	18	24	48
Barley, little *Hordeum pusillum*	S	C	C	C	C	C
Bedstraw, catchweed *Galium aparine*	S	C	C	C	C	C
Bluegrass, annual *Poa annua*	S	C	C	C	C	C
Chervil *Chaerophyllum tainturieri*	S	C	C	C	C	C
Chickweed, common *Stellaria media*	S	C	C	C	C	C
Clover, crimson *Trifolium incarnatum*	•	S	S	C	C	C
Clover, large hop *Trifolium campestre*	•	S	S	C	C	C
Speedwell, corn *Veronica arvensis*	S	C	C	C	C	C
Fescue, tall *Festuca arundinacea*	•	•	•	•	S	S
Geranium, Carolina *Geranium carolinianum*	•	•	S	S	C	C
Henbit *Lamium amplexicaule*	•	S	C	C	C	C
Ryegrass, Italian *Lolium multiflorum*	•	•	S	C	C	C
Vetch, common *Vicia sativa*	•	•	S	C	C	C

*These rates apply only to sites where an established competitive turf is present.

RELEASE OF ACTIVELY GROWING BERMUDAGRASS

NOTE: USE ONLY ON SITES WHERE BAHIAGRASS OR BERMUDAGRASS ARE DESIRED FOR GROUND COVER AND SOME TEMPORARY INJURY OR YELLOWING OF THE GRASSES CAN BE TOLERATED.

When applied as directed, this product will aid in the release of bermudagrass by providing control of annual species listed in the "Weeds Controlled" section in this label, and suppression or partial control of certain perennial weeds.

For control or suppression of those annual species listed in this label, use 3/4 to 2 1/4 pints of this product as a broadcast spray in 10 to 25 gallons of spray solution per acre, plus 2 quarts of a nonionic surfactant per 100 gallons of total spray volume. Use the lower rate when treating annual weeds below 6 inches in height (or length of runner on annual grass). Use the higher rate as size of plants increases or as they approach flower or seedhead formation.

Use the higher rate for partial control or longer term suppression of the following perennial species. Use lower rates for shorter term suppression of growth.

Bahiagrass	Johnsongrass**
Dallisgrass	Trumpet creeper**
Fescue (tall)	Vaseygrass

*Suppression at the higher rate only.
**Johnsongrass is controlled at the higher rate.

Use only on well-established bermudagrass. Bermudagrass injury may result from the treatment but regrowth will occur under moist conditions. Repeat applications in the same season are not recommended, since severe injury may result.

BAHIAGRASS SEEDHEAD AND VEGETATIVE SUPPRESSION

When applied as directed in the "Noncrop Sites" section in this label, this product will provide significant inhibition of seedhead emergence and will suppress vegetative growth for a period of approximately 45 days with single applications and approximately 120 days with sequential applications.

Reed, giant/ice plant—For control of giant reed and ice plant, apply a 1 1/2 percent solution of this product with hand-held equipment when plants are actively growing. For giant reed, best results are obtained when applications are made in late summer to fall.

Spatterdock—Apply 6 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Apply when most plants are in full bloom. For best results, apply during the summer or fall months.

Sweet potato, wild—Apply this product as a 1 1/2 percent solution using hand-held equipment. Apply to actively growing weeds that are at or beyond the bloom stage of growth. Repeat applications will be required. Allow the plant to reach the recommended stage of growth before retreatment.

Thistle: Canada, artichoke—Apply 3 to 4 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment for Canada thistle. To control artichoke thistle, apply a 2 percent solution as a spray-to-wet application. Apply when target plants are actively growing and are at or beyond the bud stage of growth.

Torpedograss—Apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment to provide partial control of torpedograss. Use the lower rates under terrestrial conditions, and the higher rates under partially submerged or a floating mat condition. Repeat treatments will be required to maintain such control.

Tules, common—Apply this product as a 1 1/2 percent solution with hand-held equipment. Apply to actively growing plants at or beyond the seedhead stage of growth. After application, visual symptoms will be slow to appear and may not occur for 3 or more weeks.

Waterhyacinth—Apply 5 to 6 pints of this product per acre as a broadcast spray or apply a 3/4 to 1 percent solution with hand-held equipment. Apply when target plants are actively growing and at or beyond the early bloom stage of growth. After application, visual symptoms may require 3 or more weeks to appear with complete necrosis and decomposition usually occurring within 60 to 90 days. Use the higher rates when more rapid visual effects are desired.

Waterlettuce—For control, apply a 3/4 to 1 percent solution of this product with hand-held equipment to actively growing plants. Use higher rates where infestations are heavy. Best results are obtained from mid-summer through winter applications. Spring applications may require retreatment.

Waterprimrose—Apply this product as a 3/4 percent solution using hand-held equipment. Apply to plants that are actively growing at or beyond the bloom stage of growth, but before fall color changes occur. Thorough coverage is necessary for best control.

Other perennials listed on this label—Apply 4 1/2 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment. Apply when target plants are actively growing and most have reached early head or early bud stage of growth.

WOODY BRUSH AND TREES

When applied as recommended under the conditions described, this product plus surfactant CONTROLS or PARTIALLY CONTROLS the following woody brush plants and trees:

Alder
Alnus spp

Ash*
Fraxinus spp

Aspen, quaking
Populus tremuloides

Bearclover, Bearmat
Chamaebatia foliolosa

Birch
Betula spp

Blackberry
Rubus spp

Broom:
French
Cytisus monspessulanus
Scotch
Cytisus scoparius

Buckwheat, California*
Eriogonum fasciculatum

Cascara*
Rhamnus purshiana

Catsclaw*
Acacia greggii

Ceanothus
Ceanothus spp

Chamise
Adenostoma fasciculatum

Cherry:
Bitter
Prunus emarginata
Black
Prunus serotina
Pin
Prunus pensylvanica

Coyote brush
Baccharis consanguinea

Creeper, Virginia*
Parthenocissus quinquefolia

Dewberry
Rubus trivialis

Dogwood
Cornus spp

Elderberry
Sambucus spp

Elm*
Ulmus spp

Eucalyptus, bluegum
Eucalyptus globulus

Hasardia*
Haplopappus squamosus

Hawthorn
Crataegus spp

Hazel
Corylus spp

Hickory
Carya spp

Holly, Florida; Brazilian Peppertree
Schinus terebinthifolius

Honeysuckle
Lonicera spp

Hornbeam, American
Carpinus caroliniana

Kudzu
Pueraria lobata

Locust, black*
Robinia pseudoacacia

Manzanita
Arctostaphylos spp

Maple:
Red**
Acer rubrum
Sugar
Acer saccharum
Vine*
Acer circinatum

Monkey Flower*
Mimulus guttatus

Oak:
Black*
Quercus velutina
Northern pine
Quercus palustris
Post
Quercus stellata
Red
Quercus rubra
Southern red
Quercus falcata
White*
Quercus alba

Persimmon*
Diospyros spp

Poison Ivy
Rhus radicans

Poison Oak
Rhus toxicodendron

Poplar, yellow*
Liriodendron tulipifera

Prunus
Prunus spp

Raspberry
Rubus spp

Redbud, eastern
Cercis canadensis

Rose, multiflora
Rosa multiflora

Russian-olive
Elaeagnus angustifolia

Sage: black, white
Salvia spp

Sagebrush, California
Artemisia californica

Salmonberry
Rubus spectabilis

Salt cedar*
Tamarix spp

Saltbush, Sea myrtle
Baccharis halimifolia

Sassafras
Sassafras arbidum

Sourwood*
Oxydendrum arboreum

Sumac:
Poison*
Rhus vernix
Smooth*
Rhus glabra
Winged*
Rhus copallina

Sweet gum
Liquidambar styraciflua

Swordfern*
Polystichum munitum

Tallowtree, Chinese
Sapium sebiferum

Thimbleberry
Rubus parviflorus

Tobacco, tree*
Nicotiana glauca

Trumpetcreeper
Campsis radicans

Waxmyrtle, southern*
Myrica cerifera

Willow
Salix spp

*Partial control

**See below for control or partial control instruction

NOTE: If brush has been mowed or trees have been cut, do not treat until regrowth has reached the recommended stage of growth.

Apply the recommended rate of this product plus 2 or more quarts of a nonionic surfactant per 100 gallons of spray solution when plants are actively growing and, unless otherwise directed, after full leaf expansion. Use the higher rate for larger plants and or dense areas of growth. On mature brush use the higher rate for plants that have reached the woody stage of growth. Best results are obtained when application is made in late summer or fall after fruit formation.

In grid areas, best results are obtained when application is made in the spring or early summer when brush species are at high moisture content and are flowering. Ensure thorough coverage when using hand-held equipment. Symptoms may not appear prior to frost or senescence with fall treatments.

Allow 7 or more days after application before tillage, mowing or removal. Repeat treatments may be necessary to control plants regenerating from underground parts or seed. Some autumn colors on undesirable deciduous species are acceptable provided no major leaf drop has occurred. Reduced performance may result if fall treatments are made following a frost.

See the "Directions for Use" and "Mixing and Application Instructions" sections in this label for labeled use and specific application instructions.

Applied as a 5 to 8 percent solution as a directed application as described in the "HAND-HELD AND HIGH-VOLUME EQUIPMENT" section, this product will control or partially control all species listed in this section of this label. Use the higher rate of application for dense stands and larger woody brush and trees.

Apply the product as follows to control or partially control the following woody brush and trees

Alder/Blackberry/Dewberry/Honeysuckle/Oak, Post/Raspberry—For control apply 4 1/2 to 6 pints per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment

Aspen, Quaking/Hawthorn/Trumpetcreeper—For control, apply 3 to 4 1/4 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/4 percent solution with hand-held equipment

Birch/Elderberry/Hazel/Salmonberry/Thimbleberry—For control apply 3 pints per acre of this product as a broadcast spray or as a 3/4 percent solution with hand-held equipment

Broom: French, Scotch—For control apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment

Buckwheat, California/Hasardia/Monkey Flower/ Tobacco, Tree—For partial control of these species, apply a 3/4 to 1 1/2 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results

Catsclaw—For partial control, apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed

Cherry: Bitter, Black, Pin/Oak, Southern Red/Sweet Gum/Prunus—For control apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 to 1 1/2 percent solution with hand-held equipment

Coyote brush—For control apply a 1 1/4 to 1 1/2 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed

Dogwood/Hickory/Salt cedar—For partial control apply a 1 to 2 percent solution of this product with hand-held equipment or 6 to 7 1/2 pints per acre as a broadcast spray

Eucalyptus, bluegum—For control of eucalyptus resprouts apply a 1 1/2 percent solution of this product with hand-held equipment when resprouts are 6 to 12-feet tall. Ensure complete coverage. Apply when plants are actively growing. Avoid application to drought-stressed plants

Holly, Florida/Waxmyrtle, southern—For partial control, apply this product as a 1 1/2 percent solution with hand-held equipment

Kudzu—For control apply 6 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications will be required to maintain control

Maple, Red—For control, apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when leaves are fully developed. For partial control, apply 2 to 7 1/2 pints of this product per acre as a broadcast spray

Maple, Sugar/Oak: Northern Pin, Red—For control apply as a 3/4 to 1 1/4 percent solution with hand-held equipment when at least 50 percent of the new leaves are fully developed

Poison Ivy/Poison Oak—For control apply 6 to 7 1/2 pints of this product per acre as a broadcast spray or as a 1 1/2 percent solution with hand-held equipment. Repeat applications may be required to maintain control. Fall treatments must be applied before leaves lose green color

Rose, multiflora—For control apply 3 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment. Treatments should be made prior to leaf deterioration by leaf-feeding insects

Sage, black/Sagebrush, California/Chamise/Tallowtree, Chinese—For control of these species apply a 3/4 percent solution of this product as a foliar spray with hand-held equipment. Thorough coverage of foliage is necessary for best results

Saltbush, Sea myrtle—For control apply this product as a 1 percent solution with hand-held equipment

Willow—For control apply 4 1/2 pints of this product per acre as a broadcast spray or as a 3/4 percent solution with hand-held equipment

Other woody brush and trees listed in this label—For partial control apply 3 to 7 1/2 pints of this product per acre as a broadcast spray or as a 3/4 to 1 1/2 percent solution with hand-held equipment

AQUATIC AND OTHER NONCROP SITES

When applied as directed and under the conditions described in the "Weeds Controlled" section in this label, this product will control or partially control the labeled weeds growing in the following industrial, recreational and public areas or other similar aquatic and terrestrial sites

Aquatic Sites—This product may be applied to emerged weeds in all bodies of fresh and brackish water which may be flowing, nonflowing or transient. This includes lakes, rivers, streams, ponds, estuaries, rice levees, seeps, irrigation and drainage ditches, canals, reservoirs, wastewater treatment facilities, wildlife habitat restoration and management areas, and similar sites

If aquatic sites are present in the noncrop area and are part of the intended treatment, read and observe the following directions

This product does not control plants which are completely submerged or have a majority of their foliage under water.

There is no restriction on the use of treated water for irrigation, recreation or domestic purposes

Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water

NOTE: Do not apply this product within 1/2 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application. The water intake may be turned on prior to 48 hours if the glyphosate level in the intake water is below 0.7 part per million as determined by laboratory analysis. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications

For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds

Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 6 hours of application. Do not re-treat within 24 hours following the initial treatment

Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. The maximum application rate of 7 1/2 pints per acre must not be exceeded in any single broadcast application that is being made over water

When emerged infestations require treatment of the total surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in fish kill

Other Noncrop-Type Sites—This product may be used to control the listed weeds in terrestrial noncrop sites and/or in aquatic sites within these areas

Airports	Petroleum Tank Farms
Golf Courses	Pipeline, Power, Telephone & Utility Rights-of-Way
Habitat Restoration & Management Areas	Pumping Installations
Highways & Roadsides	Railroads
Industrial Plant Sites	Schools
Lumberyards	Storage Areas
Parking Areas	Similar Sites
Parks	

WILDLIFE HABITAT RESTORATION AND MANAGEMENT AREAS

This product is recommended for the restoration and or maintenance of native habitat and in wildlife management areas

Habitat Restoration and Maintenance—When applied as directed, exotic and other undesirable vegetation may be controlled in habitat management areas. Applications may be made to allow recovery of native plant species, to open up water to attract waterfowl and for similar broad spectrum vegetation control requirements in habitat management areas. Spot treatments may be made to selectively remove unwanted plants for habitat enhancement. For spot treatments, care should be exercised to keep spray off of desirable plants

Wildlife Food Plots—This product may be used as a site preparation treatment prior to planting wildlife food plots. Apply as directed to control vegetation in the plot area. Any wildlife food species may be planted after applying this product, or native species may be allowed to reinfest the area. If tillage is needed to prepare a seedbed, wait 7 days after applying this product before tilling to allow for maximum effectiveness

WIPER APPLICATIONS

For wick or wiper applications, mix 1 gallon of this product with 2 gallons of clean water to make a 33 percent solution. Addition of a nonionic surfactant at a rate of 10 percent by volume of total herbicide solution is recommended

bahiagrass has been mowed to a uniform height of 3 to 4 inches. Applications must be made prior to seedhead emergence. Apply 5 fluid ounces per acre of this product plus 2 quarts of an approved nonionic surfactant per 100 gallons of total spray volume in 10 to 25 gallons of water per acre.

Sequential applications of this product plus nonionic surfactant may be made at approximately 45 day intervals to extend the period of seedhead and vegetative growth suppression. For continued vegetative growth suppression sequential applications must be made prior to seedhead emergence.

Apply no more than 2 sequential applications per year. As a first sequential application, apply 3 fluid ounces of this product per acre plus nonionic surfactant. A second sequential application of 2 to 3 fluid ounces per acre plus nonionic surfactant may be made approximately 45 days after the first application.

ANNUAL GRASS GROWTH SUPPRESSION

For growth suppression of some annual grasses, such as annual ryegrass, wild barley and wild oats growing in coarse turf on roadsides or other industrial areas, apply 3 to 4 ounces of this product in 10 to 40 gallons of spray solution per acre. Mix 2 quarts of a nonionic surfactant per 100 gallons of spray solution. Applications should be made when annual grasses are actively growing and before the seedheads are in the boot stage of development. Treatments made after seedhead emergence may cause injury to the desired grasses.

Product is protected by U.S. Patent No. 4,405,531. Other patents are pending. No license granted under any non U.S. patent(s).

EPA Reg. No. 524-343

In case of an emergency involving this product
Call Collect, day or night (314) 694-4000

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MONSANTO COMPANY
AGRICULTURAL PRODUCTS
ST. LOUIS, MISSOURI 63167 U.S.A.

Section 8

Temporary Certificate of Registration of an Agricultural Chemical for Weedar 64 dated 14/10/96

FORM C

MINISTRY OF AGRIC.
P. O. BOX 102, ENTEBBE

THE CONTROL OF AGRICULTURAL CHEMICALS STATUTE, 1989

(regulation 11)

TEMPORARY CERTIFICATE OF REGISTRATION OF AN AGRICULTURAL CHEMICAL

NUMBER UgC/96/00039/He/Tempo

It is hereby certified that the agricultural chemical described herein has been temporarily registered under the control of Agricultural Chemicals Statute and Regulations made thereunder and is subject to conditions specified herein -

1. Approved common name 2,4 - D, DIMETHYLAMINE SALT.

2. Trade name under which the chemical is traded in Uganda WEEDAR 64.
(2,4 - D DIMETHYLAMINE SALT 46.8 %).

3. Condition(s) under which agricultural chemical is registered TEMPORARY
REGISTRATION, TO CONTROL WATERHYACINTH

[either that-
(a) it is for the emergency control of infestation in LAKE VICTORIA area, or / and

(b) it is for the carrying out of Laboratory tests, experiments and field tests IN LAKE VICTORIA ;or

(c) the applicant is required to produce technical information regarding the use for which chemical is to be used; or any other condition.]

4. Registration Number UgC/96/00039/He/Tempo.

5. Registered in the name of P.S. MAAIF of (address) BOX 102, EBB Tel.No. 20803.

6. Date of Registration 15th OCTOBER, 1996.

7. Certificate expires on 14/10/1997 (ONE YEAR) from the date of Registration.

Chairman,
Agricultural Chemicals Board.

Secretary,
Agricultural Chemicals Board.

Weedar® 64

Brand Herbicide

RHÔNE-POULENC

The 2,4-D Amine Weed Killer

ACTIVE INGREDIENT:
2,4-Dichlorophenoxyacetic acid, dimethylamine salt* 46.8%
INERT INGREDIENTS: 53.2%

*2,4-Dichlorophenoxyacetic acid equivalent 38.9% by weight or 3.8 pounds per gallon
*Isomer specific by AOAC Method No. 978.05

E.P.A. Reg. No. 264-2AA

E.P.A. Est. No. 264-MO-01

KEEP OUT OF REACH OF CHILDREN

DANGER PELIGRO

Si usted no entiendo la etiqueta, busque a alguien para que se la expliquè a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

For PRODUCT USE Information Call 1-800-334-9745

For EMERGENCY Information ONLY Call 24 Hours A Day 1-800-334-7577.

STATEMENT OF PRACTICAL TREATMENT

IF ON SKIN: Wash skin with plenty of soap and water. Get medical attention.

IF SWALLOWED: If patient is conscious and alert, give 2 to 3 glasses of water or milk to drink. If available, give one tablespoon of Syrup of Ipecac to induce vomiting. Alternatively, induce vomiting by touching back of throat with finger. Do not make an unconscious person vomit. Get medical attention.

IF IN EYES: Flush with water for at least 15 minutes. Get medical attention, PREFERABLY AN OPTHAMOLOGIST.

IF INHALED: Move to an uncontaminated area. Get medical attention.

NOTE TO PHYSICIAN

This product contains a phenoxy herbicidal chemical. There is no specific antidote. All treatments should be based on observed signs and symptoms of distress in the patient. Overexposure to materials other than this product may have occurred.

PRECAUTIONARY STATEMENTS

DANGER
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

Causes irreversible eye damage. Harmful if swallowed. May be fatal if absorbed through the skin. Avoid breathing vapors or spray mist. Do not get in eyes, on skin or on clothing.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear: coveralls over short-sleeved shirt and short pants, waterproof gloves, chemical-resistant footwear plus socks, chemical-resistant headgear for overhead exposure and protective eye wear. A chemical-resistant apron should also be worn when cleaning equipment, mixing or loading.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4-6)], the handler PPE (personal protective equipment) may be reduced or modified as specified in the WPS.

For containers over 1 gallon but less than 5 gallons, mixers and loaders who do not use a mechanical system (probe and pump) to transfer the contents of this container must wear coveralls or a chemical-resistant apron in addition to the other required PPE. For containers of 5 gallons or more, a mechanical transfer system (probe and pump) must be used for transferring the contents of the container. If the contents of a non-refillable pesticide containers are emptied, the probe must be rinsed before removal. If the mechanical system is used in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4)] the handler PPE requirements may be reduced or modified as specified in the WPS.

USER SAFETY RECOMMENDATIONS

Users should: Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.

Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This product is toxic to aquatic invertebrates. Drift or runoff may adversely affect aquatic invertebrates and non-target plants. For terrestrial uses, do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters. Do not apply when weather conditions favor drift from treated areas. Do not use the same spray equipment for other purposes unless thoroughly cleaned.

Do not contaminate water used for irrigation or domestic purposes (except as specifically recommended on this label) especially in areas where grapes, cotton, tomatoes or other susceptible plants are grown.

Do not treat irrigation ditches in areas where water will be used to overhead (sprinkler) irrigate susceptible crops especially grapes, tomatoes, tobacco, and cotton.

MIXING AND LOADING: Most cases of ground water contamination involving phenoxy herbicides such as 2,4-D have been associated with mixing/loading and disposal sites. Caution should be exercised when handling 2,4-D pesticides at such sites to prevent contamination of ground water supplies. Use of closed systems for mixing or transferring this pesticide will reduce the probability of spills. Placement of the mixing/loading equipment on an impervious pad to contain spills will help prevent ground water contamination.

Do not apply WEEDAR® 64 Broadleaf Herbicide directly to, or permit to drift onto cotton, okra, grapes tomatoes, fruit trees, vegetables, flowers or other desirable crop or ornamental plants which are susceptible to 2,4-D herbicide. Do not apply near susceptible plants since very small quantities of the 2,4-D will cause severe injury during the growing or dormant periods. Crops contacted by WEEDAR® 64 Broadleaf Herbicide sprays or spray drift may be killed or suffer significant stand loss with extensive quality and yield reduction.

Do not apply when a temperature air inversion exists. Such a condition is characterized by little or no air movement and an increase in air temperature with an increase in height. In humid regions, a fog or mist may form. An inversion may be detected by producing a smoke column and checking for a layering effect. If questions exist pertaining to the existence of an inversion, consult with local weather services before making an application.

Use coarse sprays to minimize drift. Do not apply with hollow cone-type insecticide or other nozzles that produce fine spray droplets. Drift from aerial or ground application may be reduced by: (1) applying as near to the target as possible in order to obtain coverage; (2) by increasing the volume of spray mix per acre; (3) by decreasing the pounds of pressure at the nozzle tips; and (4) by using nozzles which produce a coarse spray pattern; (5) by not applying when wind is blowing toward susceptible crops or valuable plants.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read entire label before using this label.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow entry into treated areas during the restricted entry interval (REI) of 48 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated such as plants, soil or water is: coveralls over short-sleeved shirt and short pants, waterproof gloves, chemical-resistant footwear plus socks, chemical-resistant headgear for overhead exposure and protective eye wear.

NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are **NOT** within the scope of the Worker Protection Standard (WPS) agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

For ornamental turf uses (golf courses, cemeteries, parks and other turf grass areas), do not enter treatment areas until sprays have dried. Do not allow people (other than applicator) or pets on treatment area during application.

STORAGE AND DISPOSAL

STORAGE
Do not contaminate water, food or feed by storage or disposal. Store in original container in a dry secured storage area. Keep container tightly closed when not in use.

PESTICIDE DISPOSAL
Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law and may contaminate ground water. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL
Triple rinse or (equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

GENERAL CAUTIONS AND RESTRICTIONS

Do not apply WEEDAR® 64 Broadleaf Herbicide through any type of irrigation system.

Do not use in or near a greenhouse.

MIXING INSTRUCTIONS

Mix WEEDAR® 64 Broadleaf Herbicide only with water, unless otherwise directed on this label. Add about one-half the water to the mixing tank, then add WEEDAR® 64 with agitation and finally the rest of water with continuing agitation.

NOTE: Adding oil, wetting agent, or other surfactants to the spray may increase effectiveness on weeds but also may reduce selectivity to crops, resulting in crop damage.

COMPATIBILITY

If WEEDAR® 64 Broadleaf Herbicide is to be tank mixed with fertilizers or with other pesticides, compatibility should be tested prior to mixing. To test for compatibility, use a small container and mix a small amount (0.5 to 1 qt) of spray, combining all ingredients in the same ratio as the anticipated use. If any indications of physical incompatibility develop, do not use this mixture for spraying. Indications of incompatibility usually will appear within 5 to 15 minutes after mixing.

Read and follow all directions and precautions on this label and on the labels of any products for which a tank mixture is being considered.

APPLICATION PROCEDURES

Apply by air or ground equipment in sufficient gallonage to obtain adequate coverage, except as otherwise directed on this label.

Use 2 or more gallons of water per acre for aerial application and 10 or more gallons of water per acre for ground application.

GENERAL INFORMATION

INJURY TO CROPS FROM THIS HERBICIDE MAY OCCUR. IF YOU ARE NOT PREPARED TO ACCEPT SOME DEGREE OF CROP INJURY DO NOT USE THIS PRODUCT.

Crop varieties vary in response to 2,4-D and some are easily injured. Apply WEEDAR® 64 Broadleaf Herbicide only to varieties known to be tolerant to 2,4-D. If you are uncertain concerning tolerant varieties or local use situations that may affect crop tolerance to 2,4-D, consult your seed company, state Agricultural Extension Service or qualified crop consultant for advice.

Be sure that use of this product conforms to all applicable laws, rules and regulations. Certain states have restrictions pertaining to application distances from susceptible crops. The applicator should become familiar with these laws, rules or regulations and follow them exactly.

GENERAL WEED LIST

Annual and Biennial Weeds

*beggarticks
bullthistle
coffeeweed
common cocklebur
common burdock
common evening primrose
common lambsquarters
hairy galinsoga
jimsonweed
*knotweed
*mallow (venice or little)
marshelder
morningglory (common, ivy, woolly)
*musk thistle(***)
mustards (except blue mustard)
pepper weeds (except perennial)
**pigweeds (Amaranthus spp.)
prickly lettuce
ragweed (common or giant)
rough fleabane
*Russian thistle
Salsify (western or common)
*smartweeds (annual species)
sowthistles (annual or spiny)
sunflower
*vervains
vetches
wild carrot
wild lettuce
wild parsnips

Perennial Weeds

*bindweed (hedge, field, European)
blue lettuce
*Canada thistle
catnip
chicory
dandelion
*docks
*dogbanes
*goldenrod
*ground ivy
healall
*hoary cress
*ironweed
Jerusalem-artichoke
many flowered aster
**nettles (including stinging)
*orange hawkweed
plantains
sowthistle (perennial)
*vervains
*wild garlic
*wild onion

*These species may require repeated applications and/or use of the higher rate recommended on this product label even under ideal conditions for application.

**Control of pigweeds in the High Plains area of Texas and Oklahoma may not be satisfactory with this product.

***Not registered for control of musk thistle in California.

SPECIFIC USE DIRECTIONS

CEREAL GRAINS

CROP	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Wheat, Barley, Oats and Rye (not underseeded with legumes)		Apply after grain is fully tillered (usually 4 to 8 inches high) but not forming joints in the stem. **Do not spray grain in the boot to dough stage.**
Postemergence		
Annual and biennial broadleaf weeds	1/2 to 2 pints*	
Perennial broadleaf weeds	1 to 2 pints*	
Wheat, Barley, Oats and Rye (underseeded with legumes)	1/4 to 1/2 pint*	Apply after grain is 8 inches tall. **Do not spray grain in boot to dough stage.** Do not spray alfalfa or sweet clover unless the infestation is severe and injury to these legumes can be tolerated.
Emergency weed control in Wheat	3 pints	Apply when weeds are approaching bud stage, after the grain dough stage. **Do not spray during the boot to dough stage.** The 3 pints per acre application can product injury to wheat. Balance the severity of your weed problem against the possibility of crop damage. Where perennial weeds are scattered, spot treatment is suggested to minimize the extent of crop injury.
Perennial broadleaf weeds		

RESTRICTIONS AND LIMITATIONS FOR USE ON CEREAL GRAINS

For aerial application on grain, apply WEEDAR® 64 Broadleaf Herbicide in 3 to 10 gallons of water per acre

For ground application a minimum of 10 to 15 gallons of water per acre is recommended for proper spray coverage

Do not permit dairy animals or meat animals being finished for slaughter to forage treated grain fields within 2 weeks after treatment

Do not feed treated straw to livestock if an emergency treatment as described above is applied

*Use the lower rate if small annual and biennial weeds are the major problem. Use the higher rate if perennial weeds or annual biennial weeds are present which are in the hard-to-kill categories as determined by local experience. The higher rates increase the of grain injury and should be used only where the weed control problem justifies the grain damage risk. Do not apply WEEDAR® grain in the seeding stage.

CORN AND SORGHUM

CROP	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
CORN (Field and Sweet)		
Preplant	1 to 2 pints	To control emerged broadleaf weed seedlings or existing cover crops prior to planting corn, apply 7 to 14 days before planting. Do not use on light, sandy soil, or where soil moisture is inadequate for normal weed growth. Use high rate for less susceptible weeds or cover crops such alfalfa.
Preemergence	2 to 3 pints	Apply 3 to 5 days after planting but before corn emerges. Do not use on light, sandy soils or where soil moisture is low.
Postemergence		Apply when weeds are small and corn is less than 8 inches tall (to top of canopy). When corn is over 8 inches tall, use drop nozzles and keep spray off foliage. Treat perennial weeds when they are in the bud to bloom stage. **Do not spray corn in the tassel to dough stage.** Corn treated with 2,4-D may become temporarily brittle. Winds or cultivation may cause stalk breakage during the period of time when the corn is brittle.
Annual broadleaf weeds	1/2 to 1 pint	
Perennial broadleaf weeds	1 to 1 1/2 pints	
Grain Sorghum (Milo)		
Postemergence	1 pint	Apply when sorghum is 6 to 15 inches tall. If sorghum is taller than 8 inches to top of the canopy, use drop nozzles and keep spray off the foliage. **Do not treat during the boot, flowering or dough stage.**

RESTRICTIONS AND LIMITATIONS FOR USE ON CORN AND SORGHUM

Do not forage or feed fodder for 7 days following application.

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Postemergence	3/4 to 1 pint	Apply not less than 15 days prior to planting soybeans, when weeds are small and actively growing. Use the higher rate on larger weeds and when perennials are present.
	> 1 to 2 pints	Apply not less than 30 days prior to planting soybeans, when weeds are actively growing.
		In addition to those weeds found on the GENERAL WEED LIST, WEEDAR® 64 will suppress or control the following broadleaf weeds frequently encountered in reduced tillage soybean production systems: alfalfa*, bullnettle, smallflowered bittercress, Carolina geranium, smallflowered buttercup, common and rough cinquefoil, red clover*, horseweed or marestail, mousetail, wild mustard, field pennycress, cutleaf evening primrose, common purslane, speedwell, velvetleaf, and Virginia copperleaf. * These weeds are only partially controlled. Apply no more than 2.0 pints of WEEDAR® 64 in one season prior to planting soybeans. After applying, plant soybean seed as deep as practical or at least 1 1/2 to 2 inches deep. Adjust the planter press wheel, if necessary, to ensure that planted seed is completely covered. If desired, WEEDAR® 64 may be applied pre-plant to soybeans in tank mixtures with other herbicides such as Poast, Poast Plus, Roundup, Roundup D-Pak, Honcho, Gramoxone Extra, Prowl, Pursuit Plus, Scepter, Scepter 70 DG, Squadron and others that are registered for pre-plant soybean use. **NOTE:** Unacceptable injury to soybeans planted in fields previously treated with WEEDAR® 64 may occur and the extent of injury will depend on weather and agronomic factors such as the amount of weed vegetation and previous crop residue present that may be in effect between the time of application and the emergence of the soybean plant.

RESTRICTIONS AND LIMITATIONS FOR USE IN SOYBEANS (PRE-PLANT)

Do not apply WEEDAR® 64 when weather conditions such as temperature, air inversions, or wind favor drift from treated areas to susceptible plants.

Apply no more than 2.0 pints of WEEDAR® 64 per acre in one season prior to planting soybeans.

Only one application per growing season, regardless of the application rate used, is allowed.

Do not apply WEEDAR® 64 prior to planting soybeans if you are not prepared to accept the results of soybean injury including poss loss of stand and yield.

Do not replant fields treated with WEEDAR® 64 in the same growing season with crops other than those labeled for 2,4-D pre-plant

Do not mow or cultivate weeds prior to treating with WEEDAR® 64 as poor control may result.

Do not cut for feed treated hay, forage or fodder or graze treated soybeans to livestock.

Do not apply WEEDAR® 64 pre-plant to soybeans in fields having a coarse-textured soil where the percent organic matter is <1.0

Only one application of WEEDAR® 64 may be made prior to planting soybeans per growing season.

Do not feed treated hay, forage, or fodder. Restrict livestock from grazing treated fields.

***Not currently registered in California.**

RICE, SUGARCANE, FALLOWLAND AND CROP STUBBLE

CROP	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Rice (Pre-plant use)	1 to 2 pints	Apply four or more weeks prior to planting rice. DO NOT USE IN CALIFORNIA.
Rice (Postemergence use)	1 to 2 1/2 pints	Apply when rice is in the late tillering stage of development at the time of first joint development. Do not apply after panicle initiation, after rice internodes exceed one-half inch, at early seedling, early panicle, boot or heading stages. Consult local university or Agricultural Extension Service specialists for more specific information on rates and timing of application
Sugarcane Preemergence Postemergence	 4 pints 1 1/2 to 2 pints	Apply before canes appear for control of emerged broadleaf weeds. Apply after cane emerges and through lay-by. DO NOT USE IN CALIFORNIA.
Fallowland and Crop Stubble Annual broadleaf weeds	1 to 2 pints	Use the lower rate when weeds are small (2 to 3 inches tall) and actively growing. Use the higher rate on older and drought-stressed plants.
Biennial broadleal weeds	2 to 4 pints	Spray while musk thistles or other biennial species are in the seedling to rosette stage and before flower stalks become apparent. The lower rate can be used in the spring during rosette stage. Use the highest rate in the fall or after flower stalks have developed.
Perennial broadleaf weeds	2 to 6 pints	Spray weed in the bud to bloom stage or while in good vegetative growth. Do not disturb treated areas for at least 2 weeks after treatment, or until tops are dead.
Wild garlic and onion in crop stubble	4 to 6 pints	Apply to new regrowth of wild garlic or onion which occurs in the fall following harvest of small grains, corn or grain sorghum.

RESTRICTIONS AND LIMITATIONS FOR USE IN FALLOWLAND AND CROP STUBBLE

Do not plant any crop for 3 months after treatment or until chemical has disappeared from the soil.

RESTRICTIONS AND LIMITATIONS FOR USE IN RICE

Do not apply more than a total of 2 1/2 pints of WEEDAR® 64 to rice per growing season.

ESTABLISHED GRASS PASTURES, RANGELAND, AND CONSERVATION RESERVE PROGRAM AREAS

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds	2 pints	Apply when weeds are small and actively growing and prior to bud stage. Spray while musk thistles or other biennial species are in the seedling to rosette stage and before flower stalks become apparent. The lower rate can be used in the spring during rosette stage. Use the highest rate in the fall or after flower stalks have developed. Do not apply to newly seeded areas until grass is well established. Do not apply to grass in the early boot through milk stage if grass seed production is desired. Bentgrass and legumes may be injured by this treatment.
Biennial and perennial broadleaf weeds	2 to 4 pints	

RESTRICTIONS AND LIMITATIONS FOR USE IN PASTURES AND RANGELANDS

Do not graze (dairy) cattle in treated areas for 7 days after application.

Do not cut forage for hay within 30 days of application.

Do not permit dairy animals or meat animals being finished for slaughter to forage treated fields within 3 days of slaughter.

CONSERVATION RESERVE PROGRAM

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds In young grasses In established grasses	1/2 to 1 pint 1/2 to 2 pints	Apply to actively growing annual broadleaf weeds. Use 1/2 to 1 pint when weeds are small; use higher rates on older weeds. Do not apply to young grasses with fewer than 6 leaves or prior to tillering, as excessive injury may result. Do not apply more than 1 pint until grasses are well established as excessive injury may result.
Biennial and perennial broadleaf weeds In established grasses	2 to 4 pints	Treat when biennial weeds are in the seedling to rosette stage and before flower stalks become apparent. Treat perennial weeds in the bud to bloom stage. Apply to actively growing weeds.

RESTRICTIONS AND LIMITATIONS FOR USE ON CONSERVATION RESERVE PROGRAM AREAS

Use at least 2 gallons of water per acre by air and 5 gallons of water per acre by ground.

Do not harvest or graze treated Conservation Reserve Program areas.

Do not apply to grasses in the boot to dough stage if grass seed production is desired.

GRASSES FOR SEED PRODUCTION

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual and perennial broadleaf weeds	2 to 4 pints	Apply to established stands in spring from tiller to early boot stage. **Do not spray in boot stage.** New spring seedings may be treated with the lower rate after grass seedlings have at least 5 leaves. Perennial weed regrowth may be treated in the fall. DO NOT USE IN CALIFORNIA.

RESTRICTIONS AND LIMITATIONS FOR USE ON GRASSES FOR SEED PRODUCTION

Do not graze dairy animals or cut forage for hay within 7 days of application.

NON-CROPLAND

fencerows, roadsides, drainage ditches, and other non-crop areas

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds **Biennial and perennial broadleaf weeds**	2 to 4 pints 4 to 8 pints	Treat when weeds are young and actively growin Perennial weeds should be near the bud stage, b not flowering at application. Do not use on susceptib southern grasses such as St. Augustine. Do n apply to newly seeded areas until grass is w established. Bentgrass, clover, legumes a dichondria may be injured by this treatment.

RESTRICTIONS AND LIMITATIONS FOR USE ON NON-CROPLAND

Do not graze dairy animals for 7 days following application.

Use sufficient gallonage for thorough and uniform coverage.

WEEDS IN ORNAMENTAL TURF AREAS

golf courses, cemeteries, parks, turfgrass, and other grass areas

WEEDS	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds	2 to 4 pints	Treat when weeds are young and actively growing. Perennial weeds should be near the bud stage, but not flowering at application. Do not use on susceptible southern grasses such as St. Augustine. Do not apply to newly seeded areas until grass is well established. Bentgrass, clover, legumes and dichondria may be injured by this treatment.
Biennial and perennial broadleaf weeds	4 pints	

RESTRICTIONS AND LIMITATIONS FOR USE ON ORNAMENTAL TURF AREAS

Use sufficient gallonage for thorough and uniform coverage.

Do not apply more than 2 broadcast applications per year per treatment site. This does not exclude spot treatments.

Do not allow people (other than applicator) or pets on treatment area during application.

Do not enter treatment areas until sprays have dried.

SPOT TREATMENT IN NON-CROP AREAS

Mix 2 to 3 fluid ounces of WEEDAR® 64 Broadleaf Herbicide in 3 gallons of water. Wet all weeds and stems thoroughly. For best results, treat when weeds are actively growing.

FORESTRY - TREE INJECTION

For controlling species such as alder, aspen, birch, blackgum, cherry, oak, sweetgum, and tulip poplar

Make injections as near to the root collar as possible, using one injection per inch of trunk dbh (4 1/2 feet). For resistant species such as hickory, injections should overlap. For best results, injections should be made during the growing season, May 15th through October 15th.

For Dilute Injection: Mix 1 gallon of WEEDAR® 64 Broadleaf Herbicide in 19 gallons of water for dilute injections.

For Concentrate Injections: Use 1 to 2 ml of concentrate WEEDAR® 64 Broadleaf Herbicide per injection. The injection bit must penetrate the inner bark.

STONE FRUIT AND NUT ORCHARDS

WEEDS IN CROP	AMOUNT OF WEEDAR® 64 PER ACRE	DIRECTIONS
Annual broadleaf weeds	3 pints	For control of weeds on the orchard floor, apply using coarse sprays and low pressure in sufficient volume of water to obtain thorough wetting of weeds. Treat when weeds are small and actively growing. Do not use on light, sandy soil. DO NOT USE IN CALIFORNIA.

RESTRICTIONS AND LIMITATIONS FOR USE IN STONE FRUIT AND NUT ORCHARDS

Do not apply to bare ground as injury may result

Do not apply immediately before irrigation and withhold irrigation for 2 days before and for 3 days after treatment

Do not allow spray to drift onto or contact foliage, fruit, stems, trunks of trees or exposed roots as injury may result

Do not apply to newly established or young orchards. Trees must be at least 1 year old and in vigorous condition

Do not apply during bloom.

Do not graze or feed cover crops from treated orchards.

Do not make more than 2 applications per year.

Do not harvest stone fruit within 40 days of application.

Do not harvest nuts within 60 days of application.

WEEDS AND BRUSH IRRIGATION CANAL DITCHBANKS

(Seventeen Western States: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Nevada, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming).

For control of annual and perennial broadleaf weeds, apply 1 to 2 quarts of WEEDAR® 64 Broadleaf Herbicide per acre in approximately 20 to 100 gallons per acre. Treat when weeds are young and actively growing before the bud or early bloom stage. For harder-to-control weeds, a repeat spray after 3 to 4 weeks using the same rates may be needed for maximum results. Apply no more than two treatments per season.

For woody brush and patches of perennial broadleaf weeds, mix 1 gallon of WEEDAR® 64 in 150 gallons of water. Wet foliage thoroughly using about 1 gallon of solution per square rod.

SPRAYING INSTRUCTIONS

Apply with low pressure (10 to 40 psi) power spray equipment mounted on a truck, tractor, or boat. Apply while traveling upstream to avoid accidental concentration of chemical into water. Spray when the air is fairly claim, 5 mph or less. Do not use on small canals (less than 10 cfs) where water will be used for drinking purposes.

Boom spraying onto water surface must be held to a minimum and no cross-stream spraying to opposite banks should be permitted. When spraying shoreline weeds, allow no more than 2 foot overspray onto water with an average of less than 1 foot overspray to prevent introduction of greater than negligible amounts of chemical into the water.

Do not allow dairy animals to graze on treated areas for at least 7 days after spraying. Water within treated banks should not be fished.

AQUATIC WEED CONTROL

For use in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, rivers and streams that are quiescent or slow moving.

NOTICE TO APPLICATORS

State and Local Coordination: Before application, coordination and approval of local and state authorities may be required either by letter of agreement or issuance of special permits for such use.

Fish Toxicity - Oxygen Ratio: Fish breathe oxygen in the water and a water - oxygen ratio must be maintained. Decaying weed use up oxygen. To avoid fish kill from decaying plant material do not treat more than one half the lake or pond at one time. For larg bodies of weed infested waters leave buffer strips of at least 100 feet wide and delay treatment of these strips for 4 to 5 weeks or unt the dead vegetation has decomposed.

Wind Velocity - Ground or Surface Application: Do not apply when wind speeds are at or above 10 mph. **Air Applicatio** Do not apply when wind speeds are at or above 5 mph. The restrictions do not apply to subsurface applications used in weed contr programs.

Irrigation: Delay the use of treated waters for irrigation for three weeks after treatment unless an approved assay shows that t water does not contain more than 0.1 ppm 2,4-D acid. Do not treat irrigation ditches in areas where water will be used to overhe sprinkler irrigate susceptible crops especially grapes, tomatoes and cotton.

Potable Water: Delay the use of treated water for domestic purposes for a period of three weeks or until such time as an approv assay shows that the water contains no more than 0.1 ppm 2,4-D acid.

Water Hyacinth *(Eichornia crassipe)* - Directions For Use

WEEDAR® 64 will control water hyacinth with surface and air applications.

Amounts to Use: 2 to 4 quarts (4 lb. acid equivalent per gallon) per acre. **Spray the weed mass only**. Use 4 quarts when pl are matured or when the weed mass is dense.

When To Apply: Spray when water hyacinth plants are actively growing. Repeat as necessary to kill regrowth and hyacinth pl missed in the previous operation.

How To Use - Surface Application: Use power sprayers operated with a boom or spray gun mounted on a boat, tractor or Thorough wetting of foliage is essential for maximum control. Use 100 to 400 gal. A of spray mixture. Special precautions such a use of low pressure, large nozzles and thickening agents should be taken to avoid spray drift in areas of sensitive crops. For DIRE SPRAY operation use WEEDAR® 64 with 1 pint of drift control agent in 50 to 100 gallons of water. For other applications, follow the control agent label for mixing directions. **Air Application**: Use drift control spray equipment or thickening agents mixed into the solution. Apply 1.0 gallon per acre of WEEDAR® 64 through standard boom systems with a minimum of 5 gallons of spray mix per For MICROFOIL® drift control spray systems, apply WEEDAR® 64 in 12 to 15 gallons spray mix per acre.

2,4-D Acid Equivalent	1/2 lb.	1 lb.	2 lbs.	3 lbs.	4 lbs.
WEEDAR® 64	1 pt.	2 pts.	2 qts.	3 qts.	4 qts.

THIS SPECIMEN LABEL IS INTENDED FOR USE ONLY AS A GUIDE IN PROVIDING GENERAL INFORMATION REGARDING THE DIRECTIONS, WARNINGS AND CAUTIONS ASSOCIATED WITH THE USE OF THIS PRODUCT. AS WITH ANY AGRICULTURAL CHEMICAL, ALWAYS FOLLOW THE LABEL INSTRUCTIONS ON THE PACKAGE BEFORE USING.

Form No. 95065
Printed USA - 9/94

Rhône-Poulenc Ag Company
P.O. Box 12014, 2 T.W. Alexander Drive
Research Triangle Park, North Carolina 27709

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EPA Approval: 6/3/94

Section 9

In-Lake Herbicide Trials - Emergency Medical Protocol

AQUATICS UNLIMITED
WATER HYACINTH CONTROL PROGRAM
International Conference Center
P. O. Box 7057, Suite 235 Kampala, Uganda
Phone: 256-41-250-550 Fax: 256-41-257-824
E-Mail: aquatics@imul.com

In-lake Herbicide Trials - Emergency Medical Protocol

06 February, 1997

The following provides information related to potential adverse health effects from exposure as well as procedures to be taken in case of accidental exposure to herbicides during the In-Lake trials of Glyphosate (RODEO) and 2,4 D (WEEDAR 64).

In case of an emergency in country medical support can be sought through the medical offices of Dr. E. R. Gibbons and Dr. R.J Stockley located at the British High Commission Bldg., 12A, Parliament Avenue, Kampala. Telephone: 256003 or Celtel: 075 - 756003. Herbicide related information is on file with their office.

Glyphosate:
Potential Adverse Health Effects:

Likely Routes of Exposure: Inhalation and skin contact
Eye Contact: No more than slightly irritating based on toxicity studies
Skin Contact: No more than slightly toxic or irritating based on toxicity studies.
Ingestion: No more than slightly toxic based on toxicity studies. No significant adverse health effects are expected to develop if only small amounts (less than a mouthful are swallowed.
Inhalation: No more than slightly toxic if inhaled based on toxicity studies

PRECAUTIONARY STATEMENTS ON LABEL

Keep out of reach of Children
Caution!
Harmful if inhaled
Avoid breathing vapors or mists
Remove contaminated clothing and wash clothing before reuse
Wash thoroughly with soap and water after handling

(Glyphosate cont.)

FIRST AID MEASURES

No specific antidote is available.

Inhaled: Remove individual to fresh air. Seek medical attention if breathing is difficulty develops.
Eye contact: Flush eyes with water for at least 15 minutes.
Ingestion: Immediately dilute by swallowing milk or water.

In case of an emergency involving this product call manufacturer Emergency line at USA 001-314- 694-4000.

****

Weedar -64 (2, 4 D):

Potential Adverse Health Effects:

Acute Eye: Causes corneal opacity, irreversible eye damage, vapors and mists can cause irritation
Acute Skin: May cause slight transient irritation. Toxic if absorbed through skin. May produce symptoms similar to those from inhalation and ingestion. May cause decreased blood pressure, muscle weakness, muscle spasms.
Acute Ingestion: Harmful if ingested. May cause nausea, vomiting, abdominal pain, decreased blood pressure, muscle weakness, muscle spasms

PRECAUTIONARY STATEMENTS ON LABEL

Keep out of reach of children
Causes irreversible eye damage
Harmful if swallowed
May be fatal if absorbed through skin
Avoid breathing vapors or spray mist
Do not get in eyes, on skin or on clothing

(Weedar 64 Cont.)

FIRST AID MEASURES

No specific antidote is available.

Eye Contact: Flush with water for at least 15 minutes. Get medical attention, preferably an opthamologist.
Skin Contact: Wash with plenty of soap and water. Get medical attention. Remove contaminated clothes and shoes while washing. Clean contaminated clothing and shoes before re-use or discard if they cannot be thoroughly cleaned
Ingestion: If patient is conscious and alert, give 2 to 3 glasses of water or milk to drink. If available, give one tablespoon of Syrup of Ipecac to induce vomiting. Alternatively, induce vomiting by touching back of throat with finger. Do not make an unconscious person vomit. Get medical attention.
Inhalation: Move to an uncontaminated area and assure victim is still breathing, If breathing is difficult, administer oxygen, if available. If victim is not breathing administer CPR . Get medical attention.

In case of emergency involving this product call manufacturer emergency line in USA 24 hours per day, 7 days per week at 001-919-549-2901.

Section 10

In-Lake Herbicide Trials Public Notification Sheet
(Message from MAAIF)

MESSAGE FROM MAAIF - GOVERNMENT OF UGANDA ON WATER HYACINTH CONTROL PROGRAM
IN-LAKE HERBICIDE TRIALS

5 February 1997

AS YOU ARE AWARE, THE PROLIFERATION OF WATER HYACINTH HAS REACHED LARGE PROPORTIONS THROUGHOUT MUCH OF THE UPPER NILE SYSTEM, INCLUDING LAKE VICTORIA, CAUSING PROBLEMS FOR THE LIFE, ECONOMY, AND ENVIRONMENT OF UGANDA AND ITS NEIGHBORING COUNTRIES. AS IN MANY OTHER LOCATIONS IN THE WORLD, WATER HYACINTH PROBLEMS IN UGANDA INCLUDE OBSTRUCTION OF BOAT TRAFFIC, INTERFERENCE WITH WATER SYSTEMS, IMPACTS TO HYDROELECTRIC POWER PRODUCTION, AND INTERFERENCE WITH FISHING AND FISHING ACCESS. THE WEED AFFECTS FISH AND WILDLIFE RESOURCES, REDUCES WATER QUALITY, AND INCREASES SEDIMENT ON THE LAKE BOTTOM.

IN ORDER TO REDUCE WATER HYACINTH PROBLEMS IN THE LAKE, SOME MEASURES ARE BEING UNDERTAKEN BY THE GOVERNMENT TO CONTROL THE MULTIPLICATION OF THE WEED. THESE MEASURES INCLUDE AN INTEGRATED APPROACH TO CONTROLLING THE HYACINTH THROUGH USE OF HERBICIDES, BIOLOGICAL AND MANUAL/MECHANICAL METHODS OF CONTROL.

THE HERBICIDES FOR USE, DURING THE IN-LAKE TRIALS ARE GLYPHOSATE AND 2, 4-D. THESE HERBICIDES ARE USED PRESENTLY IN NORMAL DAY TO DAY OPERATIONS ON OUR FARMS TO CONTROL AGRICULTURAL WEEDS, AND WIDELY USED AROUND THE WORLD. THEY CAN ALSO BE SAFELY USED ON THE WATER HYACINTH.

THESE HERBICIDES ARE NOT NEW. THEY HAVE BEEN USED IN OTHER COUNTRIES LIKE AMERICA, IN AFRICAN COUNTRIES SUCH AS NIGERIA, SOUTH AFRICA AND SUDAN, AND IN SOUTHEAST ASIA WHERE THEY HAVE PROVED EFFECTIVE IN CONTROLLING WATER HYACINTH.

THE HERBICIDE TRIALS WILL BE CARRIED OUT ON A SMALL SCALE AT WAZIMENYA BAY ADJACENT TO MUBANDA PARISH, NTENJERU SUB COUNTY MUKONO DISTRICT. SPRAYING DURING TRIALS WILL OCCUR ONCE ON 11 FEBRUARY, 1997.

1. STAY **100 METERS** AWAY FROM THE SPRAYED WATER HYACINTH FOR 30 DAYS
2. **DO NOT** COLLECT WATER, BATH OR WASH CLOTHES WITHIN 100 METERS FOR 30 DAYS
3. **DO NOT** PLACE FISHING NETS OR CATCH FISH WITHIN 100 METERS FOR 30 DAYS
4. **DO NOT** ALLOW LIVESTOCK TO DRINK THE WATER WITHIN 100 METERS FOR 30 DAYS

YOUR COOPERATION WILL BE HIGHLY APPRECIATED AND WILL ALSO ENABLE US TO COLLECT VITAL DATA INPUT FOR A SOUND ENVIRONMENTAL IMPACT ASSESSMENT.

OBUBAKA OKUVA MU MAAIF - GAVUMENTI YA UGANDA OKULWANYISA EKIDDO KUNYANJA

5 February 1997

NGABWEMUMANYI, OKWAALA KWEKIDO KWALIILA DALA EBITUNDU BINENE NYO MUMAMBUKA GOMUGA KIYIRA, NGAMWOTADE NENYANJA NALUBAALE, NEKIRETELA DALA OBUZIBU BUNGI ERI OBULAMU, EBYENFUNA, N'OBUTONDE BWA UGANDA WAMU NAMAWANGA AMALALA. NGABWEKIRI AWALALA WONA MUNSI. OBUZIBU BWEKIDO MU UGANDA BUTWALIRAMU OKUKYANKALANYA ENTAMBULA YAMATO, OKUSUMBUWA EMIDUMU GYAMAZI, AKABENJE MU KUKOLA KWAMASANYALAZE, N'OKUKYANKALANYA OBUVUBI NABAVUBI. EKIDO KYAKABAATE ERI EBYENYANJA NE BISOLO EBYOMUNSIKO, KIKENDEEZA OMUTINDO GWAMAZI, ATE KYONGERA N'OMUWENDO GWE TTOSI WANSI MUNYANJA.

OKUSOBOLA OKUKENDEEZA KUBUZIBU BWEKIDO MUNYANJA, ENKOLA EZIMU ZITESEZEBWAKO GAVUMENTI OKUSOBOLA OKUFUGA OBUFUKUNYA BWEKIDO. ENKOLA ZINO ZIJAKUTWALILAMU ENKOLA EYOBWESIMBU OKUSOBOLA OKUFUGA EKIDO OKUYITA MU NKOZESA YAMALAGALA, ENZAALA, EMIKONO N'EBYUMA. ENWANYISA EY'EBYUMA NENFUGAYOKUZALA KWEKIDO YO YATANDIKA DDA OKUKOLA.

KYETAGISA OKUSAAKO OMWOYO NTI AMALAGALA AGATESEBWAKO OKUKOZESEBWA MUKUGEZESA KU NYANJA GEGA GLYPHOSATE NE 2, 4-D. AMALAGALA GANO GAKOZESEBWA MUBULAMU NAKATI MUMASAMBA GAFFE OKUFUGA EMIDO EGYOMUNIMIRO. ATE NGA GAKOZESEBWA NE MUNSI NYINGI MUBWEGENDEREZA GASOBOLA OKUKOZESEBWA KUKIDO.

AMALAGALA GANO SIMAPYA. GABADDE GAKOZESEBWA MUMAWANGA AMALALA NGA AMERICA, MUMAWANGA G'AFRICA GAKOZESEBWAKO MU-NSI NGA NIGERIA, SOUTH AFRICA NE SUDAN NEMUMASERENGETA GOBUVANJUBA BWA ASIA, GYE GAZULIDWA OKUBA AGOMUGASO MUKUFUGA EKIDO. OKUFUYIRA KUBERAWO OMULUNDI GUMU NGA 11/02/1997.

<u>OKUGEZESA KWAMALAGALA</u> KUJAKOLEBWA KUMUTINDO OGWAWANSI KUKYEBEEYA KYE WAZIMENYA OKULIRANA KU MUBANDA PARISH, NTENJERU, MUKONO DISTRICT.

OKUMALA EBANGA LYANAKU AMAKUMI ASATU (30) OLUVANYUMA LWOKUFUYIRA EDODO, TUBASABA:

1. MUBEERE EBIFUBA KIKUMI (100) OKUVA AWAFUYIDWA EKIDO
2. TEMUKIMA MAZI, KUNAABA, OBA KWOZA ENGOYE MUBIFUBA EBYO EKIKUMI OKUVA MU BIFO EBIFUYIDDWA.
3. TEMUTEGA BUTIMBA BUVUBA OBA OKUVUBA MUBIFUBA EBYO EKIKUMI (100) OKUVA MU BIFO EBIFUYIDDWA.
4. TEMUKIRIZA BISOLO KUNYWA MAZI MU BEFUBA EBYO EKIKUMI (100) OKUBA MU BIFO EBIFUYIDDWA.

BAMBI MANYA NTI OKUSALAWO OKUKUSABA OBEERE WALA OKUVA MUKIFO EKYO, KWEKUTUSOBOZESA OKWEKAANYA EKIGENDERERWA AWATALI KUTATANYIZIBWA ERA KINO KIJAKUTUYAMBA OKWEYONGERA OKUKAKASA ENKOLA EYO.
ERA KINO KIJA KUTUYAMBA OKWEYONGERA OKUKAKASA ENKOLA EYO.
ENKOLAGANA YO NAFFE EJAKUSHIMIBWA MUKIKA KYAWAGULU. KINO KIJJA KUTUYAMBA OKUMALILIZA EKITABO EKIKWATA KUBUTONDE BWENSI.

Section 11

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AQUATICS UNLIMITED
WATER HYACINTH CONTROL PROGRAM

IN LAKE HERBICIDE TRIALS

10 February, 1997

PEST CONTROL LICENSES

State of California (USA)
Department of Pesticide Regulation

Agricultural Pest Control Advisors License
Thomas J. McNabb (License Number AA03036)

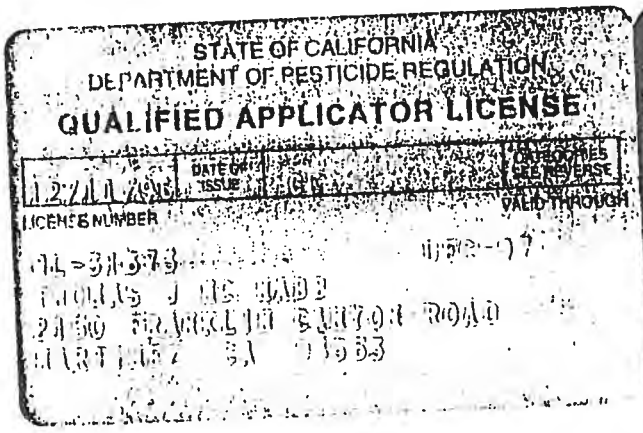
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
AGRICULTURAL PEST CONTROL
ADVISER LICENSE

	CATEGORIES SEE REVERSE	DATE OF ISSUE	12/11/96
1			

LICENSE NUMBER
AA03036
THOMAS J MCNABB
2150 FRANKLIN CANYON RD
MARTINEZ CA 94553
VALID THROUGH
DEC 1997

Qualified Applicator License

Thomas J. McNabb (License No. QL-31373)
Categories C & F (Right of Way & Aquatics)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	DATE OF ISSUE	CATEGORIES SEE REVERSE
12/11/96		

LICENSE NUMBER
QL-31373
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2150 FRANKLIN CANYON ROAD
MARTINEZ CA 94553
VALID THROUGH
DEC-97

David Najera (License No. QL30325)
Categories F (Aquatic)

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	CATEGORIES SEE REVERSE
F	

LICENSE NUMBER
QL30325
DAVID NAJERA
2513 RACHEL CT
ANTIOCH CA 94509
VALID THROUGH
DEC-1997

ANNEX B

STUDIES ON THE FATE OF WEEDAR 64 AND RODEO AQUATIC HERBICIDES FOLLOWING WATER HYACINTH TREATMENTS IN LAKE VICTORIA

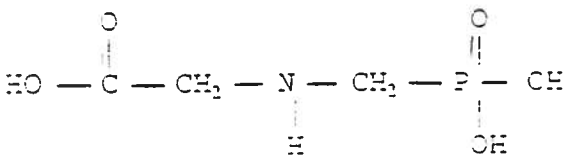
STUDIES ON THE FATE OF 2,4-D AND GLYPHOSATE HERBICIDES AFTER SPRAY IN WAZIMENYA BAY

JUDE NYANGABABO T.
CHEMISTRY DEPARTMENT, MAKERERE UNIVERSITY
P O BOX 7062 KAMPALA

Introduction

a) Glyphosate:

Glyphosate, N-(phosphonomethyl)glycine which is shown below is a systemic herbicide used to kill broad-leaves, grass species. It is used to control weeds in agricultural, aquatic and forestry situations:



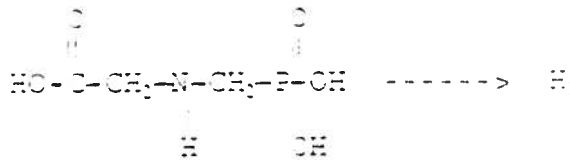
m.wt = 169.1

Glyphosate products are manufactured by Monsanto Company. The herbicide is marketed under a variety of trade names: Round up and this includes

- Round up D-Pak
- Round up Lawn
- Round up Ready-to-use.
- Rodeo, Accord and vision as the most common U.S. trade names.

The mode of action of glyphosate probably arises from the inhibition of the biosynthesis of aromatic amino acids. These amino acids, phenyl alanine, tyrosine, and tryptophan, are used in the synthesis of proteins. Glyphosate may also inhibit enzymes, chlorismate mutase and prephremate hydrarase involved in the same synthesis. These enzymes are all part of what is called the <u>shikimic acid pathway</u> present in high plants but not in animals.

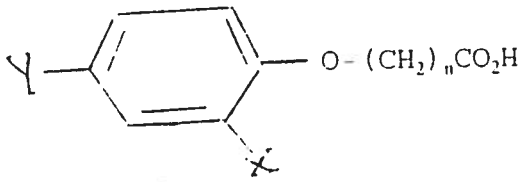
Considerable interest in this compound has risen owing to its efficacy and unique mode of action as an inhibitor of the biosynthesis of aromatic amino acids. In an environment, Rodeo breaks up into smaller molecules:



This biotransformation process renders glyphosate to loose its identity.

b) 2-4-D (weeder)

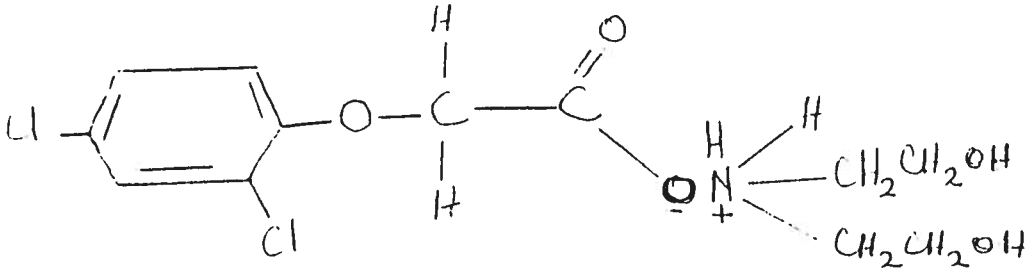
These compounds are best described as auxin-type growth regulators. They have the general formula



Y = X = Cl and n ≥ 1

Studies have indicated that the herbicidal activity alternates along the series - those members possessing an odd number of n in the side-chain are active whereas those with even number are inactive. All the phenoxy herbicides act to mimic natural plant growth hormones. Introduction of high levels of this hormone in responsive plant tissue causes the cell wall to take up water at a faster rate than normal, producing elongation in the stem, little or no growth, with leaves that are deficient in chlorophyll. At this point, the normal physiological functions collapse and this causes death. It is worth nothing that environment can detoxify 2,4-D in 1 to 4 weeks; the rate depends on local conditions of moisture, temperature, aeration and the exact formulation used.

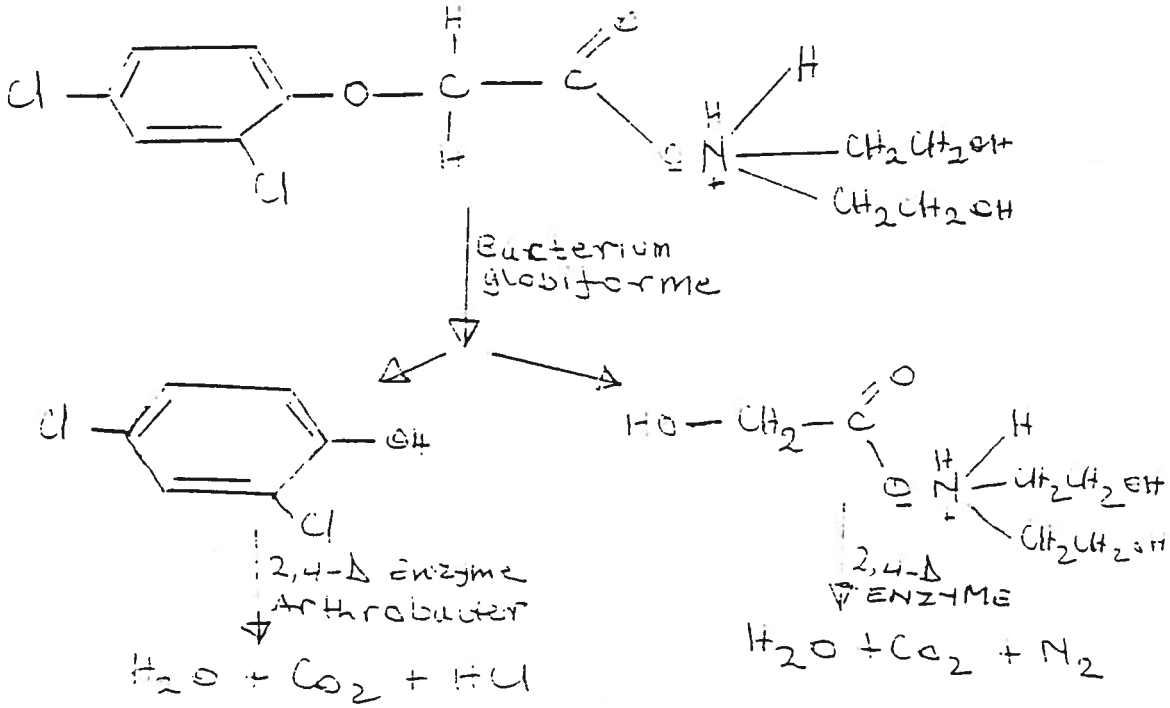
The acid form of 2,4-D is only slightly soluble in water, so it is not applied as a water spray. The sodium and ammonium salts are water soluble powders. But they are not soluble enough to be applied in low-gallonage equipment at high rates of application. The amine salts have therefore replaced the sodium and ammonium salts of 2,4,D- because the amine salts are more easily mixed with water. The most common amines salts sold are diethylamine, triethanolamine, dimethylamine, trimethylamine, triethylamine or mixtures of these. The structure of the diethanolamine salt used in the lake trials is:



This formulation is always simply refereed to as 2,4-D diamine. when it is dissolved in water, it dissociates into free ions which can combine with other ions in the solution or environment. Calcium and Magnesium salts of 2,4-D are only slightly soluble in water. Thus if present in the environment, a precipitate may be formed which will settle at the bottom of the lake.

2,4-D has been shown to be biodegradable in an environment by several workers[1,3,4]. Others[5] have enlisted numerous microorganisms which are capable of degrading 2,4-D. Several environmental conditions under which 2,4-D would persist or be biodegraded in natural lake waters have already been investigated[6]. It was found that in warm aerobic waters, 2,4-D was biodegraded apparently, within six days whereas 2,4-D persisted for as long as 80 days in cold deoxygenated waters.

It becomes apparent from the above literature review that 2,4-D in degraded quite readily in environments where conditions are favourable. The ultimate biodegradation of 2,4-D is assumed to follow the reaction mechanisms.



<u>Calculation of Active Ingredient in the Tank Mix</u>

a) Redeo

Liquid formulation containing 648g/litre of glyphosate
Volume of water used = 140 litres
Volume of surfactant used = 0.35 litres
Volume of Redeo used = 1.4 litres
Total volume of mixture = 141.75 Litres

One litre of formulation ≡ 648g
∴ 1.4 litres will contain = 648 x 1.4

∴ 141.75 litres of mixture ≡ 907.2g
∴ 1 litre of mixture ≡ 6.4g
≡ 6.4×10^3 mgL^{-1}
= 6400 $mgKg^{-1}$

b) **Weeder 64**

Liquid Formulation containing	1.81kg/3.78 litre of weeder 64
	= 0.47884 KgL^{-1}
	= 479 g/ litre formulation
Volume of water used	= 374 litres
Volume of weeder taken	= 1.86 litres
Total volume of mixture	= 375.86 litres
One litre of formulation	≡ 479g

∴ 1.86 litres	≡	890.94g active ingredient
∴ 375.86 litres of mixture	≡	890.94g
1 litre of mixture	≡	$2.4 \times 10^{1} mgL^{-1}$
	=	2400 $mgKg^{-1}$.

MATERIALS AND PROCEDURES

Determination of Rodeo and weeder residues in water, sediment fish and inland samples.

The determination of Rodeo and weeder residues in the sample (water, sediment, fish, inland water and soil) were determined by chemistry Department, Analylitical Chemistry Section. Makerere University. The analysis was not necessarily carried out after collection of the samples. The samples were however, kept at how temperature of approximately 4°C. A literature survey together with practical procedures developed were carried out on special samples for each of the test materials. This lead to the requirement for recovery determinations to be carried out. The MONSANTO S.,A. EUROPE Supplied Rodeo and weeder 64 standards were used for calibration purposes.

SAMPLE COLLECTION

Over a month period, water, sediment and fish samples were systematically collected from plots A, B, C, D and E dermacarted within wazimerya bay. Water and sediment samples were also collected on an occasional basis from inland boreholes constructed in the vicinity of A, B, C and D plots.

Water samples

These were taken at various sampling stations, 0,1,2, and 3 within a plot. The samples were collected in clean glass bottles (1 litres) provided with a screw-top. Duplicate samples were taken at each sampling station. The samples were kept in polystyrene container which was maintained at very low temperature with ice blocks. Prior to spraying, all the plots and the inland boreholes were sampled.

Sediment samples

These samples were taken in jars (250cm^3) with screw-tops. They were also kept at low temperature using ice blocks.

Fish samples

Fish was trapped with fish-net in the vicinity of the experimental plots. Several fish were caught at different occasions. They were also kept at low temperatures.

Spray Samples

A sample of the spray solution was taken from the tank of the pump. These samples were taken to the laboratory for analysis so that the uniformity of the diluted formulation can be checked.

ANALYTICAL PROCEDURES

i) 2,4-D (weeder 64)

Water samples

A portion of water was extracted with a mixture of dichloromethane and hexane (1:1 vol.). The extract obtained was evaporated on a water both till a residue was left behind. The residue was dissolved in methanol in a volumetric flask of 10cm^3. A portion of this solution (7cm^3) was placed into the electrolysis cell. The measurements were performed in the differential pulse mode.

SEDIMENT SAMPLES

The sample of sediment was ground with anhydrous sodium sulphate until fine powder was obtained. This powder was then extracted using a mixture of dichloromethane and hexane (1:1 vol). The procedure followed hereafter is similar to that outlined for water samples.

Fish Samples

The method used for the analysis of fish samples is similar to that outlined for the sediment samples.

ii) Glyphosate (Rodeo)

Water samples

Water sample (250cm^3) was allowed to percolate through the column (Dowex 1,8X anion-exchange resin, 50 - 100 mesh, chloride form) at a rate of 10cm^3 min^{-1} followed by 25cm^3 potassium hydroxide. The percolates were discarded. The column was then eluted with dilute hydrochloric acid at the same rate. The first 2.5cm^3 were discarded and the next 10cm^3 of eluate collected. The eluate was then evaporated on a water bath to approximately 2cm^3.

To the 2cm³ eluate fraction was added 1cm³ of sulphuric acid (1+1), 0.5cm³ of potassium bromide and 0.5cm of sodium nitrite solution. The mixture was swirled and left to stand for 10 minutes and then 0.5cm3 of ammonium sulphamate solution added.

The final solution was transferred into the electrolysis cell and the measurements performed in the differential pulse mode.

Sediment samples

The sediment samples were treated with aqueous potassium hydroxide solution. The mixture was then filtered and the solid discarded. The filtrate obtained was passed through the procedure outlined for water samples above.

Fish samples

Fish samples were ground with anhydrous sodium sulphate until in powder form. This was then treated with aqueous potassium hydroxide and the mixture filtered. The filtrate obtained was passed through the procedure outlined for water samples above.

Polarographic analyzer/stripping Voltammeter

Operating parameters for the analysis of weeder 64 and Rodeo

Parameter	Weeder 64	Rodeo
Operating mode	DPASV	DPP
Cut off potential (V)	+0.30	-0.60
Potential range (V)	0.40	0.50
Current range (μA)	100	50
Scan rate (mv/sec)	5	5
Drop size	small	small
Deposition time (sec)	30	-
Equilibrium time (sec)	15	-

RESULTS

The results of analyses for Rodeo and weeder in water samples are indicated in Table 1 and 2 respectively. Those for sediment samples, fish and inland samples are also shown in Table 3,4 and 5.

TABLE 1. RODEO RESIDUES IN WATER SAMPLES ($\mu g\ Kg^{-1}$)

DAYS AFTER SPRAY	SAMPLING LOCATION	PLOT NUMBER		
		A	D	E
0	0	ND	ND	ND
	1	ND	ND	ND
	2	ND	ND	ND
	3	ND	ND	ND
2/24(1)	0	245	208	ND
	1	204	150	ND
	2	17	73	ND
	3	ND	ND	ND
1(2)	0	21.60	17.60	ND
	1	14.30	13.40	ND
	2	5.05	10.90	ND
	3	ND	ND	ND
2(3)	0	8.61	5.04	ND
	1	5.55	5.17	ND
	2	0.16	0.58	ND
	3	ND	ND	ND
7(4)	0	0.13	0.15	ND
	1	0.09	0.12	ND
	2	0.01	0.08	ND
	3	ND	ND	ND
14(5)	0	0.02	0.01	ND
	1	0.01	<0.01	ND
	2	<0.01	<0.01	ND
	3	ND	ND	ND
21(6)	0	0.01	<0.01	ND
	1	ND	ND	ND
	2	ND	ND	ND
	3	ND	ND	ND
30(7)	0	ND	ND	ND
	1	ND	ND	ND
	2	ND	ND	ND
	3	ND	ND	ND

TABLE 2. WEEDER RESIDUES IN WATER SAMPLES ($\mu g\ Kg^{-1}$)

DAYS AFTER SPARY	SAMPLING LOCATION	PLOT NUMBER B	C	E
0	0	ND	ND	ND
	1	ND	ND	ND
	2	ND	ND	ND
	3	ND	ND	ND
2/24	0	151	175	0.04
	1	129	166	0.08
	2	24	115	ND
	3	ND	ND	ND
1	0	38	43	ND
	1	21	29	ND
	2	3.10	2.30	ND
	3	ND	ND	ND
2	0	5.12	2.70	ND
	1	0.22	0.10	ND
	2	0.04	0.02	ND
	3	ND	ND	ND
7	0	1.25	0.08	ND
	1	0.01	0.01	ND
	2	0.01	<0.01	ND
	3	ND	ND	ND
14	0	0.06	<0.01	ND
	1	0.01	ND	ND
	2	ND	ND	ND
	3	ND	ND	ND
21	0	0.02	ND	ND
	1	ND	ND	ND
	2	ND	ND	ND
	3	ND	ND	ND
30	0	<0.01	<0.01	ND
	1	ND	ND	ND
	2	ND	ND	ND
	3	ND	ND	ND

TABLE 3. WEEDER 64 RESIDUES IN SEDIMENTS SAMPLES (mg Kg^{-1})

DAYS AFTER SPRAY	SAMPLING LOCATION	PLOT NUMBER		
		B	C	E
0	0	ND	ND	ND
	2	ND	ND	ND
2/24(1)	0	<0.001	0.001	ND
	2	<0.001	<0.001	ND
14(5)	0	<0.001	0.002	ND
	2	<0.001	<0.001	ND
30(7)	0	ND	<0.001	0.002
	2	ND	<0.001	<0.001

TABLE 4. RODEO RESIDUES IN SEDIMENTS (mg Kg^{-1})

DAYS AFTER SPRAY	SAMPLING LOCATION	PLOT NUMBER		
		A	D	E
O	0	ND	ND	ND
	2	ND	ND	ND
2/24(1)	0	<0.001	0.001	ND
	2	ND	ND	ND
14(5)	0	0.0	0.001	ND
	2	0.001	0.001	ND
30(7)	0	ND	ND	ND
	2	ND	ND	ND

TABLE 5: RODEO AND WEEDER 64 RESIDUES IN FISH SAMPLES (mg Kg^{-1})

Sample Number	Rodeo	Weeder 64
PLOT D (BIG)	ND	ND
PLOT A (MEDIUM)	ND	ND
USA. (FISH)	0.02	<0.01

TABLE 6: RODEO AND WEEDER 64 RESIDUES IN INLAND SOIL AND WATER (mgKg^{-1})

DAYS AFTER SPRAY	RODES				WEEDER 64			
	SOIL		WATER		SOIL		WATER	
	A	D	A	D	B	C	B	C
0	ND	ND	ND	ND	ND	ND	ND	ND
7	ND	ND	ND	ND	ND	ND	ND	ND
30	ND	ND	-	-	ND	ND	-	-

ENTEBBE SAMPLES

Sample number	2,4-(weeder 64)	Glyhosate (Rodeo)
1. SEDIMENTS (20/3/97)	ND	ND
2. RAW WATER (INTAKE) 20/3/97)	ND	ND
3. WEED (INTAKE) 20/3/97)	ND	ND

In the Table below, are the percentages of recovery after extraction from water sparking with 100,10 and 1μgKg^{-1}

Herbicide	Recovery Percentage		
	100μg Kg^{-1}	10μgKg^{-1}	1μgKg^{-1}
Redeo	90 ± 7	102 ± 4	94 ± 8
Weeder 64	97 ± 11	88 ± 9	96 ± 3

As it can be seen recovery is practically independent of the initial concentration.

The highest concentration of Rodeo (245μgKg^{-1}) were observed on the first day of spraying in plot A (sampling location O) and in plot C (sampling location O) respectively. The result of Tables 1 and 2, show that there is a tremendous decrease in herbicide levels. It is clear that after 21 days from the date of spray, both herbicides (Rodeo and weeder 64) have completely degraded.

Redeo and Weeder 64 residues in sediments are generally absent. In some cases the levels are much less than 0.001 mg Kg^{1}. The case of fish cannot be fully examined because attempts to confine some species to various plots failed. So any fish that was caught in the vicinity of any plot could not be surely regarded as a resident of that plot. However, in one of the fish caught, there were some traces of herbicides found. The results of inland water and soil samples, show that no herbicide residues were detected. An indication that no herbicide migrated by any route to contaminate the local source of domestic water.

The analysis of tank spray solution indicated the concentrations of 1840 $mgKg^{1}$ for weeder 64 and 4980 $mgKg^{1}$ for Rodeo.

CONCLUSION

A clear advantage of the two herbicides, Rodeo and weeder 64, is their low toxicity to non-targeted organisms. This was evidenced, in this study, by the herbicides having no direct influence on fish (e.g. fish deaths). The herbicides residues were very low in water and sediments. This was an indication that the spray mechanisms was efficient and effective in hitting the target.

A more advantage to the herbicides was that their effect on the water hyacinth, was gradual. This of course depended on the spray dose received and the state of health each individual plant is in. This minimized massive decay which would otherwise have caused depletion of oxygen in the lake water. The fact that the herbicide residues in water at 100 metre-sampling station, were very low indicates that the herbicides under our conditions are non-volatile. This means they cannot give of vapour that may kill or injure susceptible plants. As far as degradation is concerned the herbicides residues are broken down by several processes, some of which are biodegradation and photolysis reactions. Photolysis inevitably plays its part. In the decomposition by microorganisms, the growth and activity of these organisms is affected by food supply, environment temperature, environment moisture, and aeration.

With the type of tropical environment prevailing, the low levels of herbicides should be decomposed within 1 to 4 weeks. There is no risk of herbicides accumulating in the environment from one year to the next one under such conditions. The disadvantage of slow exacted effect by the herbicides created a situation where live water hyacinth and dead water hyacinth mixed. This would interfere with respraying and make operations more expensive.

SUMMARY

The herbicides Rodeo and weeder 64 have shown their effectiveness as far as the control of the water Hyacinth is concerned. The fact that there were no direct ill effects on the fish, shows that the two herbicides are friendly. The studies carried out show that biodegration of Rodeo and weeder is very rapid. This is expected as the climatic conditions prevailing in this region is very conducive to the growth and activity of microorganisms. By scanning through the results of the study, it can be concluded that the two herbicides can effectively be used in the control of water hyacinth with assured safety.

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ANNEX C

THE EFFECT OF RODEO AND WEEDAR 64 ON WATER QUALITY IN THE TREATMENT OF WATER HYACINTH IN WAZIMENYA BAY, LAKE VICTORIA

THE EFFECT OF GLYPHOSATE AND 2, 4-D ON WATER QUALITY IN THE HERBICIDAL CONTROL OF WATER HYACINTH IN WAZIMENYA BAY, LAKE VICTORIA-UGANDA

A REPORT ON THE IN LAKE HERBICIDE TRAIL WAZIMENYA BAY LAKE VICTORIA, UGANDA

WATER HYACINTH CONTROL PROGRAM

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INTRODUCTION

Water hyacinth *Eichhornia crassipes* (Mart) Solms was first seen in Ugandan waters in 1988 (Twongo, 1991; Twongo, *et al* 1995; Orach-Maza, 1996, Matagi 1997). Since then proliferation has reached large proportions covering much of the upper Nile system, including Lake Victoria. In Lake Victoria large tonnage of water hyacinth mats of up to 500,000 tonnes are known to float on the lake where they block fish landing sites, train ferry piers, water abstraction points and decomposing debris chock the screens at the turbine chambers and blocks the cooling system of the transformers at the Hydro-electric power generation station in Jinja (NTCWH, 1995; Matagi, 1997).

In the initial stages of attempting to solve the water hyacinth menace, the government of Uganda designed a multi-facilitated control program using mechanical, manual and biological methods (Baarveld, 1995; NTCWH, 1995; Orach-Maza, 1996). However, the public was disappointed when these recommended remedies both individually and collectively failed to control the water hyacinth. The reason for this failure was simple! The above control methods removed far much less than the reproductive rate of water hyacinth. It is on record that one water hyacinth plant can produce upto 1 million plants in a year if the conditions are favourable (Harley, 1990; Akinyenminyu, 1993). Therefore for any control measure that is worth mentioning, it must be able to match the proliferation rate of water hyacinth.

The control of water hyacinth using herbicides was initially left out by the Uganda government authorities largely because of their toxicology effects. But as it became evident that the control measures mentioned above wouldn't check the spread of the water hyacinth and the Ugandan economy was beginning to suffer, government was forced to reconsider the use of herbicides. This resulted in the so called integrated approach which was recommended by the National Technical Committee on the Control and Management of Water Hyacinth (NTCWH, 1995). The integrated approach included the earlier control methods and added the herbicide option.

The use of herbicides caused plethora both in parliament and the press. Accusations and counter accusations were traded. Criticism from the public, politicians and academia were made. Both proponents and opponents of herbicides went out of their way and the reasons given by both sides were more emotional rather than rational and for the first time

the Ugandan public became hysterical over an environmental issue. As the issue of to use or not to use chemicals became contentious and polarised the general public (Rushedge, 1996) a multi-disciplinary team of eminent Ugandan scientists composed of a weed scientist, fish biologist, soil scientist, toxicologist, water quality specialist, environmentalist, public health specialist, analytical chemist and limnologists from lead institutions in the country, were assembled under the auspices of National Agricultural Research Organisations (NARO) and constituted the Chemical Verification Committee, a sub-committee of the National Technical Committee on the Control and Management of Water Hyacinth.

In its systematic approach of using herbicides, the sub-committee scanned through literature and finally selected three candidate herbicides namely glyphosate, diquat and 2,4-D. Laboratory level, experiments were carried out at Kituza Coffee Research Station and optimum concentration dosage of each herbicide were determined (Wetala, 1996). At Kajjansi, the three herbicides were sprayed at their optimum concentration on three separate ponds previously stocked with water hyacinth, macro-invertebrates, water and plankton life from a nearby excavated man made lake that had been infested with water hyacinth. Commercial fish species from a near by fish breeding station had also been introduced into the ponds to stimulate a complete lake environment. The findings of this sub-committee are recorded elsewhere (NTCWH, 1996).

It was on the recommendations of the Chemical Verification Committee that an in-lake herbicide trail was conducted by the Water Hyacinth Unit of the Department of Fisheries with technical assistance from Aquatics Unlimited. On 11 Th. February 1996, two herbicide brands: glyphosate (Rodeo 6.99 l/ha) and 2,4-D (Weeder 9.34 l/ha) were sprayed in inner Wezimenya bay, of lake Victoria. For 30 days the experimental plots were monitored and the effect of herbicidal treatment on water quality are presented.

STUDY AREA

The in-lake herbicide trail was conducted in inner Wazimenya bay, which is part of the large Wazimenya bay, itself being an offshoot of Murchison Bay (Fig. 1). Murchison bay is an extensive irregular shaped inlet in the north-eastern corner of lake Victoria which extends inland 24 km along the north axis. Murchison Bay is cut off from the open lake water of lake Victoria by the over laying Sese Islands and three constrictions further north. The most significant area to the present study is inner Wezimenya bay, that is found at the

In Lake Herbicide Trials (02-97)

Fig 1

north-east tip of Wezimenya bay. The bathymetric parameters of inner Wezimenya bay are given in Table 1.

Table 1.

The bathymetric parameters of Wazimenya Bay, Lake Victoria-Uganda

Parameter	Measurement
Surface area	4.15km^2
Shoreline length	5.2km
Length of bay	2.3km
Latitude	00^0 05' - 00^0 18' N
Longitude	32^0 33' - 32^0 41' E
Altitude	1133m
Volume	8.29 x 10^{6}m^3

The catchment area is made up of hills that rise about 85m above the water level. The hills have flat hill tops typical of Buganda (Hickman and Dickins, 1991). The hills were once heavily covered by highland forest which now show signs of degradation and encroachment due to the small scale non-uniform farming methods (Forest Department, 1996).

The spray site was 12km from Gaba I and Gaba II water works the main water abstraction points for Kampala, the capital city of Uganda. The city centre was located 20km away from the spray site. Inner Wezimenya bay has a fairly circulated shoreline with a papyrus swamp on its north-east fringe. The dominant plant in the swamp is *Cyperus papyrus*. A residential floating water hyacinth mat stretched 2.5km with a width of 10-20m. It was permanently attached to the papyrus, was demarcated into experimental plots.

Five test plots designed as A, B, C, D and E of 0.2ha were demarcated on the water-hyacinth mat. Plot A and D were sprayed with glyphosate, plot B and C were sprayed with 2,4-D and plot E was the control.

Plot A started on the border of Busoke and Mubanda villages. The shoreline vegetation was primarily made up of papyrus, phragamites and fern. The plot was treated with glyphosate (Rodeo 6.99 l/ha; 4.56 kg/ha a.i).

Plot E was located 150m NE from plot A. The shoreline vegetation was made up of primarily hippo grass. This plot was the control and received no treatment.

Plot B was located approximately 150m NE of Plot E. The shore line vegetation was primarily made up of hippo grass. The plot was sprayed with 2,4-D (Weeder 9.34 l/ha; 4.47 kg/ha a.i).

Plot C was located 150m NE of plot B. The shoreline vegetation is primarily made up of papyrus, hippo grass and fern. The plot was treated with 2,4-D (Weeder 9.34 l/ha 4.47 kg/ha a.i)

Plot D was located 200m NE of plot C. The shoreline vegetation was made of papyrus with fern. The plot was treated with glyphosate (Rodeo 6.99 kg/ha; 4.56 kg/ha a.i).

In each experimental plot water samples were collected from four sampling stations designated as 0, 1, 2 and 3. Station 0 was 5m inside the water hyacinth mat, Station 1 was at the water hyacinth mat-open water interphase i.e. edge, station 2 was 30m in open water and station 4 was 100m in the open water. These sampling stations at each plot have been designated as -5m, 0m, 30m and 100m indicating their relative distance with the water hyacinth mat Table 3.

MATERIALS AND METHODS

On 10th February, 1997 pre-treatment water samples were collected from all sampling stations and analysed. Then on 11th February 1997 the experimental plots were sprayed using a motorised pump from a boat. Then water samples were collected after 2 hours, 1 day, 2 days, 7 days, 14 days, 21 days and 30 days after spraying.

At each plot, water samples were collected at 5m inside the water hyacinth mat (station 0); at the edge of the water hyacinth mat-open water interphase (station 1), 30m in open water (station 2) and 100m in open water (station 3). At each station water samples were drawn 0.5m below water surface using a Van Dorn water sampler. Water samples were

Table 2.

A summary of the water quality status in Wazimenya Bay, Lake Victoria-Uganda.

Parameter	unit	n	mean	min.	max.	SD
Depth	m	153	2.24	0.84	6.36	1.25
Secchi Depth	m	153	0.97	0.01	1.64	0.31
Temperature	°c	145	26.5	24.5	28.2	0.81
pH	valve	146		4.76	8.63	
Dissolved Oxygen	mg/l	142	4.43	0.53	7.13	1.6
Dissolved Oxygen Percentage Saturation	%	152	62.8	7.8	101.4	23.1
Reactive phosphate	mg/l	152	0.03	0.0	0.42	0.068
Total phosphorus	"	152	0.21	0.01	1.33	0.17
Nitrite	"	152	0.004	0.0	0.016	0.002
Nitrate	"	152	0.076	0.02	0.106	0.014

SD = Standard derivation n = No

There was progressive increase in secchi depth as we moved away from the shore stations to the 100m open water stations; Table 3 and Fig. 2. However, this may be misleading giving the impression that stations at 100m had better transparency. On the contrary stations inside the water hyacinth mat had good visibility, at times we were able to see the lake bottom. The factor which made the water hyacinth mat stations appear to have shorter transparency was that the depth was also short (Table 2). Residential water hyacinth is known to improve optical density, turbidity, color and suspended solids (Timmer and Weldon, 1967). This is because water hyacinth roots are known to have electrostatic forces which attract negatively charged suspended particles (Matagi, 1996). This removes the suspended particles hence increasing transparency. The attracted particles form slimy floc-like materials round the roots (per obs.). Secchi depth is an indirect way of measuring algal biomass and values with less than 1m are associated with hypereutrophic conditions (EPA, 1980). The overall secchi depth of Wazimenya Bay was 0.97m which is an indication of eutrophication. This is confirmed by the casual observations of algal blooms which were seen during the sampling period. Chlorophyll 'a' and phytoplankton results reported elsewhere in this report confirm the eutrophic status of the lake.

Table 3 Water quality parameters at each sampling station in Wazimenya Bay Lake Victoria - Uganda

Station	Distance	Depth (m)					Secchi Depth (m)					Temp (°C)					pH (value)			Dissolved Oxygen (mg/l)				
		n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	min	max	n	mean	min	max	sd
A0	-5m	6	0.93	0.54	1.06	0.16	6	0.685	0.4	0.65	0.16	24	25.4	24.3	28.1	1.12	16	4.72	7.9	23	3.57	0.4	6.1	1.46
A1	0m	6	1.06	0.94	1.35	0.13	6	0.85	0.40	*	0.19	24	25.3	24.7	27.7	0.92	16	4.87	7.66	23	4.32	2	6.3	1.27
A2	30m	6	2.4	1.49	3.64	0.66	6	1.19	0.96	1.63	2.13	24	25.8	25.2	26.2	1.01	15	6.12	8.62	23	5.23	2.6	7.2	1.51
A3	100m	6	3.54	2.06	5.62	1.12	6	1.11	0.62	1.54	0.21	24	25.7	25.4	26.6	0.96	16	5.71	8.64	23	5.5	1.9	*	1.39
B0	-5m	6	1.06	1	1.24	0.09	6	0.623	0.33	0.95	0.242	22	26.5	25.2	29	1.02	14	5.56	7.74	23	3.18	*	5.4	1.4
B1	0m	6	1.2	*	1.46	0.19	6	0.599	0.5	1.05	0.186	23	26.6	25.6	29.1	0.92	16	5.54	8.27	23	4.05	1.5	6.3	1.56
B2	30m	6	2.51	1.9	3.86	0.73	6	1.026	0.83	1.28	0.174	23	25.7	25.7	28.3	0.81	14	6.59	8.45	24	4.85	2	7	1.71
B3	100m	6	3.55	1.5	6.36	1.54	6	1.07	*	1.19	0.054	23	25.7	25.7	26	0.73	13	5.71	8.61	23	5.18	2	7.1	1.76
C0	-5m	6	1.3	1.16	1.55	0.15	6	0.69	0.42	*	2	16	25.2	25.1	28.3	0.92	12	6.94	7.85	16	3.33	0.6	5.9	1.57
C1	0m	6	1.41	1.3	1.56	0.09	6	0.925	0.1	1.32	0.43	16	25.5	25.4	28.1	0.81	12	5.54	7.85	16	4.34	1.5	6.1	1.36
C2	30m	6	2.59	2.56	3.5	0.32	6	1.29	0.94	1.64	0.231	16	25.6	25.7	27.9	0.78	12	6.98	7.6	16	4.81	1.3	6.6	1.7
C3	100m	7	4.24	3.13	5.18	0.84	7	1.15	1.07	1.3	0.084	21	25.5	25.5	26.3	0.85	14	6.3	7.9	21	4.85	1.4	6.3	1.59
D0	-5m	6	1.66	1.36	1.92	0.16	6	1.12	0.7	1.5	0.32	24	25.3	25.5	27.4	0.56	16	5.76	7.73	24	3.65	0.4	6.1	1.57
D1	0m	6	2.07	1.85	2.5	0.2	6	1.14	0.9	1.5	0.23	24	25.4	25.6	27.5	0.57	16	7.05	8.05	24	4.47	0.6	6.3	1.69
D2	30m	6	2.66	2.4	2.85	0.16	6	1.19	*	1.4	0.15	24	25.5	25.7	27.9	0.62	16	6.93	8.22	24	4.83	0.6	7.1	1.89
D3	100m	6	3.82	3.05	4.56	0.52	6	1.23	0.85	1.45	0.216	24	25.5	25.6	28	0.66	24	7.65	8.41	24	4.64	1.3	7.1	1.84
E0	-5m	6	0.6	0.37	0.8	0.15	6	0.59	0.37	0.8	0.16	23	26.2	24.4	26	0.98	14	5.8	7.7	23	3	0.8	5.6	1.55
E1	0m	6	1.04	0.98	1.12	0.05	6	0.67	0.56	1	26.7	23	26.4	25	29	0.85	16	5.56	8.09	23	4.31	1.6	6.3	1.56
E2	30m	6	2.67	1.73	5	1.07	7	1.02	0.77	1.2	0.13	23	25.6	25.4	28.6	0.88	16	5.37	8.51	23	5.27	3.2	6.9	1.36
E3	100m	6	3.86	3.27	4.8	0.5	6	*	*	1.27	0.12	23	25.6	25.6	25.6	0.77	16	5.37	8.5	23	5.23	2.4	7	1.45

Temperature

The temperature ranged from 24.5 to 28.2°C with a mean of 26.5°C, Table 2. This is within the acceptable range for tropical lakes. There was no significant difference between herbicide treatment and the control. There were significant differences between stations. There was slight progressive increase in temperature from the shore stations into the open water, with water hyacinth mat stations having the lowest; Table 3 and Fig. 3. The water hyacinth has an insulating effect (Ultsch, 1973; Schreiner, 1980). The findings of this study concur with those of Schreiner (1980) who observed that the insulating capacity of water hyacinth mat was greater towards the shore and decreased outwards into open water.

pH

The pH ranged from 4.76 to 8.63; Table 2. There was no significant difference between the treatment and the control. However, there was significant difference between the stations ($p = 0.001$). pH was lowest at the mat stations and progressively increased into open water; Table 3 and Fig. 4. The mat stations had pH which is in the acidic range while the open surface water slightly alkaline. These findings concur with McVea and Boyd (1975) and Twongo *et al* (1995) who found that pH was lowest in water hyacinth mats on the shore and increases into open water. Schreiner (1980) attributed this difference to the different rate of CO_2 production by phytoplankton, while NTCWH (1996) also attributed the low pH in the mat due to decomposition of debris which released humic and organic acids leading to reduction in pH values to the acid side of the pH scale.

Dissolved oxygen and percentage saturation

Oxygen is the most important parameter of fresh water after water itself (Wetzel, 1983; Matagi, 1993). It is essential in the metabolism of all aerobic aquatic organisms and is a precondition for the existence and maintenance of aquatic life (Matagi, 1993). It is also responsible for the nature and diversity of aquatic communities, the solubility of several ions and the release of nutrients from sediments (Matagi, 1993). Dissolved oxygen in the study area ranged from 0.53 to 7.13 mg/l with a mean of 4.43 mg/l., Table 2. Percentage saturation of dissolved oxygen also ranged from 7.8% to 101.4% with a mean of 62.8%,

Table 3 Water quality parameters at each sampling station in Wazimenya Bay, Lake Victoria - Uganda

Station		Oxygen % saturation					Phosphate (mg/l)					Total Phosphate (mg/l)					Nitrite (mg/l)					Nitrate (mg/l)				
	Distance	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd
A0	-5m	23	51.7	15.1	85.1	19.9	6	0.075	0.01	0.42	0.14	6	0.286	0.1	0.9	0.256	6	0.006	0.003	0.011	0.003	8	0.0753	0.06	0.086	0.009
A1	0m	23	63	31.6	90.5	16.9	6	0.01	0.01	0.02	0	6	0.23	0.04	0.38	0.12	6	0.0045	0.003	0.006	0.009	6	0.07	0.05	0.09	0.01
A2	30m	23	74.4	37.6	102	21.1	6	0.012	0	0.03	0.01	6	0.16	0.02	0.22	0.065	6	0.005	0.002	0.008	0.002	7	0.08	0.06	0.096	0.014
A3	100m	23	76.2	19.6	101	20.3	6	0.025	0.01	0.09	0.029	6	0.181	0.11	0.24	0.052	6	0.004	0.001	0.006	0.002	6	0.07	0.034	0.086	0.017
B0	-5m	23	43.6	15.4	74.3	20.9	6	0.041	0.01	0.15	0.05	6	0.251	0.1	0.55	0.14	6	0.005	0.001	0.01	0.003	8	0.078	0.07	0.094	0.008
B1	0m	23	58.7	22.5	90.2	23.4	6	0.028	0	0.16	0.054	6	0.176	0.02	0.33	0.089	6	0.005	0.003	0.008	0.001	6	0.0775	0.06	0.092	0.0097
B2	30m	24	65.6	27.4	95	25.3	6	0.028	0	0.16	0.053	6	0.004	0.002	0.006	0.001	6	0.004	0.002	0.006	0.001	8	0.074	0.038	0.091	0.017
B3	100m	23	77.9	29.1	112	25.6	6	0.014	0	0.04	0.012	6	0.16	0.02	0.27	0.09	6	0.005	0.002	0.006	0.002	6	0.075	0.06	0.102	0.012
C0	-5m	6	45	18.5	0.06	0.0207	6	0.027	0.01	0.06	0.021	6	0.262	0.04	0.54	0.167	6	0.007	0.003	0.16	0.005	6	0.077	0.05	0.1	0.017
C1	0m	16	62.5	22.5	89.6	19.9	6	0.015	0	0.04	0.014	6	0.21	0.05	0.38	0.107	6	0.004	0.003	0.006	0.001	6	0.079	0.05	0.1	0.017
C2	30m	16	67	19.8	91.6	23.1	6	0.02	0.01	0.06	0.02	6	0.153	0.01	0.32	0.112	6	0.004	0.003	0.006	0.001	6	0.077	0.06	0.092	0.0138
C3	100m	21	67.9	20.1	90.2	21.8	7	0.019	0	0.05	0.016	7	0.21	0.04	0.45	0.17	7	0.004	0.002	0.006	0.001	7	0.06	0.06	0.092	0.01
D0	-5m	24	49.4	5.5	84.1	20.7	6	0.075	0.01	0.36	4	9	0.32	0.05	0.73	0.27	6	0.006	0.003	0.015	0.004	6	0.076	0.06	0.092	0.01
D1	0m	24	62.3	11.2	90	24.3	6	0.03	0	0.2	0.06	6	0.19	0.03	0.56	0.17	6	0.0041	0.001	0.006	0.0016	6	0.079	0.06	0.09	0.015
D2	30m	24	68.7	13.3	101	26	6	0.02	0	0.06	0.025	6	0.15	0.02	0.3	0.096	6	0.004	0.001	0.006	0.001	6	0.081	0.06	0.094	0.0116
D3	100m	24	69.6	18.2	103	26.4	6	0.02	0	0.06	0.02	6	0.161	0.04	0.32	0.09	6	0.004	0.001	0.006	0.002	6	0.082	0.06	0.094	0.01
E0	-5m	23	43.4	16.9	82.6	20.5	6	0.08	0	0.31	0.11	6	0.36	0.02	1.33	0.446	0.6	0.004	0.001	0.007	0.003	6	0.08	0.06	0.089	0.01
E1	0m	21	61	26.3	93.6	23.7	7	0.024	0.01	0.08	0.025	7	0.21	0.03	0.45	0.13	7	0.004	0.001	0.008	0.025	7	0.07	0.02	0.096	0.027
E2	30m	23	74.7	46.9	97.1	18.2	6	0.02	0	0.09	0.029	6	0.183	0.04	0.36	0.1	6	0.003	0	0.005	0.002	6	0.07	0.03	0.11	0.02
E3	100m	23	74.5	34	100	20.9	6	0.03	0	0.1	0.036	6	0.166	0.04	0.27	0.077	6	0.003	0.001	0.005	0.002	6	0.07	0.03	0.086	0.0175

Fig. 3

Changes in temperature at different stations
after treatment application

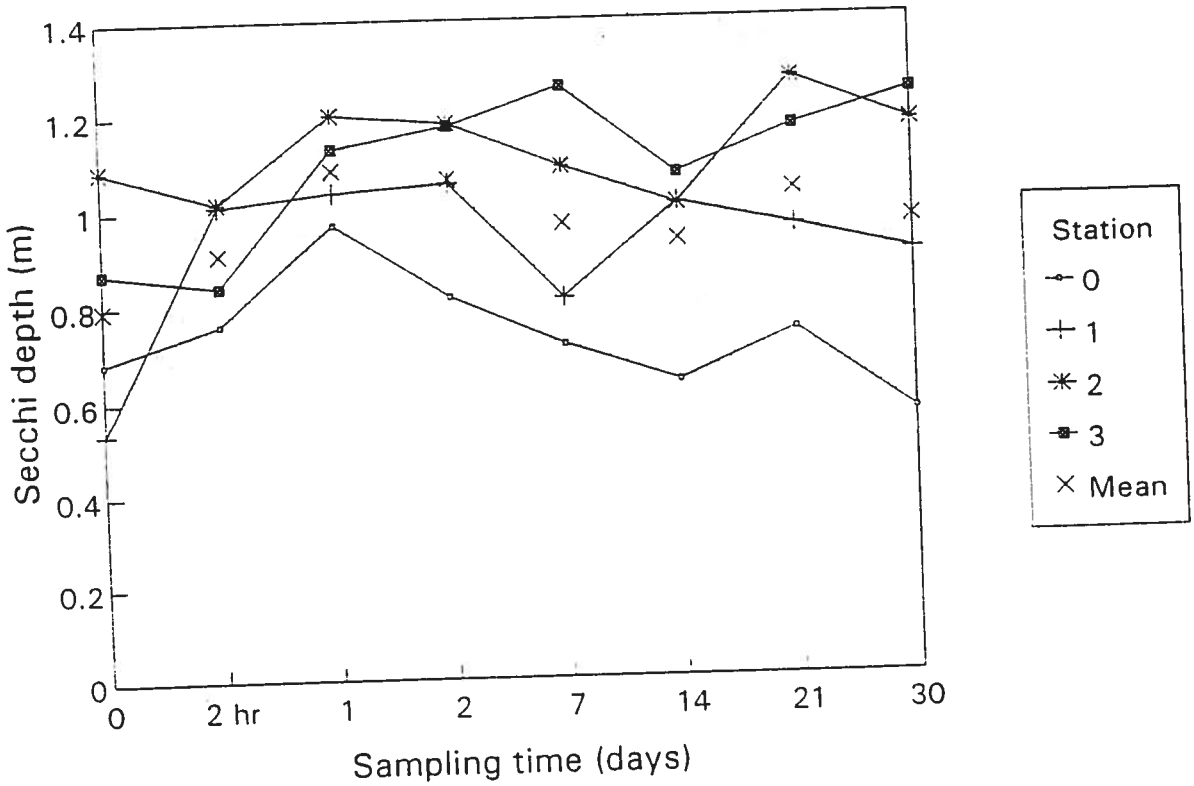
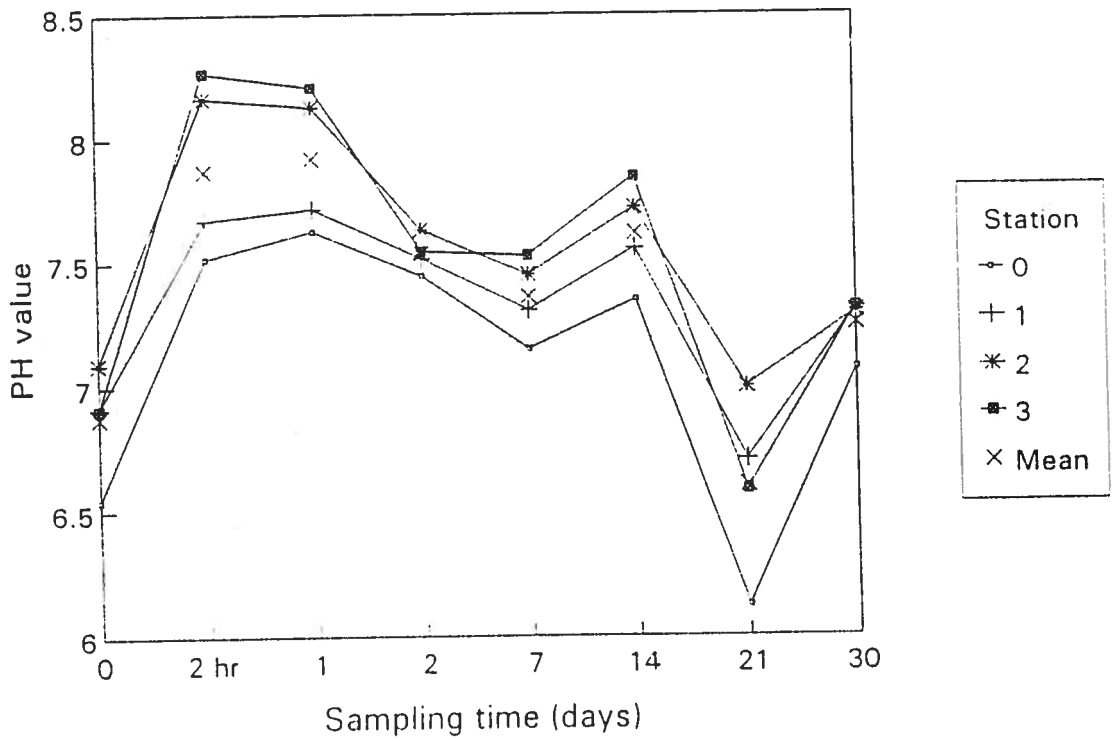


Fig. 4

Changes in PH at different stations
after treatment application



Changes in dissolved oxygen at different stations
after treatment application

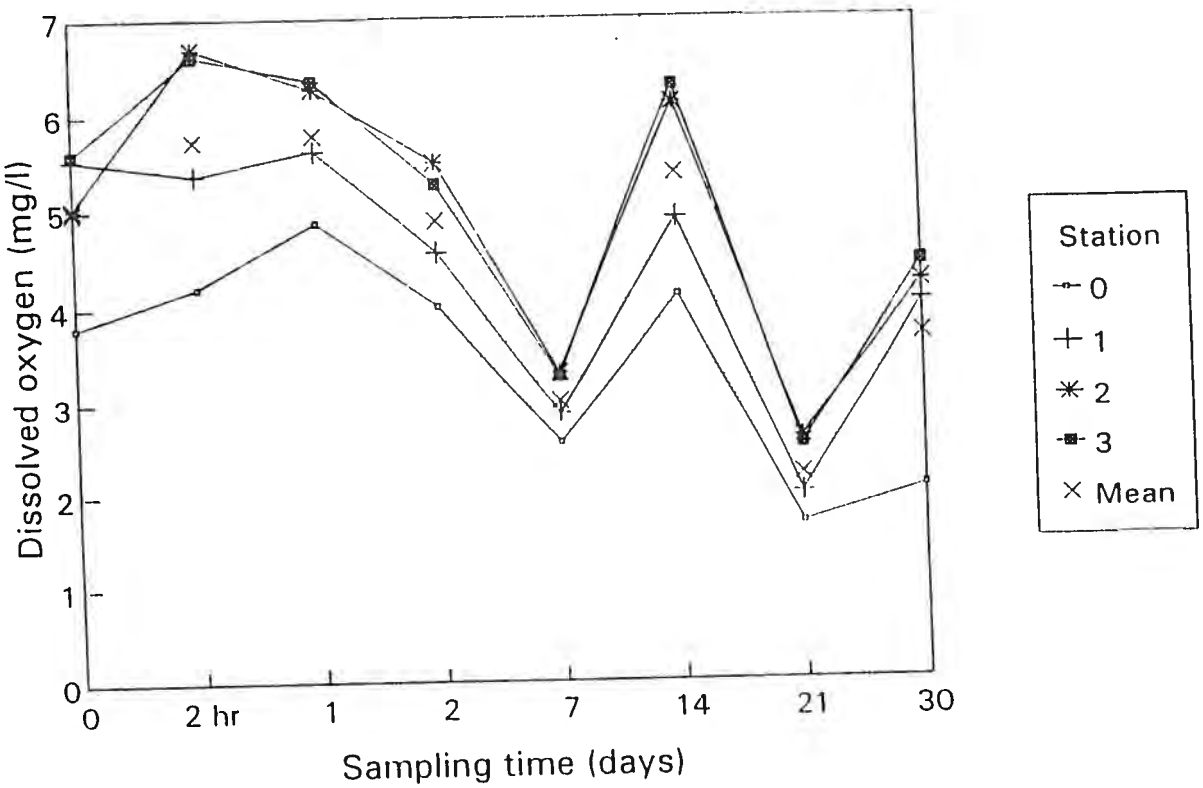


Table 2. Most natural communities in fresh water normally require at least 4.0 mg/l for comfortable existence (Wetzel, 1983). Since the mean temperature of the study was 4.43 mg/l this was an indication that the bay had the capacity to support a high diversity of biota. The concentration of oxygen in water depends on temperature, pressure and concentration of various ions (Wetzel, 1983). Thus Lake Victoria at a mean temperature of 25°C, an altitude of 1133m above sea level and on the equator is saturated at 7.00 mg/l oxygen (Gauff, 1988). This compares with 11.00 mg/l in a temperate lake at sea level at 10°C (Gauff 1988). Gauff (1980) further explains that tropical waters have therefore a relatively lower resilience to oxygen stress than temperate waters and are naturally closer in concentration, even at saturation, to the 4.0 mg/l level usually regarded as the minimum acceptable level for the maintenance of aquatic life. There was no significant difference between the treatments, but there were significant differences between the stations. The under mat stations had the least oxygen, while the 100m open water stations had the highest dissolved oxygen; Table 3 and Fig. 5. This finding is in agreement with Penfound and Earle (1948) and Twongo *et al* (1995) who found lower dissolved oxygen under water hyacinth mat as compared with equivalent location in open water. Twongo *et al* (1995) attributed the low dissolved oxygen levels under the mat due to a combination of water hyacinth respiration, decay processes of the dead parts of the weed and the reduced exchange at the water-air interphase due to close weed cover. Anoxic conditions were observed in water hyacinth mat stations at day 21. This was attributed to decomposing hyacinth due to the efficacy of the herbicides and also that day three quarters of the bay had been covered with thick mats of water hyacinth which had been blown from Murchison bay. The coverage of huge extensive water hyacinth mats blocks sunlight. Hence the photosynthetic algae can not produce oxygen which is responsible for saturation in this part of Lake Victoria (Gauff, 1988).

Reactive Phosphate

Reactive phosphate values ranged from 0 to 0.42 mg/l with a mean of 0.03 mg/l; Table 2. These ranges are comparable to the rest of the lake Victoria. Comparison between herbicides treatment and the control using ANOVA showed no significant difference. But however significant differences were obtained between stations ($p = 0.0027$) and days ($p = 0.001$). Additionally, the station x day interaction was highly significant ($p = 0.001$). A two-way table of means is shown in Table 4. The corresponding graphs are shown in Fig. 6 and Fig 7.

Fig. 6

Changes in reactive phosphate levels with time
for different herbicide applications

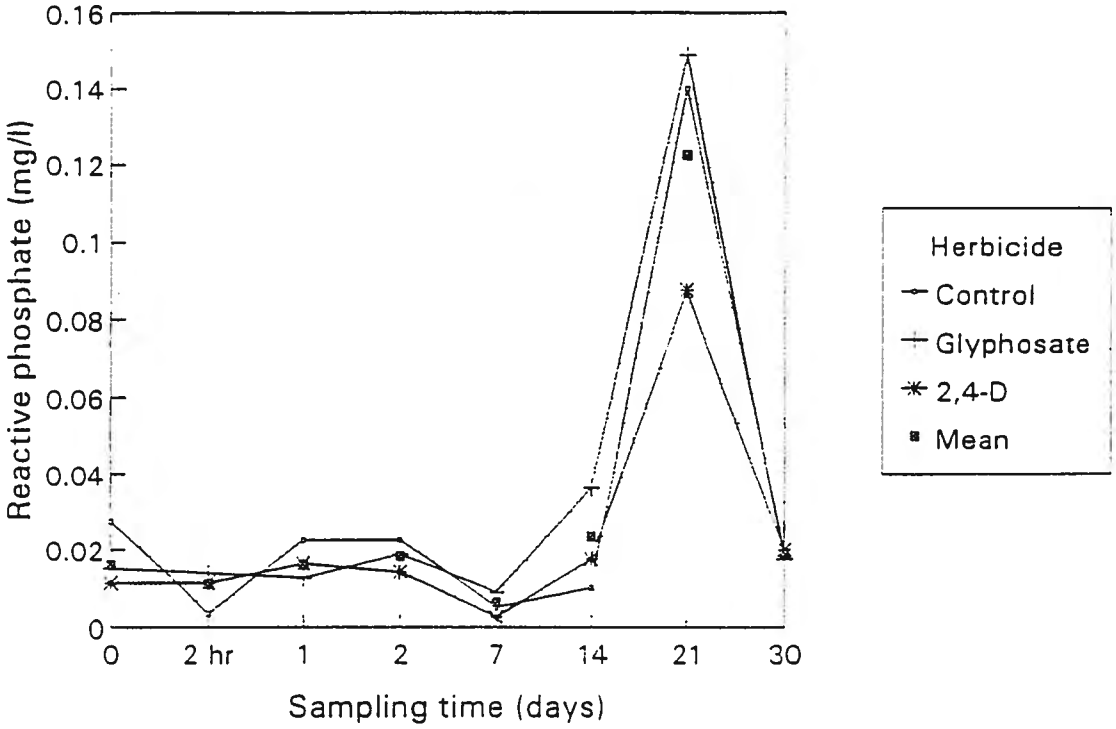


Fig. 7

Reactive phosphate levels at different stations
Changes with time after treatment application

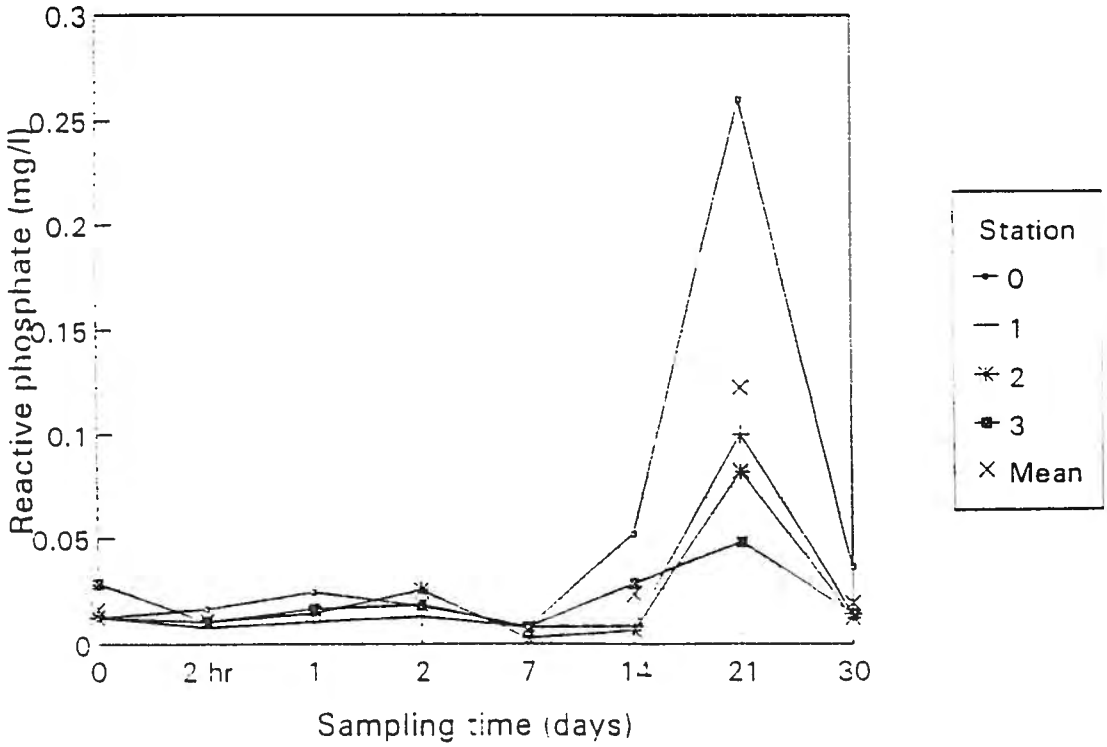


Table 4.

Means of reactive phosphate at different stations and sampling times/day.

Day	Stations				Day mean
	0	1	2	3	
0	0.0120	0.0120	0.0120	0.0280	0.01600
2 hr	0.0160	0.0075	0.0100	0.0100	0.01105
1	0.0240	0.0100	0.0140	0.0160	0.01600
2	0.0175	0.0125	0.0250	0.0180	0.01825
7	0.0075	0.0075	0.0025	0.0075	0.00625
14	0.0520	0.0080	0.0060	0.0280	0.02350
21	0.2600	0.1000	0.0820	0.0480	0.12250
30	0.0360	0.0140	0.0120	0.0140	0.01900
Station Mean	0.0552	0.02243	0.02078	0.02153	0.03000

s.e of station means = 0.00356

s.e of day means = 0.00679

s.e of station x day mean = 0.01357

Dunnet's test showed that on average, stations in the water hyacinth mat had significantly higher reactive phosphate levels than those of the other three stations. The mat stations had more reactive phosphates because of decomposing debris which released phosphates as it decomposed. The relative changes in reactive phosphate at various stations with time was fairly similar except for day 21 where the increase in level was far much higher than the rest of the other days. The high peak values at day 21 was due to the rain. This was the beginning of the rainy season. Rain water is known to have phosphate and surface run off from the catchment area also brings phosphate with it (Payne, 1986; Matagi, 1993). Hence there was the flushing effect at the on set of the rainy season, which gave the spike peak value as observed at day 21.

Total Phosphate

Total phosphate is a summation of phosphate in water. It combines soluble reactive phosphate, particulate phosphate and bond phosphorus to organic matter. There was significant correlation between reactive phosphate and total phosphate

Fig. 8

Changes in total phosphate levels with time
for different herbicide applications

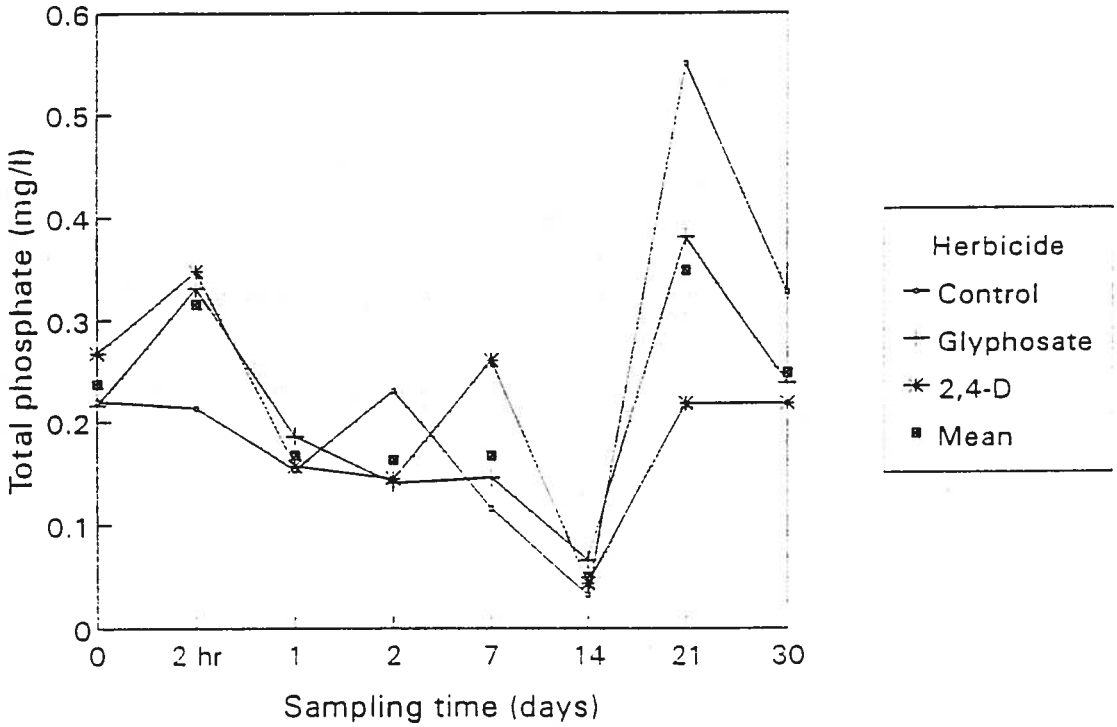
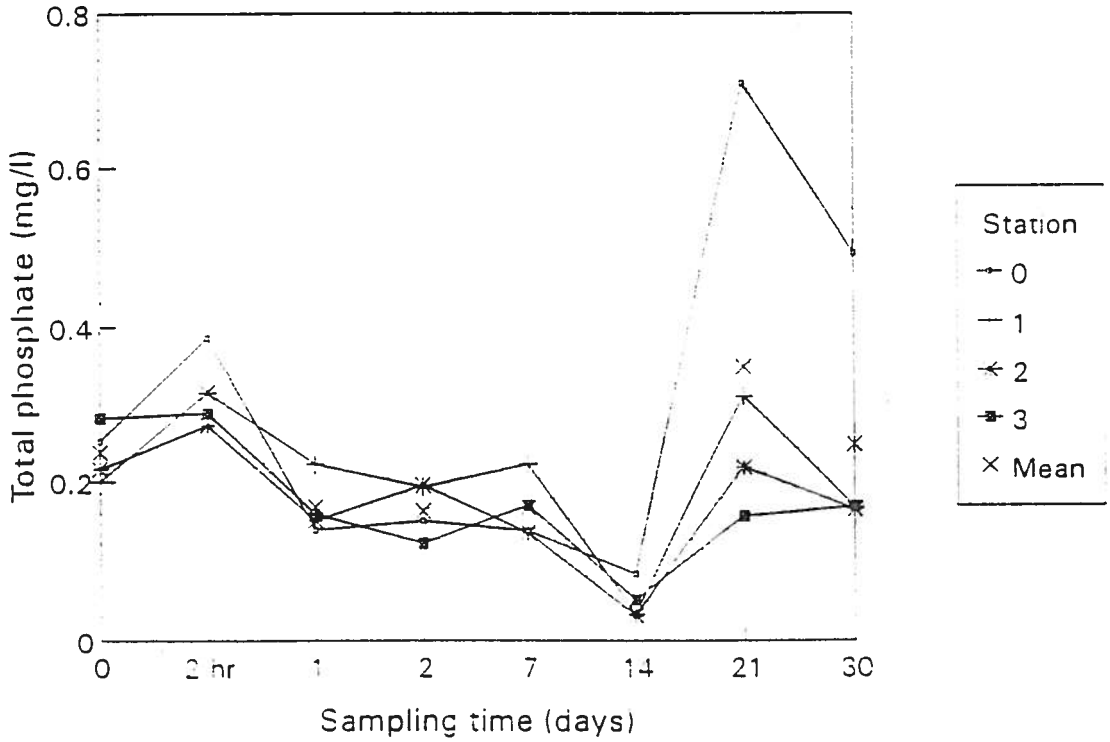


Fig. 9

Total phosphate levels at different stations
Changes with time after treatment application



(r = 0.563; p = 0.001). Therefore, total phosphate variation trend was similar to that of relative phosphate. Total phosphate ranged from 0.01 to 1.33 mg/l with a mean of 0.17 mg/l, Table 2. ANOVA showed that there was no significant difference between glyphosate, 2,4-D and control. But there was significant difference between stations (p = 0.0027), days (p = 001), herbicides x day interaction (p = 0.006) and station x day interaction (p = 0.001). Two way ANOVA tables of means are shown in Table 5 and , while the respective figures are given in figure 8 and 9. While the total phosphate levels did not differ for different herbicide treatment, days 14 and day 21 levels differed from the day 0 total phosphate levels. Day 14 had significantly lower levels, while day 21 had a significantly higher level than of day 0. The unproportional fluctuations especially for the control are responsible for the herbicide x day interaction (Fig. 8). All other stations 0m, 30m and 100m had significantly lower total phosphate levels than that of water hyacinth mat stations. Again this difference is explained by the presence of decomposing debris under the water hyacinth mat led to these stations have high levels compared to the other open water surface stations.

Table 5

Means of total phosphate for different herbicides and sampling times/day

	Herbicides			
Day	Control	Glyphosate	2-4-D	Day Mean
0	0.2200	0.2162	0.2675	0.2375
2 hr	0.2133	0.3312	0.3475	0.3153
1	0.1525	0.1850	0.1562	0.1670
2	0.2300	0.1400	0.1440	0.1624
7	0.1150	0.1450	0.2600	0.1662
14	0.0325	0.0662	0.0438	0.0505
21	0.5550	0.3812	0.2125	0.3485
30	0.3275	0.2375	0.2175	0.2475
Herbicide mean	0.2313	0.2116	0.2056	0.2134
s.e	0.0441	0.0205	0.0165	0.0255

s.e of day means = 0.0221

Nitrites

Nitrates ranged from 0.0 to 0.016 mg/l, with a mean of 0.004 mg/l; Table 2. These values are in agreement with the rest of lake Victoria values. Comparison of glyphosate, 2, 4-D and the control showed no significant difference. But however significant differences between stations ($p = 0.0497$) and between sampling days ($p = 0.0012$) were observed. The 30 m and 100 m stations in the open water had significantly lower nitrite levels than water hyacinth mat stations Fig. 10. The mat stations had more nitrites because of the decomposition of debris.

Nitrates

Nitrates ranged from 0.02 to 0.106 mg/l with a mean of 0.076 mg/l; Table 2. These values are in agreement with the rest of the lake Victoria. There was no significant difference between the glyphosate, 2,4-D and the control nor between the sampling stations Fig. 11 and 12. This shows that the lake water was well mixed so that no change was observed. However significant differences with respect to nitrate were only obtained for different days. While at day 14 nitrate level was less , those at day 2, 3, 4 and 7 had more nitrate than at day 0; Fig. 12

CONCLUSION

In all the water quality parameters investigated there was no significant difference between 2,4-D, glyphosate and the control. This meant that treatment never caused any change in water quality. This may be due to the large volume of water, its complete mixing due to wind action and hydraulic flow of water in and out of the bay or the sprayed area was too small. The environmental factors of a large volume and complete mixing of the water may either singly or collectively be responsible for making the dilution factor too high so that detecting any difference was impossible. For instance in an earlier experiment using small ponds at Kajjasi, phosphate levels were observed to increase after 2 hours of application of glyphosate (NTCWH, 1996). This is because glyphosate has a phosphate group which caused a peak rise in phosphate because the water volume was small.

All water quality parameters between stations were significantly different except nitrates. This is because of the diversity of habitats. Of course the water hyacinth mat stations were different from the rest because mat blocked sunlight, prevented complete mixing of water and decomposition of debris.

Changes after treatment application

Fig- 10

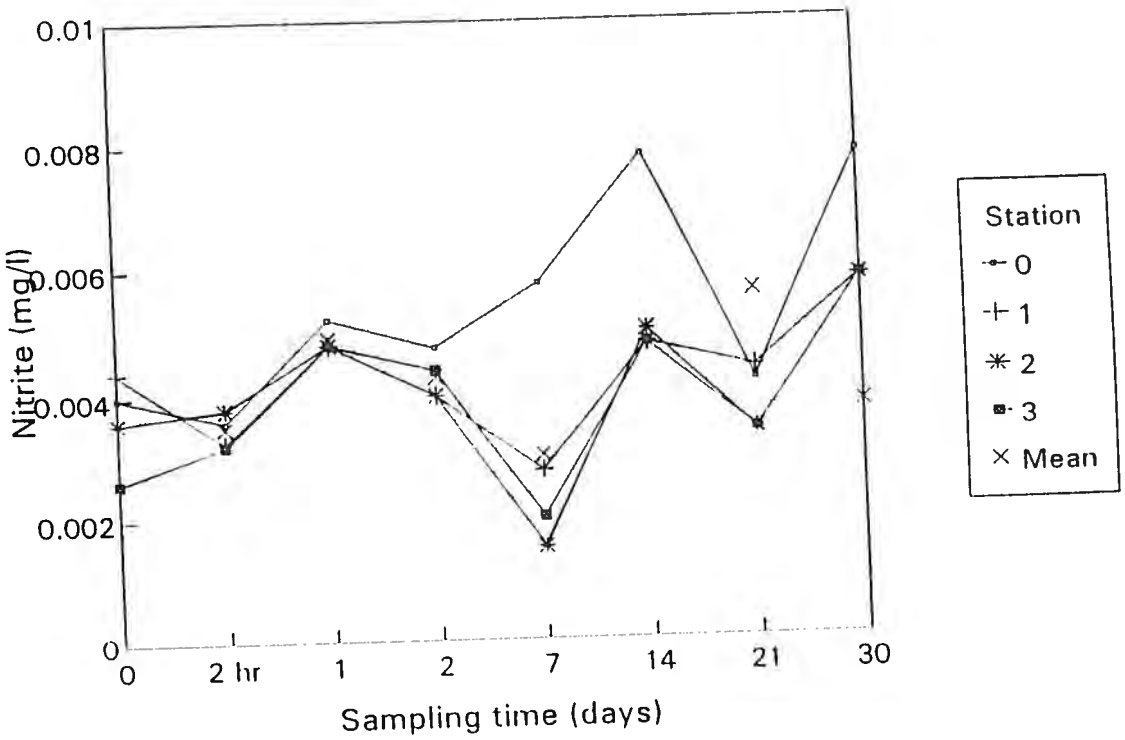


Fig. 11

Changes in nitrate levels with time
for different herbicide applications

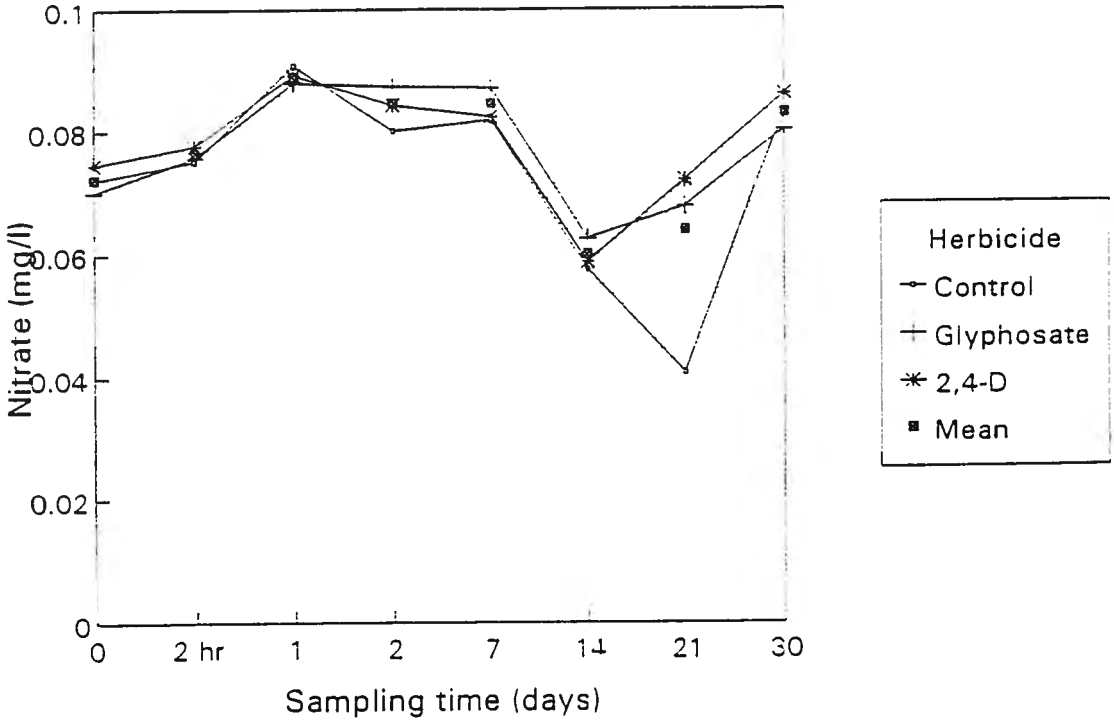
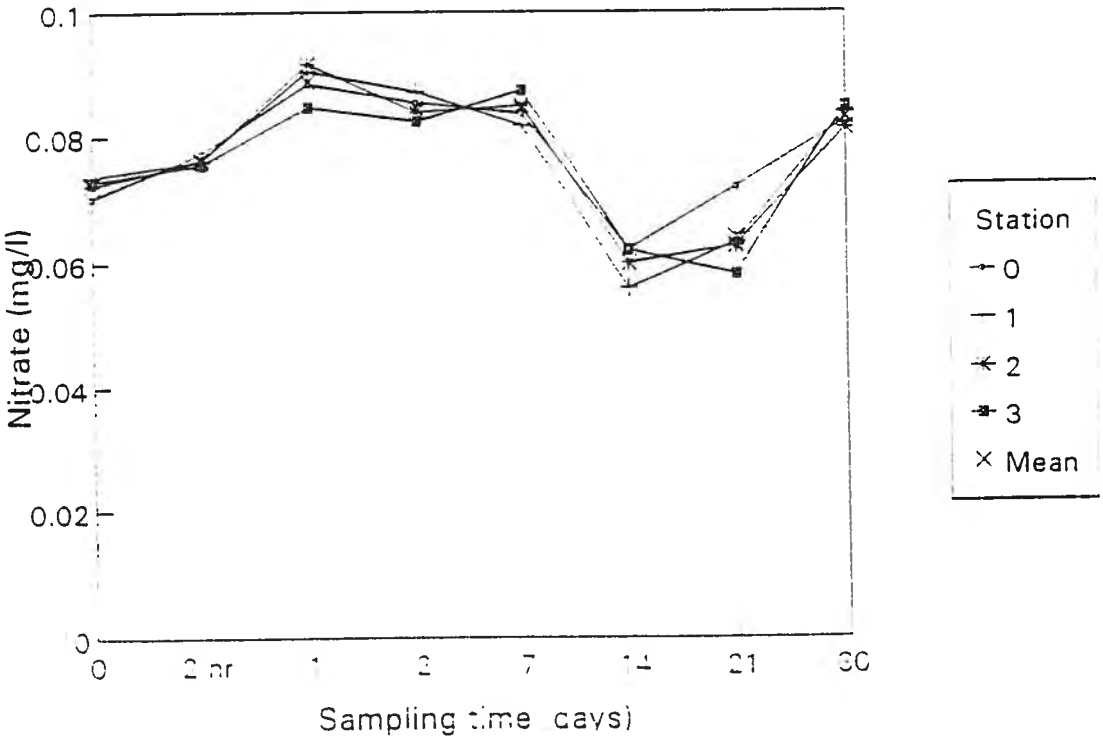


Fig. 12

Nitrate levels at different stations
Changes after treatment application



RECOMMENDATIONS

Large scale spraying is recommended. Only one herbicide should be used so as to avoid "cock tail" of chemicals on lake Victoria. The control should get the same number of replications as other treatments. The number of replicated plots should be at least 3 and at most four for any meaningful statistical analysis. BOD, NH_3 and COD should be included for testing in the sampling programm.

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ANNEX D

THE EFFECT OF SELECTED AQUATIC HERBICIDES ON PHYTOPLANKTON IN WAZIMENYA BAY, LAKE VICTORIA

THE EFFECT OF HERBICIDES ON PHYTOPLANKTON IN WAZIMENYA BAY, L. VICTORA

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SUMMARY:

During the in-lake herbicide trials in Wazimenya Bay, Cyanobacteria dominated the phytoplankton, constituting more than 85%. The green algae and diatoms were always rare. There was a low species diversity.

Algal cell counts were generally lower below the Hyacinth mat (5m inside) than at the edge (0m). There was no significant difference in the cell counts from the Rodeo and Weedar-64 sprayed stations nor between those from the Weedar-64 and control stations.

However, there was a significant difference in the counts between Rodeo and control stations. But, the control counts were almost always lower than the Rodeo counts, an observation which could not easily be explained.

1.0 Introduction

This short study attempts to investigate the effect of hervicides: Rodeo and Weedar-64 on the quality and quantity of phytoplankton in Wazimenya Bay, where in-lake herbicide trials have been carried out on the notorious aquatic weed, *Eichhornia crassipes*, commonly known as the Water Hyacinth.

Phytoplankton in an aquatic ecosystem carry out primary productivity. This involves the process of photosynthesis, during which light energy is captured and transformed into chemical energy. Sugars are manufactured and converted into complex carbohydrates. This biomass, together with the chemical energy are then readily available to the primary consumers (the zooplankton and fish) which directly feed on the phytoplankton (the primary producers). During photosynthesis oxygen is passed out as a by-product and is readily available to the

other living organisms for respiration.

Since algae are plants, they are sensitive to herbicides. These could affect their quality and/or quantity. Because they are microorganisms, the effect of these chemicals on them could be more felt than in the macrophyte vegetation.

It was therefore fitting that while these spray trials were being carried out, a concurrent ecological study be carried out on the phytoplankton to avoid an ecological catastrophe should the chemicals destroy these organisms.

2.0 Materials and Methods

2.1 The Study area

The in-lake trials together with this short phytoplankton study were carried out in Wazimenya Bay, a smaller Bay of Murchison Bay north of Lake Victoria.

2.2 Methods

Water samples were collected with an intergrated 0.5-litre water sampler from five sampling statios labelled A, B, C, D, and E. Stations A and D were sprayed with Rodeo, B and C with Weedar-64 and E was the control (not sprayed).

The samples were collected a day before spraying and then 2 hours, 1 day, 2 days, 7 days, 14 days, 21 days and 30 days after spraying. From each station water was obtained from the edge of Hyacinth mat (0m) and 5m inside the mat (in the sprayed zone). The water was then

emptied into plastic sample bottles and then fixed with Lugol's Iodine to preserve the algal cells.

In the laboratory, 1 ml from each sample was placed in a Sedgewick Rafter cell (counting chamber). The chamber was then placed under the microscope. Algal cells were indentified and quantified.

3.0 Results

During this study major phyla of algae, namely *Cyanobacteria* (blue-green algae), Chlorophyta (green algae) and Bacillariophyta (diatoms) were represented (Table 1)

Table 1 Algal species found in Wazimenya Bay (L. Victoria) during the herbicide trials

* = abundant

***Cynabacteria* (*Blue-gree algae*)**

**Anabaenopsis* sp.

**Merismopedia glauca*

**Microcystis aeruginosa*

**Spirulina* spp.

***Chlorophyta* (*green algae*)**

Pandorina sp.

Pediastrum spp.

Scenedesmus spp.

Staurastrum spp.

Bacillariophyta (Diatoms)

Cocconeis placentula

Navicula spp.

Nitzschia sp.

The blue-gree algal flora dominated the phytoplankton throughout the period of study, both before and after spray. They formed more than 85% of the algal population. The diatoms formed about 15% while the green algae were just negligible throughout the study (Table 2).

Table 3 shows the average algal cell counts in the Rodeo, Weedar-64 and control sampling stations. Counts from samples collected before and after spray were generally higher at the edge of the mat (0m) than inside the mat (5m inside). Using the Student's t-test, the results of cell counts from the Rodeo stations (A and D) were not significantly different from the Weeder-64 (B and C) counts. Nor were those from Weedar-64 and control stations significantly different. However, there was a significant difference in the results from Rodeo and Control Stations.

Table 2: Showing algal cell counts (cells/ml) during the period of study

PRE-SPTAYING DAY (10-2-97)

Algal species	A-Rodeo		D-Rodeo		B-Weedar 64		C-Weeder 64		E-Control	
	0m	5m	0m	5m	0m	5m	0m	5m	0m	5m
Blue Green Algae										
Anabaenopsis spp	1026	378	486	594	558	18	126	90	486	72
Merismopedia spp	666	360	180	144	216	90	486	54	252	216
Microcystis spp	5598	4032	2340	1350	2952	1188	1908	2340	4896	684
Spirulina spp	72	18	72	72	90	36	36	0	0	0
Green Algae										
Pandorina spp	36	0	0	0	0	0	0	0	0	0
Pediastrum spp	0	0	0	0	0	0	0	0	0	0
Scenedesmus spp	0	0	0	18	0	0	0	0	0	0
Staurastrum spp	0	0	0	0	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	0	0	0	0	0	0	0	0	0
Navicula spp	0	0	0	0	0	0	0	0	0	0
Nitzschia spp	0	0	0	0	0	0	0	0	0	0
Totals:	8046	5095	3528	2448	4284	1566	3258	2628	5706	1674

Table 2 ctd.

2 HOURS AFTER SPRAYING (11-2-97)

Algal species	A-Rodoe		D-Rodeo		B-Weedar 64		C-Weeder 64		E-Control	
	0m	5m	0m	5m	0m	5m	0m	5m	0m	5m
Blue Green Algae										
Anabaenopsis spp	1098	864	882	-	864	252	792	216	72	342
Merismopedia spp	432	342	414	-	270	990	162	468	324	288
Microcystis spp	7902	10746	774	-	8046	10260	2790	5922	3078	3090
Spirulina spp	198	90	18	-	90	54	108	36	54	54
Green Algae										
Pandorina spp	0	0	0	-	0	0	0	36	0	0
Pediastrum spp	0	0	0	-	0	0	0	0	0	0
Scenedesmus spp	0	0	0	-	18	18	18	18	0	18
Stamastum spp	0	0	0	-	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	0	0	-	0	0	0	18	0	0
Navicula spp	0	0	0	-	0	0	0	0	0	0
Nitzschia spp	0	0	18	-	0	0	0	0	0	0
Totals:	10404	12510	2412	-	9288	12204	4230	7002	3798	4350

Table 2. Cont.

1 DAY AFTER SPRAYING (12-2-97)

Algal species	A-Rodeo 0m	A-Rodeo 5m	D-Rodeo 0m	D-Rodeo 5m	B-Weedar 64 0m	B-Weedar 64 5m	C-Weeder 64 0m	C-Weeder 64 5m	E-Control 0m	E-Control 5m
Blue Green Algae										
Anabaenopsis spp	1638	720	1872	196	1044	36	1242	0	1710	0
Aferismopedia spp	360	234	450	216	432	126	468	198	486	432
Microcystis spp	4050	4230	3744	3996	7308	882	2232	486	5472	2070
Spirulina spp	72	36	144	36	108	0	36	0	108	0
Green Algae										
Pandorina spp	36	36	0	18	18	0	0	0	0	18
Pediastrum spp	0	18	0	0	0	0	0	0	0	0
Scenedesmus spp	0	0	0	18	0	0	18	0	18	0
Staurastrum spp	0	0	0	0	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	0	0	0	0	0	0	0	0	0
Navicula spp	0	0	18	0	0	0	18	0	18	0
Nitzschia spp	486	360	468	342	522	252	486	0	792	504
Totals:	6642	5580	6696	4822	9432	1296	4500	684	8604	3024

Table 2. Cont.

2 DAY AFTER SPRAYING (13-2-97)

Algal species	A-Rodoe 0m	A-Rodoe 5m	D-Rodeo 0m	D-Rodeo 5m	B-Weedar 64 0m	B-Weedar 64 5m	C-Weeder 64 0m	C-Weeder 64 5m	E-Control 0m	E-Control 5m
Blue Green Algae										
Anabaenopsis spp	900	1098	-	-	810	270	630	396	846	774
Aferismopedia spp	216	144	-	-	234	54	432	126	126	144
Microcystis spp	1890	4140	-	-	2340	540	450	2610	2934	1368
Spirulina spp	0	54	-	-	18	0	0	0	0	0
Green Algae										
Pandorina spp	0	0	-	-	0	0	0	0	0	0
Pediastrum spp	0	0	-	-	0	0	0	0	0	0
Scenedesmus spp	18	36	-	-	18	0	54	18	0	0
Staurastrum spp	0	18	-	-	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	18	-	-	0	0	72	0	0	18
Navicula spp	0	0	-	-	0	0	54	18	0	0
Nitzschia spp	738	648	-	-	756	468	378	468	810	828
Totals:	3762	6156	-	-	4176	1332	2070	3636	4716	3132

Table 2. Cont.
14 DAYS AFTER SPRAYING (13-2-97)

Algal species	A-Rodoe		D-Rodeo		B-Weedar64		C-Weeder64		E-Control	
	0m	5m	0m	5m	0m	5m	0m	5m	0m	5m
Blue Green Algae										
Anabaenopsis spp	-	1530	8442	990	1998	1026	1584	612	2934	1206
Merismopedia spp	-	324	216	144	234	306	324	270	108	234
Microcystis spp	-	1620	1350	2988	4572	1530	1710	2664	3150	990
Spirulina spp	-	54	36	36	54	0	54	0	252	90
Green Algae										
Pandorina spp	-	0	0	0	0	0	36	0	0	0
Pediastrum spp	-	0	0	18	18	18	0	0	0	0
Scenedesmus spp	-	0	0	18	0	18	0	0	0	0
Stauastrum spp	-	0	0	0	18	0	0	0	0	0
Diatom species:										
Cocconeis spp	-	0	0	0	0	0	0	0	0	0
Navicula spp	-	18	0	0	0	0	0	0	0	0
Nitzschia spp	-	1206	990	486	1080	1044	702	72	1314	918
Totals:	-	4752	11034	4680	7974	3942	4410	3618	7776	3438

Table 2, Cont..
21 DAY AFTER SPRAYING (4-3-97)

Algal species	A-Rodoe		D-Rodeo		B-Weedar64		C-Weeder64		E-Control	
	0m	5m	0m	5m	0m	5m	0m	5m	0m	5m
Blue Green Algae										
Anabaenopsis spp	3024	1062	378	732	972	1008	828	324	648	468
Merismopedia spp	342	126	162	234	144	162	54	18	108	126
Microcystis spp	1890	2340	180	4410	1098	1620	2070	900	810	126
Spirulina spp	36	36	18	18	18	0	18	0	0	0
Green Algae										
Pandorina spp	0	18	36	0	0	0	18	0	0	0
Pediastrum spp	0	0	0	0	0	0	18	0	0	0
Scenedesmus spp	36	18	72	54	36	90	18	54	36	72
Staurastrum spp	0	0	0	0	0	0	0	0	0	18
Diatom species:										
Cocconeis spp	0	0	0	18	0	54	36	18	0	18
Navicula spp	0	0	0	0	0	0	0	0	0	0
Nitzschia spp	360	234	162	234	234	90	162	126	162	234
Totals:	5688	3834	1008	5400	2502	3042	3222	1458	1764	1062

Table 2, Cont..
30 DAY AFTER SPRAYING (4-3-97)

Algal species	A-Rodoe		D-Rodeo		B-Weedm64		C-Weeder64		E-Control	
	0m	5m	0m	5m	0m	5m	0m	5m	0m	5m
Blue Green Algae										
Anabaenopsis spp	1116	126	4086	3042	3348	36	3456	90	2196	1080
Aterismopedia spp	144	36	270	324	342	396	234	504	90	162
Microcystis spp	2088	1080	306	1080	4266	360	1800	1620	1170	540
Spirulina spp	54	18	54	36	18	0	162	0	0	36
Green Algae										
Pandorina spp	0	0	0	0	0	0	0	0	0	0
Pediastrum spp	0	0	0	0	0	18	0	0	0	18
Scenedesmus spp	126	36	36	0	54	0	0	54	0	0
Staurastrum spp	0	0	0	0	0	0	0	0	0	0
Diatom species:										
Cocconeis spp	0	0	0	18	0	18	0	0	0	0
Navicula spp	0	18	36	0	0	0	0	0	18	0
Nitzschia spp	144	126	648	252	324	126	450	288	306	180
Totals:	3672	1440	5436	4752	8352	954	5102	2556	3780	2016

Table 3 Average algal cell counts in Rodeo, Weedar-64 sprayed and control sampling stations

	RODEO		WEEDAR-64		CONTROL	
Time after spray	0m	5m	0m	5m	0m	5m
Pre-spray	5787	3772	3771	2097	5706	1674
2 hours after	6408	6255	6759	9603	3798	4350
1 day after	6669	5201	6966	990	8604	3004
2 day after	6768	3031	8550	4806	8676	6804
7 day after	3762	6156	3123	2484	4716	3132
14 days after	5517	4716	6192	3780	7776	3438
21 days after	3348	4617	2862	2250	1764	1062
30 days after	4554	3096	6727	1755	3780	2016

4.0 Discussion

The observation that blue-green algae now dominate the phytoplankton flora in Lake Victoria is as a result of recent changes in the physico-chemical nature of the lake water and the general global climatic changes.

Up to the late 1970's Lake Victoria phytoplankton was dominated by diatoms, namely *Melosira (Aulacoseira)* species. Of recent, inputs into the lake from the mushrooming industries, fish processing plants, and surface run-off from cultivated land surrounding the

Melosira (Aulacoseira) species. Of recent, inputs into the lake from the mushrooming industries, fish processing plants, and surface run-off from cultivated land surrounding the lake add a lot of organic and inorganic nutrients into the lake, making it more eutrophic. The recent outbursts of the notorious *Eichhornia crassipes* have led to high rates of decomposition which ultimately results in reduced oxygen levels. All the above encourage flourishing of the blue-green algal flora while other forms of algae reduce in abundance.

Because of the general global warming phenomenon, the deep waters of this lake no longer undergo complete mixing. The algae, particularly the heavy diatom cells which are normally redistributed to the surface by the vertical water movements have remained in the dark, bottom mud where they have contiued to perish, leaving the blue-greens to dominate the phytoplantkon biomass.

At each sampling site, both before and after spray, there was a higher algal count at the edge (0m) of the water hyacinth mat than at 5m inside the weed mat (Table 3). Algal cells are photosynthetic and therefore need light for the process. Some of these cells are motile and can thus move to the lighted areas, away from the mat.

However, the reduction in numbers in the mat (the sprayed areas) could also be a result of the effect of the herbicides. But, in the control station E, the observation of lower algal counts under the mat could not be attributed to the effect of the chemicals, since the station was not sprayed.

The significant difference between counts from Rodeo and control stations is also questionable because the difference was due to the fact that the counts in the control station E were generally lower than in Rodeo stations, A and D. The counts in E should not have been lower than in A and D since E was not sprayed. Also, one would have expected higher cell counts before spray (pre-spray) but this was not the case in almost all stations.

The fact that this area of study remained part of the large body of the whole lake complicated the observations. Thus, the herbicides sprayed could not have an obvious effect as they would have in isolated culture experiments with known concentrations of the herbicide(s). Even under the mat, horizontal water movements continue to transport algal cells. Cells picked after spray were not necessarily the ones that were there before the spray! The dilution effect of this large water body was another loophole of these observations. Thus, no concrete conclusion or recommendation can be drawn from these in-lake trial observations!

ANNEX E

EFFECT OF IN-LAKE APPLICATIONS OF RODEO AND WEEDAR 64 TO CONTROL SHORELINE WATER HYACINTH ON PHYTOPLANKTON BIOMASS

EFFECT OF INLAKE APPLICATION OF GLYPHOSATE AND 2,4-D TO CONTROL SHORELINE WATER HYACINTH ON PHYTOPLANKTON BIOMASS.

T. Twongo
Fisheries Research Institute,
Jinja, Uganda

March 1997

Introduction

The purpose of inlake herbicide trials was to assess the effects on the aquatic environment and resources, of inlake application of weeder 64 (2,4-D amine) and Rodio (Glyphosate) to control water hyacinth

The experiments reported here specifically studied the effects of the herbicides on the biomass of phytoplankton (determined as chlorophyll-a) in water hyacinth mats. Results from this and similar experiments which assessed herbicide efficacy on water hyacinth; dissipation in water, impact on water quality, algal biomass and on the diversity and abundance of zooplankton and macrofauna were all to be evaluated as input into the environmental impact assessment exercise required to facilitate decisions on the use of herbicides to control water hyacinth in Uganda.

Experimental area and sites

Inlake herbicide trials were conducted in Wazimenya, a sub-bay of Murchison Bay of Lake Victoria near Kampala . Wazimenya sub-bay is located in Ntenjeru country, Mukono District about 4 km from Gaba landing beach (Fig.1). The experimental sites A to E were located in an extensive band of resident water hyacinth average width about 13m. The water depth at the edge of the weed fringe ranged between 1 and 2.5m and the lake bottom was basically a hard sandy clay, covered in parts with some mud particularly at sites D and part of A which had a belt of papyrus in the background. The water hyacinth fringe at sites E, C, B, and part of A were bordered by patches of papyrus, *Vossia* and light thicket; against a background of remnants of savannah woodland and gardens of banana replaced in part with other crops including sugarcane.

Materials and methods

Glyphosate was applied on plots A and D while 2,4-D amine was sprayed on plots B and C. Plot E was the control. Application rates and mode for the herbicides are detailed elsewhere in related studies.

The following materials and methods were used to assess the impact of herbicide application on the biomass of phytoplankton in the water hyacinth fringe and adjacent open water. The sampling schedule consisted of seven rounds starting one day before herbicides were applied. Pre-herbicide application sampling was followed a day later by the second sampling 2 hours after spraying, and then 1, 2, 3, 7, 14, and 30 days later. Water samples were taken from just under the surface in 0.5l plastic bottles at three sites namely 5m and 1m into the shoreline strip of water hyacinth, and at 30m from the mat towards the open lake. Sampling was done in each plot except when mobile water hyacinth mats which hovered about Wazimenya sub-bay throughout the study period, made it impossible to access a sampling site.

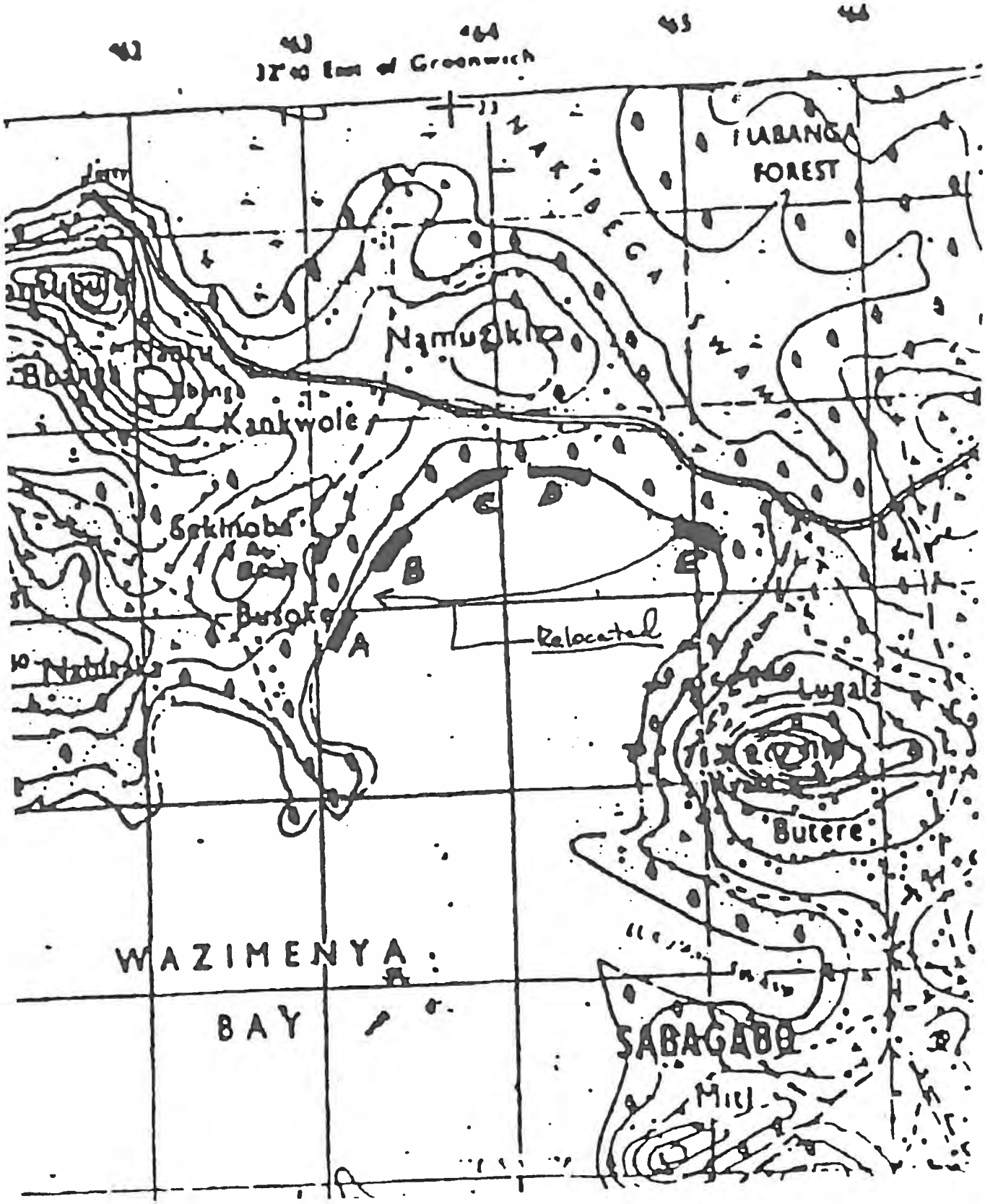

Fig. 1: Experimental area and sampling sites (A to E) for the In - Lake herbicide trials at Wazimenya/Murchison Bay.

Analysis for chlorophyll-a concentration was done as in Stainton et al. 1977. Phytoplankton was separated by filtration through glass fibre filters and chlorophyll-a was extracted in methanol. Absorbence due to the samples was determined using a Milton Roy Spectronic 501 spectrophotometer.

Results and discussion

Phytoplankton biomass expressed as chlorophyll-a concentrations is plotted in Fig.2. Relevant data together with standard deviations to give some indication of the significance of variability are also given in Appendix I. Logistical considerations did not permit larger sample sizes.

The following deductions were made based on the data.

1. Variations in the magnitude of chlorophyll-a and hence phytoplankton biomass from one sampling day to the other appeared to be generally uniform to all treatments especially within the water hyacinth mat (Fig.2a & b). This suggested influence on phytoplankton biomass by some factor or factors other than herbicide application. The above observation was illustrated more clearly by the data from the control plot especially within the water hyacinth strip.

2. Data taken seven days after herbicide application on 18 February indicated significantly higher quantities of phytoplankton biomass 5m into the plots treated with Glyphosate (Fig.2b) when compared to values from the control plot. Production of the higher biomass of phytoplankton was possibly in response to a probable input of available phosphorus from Glyphosate. Lack of significant difference of phytoplankton biomass 1m into the mat (Fig. 2a) may be due to the constant flushing of the zone by waves. A similar observation of increase in phytoplankton production was made during pond herbicide trial experiments one and two weeks after herbicide application.

3. Significantly higher phytoplankton biomass was measured 5m into hyacinth in plots treated with Glyphosate and 2,4-D amine when compared to the control, 21 and 30 days after herbicide application. On the later date, the biomass of phytoplankton was significantly higher in the plots treated with 2,4-D than in those treated with Glyphosate. These observations probably indicate nutrient enrichment due to on-set of decay of water hyacinth biomass combined with the effects of increased light intensity and penetration as the shading magnitude of the weed progressively reduced.

Conclusion

No other adverse effects relating to phytoplankton biomass and attributable to use of Glyphosate and 2,4-D to control water hyacinth in Wazimenya-Murchison Bay were found apart from:

i. a significant increase in phytoplankton production around day 7, attributable to spraying with Glyphosate;

ii. a significant increase in phytoplankton production beginning

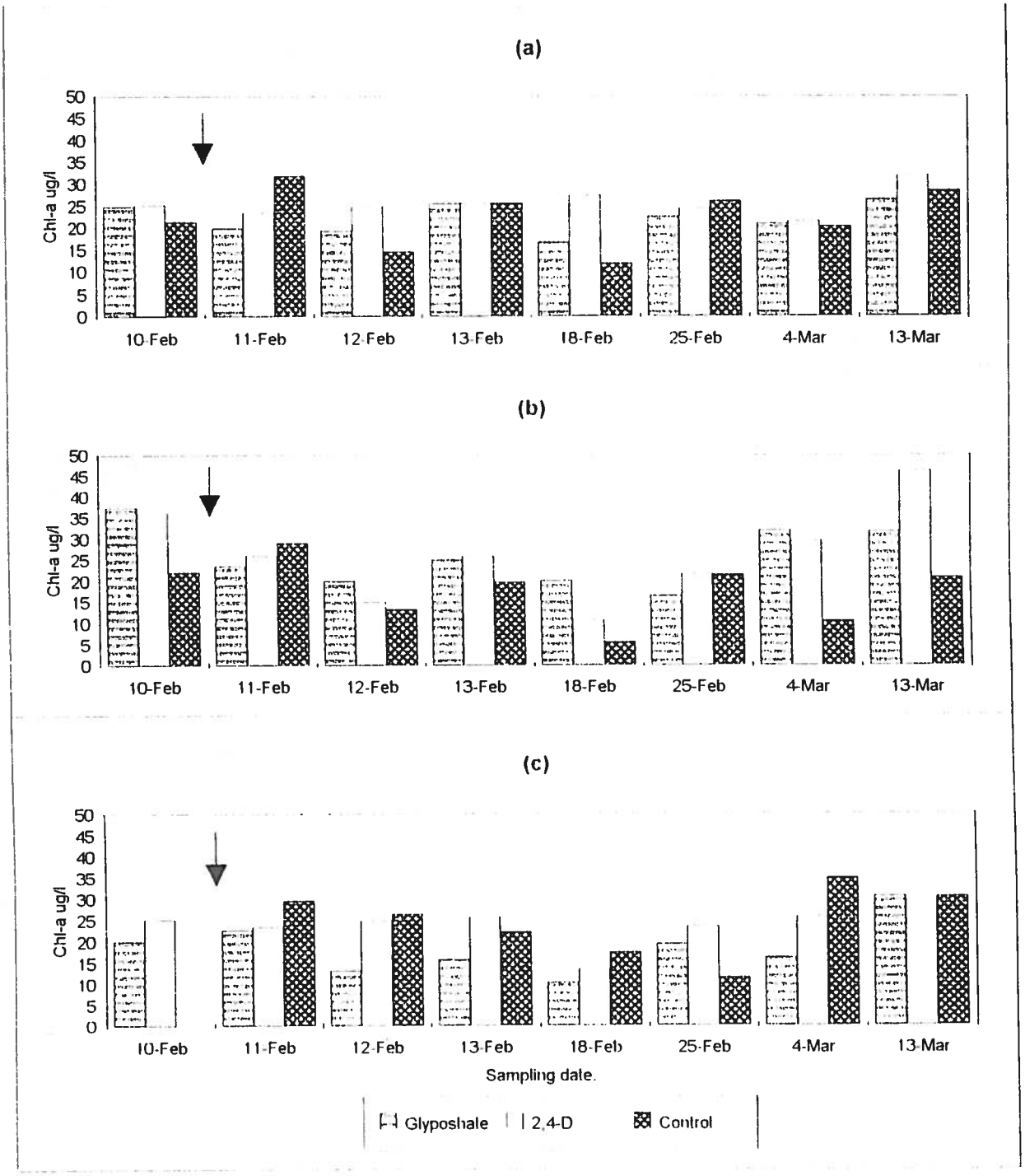

Fig. 2 Impact of herbicide application on phytoplankton biomass (as chlorophyll-a), (a) 1m, (b) 5m, into the mat and (c) 30m off the mat of shoreline water hyacinth - Wazimenya/Murchison Bay.

▶ = herbicides application.

around day 21, attributable to nutrient release at onset of decay of sprayed water hyacinth and to the consequent increase in light intensity in the water colunm.

This conclusions is, however, subject to the fact that the experimental area was a huge open system with numerous possible environmental differences and impacts that could have influenced the experiments in ways difficult to specify. Those influences would have been exacerbated by the diurnal influx and efflux of a vast mat of water hyacinth into and out of Wazimenya sub-bay throughout the experimental period.

Reference

Stainton, M.P., M.J. Capel and F.A.J. Armstrong. 1977. The Chemical Analysis of Fresh water, 2nd ed. Fish. Mar. Serv. Misc. Spec. Publ. 25: 166p.

Appendix I : Phytoplankton biomass (as chlorophyll-a) from various sampling sites in Wazimenya/Murchison Bay following herbicide application

Date	Plot	Chla ug/l	Mean	STD
10-Feb-97	A P0		37.53	
	D P 0	37.53		
	A P 1	25.02	24.87	0.22
	D P 1	24.71		
	A P 2	23.91	20.06	5.44
	D P 2	16.22		
	B P 0	30.02	36.27	8.83
	C P 0	42.51		
	B P 1	20.57	27.43	9.70
	C P 1	34.29		
	B P 2	28.08	25.16	4.13
	C P 2	22.24		
	E P 0	22.08	22.08	
	E P 1	21.41	21.41	
	E P 2			
11-Feb-97	A 2h 0	25.48	23.62	2.63
	D 2h 0	21.76		
	A 2h 1	23.75	19.89	5.45
	D 2h 1	16.04		
	A 2h 2	21.35	22.72	1.94
	D 2h 2	24.09		
	B 2h 0	29.54	26.06	4.91
	C 2h 0	22.59		
	B 2h 1	24.90	24.33	0.82
	C 2h 1	23.75		
	B 2h 2	25.48	23.46	2.87
	C 2h 2	21.43		
	E 2h 0	28.96	28.96	
	E 2h 1	31.85	31.85	
	E 2h 2	29.54	29.54	
12-Feb-97	A D1 0	17.0	19.98	4.18
	D D1 0	22.9		
	A D1 1	24.0	19.29	6.63
	D D1 1	14.6		
	A D1 2	9.4	13.26	5.49
	D D1 2	17.1		
	B D1 0	16.2	15.06	1.64
	C D1 0	13.9		
	B D1 1	16.5	21.46	7.00

Date	Plot	Chla ug/l	Mean	STD
13-Feb-97	A D2 0	19.84	25.04	7.34
	D D2 0	30.23		
	A D2 1	20.02	25.58	7.86
	D D2 1	31.14		
	A D2 2	17.79	15.85	2.75
	D D2 2	13.90		
	B D2 0	25.85	25.85	
	C D2 0			
	B D2 1	31.97	31.97	
	C D2 1			
	B D2 2	25.58	25.58	
	C D2 2			
	E D2 0	19.81	19.81	
	E D2 1	25.58	25.58	
	E D2 2	22.24	22.24	
18-Feb-97	A D7 0	20.16	20.16	
	D D7 0			
	A D7 1	16.68	16.68	
	D D7 1			
	A D7 2	11.82	10.43	1.97
	D D7 2	9.04		
	B D7 0	15.99	10.77	7.37
	C D7 0	5.56		
	B D7 1	9.73	6.60	4.42
	C D7 1	3.48		
	B D7 2	13.21	13.55	0.49
	C D7 2	13.90		
	E D7 0	5.56	5.56	
	E D7 1	11.82	11.82	
	E D7 2	17.38	17.38	
25-Feb-97	A D14 0	16.80	16.51	0.41
	D D14 0	16.22		
	A D14 1	30.12	22.59	10.65
	D D14 1	15.06		
	A D14 2	29.54	19.40	14.33
	D D14 2	9.27		
	B D14 0	24.90	21.72	4.50
	C D14 0	18.53		
	B D14 1	32.43	25.48	9.83

Date	Plot	Chla ug/l	Mean	STD
12-Feb-97	C D1 1	26.4		
	B D1 2	23.2	24.79	2.29
	C D1 2	26.4		
	E D1 0	13.3	13.3	
	E D1 1	14.5	14.5	
	E D1 2	26.4	26.4	
4-Mar-97	A D21 0	43.73	32.00	16.59
	D D21 0	20.27		
	A D21 1	28.96	20.85	11.47
	D D21 1	12.74		
	A D21 2	14.48	16.22	2.46
	D D21 2	17.95		
	B D21 0	35.33	29.54	8.19
	C D21 0	23.75		
	B D21 1	26.64	27.99	1.91
	C D21 1	29.34		
	B D21 2	20.27	25.58	7.51
	C D21 2	30.89		
	E D21 0	10.64	10.64	
	E D21 1	20.27	20.27	
	E D21 2	34.75	34.75	

Date	Plot	Chla ug/l	Mean	STD
25-Feb-97	C D14 1	18.53		
	B D14 2	30.12	23.46	9.42
	C D14 2	16.80		
	E D14 0	21.43	21.43	
	E D14 1	26.06	26.06	
	E D14 2	11.58	11.58	
13-Mar-97	A D30 0	31.69	31.69	
	D D30 0			
	A D30 1	21.55	26.41	6.88
	D D30 1	31.28		
	A D30 2	28.50	30.37	2.65
	D D30 2	32.25		
	B D30 0	43.79	46.22	3.44
	C D30 0	48.65		
	B D30 1	29.89	45.87	22.61
	C D30 1	61.86		
	B D30 2	29.33	29.68	0.49
	C D30 2	30.02		
	E D30 0	20.85	20.85	
	E D30 1	28.50	28.50	
	E D30 2	30.23	30.23	

ANNEX F

ZOOPLANKTON

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ZOOPLANKTON

Introduction

This is a report of observations on the changes of Zooplankton densities in water hyacinth mat at Wazimenya, Murchison Bay, Lake Victoria that had been sprayed with herbicides: Rodeo and Weeder-64. These observation were made over a time period of 30 days. The report does not pretend to give toxicological tests results conducted on the zooplankton assemblage of the bay.

Method

The sampled zooplankton was immediately preserved in 5% formaldehyde solution. Zooplankton counting was done with an inverted microscope on sedimented whole samples. Identification of the taxon was done during the counting.

Results

Table 1 shows the changes in the zooplankton densities (Individuals per litre) in the experimental and control plots of the water hyacinth stand during the investigation period.

One clear observation is the continous presence of Zooplankton in the experimental and control plots throughout the study period. The continous mixing of lake water by wave action with that one in the experimental plots is responsible for the observed results.

Table 1: Changes in zooplankton Community Structures and Densities at Wazimenya-Murchison Bay, Lake Victoria during the Inlake Herbicide Spraying Trial Experiments. A-Rodeo, B-Weedar-64, C-Weedar-64 D-Rodeo and E-Control. (i)- Edge of water Hyacinth Stand and (ii)- 5 metres Inside the Water Hyacinth Stand.

			ZOOPLANKTON IND./L.					
	Date	Plot	Rotifera		Copepoda		Cladocera	
			i.	ii	i	ii	i	ii
Pre-spraying	10.2.1997	A	7	6	203	105	2	0
	"	B	2	11	80	35	1	1
	11.2.1997	C	10	-	122	-	1	-
	"	D	9	36	45	853	2	30
	"	E	6	11	53	57	1	1
Two hours after spraying	11.2.1997	A	10	5	251	13	2	1
	"	B	15	8	750	75	10	5
	"	C	19	9	200	255	13	5
	"	D	19	14	258	137	12	9
	"	E	-	-	-	-	-	-
Two days after spraying	13.2.1997	A	12	5	38	3	0	0
	"	B	6	17	143	89	1	3
	"	C	-	-	-	-	-	-
	"	D	7	13	86	74	2	2
	"	E	7	3	73	10	1	0
7 days after spraying	18.2.1997	A	11	19	82	123	0	0
	"	B	9	17	44	102	0	1
	"	C	7	14	63	155	0	0
	"	D	-	-	-	-	-	-
	"	E	6	9	34	74	0	0
14 days after spraying	25.2.1997	A	10	9	67	39	5	3
	"	B	7	1	124	1	3	0
	"	C	0	4	163	81	0	1
	"	D	2	8	510	291	12	4
	"	E	5	8	23	91	2	4
21 days after spraying	4.3.1997	A	7	19	13	28	0	5
	"	B	10	28	36	65	6	9
	"	C	6	12	50	281	3	8
	"	D	6	24	41	96	1	9
	"	E	5	19	79	145	2	9
30 days after spraying	13.3.1997	A	6	6	38	95	1	2
	"	B	4	13	21	36	1	4
	"	C	4	18	84	206	2	3
	"	D	6	4	67	77	2	1
	"	E	4	3	37	30	1	1

Comments

The presence or absence of zooplankton in the control and experimental plots during the course of the investigation should not be misinterpreted to mean that the sprayed herbicides have no significant toxic effects on the zooplankton.

The herbicides' toxicity on the zooplankton is best assessed in controlled laboratory experiments. In this regard, the dilution of the applied herbicide will not immidiately take place as is the case in the present Inlake Trial Experiments.

It should have been much better to run the experiment for a time period longer than 30 days. This would enable observations to be made on zooplankton community structure successions and on responses and adaptations to hypoxic/anoxic conditions that normally characterise the decomposing water hyacinch mat.

For comparison purpose , it should have been better to study the zooplankton community structures and densities also from an offshore station (e.g. 30 metres from the experimental plots). This was not possible mainly because of funds limitations.

Acknowledgements

Thanks are due to: Mr. J.B. Ggulira. Principle Technician Department of Zoology for his assistance during the sampling of the zooplankton from the lake.

Ms Susan Luyiga a Research Assistant. assisted with the microscopic analysis of the samples.

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ANNEX G

EFFECTS OF RODEO AND WEEDAR 64 TO CONTROL SHORELINE WATER HYACINTH ON DIVERSITY AND ABUNDANCE OF ASSOCIATED MACROFAUNA

EFFECTS OF INLAKE APPLICATION OF GLYPHOSTE AND 2,4-D TO CONTROL SHORELINE WATER HYACINTH ON DIVERSITY AND ABUNDANCE OF ASSOCIATED MACROFAUNA.

T. Twongo
Fisheries Research Institute,
Jinja, Uganda

March 1997

Introduction

The purpose of inlake herbicide trials was to assess the effects on the aquatic environment and resources, of in-lake application of Weeder 64 (2,4-D amine) and Rodio (Glyphosate) to control water hyacinth

The experiments reported here specifically studied the effects of the herbicides on the diversity and abundance of aquatic macrofauna associated with the water weed. Results from this and similar experiments which assessed herbicide efficacy on water hyacinth; dissipation in water, impact on water quality, algal biomass and on diversity and abundance of zooplankton and macrofauna were all to be evaluated as input into the environmental impact assessment exercise required to facilitate decisions on the use of herbicides to control water hyacinth in Uganda.

Experimental area and site

Inlake herbicide trials were conducted in Wazimenya, a sub-bay of Murchison Bay of Lake Victoria. Wazimenya sub-bay is located in Ntenjeru country, Mukono District about 4 km from Gaba landing beach (Fig.1). The experimental sites A to E were located in an extensive band of resident water hyacinth average width of about 13m. The water depth at the edge of the weed mat ranged between 1 and 2.5m and the lake bottom was basically a hard sandy clay, covered in parts with some mud particularly at sites D and part of A which had a belt of papyrus in the background. The water hyacinth fringe at sites E, C, B and part of A were bordered by patches of papyrus, *Vossia* and light thicket; against a background of remnants of savannah woodland and gardens of banana being replaced with other crops including sugarcane.

Materials and methods

Glyphosate was applied on plots A and D while 2,4-D amine was sprayed on plots B and C. Plot E was the control. Application rates and mode for the herbicides will be detailed elsewhere among the inlake herbicide trial studies.

The following materials and methods were used to assess the impact of herbicide application on macrofauna in the below-water biomass of sprayed water hyacinth and from sediments under the same mart. The sampling schedule consisted of seven rounds starting one day before herbicides were applied. Samples were then taken 2 hours after herbicide application and then 2, 3, 7, 14, and 30 days later. A quarter metre quadrat was used to sample water hyacinth biomass while the bottom sediment was collected at the same spot using a ponar grabber with a maximum grab area 245.05 cm^2. Samples were collected in triplicate 1m and 5m into the shoreline strip. Only the below-water biomass of the water weed was used in the study. Sampling was done in each plot except when mobile water hyacinth mats which hovered about Wazimenya sub-bay throughout the study period, made it impossible to access a sampling site.

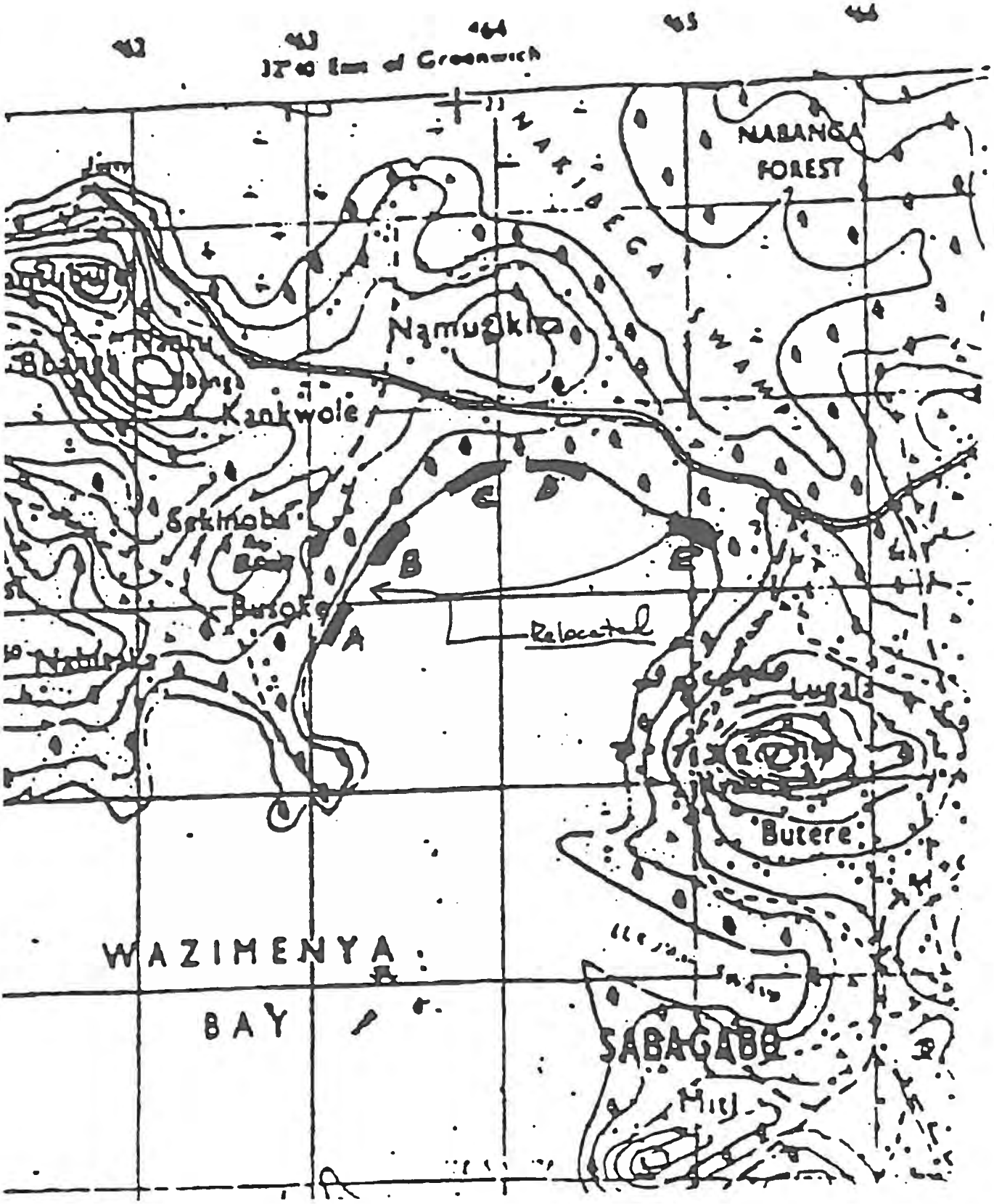

Fig. 1: Experimental area and sampling sites (A to E) for the In - Lake herbicide trials at Wazimenya/Murchison Bay.

The samples kept in large polythene bags were transferred to the laboratory for sorting. In the laboratory water hyacinth and sediment samples were placed on appropriate sieves and washed to remove mud and small bits of debris. Visible macrofauna were hand sorted before the material was sprinkled with ethanol to excite attached and hidden animals which were then collected. The specimens were finally separated into taxonomic groups, counted and calculation of abundance expressed as numbers per metre square. Formalin (10%) was used when necessary, to preserve the invertebrates.

Results and discussion

Data on abundance of 8 most frequent taxonomic groups of macrofauna found in the below-water biomass of water hyacinth treated with test herbicides and in the sediment below the weed mats are displayed in the Figs that follow. Relevant raw data are given as Appendix I and II. Presentation of the data in histograms was intended to facilitate visual comparison so as to expose the effects, if any, of herbicide application on the diversity and abundance of macrofauna associated with water hyacinth in the test plots. More rigorous statistical analysis was not used in view of the patchiness of the data especially that from sediment; and of the limited sample sizes and lack of replication for the control.

Macrofauna from below-water biomass

Data in Fig. 2a and b show the effects of herbicide application on the macrofauna in the below-water biomass of water hyacinth. The following deductions were made.

i **Diversity:** On the whole, all the 8 major taxonomic groups of macrofauna were well represented in the below-water biomass of water hyacinth throughout most of the experimental period of 30 days, at both sampling sites of 1m and 5m. The absence of **Odonata** in the test plots on day 30, 5m into the mat yet it occurred 1m into the mat cast doubt on the indication that herbicide application may be responsible. This is because herbicides would have had a longer residence time at 5m than at 1m site into the water hyacinth fringe. It is possible that the cause of the disparity could be some other unknown factor.

ii **Abundance:** comparison of the abundance of macrofauna in the below-water biomass of water hyacinth in the control and test plots did not reveal significant effects attributable to herbicide application during the first 21 days of the experiments. The abundance of **Ephemeroptera, Chironomidae, Gastropoda, Hirudinia, Caridina and Odonata** at 1m into the mat; and of **Chironomidae** and **Gastropoda** at 5m into the weed mat at day 30 was significantly lower than that of macrofauna from the control plot. At this period of the experiment, there was considerable environmental change particularly of increased light penetration, dissolved oxygen as well as of reduced shelter from wave action especially at 1m into the mat. The environmental changes which set in as the water hyacinth biomass began to die could have contributed to the above effects on macrofauna abundance.

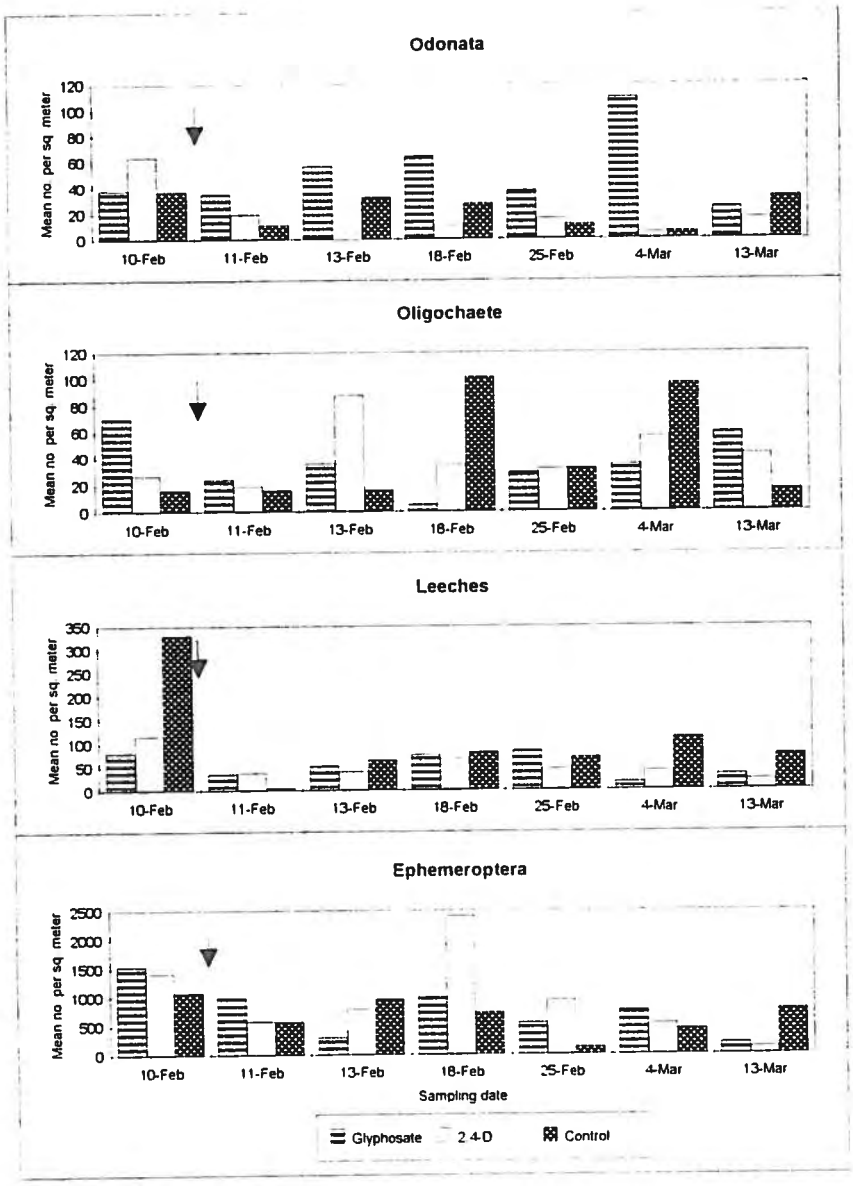

Fig 2a cont. Abundance of macrofauna in below water biomass 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay ——▶ = herbicides application.

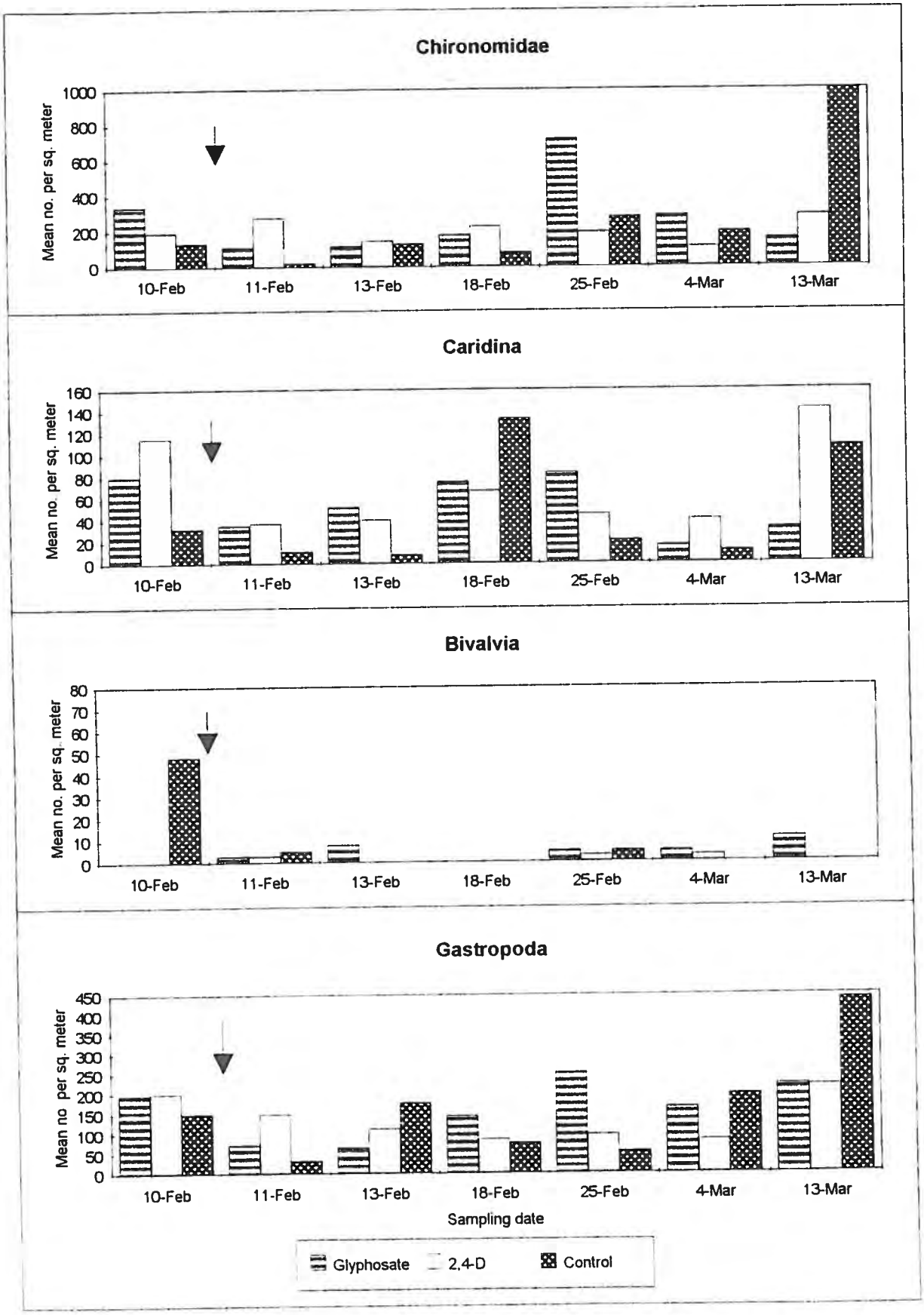

Fig 2a: Abundance of macrofauna in below water biomass 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay. ⟶ = herbicides application.

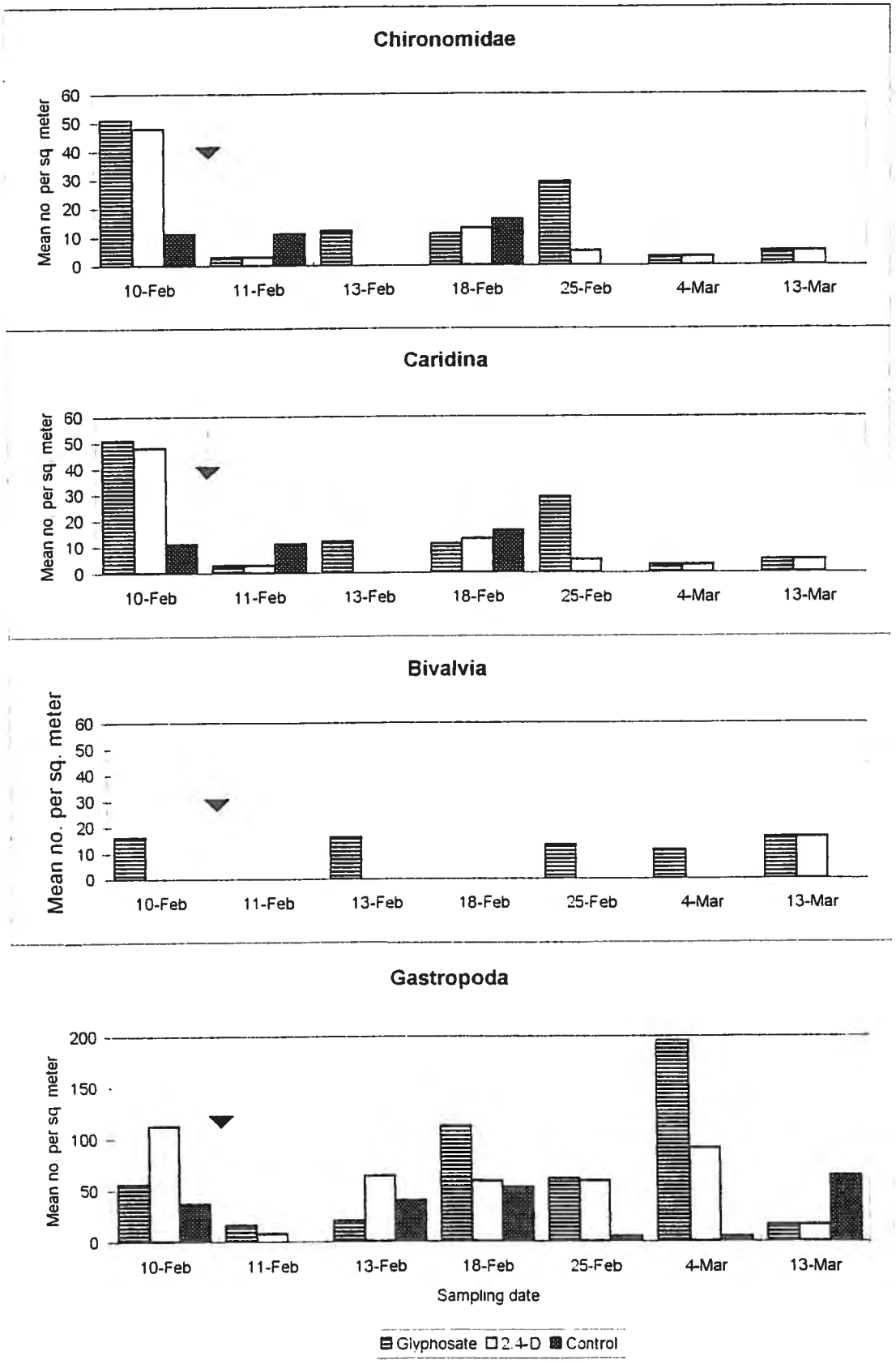

Fig 2b: Abundance of macrofauna in below water biomass 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay. ——▶ = herbicides application

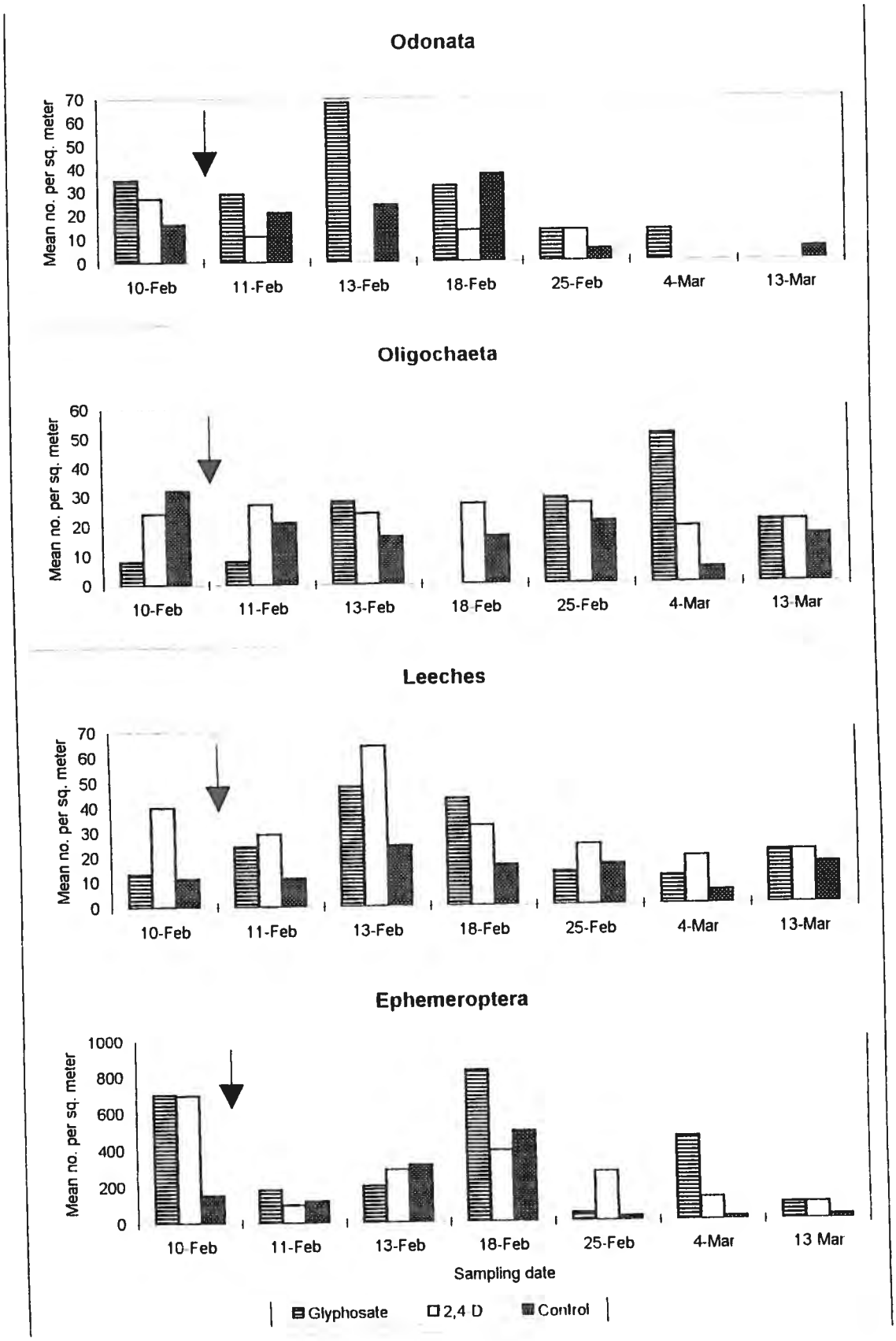

Fig 2b cont. Abundance of macrofauna in below water biomass 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay. ▶ = herbicides application.

Macrofauna in sediment

Data in Fig. 3 a and b present the effects of herbicide application on the macrofauna associated with sediments under water hyacinth mats. The following deductions were made:

Diversity: while the overall diversity of the major macrofauna in the sediments was the same as that found with respect to the above-water biomass of water hyacinth, the distribution was much more patchy and hence representation during the sampling rounds was not as frequent. However, based on comparison with diversity in the control plot no evidence of adverse effect of herbicide application on water hyacinth in the diversity of macrofauna in the sediments was found.

Abundance - The abundance of macrofauna in sediment was much lower than that in the above-water biomass of water hyacinth. Similarly, macrofauna were more abundant in the sediment 1m into the mat than at 5m. The data does not show adverse impact attributable to application of the two herbicides on the abundance of macrofauna in the sediments below the mats before day 21 of the study. However, samples taken on day 30 indicate significantly higher abundance of **Oligochaeta**, **Ephemeroptera**, **Caridina**, **Odonata Gastropoda** and **Bivalvia** at 1m into the mat. Indication of significant depression of the abundance of **Bivalvia**, **Oligochaeta**, **Chironomidae** due to herbicides only two hours after application on 11 February is difficult to uphold because similar effect was not observed for the same taxonomic groups in the below-water biomass where the herbicides were applied direct. It is likely that the observations are due to the patchy distribution and low abundance of macrofauna in the sediments.

Conclusion

The experiments did not reveal adverse effects attributable to spraying with Glyphosate or 2,4-D amine on the diversity and abundance of major taxonomic groups of macrofauna found in the below-water biomass of shoreline water hyacinth and in the sediment below the weed mats in Wazimenya sub-bay before day 21 after herbicide application. The significant influence on the abundance of some macrofauna after day 21 was attributed to environmental changes which set in as water hyacinth progressively died. These conclusions are, however, subject to the fact that the experimental area was a huge open system with numerous possible environmental diferences and impacts that could have influnced the experiments in ways difficult to specify. Those influences would have been exacerbated by the diurnal influx and efflux of a vast mat of water hyacinth into and out of Wazimenya sub-bay thoughout the experimental period.

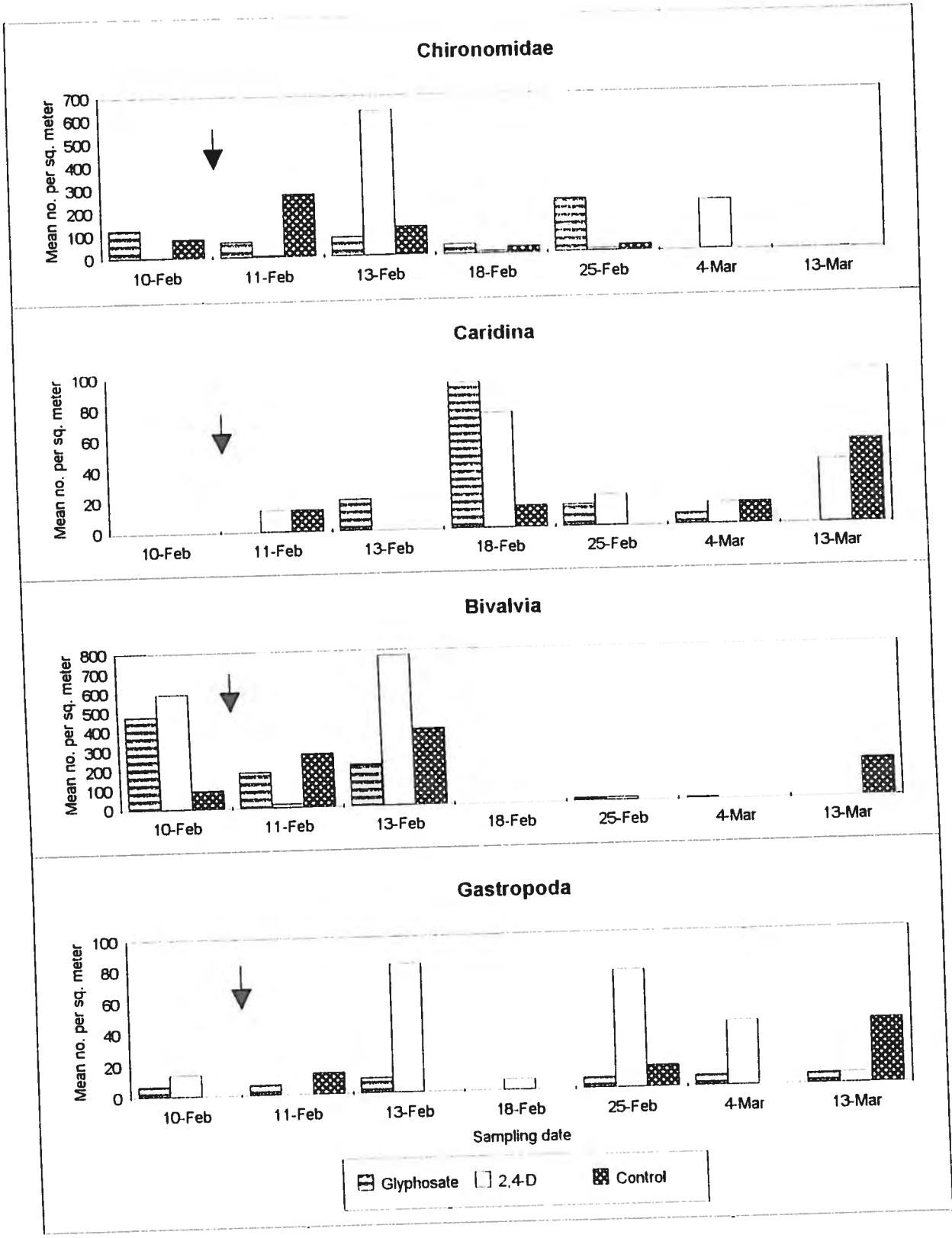

Fig. 3a: Abundance of macrofauna in sediment under 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay. ▶ = herbicides application

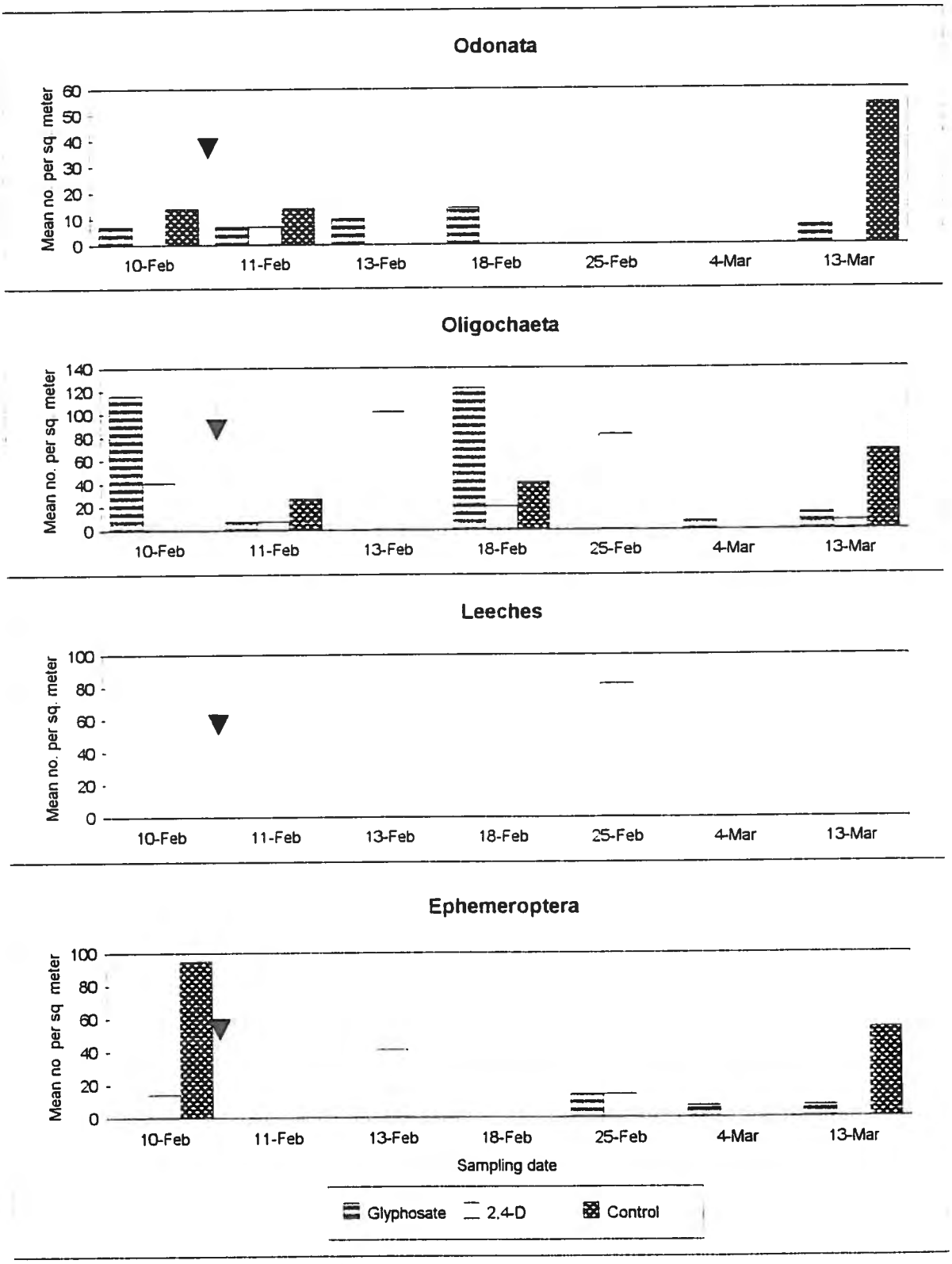

Fig. 3a cont. Abundance of macrofauna in sediment under 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay ⟶ = herbicides application

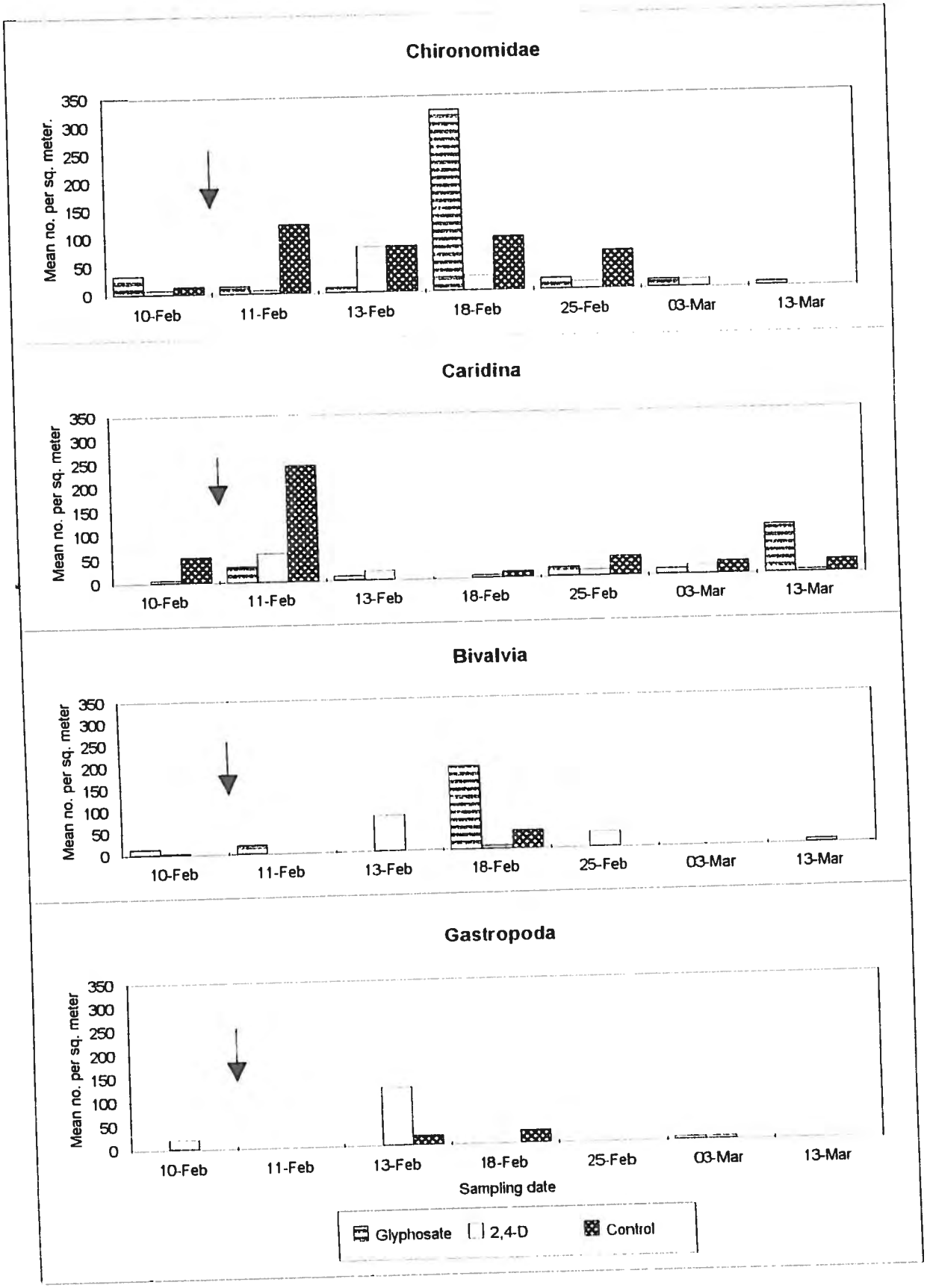

Fig. 3b: Abundance of macrofauna in sediment under 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

▶ = herbicides application.

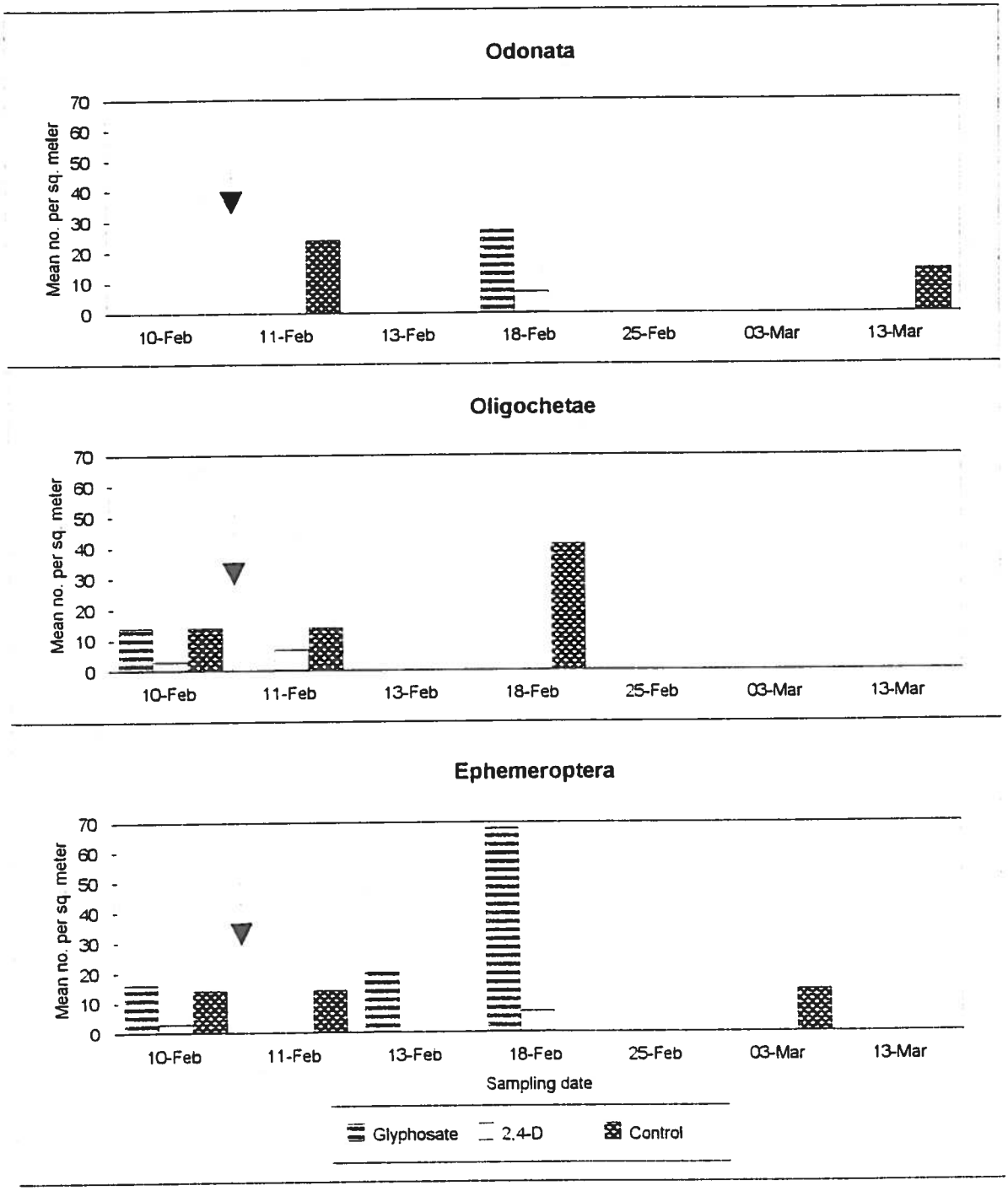

Fig. 3b cont. Abundance of macrofauna in sediment under 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

→ = herbicides application.

Appendix I a: Abundance of macrofauna in below water biomass 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Leeches	Oligoch	Tricoptera	Nematoda	Chiron
10-Feb-97.										
Plot A	240	0	1440	48	16	0	0	0	0	224
Plot A	144	0	1168	32	64	0	32	0	0	80
Plot A	144	0	1536	112	272	32	64	48	0	96
Plot D	496	0	1712	0	128	272	224	80	0	1136
Plot D	64	0	1152	16	32	64	48	0	0	17
Plot D	80	0	2224	16	192	112	48	0	0	13
Mean	195	0	1539	37	117	80	69	21	0	261
STD	146.2	0.0	364.3	36.6	91.3	94.2	72.0	31.6	0.0	397.5
Count	6	6	6	6	6	6	6	6	6	6
Plot B	208	0	2496	96	432	256	32	16	0	208
Plot B	176	0	1248	48	496	96	16	32	0	256
Plot B	272	0	2160	112	160	64	0	176	0	384
Plot C	144	0	1136	64	208	112	32	96	0	96
Plot C	48	0	576	32	96	32	32	0	0	112
Plot C	192	0	832	32	48	128	48	0	0	96
Mean	173	0	1408	64	240	115	27	53	0	192
STD	68.1	0.0	692.0	30.6	167.0	70.6	15.1	63.8	0.0	104.9
Count	6	6	6	6	6	6	6	6	6	6
Plot E	352	144	672	64	16	464	32	16	16	144
Plot E	32	0	1792	32	16	304	16	16	0	176
Plot E	64	0	752	16	64	224	0	48	0	80
Mean	149	48	1072	37	32	331	16	27	5	133
STD	143.9	67.9	510.2	20.0	22.6	99.8	13.1	15.1	7.5	39.9
Count	3	3	3	3	3	3	3	3	3	3
11-Feb-97.										
Plot A	128	0	576	80	16	16	32	0	0	32
Plot A	192	0	1312	48	0	48	32	16	0	128
Plot A	32	0	576	32	0	0	0	0	0	96
Plot D	16	0	640	0	0	80	80	32	0	272
Plot D	64	0	1888	32	32	0	0	0	0	64
Plot D	0	16	928	16	16	64	0	0	0	80
Mean	72	3	987	35	11	35	24	8	0	112
STD	67.7	6.0	479.4	25.2	11.9	31.2	28.8	12.2	0.0	77.3
Count	6	6	6	6	6	6	6	6	6	6
Plot B	144	16	496	48	16	96	64	16	0	208
Plot B	320	0	416	16	16	32	0	0	0	256
Plot B	192	0	608	0	0	0	0	16	0	336
Plot C	64	0	512	16	0	0	0	32	0	304
Plot C	64	0	480	0	0	80	16	0	0	432
Plot C	112	0	928	32	0	16	32	16	0	112
Mean	149	3	573	19	5	37	19	13	0	275
STD	88	6	168	17	8	38	23	11	0	101
Count	6	6	6	6	6	6	6	6	6	6
Plot E	0	0	304	0	0	0	0	0	0	48
Plot E	16	16	736	32	0	0	0	16	0	0
Plot E	80	0	656	0	32	16	48	0	0	16

Appendix I a: Abundance of macrofauna in below water biomass 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Leeches	Oligoch	Tricoptera	Nematoda	Chiron
Mean	32	5	565	11	11	5	16	5	0	21
STD	34.6	7.5	187.7	15.1	15.1	7.5	22.6	7.5	0.0	20.0
Count	3	3	3	3	3	3	3	3	3	3
13-Feb-97.										
Plot A	32	0	496	96	48	16	80	16	0	240
Plot A	128	16	432	48	48	16	48	0	0	96
Plot D	96	0	128	64	0	144	0	0	0	48
Plot D	0	16	144	16	16	32	16	16	0	80
Mean	64	8	300	56	28	52	36	8	0	116
STD	50.6	8.0	165.7	28.8	20.8	53.5	30.7	8.0	0.0	73.6
Count	4	4	4	4	4	4	4	4	4	4
Plot B	112	0	1056	0	0	80	176	0	0	144
Plot B	112	0	496	0	0	0	0	32	0	144
Mean	112	0	776	0	0	40	88	16	0	144
STD	0.0	0.0	280.0	0.0	0.0	40.0	88.0	16.0	0.0	0.0
Count	2	2	2	2	2	2	2	2	2	2
Plot E	304	0	1280	64	16	112	32	16	0	0
Plot E	48	0	640	0	0	16	0	16	0	16
Mean	176	0	960	32	8	64	16	16	0	8
STD	128.0	0.0	320.0	32.0	8.0	48.0	16.0	0.0	0.0	8.0
Count	2	2	2	2	2	2	2	2	2	2
18-Feb-97.										
Plot A	80	0	1408	176	16	80	16	0	0	160
Plot A	192	0	896	16	400	80	0	48	0	160
Plot A	160	0	688	0	256	64	0	32	0	160
Mean	144	0	997	64	224	75	5	27	0	160
STD	47.1	0.0	302.5	79.5	158.4	7.5	7.5	20.0	0.0	0.0
Count	3	3	3	3	3	3	3	3	3	3
Plot B	80	0	736	48	64	32	48	32	0	272
Plot B	16	0	1920	16	0	80	0	32	0	112
Plot B	48	0	928	0	16	64	16	32	0	224
Plot C	64	0	7616	0	0	144	48	0	0	224
Plot C	304	0	2432	0	16	32	16	48	0	192
Plot C	0	0	736	0	0	48	80	16	0	320
Mean	85	0	2395	11	16	67	35	27	0	224
STD	101.5	0.0	2420.1	17.7	22.6	38.6	26.8	15.1	0.0	64.7
Count	6	6	6	6	6	6	6	6	6	6
Plot E	64	0	880	48	64	128	32	32	0	192
Plot E	96	0	1184	16	96	16	256	80	0	48
Plot E	64	0	96	16	240	96	16	0	0	0
Mean	75	0	720	27	133	80	101	37	0	80
STD	15.1	0.0	458.4	15.1	76.5	47.1	109.6	32.9	0.0	81.6
Count	3	3	3	3	3	3	3	3	3	3

25-Feb-97.

Appendix I a: Abundance of macrofauna in below water biomass 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Leeches	Oligoch	Tricoptera	Nematoda	Chiron
Plot A	96	0	720	64	48	32	0	0	0	144
Plot A	128	0	704	48	48	32	32	0	0	144
Plot A	224	0	1280	48	32	80	16	16	0	400
Plot D	320	32	192	16	16	32	16	0	0	720
Plot D	256	0	224	0	0	192	96	0	0	1440
Plot D	416	0	128	48	240	128	16	0	0	0
Mean	240	5	541	37	64	83	29	3	0	475
STD	108.9	11.9	407.8	22.0	80.5	60.2	31.2	6.0	0.0	490.2
Count	6	6	6	6	6	6	6	6	6	6
Plot B	80	0	1136	48	128	0	0	80	0	352
Plot B	48	0	256	0	16	16	64	0	0	240
Plot B	0	0	0	0	0	0	0	0	0	0
Plot C	32	0	1024	0	96	32	16	0	0	112
Plot C	128	16	1200	16	32	64	80	0	0	112
Plot C	288	0	1952	32	48	160	32	0	0	336
Mean	96	3	928	16	53	45	32	13	0	192
STD	94.7	6.0	643.9	18.5	44.9	55.7	30.6	29.8	0.0	128.0
Count	6	6	6	6	6	6	6	6	6	6
Plot E	48	16	112	0	0	96	16	16	0	192
Plot E	48	0	128	16	0	0	64	0	0	112
Plot E	64	0	128	16	64	112	16	16	16	528
Mean	53	5	123	11	21	69	32	11	5	277
STD	7.5	7.5	7.5	7.5	30.2	49.5	22.6	7.5	7.5	180.2
Count	3	3	3	3	3	3	3	3	3	3
4-March-97.										
Plot A	192	0	1584	48	144	0	32	0	0	128
Plot A	96	0	912	528	16	32	48	16	0	256
Plot A	112	32	1504	32	32	32	96	16	0	272
Plot D	144	0	352	32	32	32	64	0	0	512
Plot D	128	0	96	0	16	0	32	0	0	352
Plot D	320	0	80	16	0	0	0	0	0	192
Mean	165	5	755	109	40	16	45	5	0	285
STD	75.4	11.9	622.5	187.8	47.8	16.0	29.8	7.5	0.0	122.7
Count	6	6	6	6	6	6	6	6	6	6
Plot B	48	0	384	0	0	0	0	16	0	32
Plot B	112	0	640	0	0	32	0	16	0	96
Plot B	112	0	224	0	0	0	160	0	0	80
Plot C	112	16	320	0	0	32	64	32	0	80
Plot C	64	0	80	16	0	32	32	0	0	48
Plot C	48	0	1472	16	16	144	80	0	0	304
Mean	83	3	520	5	3	40	56	11	0	107
STD	29.8	6.0	458.3	7.5	6.0	48.7	55.2	11.9	0.0	90.8
Count	6	6	6	6	6	6	6	6	6	6
Plot E	192	0	624	0	0	192	208	0	0	208
Plot E	272	0	336	16	32	64	0	16	0	256
Plot E	128	0	336	0	0	80	80	16	0	112

Appendix Ib: Abundance of macrofauna in below water biomass 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Leeches	Oligoch	Tricoptera	Cleoptera	Nematoda	Chiron
10-Feb-97.											
Plot A	144	16	1248	16	272	16	16	0	0	0	624
Plot A	112	0	976	96	32	0	0	0	0	0	256
Plot A	32	0	1072	16	0	0	0	64	0	0	64
Plot D	0	80	528	0	0	0	0	0	0	0	0
Plot D	32	0	304	16	0	64	32	64	16	0	0
Plot D	16	0	96	32	0	0	0	64	0	0	144
Mean	56	16	704	29	51	13	8	32	3	0	181
STD	52.9	29.2	421.5	31.2	99.7	23.4	12.2	32.0	6.0	0.0	217.0
Count	6	6	6	6	6	6	6	6	6	6	6
Plot B	32	0	640	0	32	16	16	16	0	16	0
Plot B	160	0	928	32	144	0	48	80	48	0	304
Plot B	448	0	2352	48	48	112	48	32	64	0	160
Plot C	16	0	16	0	32	0	16	32	0	0	160
Plot C	0	0	128	32	32	80	0	80	32	0	80
Plot C	16	0	112	48	0	32	16	0	16	0	256
Mean	112	0	696	27	48	40	24	40	27	48	160
STD	159.5	0.0	808.8	20.0	45.3	42.1	17.9	30.3	23.9	6.0	101.6
Count	6	6	6	6	6	6	6	6	6	6	6
Plot E	48	0	96	0	0	0	48	0	0	0	160
Plot E	32	0	192	16	0	16	32	16	0	0	128
Plot E	16	0	160	32	32	16	16	32	0	0	48
Mean	32	0	149	16	11	11	32	16	0	0	112
STD	13.1	0.0	39.9	13.1	15.1	7.5	13.1	13.1	0.0	0.0	47.1
Count	3	3	3	3	3	3	3	3	3	3	3
11-Feb-97.											
Plot A	16	0	240	32	0	0	0	16	0	0	64
Plot A	16	0	256	32	0	0	16	0	0	0	64
Plot A	48	0	144	16	0	32	0	0	0	0	48
Plot D	0	0	176	32	0	16	0	32	0	0	64
Plot D	16	0	64	32	16	32	0	16	16	0	144
Plot D	0	0	192	32	0	64	32	0	0	0	80
Mean	16	0	179	29	3	24	8	11	3	0	77
STD	16.0	0.0	63.6	6.0	6.0	22.2	12.2	11.9	6.0	0.0	31.2
Count	6	6	6	6	6	6	6	6	6	6	6
Plot B	0	0	80	48	16	48	64	16	16	0	320
Plot B	48	0	32	0	0	48	32	16	16	0	64
Plot B	0	0	64	0	0	16	0	0	0	0	96
Plot C	0	0	272	16	0	32	48	0	0	0	80
Plot C	0	0	96	0	0	16	0	0	0	0	48
Plot C	0	0	48	0	0	16	16	16	0	0	112
Mean	8	0	99	11	3	29	27	8	5	0	120
STD	17.9	0.0	80.2	17.7	6.0	14.4	23.9	8.0	7.5	0.0	91.8

Appendix I a: Abundance of macrofauna in below water biomass 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Leeches	Oligoch	Tricoptera	Nematoda	Chiron
Mean	197	0	432	5	11	112	96	11	0	192
STD	58.9	0.0	135.8	7.5	15.1	56.9	85.7	7.5	0.0	59.9
Count	3	3	3	3	3	3	3	3	3	3
13/3/97										
Vegetation Samples										
Plot A	96	64	160	96	0	32	192	0	0	256
Plot A	384	0	688	32	0	112	96	16	0	224
Plot A	352	0	272	16	16	32	0	0	0	80
Plot D	144	0	0	0	0	0	48	0	0	128
Plot D	256	0	16	0	0	16	16	0	0	112
Plot D	96	0	0	0	0	0	0	0	0	128
Mean	221	11	189	24	3	32	59	3	0	155
STD	117.0	23.9	244.3	34.3	6.0	38.1	68.3	6.0	0.0	63.1
Count	6	6	6	6	6	6	6	6	6	6
Plot B	320	0	272	48	336	80	112	0	0	400
Plot B	48	0	128	16	32	0	48	0	0	304
Plot B	128	0	224	16	384	0	0	16	0	656
Plot C	432	0	64	16	48	32	32	0	0	176
Plot C	272	0	144	0	32	0	48	0	0	176
Plot C	112	0	32	0	16	16	16	0	0	0
Mean	219	0	144	16	141	21	43	3	0	285
STD	133.8	0.0	83.7	16.0	155.5	28.7	35.4	6.0	0.0	206.6
Count	6	6	6	6	6	6	6	6	6	6
Plot E	528	0	800	64	240	112	16	16	0	1632
Plot E	528	0	1008	16	80	80	32	160	0	976
Plot E	256	0	512	16	0	32	0	0	0	384
Mean	437	0	773	32	107	75	16	59	0	997
STD	128.2	0.0	203.4	22.6	99.8	32.9	13.1	72.0	0.0	509.7
Count	3	3	3	3	3	3	3	3	3	3

Appendix Ib: Abundance of macrofauna in below water biomass 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Leeches	Oligoch	Tricoptera	Cleoptera	Nematoda	Chiron
Count	6	6	6	6	6	6	6	6	6	6	6
Plot E	0	0	112	32	16	16	32	0	16	0	48
Plot E	0	0	80	16	16	0	0	0	0	0	16
Plot E	0	0	160	16	0	16	32	16	0	0	32
Mean	0	0	117	21	11	11	21	5	5	0	32
STD	0.0	0.0	32.9	7.5	7.5	7.5	15.1	7.5	7.5	0.0	13.1
Count	3	3	3	3	3	3	3	3	3	3	3
13-Feb-97.											
Plot A	64	0	16	160	0	0	32	0	0	0	128
Plot A	0	16	112	48	0	16	32	0	0	0	128
Plot D	0	0	240	32	0	112	48	0	0	0	128
Plot D	16	48	432	32	48	64	0	16	0	0	480
Mean	20	16	200	68	12	48	28	4	0	0	216
STD	26.2	19.6	155.7	53.5	20.8	43.8	17.4	6.9	0.0	0.0	152.4
Count	4	4	4	4	4	4	4	4	4	4	4
Plot B	128	0	368	0	0	48	48	16	0	0	240
Plot B	0	0	208	0	0	80	0		0	0	192
Mean	64	0	288	0	0	64	24	8	0	0	216
STD	64.0	0.0	80.0	0.0	0.0	16.0	24.0	8.0	0.0	0.0	24.0
Count	2	2	2	2	2	2	2	2	2	2	2
Plot E	48	0	432	16	0	48	0	0	0	0	240
Plot E	32	16	192	32	0	0	32	0	0	0	96
Mean	40	8	312	24	0	24	16	0	0	0	168
STD	8.0	8.0	120.0	8.0	0.0	24.0	16.0	0.0	0.0	0.0	72.0
Count	2	2	2	2	2	2	2	2	2	2	2
18-Feb-97.											
Plot A	16	0	36	16	0	32	0	16	0	0	160
Plot A	288	0	67	64	32	80	0	0	32	0	0
Plot A	32	0	52	16	0	16	0	0	0	0	176
Mean	112	0	52	32	11	43	0	5	11	0	112
STD	124.6	0.0	12.7	22.6	15.1	27.2	0.0	7.5	15.1	0.0	79.5
Count	3	3	3	3	3	3	3	3	3	3	3
Plot B	112	0	32	32	16	16	32	0	0	0	320
Plot B	0	0	224	16	0	32	64	0	0	0	96
Plot B	64	0	208	0	0	48	16	16	0	0	64
Plot C	80	0	352	32	48	16	16	0	0	0	256
Plot C	96	0	896	0	0	16	32	32	0	0	160
Plot C	0	0	624	0	16	64	0	0	16	0	240
Mean	59	0	389	13	13	32	27	8	3	0	189
STD	44.0	0.0	289.0	14.4	17.1	18.5	20.0	12.2	6.0	0.0	90.7
Count	6	6	6	6	6	6	6	6	6	6	6

Appendix Ib: Abundance of macrofauna in below water biomass 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivaivia	Ephem	Odonata	Caridina	Leeches	Oligoch	Tricoptera	Cleoptera	Nematoda	Chiron
Plot B	288	0	160	0	0	32	16	16	0	0	256
Plot B	208	0	128	0	0	0	16	48	0	0	240
Plot B	0	0	176	0	0	16	16	0	0	0	192
Plot C	0	0	64	0	16	16	16	32	0	0	64
Plot C	0	32	160	0	0	48	32	0	0	0	32
Plot C	48	16	48	0	0	0	16	16	0	0	32
Mean	91	8	123	0	3	19	19	19	0	0	136
STD	114.9	12.2	49.5	0.0	6.0	17.1	6.0	17.1	0.0	0.0	95.9
Count	6	6	6	6	6	6	6	6	6	6	6
Plot E	0	0	0	0	0	0	0	0	0	0	176
Plot E	16	0	32	0	0	0	0	0	0	0	112
Plot E	0	0	16	0	0	16	16	0	0	0	64
Mean	5	0	16	0	0	5	5	0	0	0	117
STD	7.5	0.0	13.1	0.0	0.0	7.5	7.5	0.0	0.0	0.0	45.9
Count	3	3	3	3	3	3	3	3	3	3	3
13-March-97.											
Plot A	208	16	176	64	16	32	0	0	0	0	32
Plot A	176	16	176	0	48	32	0	0	0	0	112
Plot A	32	16	32	16	48	32	16	0	16	0	96
Plot D	0	0	0	0	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0	0	0	0	0
Mean	69	8	64	13	19	16	3	0	3	0	40
STD	88.0	8.0	80.0	23.4	21.5	16.0	6.0	0.0	6.0	0.0	46.9
Count	6	6	6	6	6	6	6	6	6	6	6
Plot B	48	0	80	32	16	16	16	0	0	0	16
Plot B	48	0	64	0	32	0	32	0	16	0	80
Plot B	48	0	208	0	0	48	80	0	0	0	128
Plot C	208	0	160	0	16	48	48	64	16	0	304
Plot C	288	48	64	32	0	0	48	16	0	0	80
Plot C	96	144	32	0	0	64	16	0	0	0	32
Mean	123	32	101	11	11	29	40	13	5	0	107
STD	93.1	53.1	61.7	15.1	11.9	25.2	22.2	23.4	7.5	0.0	95.
Count	6	6	6	6	6	6	6	6	6	6	6
Plot E	112	0	32	0	0	0	16	48	16	0	35
Plot E	0	0	0	0	0	0	16	0	0	0	11
Plot E	80	0	32	16	0	48	16	16	0	0	75
Mean	64	0	21	5	0	16	16	21	5	0	40
STD	47.1	0.0	15.1	7.5	0.0	22.6	0.0	20.0	7.5	0.0	264
Count	3	3	3	3	3	3	3	3	3	3	3

Appendix IIa: Abundance of macrofauna in sediment under 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Oligoch	Chiron
10-Feb-97.							
Plot A	0	2122	0	0	0	245	408
Plot A	41	326	0	0	0	408	163
Plot A	0	408	0	0	0	0	163
Plot D	0	0	0	0	0	41	0
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	41	0	0	0
Mean	7	476	0	7	0	116	122
STD	16.7	826.6	0.0	16.7	0.0	172.0	161.2
Count	6	6	6	6	6	6	6
Plot B	82	1183	0	0	0	245	0
Plot B	0	449	82	0	0	0	0
Plot B	0	1143	0	0	0	0	0
Plot C	0	1959	0	0	0	0	0
Plot C	0	0	0	0	0	0	41
Plot C	0	0	0	0	0	0	0
Mean	14	789	14	0	0	41	7
STD	33.3	775.9	33.3	0.0	0.0	100.0	16.7
Count	6	6	6	6	6	6	6
Plot E	0	0	0	0	0	0	0
Plot E	0	0	41	41	0	0	245
Plot E	0	286	0	0	0	0	0
Mean	0	95	14	14	0	0	82
STD	0.0	164.9	23.6	23.6	0.0	0.0	141.4
Count	3	3	3	3	3	3	3
11-Feb-97.							
Plot A	41	816	0	0	0	0	245
Plot A	0	0	0	41	0	41	163
Plot A	0	286	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Mean	7	184	0	7	0	7	68
STD	16.7	330.3	0.0	16.7	0.0	16.7	108.5
Count	6	6	6	6	6	6	6
Plot B	0	41	0	0	0	0	41
Plot B	0	82	0	41	0	0	0
Plot B	0	0	0	0	41	41	0
Plot C	0	0	0	0	41	0	0
Plot C	0	0	0	0	0	0	0
Plot C	0	0	0	0	0	0	0
Mean	0	20	0	7	14	7	7
STD	0.0	34.1	0.0	16.7	21.1	16.7	16.7

Appendix IIa: Abundance of macrofauna in sediment under 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Oligoch	Chiron
Count	6	6	6	6	6	6	6
Plot E	0	245	0	0	0	82	286
Plot E	0	571	0	41	0	0	490
Plot E	41	0	0	0	41	0	41
Mean	14	272	0	14	14	27	272
STD	23.6	286.6	0.0	23.6	23.6	47.1	224.8
Count	3	3	3	3	3	3	3
13 Feb 97.							
Plot A	41	490	0	0	82	0	41
Plot A	0	326	0	0	0	0	122
Plot D	0	0	0	0	0	0	0
Plot D	0	41	0	41	0	0	0
Mean	10	214	0	10	20	0	41
STD	20.4	234.1	0.0	20.4	40.8	0.0	57.7
Count	4	4	4	4	4	4	4
Plot B	82	939	82	0	0	204	816
Plot B	82	612	0	0	0	0	449
Mean	82	775	41	0	0	102	633
STD	0.0	230.9	57.7	0.0	0.0	144.3	259.7
Count	2	2	2	2	2	2	2
Plot E	0	326	0	0	0	0	245
Plot E	0	449	0	0	0	0	0
Mean	0	388	0	0	0	0	122
STD	0.0	86.6	0.0	0.0	0.0	0.0	173.1
Count	2	2	2	2	2	2	2
18 Feb 97.							
Plot A	0	898	0	41	286	163	8
Plot A	0	163	0	0	0	163	286
Plot A	0	0	0	0	0	41	82
Mean	0	82	0	0	0	102	184
STD	0.0	115.4	0.0	0.0	0.0	86.6	144.3
Count	2	2	2	2	2	2	2
Plot B	0	0	0	0	0	41	0
Plot B	0	0	0	0	41	82	82
Plot B	41	122	0	0	41	0	0
Plot C	0	0	0	0	204	0	0
Plot C	0	0	0	0	163	0	0
Plot C	0	41	0	0	0	0	0
Mean	7	27	0	0	75	20	14
STD	16.7	49.4	0.0	0.0	87.2	34.1	33.3
Count	6	6	6	6	6	6	6

Appendix IIa: Abundance of macrofauna in sediment under 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Oligoch	Chiron
Plot E	0	82	0	0	0	41	0
Plot E	0	41	0	0	0	0	82
Plot E	0	326	0	0	41	82	0
Mean	0	150	0	0	14	41	27
STD	0.0	154.5	0.0	0.0	23.6	40.8	47.1
Count	3	3	3	3	3	3	3
25-Feb-97.							
Plot A	0	0	0	0	0	0	0
Plot A	41	0	82	0	41	0	0
Plot A	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	0	41	0	0
Plot D	0	0	0	0	0	0	0
Mean	7	0	14	0	14	0	0
STD	16.7	0.0	33.3	0.0	21.1	0.0	0.0
Count	6	6	6	6	6	6	6
Plot B	41	82	0	0	0	0	490
Plot B	245	20	0	0	82	0	408
Plot B	163	163	0	0	41	0	82
Plot C	0	0	0	0	0	41	82
Plot C	0	122	0	0	0	367	41
Plot C	0	82	82	0	0	82	204
Mean	75	78	14	0	20	82	218
STD	104.6	61.2	33.3	0.0	34.1	143.7	189.1
Count	6	6	6	6	6	6	6
Plot E	0	41	0	0	0	0	0
Plot E	0	0	0	0	0	0	0
Plot E	41	122	0	0	0	0	0
Mean	14	54	0	0	0	0	0
STD	23.6	62.3	0.0	0.0	0.0	0.0	0.0
Count	3	3	3	3	3	3	3
4-March-97.							
Plot A	0	163	41	0	0	0	245
Plot A	0	0	0	0	41	41	286
Plot A	41	163	0	0	0	0	163
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Mean	7	54	7	0	7	7	116
STD	16.7	84.3	16.7	0.0	16.7	16.7	132.7
Count	6	6	6	6	6	6	6

Appendix IIa: Abundance of macrofauna in sediment under 1m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Oligoch	Chiron
Plot B	0	0	0	0	0	0	0
Plot B	163	163	0	0	0	0	0
Plot B	41	0	0	0	0	0	0
Plot C	41	0	0	0	0	0	41
Plot C	0	0	0	0	41	0	0
Plot C	0	0	0	0	41	0	41
Mean	41	27	0	0	14	0	14
STD	63.2	66.6	0.0	0.0	21.1	0.0	21.1
Count	6	6	6	6	6	6	6
Plot E	0	0	0	0	41	0	0
Plot E	0	0	0	0	0	0	0
Plot E	0	0	0	0	0	0	0
Mean	0	0	0	0	14	0	0
STD	0.0	0.0	0.0	0.0	23.6	0.0	0.0
Count	3	3	3	3	3	3	3
13-March-97.							
Plot A	0	0	0	0	0	0	0
Plot A	0	0	0	0	0	82	0
Plot A	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Plot D	41	0	41	41	0	0	0
Plot D	0	0	0	0	0	0	0
Mean	7	0	7	7	0	14	0
STD	16.7	0.0	16.7	16.7	0.0	33.3	0.0
Count	6	6	6	6	6	6	6
Plot B	41	0	0	0	0	41	0
Plot B	0	0	0	0	0	0	0
Plot B	0	0	0	0	204	0	0
Plot C	0	0	0	0	0	0	0
Plot C	0	0	0	0	41	0	0
Plot C	0	0	0	0	0	0	0
Mean	7	0	0	0	41	7	0
STD	16.7	0.0	0.0	0.0	81.6	16.7	0.0
Count	6	6	6	6	6	6	6
Plot E	0	0	0	0	0	41	41
Plot E	82	245	0	0	0	163	0
Plot E	41	326	163	0	163	0	490
Mean	41	190	54	0	54	68	177
STD	41	170	94	0	94	85	272
Count	3	3	3	3	3	3	3

Appendix IIb: Abundance of macrofauna in sediment under 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Oligoch	Chiron
10-Feb-97.							
Plot A	0	82	0	0	0	41	122
Plot A	0	0	0	0	0	0	0
Plot A	0	0	0	0	0	41	82
Plot D	0	0	204	0	0	0	0
Plot D	0	0	0	0	0	0	0
Plot D	0	0	41	0	0	0	0
Mean	0	14	41	0	0	14	34
STD	0.0	30.4	74.5	0.0	0.0	19.2	49.5
Count	6	6	6	6	6	6	6
Plot B	0	0	0	0	0	0	0
Plot B	0	0	41	0	0	41	0
Plot B	0	41	0	0	0	0	122
Plot C	0	0	0	0	41	0	0
Plot C	2	0	0	0	0	0	0
Plot C	41	0	0	0	0	0	0
Mean	7	7	7	0	7	7	20
STD	15.1	15.2	15.2	0.0	15.2	15.2	45.6
Count	6	6	6	6	6	6	6
Plot E	0	0	0	0	163	41	0
Plot E	0	0	41	0	0	0	0
Plot E	0	0	0	0	0	0	41
Mean	0	0	14	0	41	14	14
STD	0.0	0.0	19.2	0.0	77.0	19.2	19.2
Count	3	3	3	3	3	3	3
Plot A	0	0	0	0	82	0	0
Plot A	0	0	0	0	0	0	82
Plot A	0	122	0	0	0	0	0
Plot D	0	0	0	0	41	0	0
Plot D	0	0	0	0	82	0	0
Plot D	0	0	0	0	0	0	0
Mean	0	20	0	0	34	0	14
STD	0.0	45.6	0.0	0.0	36.6	0.0	30.4
Count	6	6	6	6	6	6	6
Plot B	0	0	0	0	82	0	0
Plot B	0	0	0	0	0	41	0
Plot B	0	0	0	0	41	0	41
Plot C	0	0	0	0	4	0	0
Plot C	0	0	0	0	0	0	0
Plot C	0	0	0	0	82	0	0
Mean	0	0	0	0	35	7	7
STD	0.0	0.0	0.0	0.0	36.0	15.2	15.2
Count	6	6	6	6	6	6	6

Appendix IIb: Abundance of macrofauna in sediment under 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Oligoch	Chiron
Plot E	0	0	0	0	0	0	367
Plot E	0	0	41	0	204	41	0
Plot E	0	0	0	0	531	0	0
Mean	0	0	14	0	245	14	122
STD	0.0	0.0	19.2	0.0	218.5	19.2	173.1
Count	3	3	3	3	3	3	3
13-Feb-97.							
Plot A	0	0	0	0	0	0	0
Plot A	0	0	0	0	0	0	0
Plot D	0	0	41	0	0	0	41
Plot D	0	0	41	0	41	0	0
Mean	0	0	20	0	10	0	10
STD	0.0	0.0	20.4	0.0	17.7	0.0	17.7
Count	4	4	4	4	4	4	4
Plot B	82	82	0	0	41	0	41
Plot B	163	82	0	0	0	0	122
Mean	122	82	0	0	20	0	82
STD	40.8	0.0	0.0	0.0	20.4	0.0	40.8
Count	2	2	2	2	2	2	2
Plot E	41	0	0	41	0	0	82
Plot E	0	0	0	0	0	0	82
Mean	20	0	0	20	0	0	82
STD	20.4	0.0	0.0	20.4	0.0	0.0	0.0
Count	2	2	2	2	2	2	2
18-Feb-97.							
Plot A	0	163	40.81*3	41	0	0	204
Plot A	0	41	82	41	0	0	286
Plot A	0	286	0	0	0	0	0
Mean	0	163	27	27	0	0	163
STD	0.0	100.0	38.5	19.2	0.0	0.0	120.1
Count	3	3	3	3	3	3	3
Plot B	0	0	0	0	0	0	41
Plot B	0	0	0	0	41	0	41
Plot B	0	0	0	0	0	0	0
Plot C	0	0	41	0	0	0	0
Plot C	0	41	0	0	0	0	41
Plot C	0	0	0	41	0	0	41
Mean	0	7	7	7	7	0	27
STD	0.0	15.2	15.2	15.2	15.2	0.0	19.2
Count	6	6	6	6	6	6	6

Appendix IIb: Abundance of macrofauna in sediment under 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Oligoch	Chiron
Plot E	41	0	0	0	41	41	82
Plot E	0	82	0	0	0	0	163
Plot E	41	41	0	0	0	82	41
Mean	27	41	0	0	14	41	95
STD	19.2	33.3	0.0	0.0	19.2	33.3	50.9
Count	3	3	3	3	3	3	3
25-Feb-97.							
Plot A	0	0	0	0	41	0	122
Plot A	0	0	0	0	41	0	0
Plot A	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	0	41	0	0
Mean	0	0	0	0	20	0	20
STD	0.0	0.0	0.0	0.0	20.4	0.0	45.6
Count	6	6	6	6	6	6	6
Plot B	0	41	0	0	0	0	41
Plot B	0	82	0	0	41	0	0
Plot B	0	41	0	0	0	0	41
Plot C	0	41	0	0	41	0	0
Plot C	0	0	0	0	0	0	0
Plot C	0	0	0	0	0	0	0
Mean	0	34	0	0	14	0	14
STD	0.0	28.0	0.0	0.0	19.2	0.0	19.2
Count	6	6	6	6	6	6	6
Plot E	0	0	0	0	0	0	82
Plot E	0	0	0	0	41	0	41
Plot E	0	0	0	0	82	0	82
Mean	0	0	0	0	41	0	68
STD	0.0	0.0	0.0	0.0	33.3	0.0	19.2
Count	3	3	3	3	3	3	3
4-March-97.							
Plot A	0	0	0	0	0	0	0
Plot A	0	0	0	0	0	0	0
Plot A	41	0	0	0	0	0	41
Plot D	0	0	0	0	82	0	0
Plot D	0	0	0	0	0	0	41
Plot D	0	0	0	0	0	0	0
Mean	7	0	0	0	14	0	14
STD	15.2	0.0	0.0	0.0	30.4	0.0	19.2
Count	6	6	6	6	6	6	6
Plot B	0	0	0	0	0	0	0

Appendix IIb: Abundance of macrofauna in sediment under 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Oligoch	Chiron
Plot B	0	0	0	0	0	0	0
Plot B	0	0	0	0	82	0	0
Plot C	0	0	0	0	0	0	0
Plot C	0	0	0	0	41	0	41
Plot C	41	0	0	0	0	0	41
Mean	7	0	0	0	20	0	14
STD	15.2	0.0	0.0	0.0	31.2	0.0	19.2
Count	6	6	6	6	6	6	6
Plot E	0	0	0	0	82	0	0
Plot E	0	0	0	0	0	0	0
Plot E	0	0	41	0	0	0	0
Mean	0	0	14	0	27	0	0
STD	0.0	0.0	19.2	0.0	38.5	0.0	0.0
Count	3	3	3	3	3	3	3
13-March-97.							
Plot A	0	0	0	0	41	0	0
Plot A	0	0	0	0	531	0	0
Plot A	0	0	0	0	41	0	41
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Plot D	0	0	0	0	0	0	0
Mean	0	0	0	0	102	0	7
STD	0.0	0.0	0.0	0.0	192.5	0.0	15.2
Count	6	6	6	6	6	6	6
Plot B	0	41	0	0	41	0	0
Plot B	0	0	0	0	0	0	0
Plot B	0	0	0	0	0	0	0
Plot C	0	0	0	0	0	0	0
Plot C	0	0	0	0	0	0	0
Plot C	0	0	0	0	0	0	0
Mean	0	7	0	0	7	0	0
STD	0.0	15.2	0.0	0.0	15.2	0.0	0.0
Count	6	6	6	6	6	6	6
Plot E	0	0	0	41	41	0	0
Plot E	0	0	0	0	41	0	0
Plot E	0	0	0	0	0	0	0
Mean	0	0	0	14	27	0	0
STD	0.0	0.0	0.0	19.2	19.2	0.0	0.0
Count	3	3	3	3	3	3	3

Appendix Ib: Abundance of macrofauna in below water biomass 5m into shoreline water hyacinth mat - Wazimenya/Murchison Bay.

	Gastropoda	Bivalvia	Ephem	Odonata	Caridina	Leeches	Oligoch	Tricoptera	Cleoptera	Nematoda	Chiron
Plot E	64	0	800	48	0	0	32	0	0	0	192
Plot E	48	0	448	32	48	48	0	32	0	0	176
Plot E	48	0	224	32	0	0	16	16	0	0	96
Mean	53	0	491	37	16	16	16	16	0	0	155
STD	7.5	0.0	237.1	7.5	22.6	22.6	13.1	13.1	0.0	0.0	42.0
Count	3	3	3	3	3	3	3	3	3	3	3
25-Feb-97.											
Plot A	48	0	0	48	0	32	64	48	0	0	192
Plot A	0	0	48	0	16	0	0	0	0	0	128
Plot A	0	0	48	16	0	0	0	0	0	0	32
Plot D	32	64	0	16	16	16	64	0	16	0	96
Plot D	208	16	32	0	32	16	48	0	0	16	128
Plot D	80	0	144	0	112	16	0	0	0	0	112
Mean	61	13	45	13	29	13	29	8	3	3	115
STD	71.2	23.4	48.4	17.1	38.6	11.0	29.8	17.9	6.0	6.0	47.5
Count	6	6	6	6	6	6	6	6	6	6	6
Plot B	64	0	464	16	0	48	16	16	0	0	224
Plot B	32	0	176	0	32	32	16	0	0	0	160
Plot B	32	0	224	32	0	48	16	16	0	16	224
Plot C	32	0	64	16	0	0	16	0	0	0	96
Plot C	80	0	160	0	0	0	32	0	0	0	32
Plot C	112	0	528	16	0	16	4	2	0	0	192
Mean	59	0	269	13	5	24	17	6	0	3	155
STD	30.2	0.0	168.2	11.0	11.9	20.1	8.1	7.3	0.0	6.0	70.1
Count	6	6	6	6	6	6	6	6	6	6	6
Plot E	0	0	32	0	0	32	32	0	0	0	208
Plot E	16	0	32	0	0	16	16	0	0	0	160
Plot E	0	0	0	16	0	0	16	16	0	0	80
Mean	6	2	18	6	2	14	18	6	2	2	114
STD	7.5	0.0	15.1	7.5	0.0	13.1	7.5	7.5	0.0	0.0	52.8
Count	3	3	3	3	3	3	3	3	3	3	3
4-March-97.											
Plot A	64	0	720	32	0	16	16	0	0	0	288
Plot A	96	0	448	16	0	0	48	16	0	0	240
Plot A	304	0	864	32	16	0	16	16	0	0	528
Plot D	112	64	112	0	0	0	32	0	0	16	48
Plot D	560	0	480	0	0	48	160	0	0	0	544
Plot D	32	0	112	0	0	0	32	0	0	0	128
Mean	195	11	456	13	3	11	51	5	0	3	296
STD	185.1	23.9	280.9	14.4	6.0	17.7	50.1	7.5	0.0	6.0	186.3
Count	6	6	6	6	6	6	6	6	6	6	6

ANNEX H

IN-LAKE HERBICIDE TRIALS, WAZIMENYA BAY, LAKE VICTORIA, UGANDA

EFFICACY

IN LAKE HERBICIDE TRIALS
WAZIMENYA BAY
LAKE VICTORIA, UGANDA.

EFFICACY - Observations carried out by Laurence Mebesa - Plant Protection Dept.

Introduction:

An integrated approach in the control of water hyacinth has been recommended. The Ministry of Agriculture, Animal Industry and Fisheries has initiated mannual, mechanical and biological control. The use of chemicals has not been accepted by some civic leaders and environmetalists and have advocated for carrying out trials before chemical control on the lake can be adopted as another method.

Early 1996 trials were carried out at Kajansi on specially prepared ponds. The chemical verification committee which carried out the experiments recommended glyphosate among others for optimum efficacy. The optimum rates recommended were:

Glyphosate (Round up)	2.6 kg a.i per ha (8.0 L/ha)
2, 4-D amine	2 kg a.i per ha (2.9 L/ha)

From the pond trials glyphosate was observed as the most efficatious of the trial herbicides. All Aquatics unlimited in conjuction with water hyacinth unit of MAAIF.

Site location:

The inlake herbicide trials were carried out in Wazimenya Bay of Lake Victoria. This is a protected bay where a 20-40 meter fringe of water hyacinth is

growing fixed to the shore line. The bay is accessible and had been approved by Government of Uganda agencies.

Objectives:

The main objective of the in Lake herbicide trials among others was to determine the relative efficacy of Rodeo (glyphosate) and Weeder 64 (2, 4-D Amine) on water-hyacinth. Other parameters like herbicide residues in water, sediments; fish tissue, biota and macrofauna in and adjacent to the treatment sites were investigated by other scientists and their reports are under seperate cover. The trial was carried by Aquatics Unlimited in conjunction with water Hyacine Unit of MAAIF.

Methods used:

The trials area was divided into five plots labled A,E,B,C and D in that order. Each plot was separated from an adjacent plot by a fringe of water hyacinth measuring 150 meters. The approximate size of the plot was 2000 sq. meters which is about 0.2 ha. Plots A and D were treated with Rodeo (glyphosate) while plots B and C were treated with weedar 64 (2, 4-D). Plot E was the control. A spray pump of capacity 375 Litres was mounted on a motor boat, the pump speed and pressure (150 PSI), out put (i.e. litres per hectare of tankmix), were pre-set to minimise drift. Boat speed was calibrated against width (10 metres of the spray area. The desired application rate was applied.

Herbicide rate used was:-

Rodeo (glyphosate) (by volume) 6.99 Litres/ha.

per test plot 6.99 L/ha x 0.20 ha = 1.40 L/ha of Rodeo per test plot A and D.

(by active ingredient) a.i. rate used was 4.56 kg/ha

or 4.56 kg/ha x 0.20 (plot size) = 0.91 kg a.i.

per plot.

A surfactant 0.35 litres (at 0.25%) was added to the tank mixture to aid penetration of glyplosate into the water hyacinth.

(Weedar 64 (2, 4-D Amine)

Volume used was 9.34 Litres/ha.

Test plot 9.34.L/ha x 0.20 ha plot size = 1.86 Litres of weedar. 64 per test plot.

Active ingredient (a.i.) was 4.47 kg/ha a.i. or 4.47 kg/ha x 0.20 ha plot size = 0.89 kg a.i. per test plot.

Application of Herbicide:

Weedar 64: A tank mixture of 374 litres of water, 1.86 litres of 2, 4-D amine was made and applied to plots B and C respectively.

Rodeo, (Glyphosate); A tank mixture of 140 litres of water, 0.35 litres of surfactant 0.25% and 1.4 litres of Rodeo was made and applied to the test pots A and D.

The spray boom in both cases covered about 10 metres width from the edge of the hyacinth mat.

Visual observations on the surrounding vegetation, and the sprayed hyacinth were made, photographs taken on the 10th February 1997, before spraying. Subsequent observations were made on day 1 after spraying i.e. on 11th February 1997, day 7, 14, 21, 30 and 40. The vegetation was rated on a scale of 1-10 in the appearance with the surroundings.

Results

The observations and results are indicated in the following tables.

IN-LAKE HERBICIDE TRIALS AQUATICS UNLIMITED SAMPLING DATA FORM

WATER HYACINTH CONTROL PROGRAM

Efficacy:	February 10th 1997
Sample Day: Pre-Treatment	Time: 9.30 - 1.45 pm
Plot	Location 1
Observations	
A-Rodeo	Dense hyacinth mat, 20-30 metres wide. surrounding vegetation of hippograss, papyms, sugar cane, healthy.
B-Weedar 64	Hyacinth petioles erect and healthy - off shore vegetation dense and normal.
C-Weedar 64	Normal hyacinth offshore veg. Fern, Papyrus, hippograss.
D-Rodeo	Dense mat 10-15 meters wide. Papyrus and fern on shore.
E-Control	Dense hyacinth mat 10-20 meters wide - surrounded by sugar cane, palms, bamboo, papyrus hippograss.
Evaluation Scale 1-10 (10-Best)	
A-Rodeo	9-10 slight browning due to aging
B-Weedar 64	9 some damage due to may fry and age
C-Weedar 64	9 slight browning
D-Rodeo	10
E-Control	10 Normal
Photos	- Taken by:
A-Rodeo	Mc. Nabb
B-Weedar 64	Mc.Nabb
C-Weedar 64	Mc Nabb
D-Rodeo	Mc Nabb
E-Rodeo	Mc Nabb

IN-LAKE HERBICIDE TRIALS AQUATICS UNLIMITED SAMPLING DATA FORM

WATER HYACINTH CONTROL PROGRAM

Efficacy:	February 12th, 1997
Sample Day: 1	Time: 9.30 a.m.
Plot	Location 1
Observations	
A-Rodeo	Drooping plants otherwise green,wilting,leaf curling upper petiole weakening. Hoppograss and papyrus same appearance as pre-treatment.
B-Weedar 64	Weakening petiole,browning,45 degree bending of petiole. Sorrounding vegetation no change.
C-Weedar 64	Weakening petiole 30 degree drooping, yellow, browning occurring. Sorrounding vegetation no change.
D-Rodeo	Weakening petole leaf curling approximately 30 to 40 degrees, lightening of leaf color, sorrounding vegetation no change.
E-Control	Some browning likely from mayfly larvae damage. Approximately 1% damage.
Evaluation Scale 1-10 (10-Best)	
A-Rodeo	9+ = 10% weakening petiole.
B-Weedar 64	9 = 10% damage
C-Weedar 64	9 = 10% damage
D-Rodeo	9 = 10% damage
E-Control	10% damage
Photos	- Taken by:
A-Rodeo	McNabb
B-Weedar 64	McNabb
C-Weedar 64	McNabb
D-Rodeo	McNabb
E-Rodeo	McNabb

IN-LAKE HERBICIDE TRIALS AQUATICS UNLIMITED SAMPLING DATA FORM

WATER HYACINTH CONTROL PROGRAM

Efficacy:	February 18th 1997
Sample Day: 7	Time: 9.00 - 12.00 pm
Plot	Location 1
Observations	
A-Rodeo	97% Sprayed area show yellowing and scotched leaves 3% still greenish, small portion rippedaway.
B-Weedar 64	90% leaves scotched. 10% distorted regrowth petiole still firm. Dragon flies seen.
C-Weedar 64	Scotched leaves youngshoots emerging, 4% regrowth. Sorrounding vegetation healthy.
D-Rodeo	Not accessible due to thick hyacinth mat.
E-Control	9.45 a.m.Few scotched leaves. Normal ageing. Bombo banana, papyrus, hippogram normal.
Evaluation Scale 1-10 (10-Best)	
A-Rodeo	2 Insprayed area plants are dying.
B-Weedar 64	3
C-Weedar 64	2
D-Rodeo	2
E-Control	10 - outer edge ripped away by waves.
Photos	Taken by:
A-Rodeo	Mwebesa
B-Weedar 64	Mwebesa
C-Weedar 64	Mwebesa
D-Rodeo	Taken from 250 metres - site in accessible
E-Rodeo	9.45 a.m. Mwebesa

IN-LAKE HERBICIDE TRIALS AQUATICS UNLIMITED SAMPLING DATA FORM

WATER HYACINTH CONTROL PROGRAM

Efficacy:	March 4th, 1997
Sample Day: 21	Time: 9.00 a.m.
Plot	Location 1
Observations	
A-Rodeo	Plant leaves mostly brown, some droping off petiole. Some yellow stems still visible. Surrounding vegetation Ok. Plot width all plots decreasing.
B-Weedar 64	Hyacinth leaves mostly browning curled, dessicated petioles. Green to mostly yellow or brown. 5% leaves still green, but uncontrolled growth especially on inside fringe of mats. Surrounding vegetation no change.
C-Weedar 64	Hyacinth leaves mostly brown, dessicated petioles or elongated, some still yellow, mostly brown surrounding is normal. Some plants showing elongated stems still green leaves, uncontrolled growth.
D-Rodeo	Hyacinth brown leaves, petioles dessicated, surrounding vegetation normal.
E-Control	Green Healthy tall plants.
Evaluation Scale 1-10 (10-Best)	
A-Rodeo	1
B-Weedar 64	1
C-Weedar 64	2
D-Rodeo	2
E-Control	10
Photos	
A-Rodeo	Moorhouse
B-Weedar 64	Moorhouse
C-Weedar 64	Moorhouse
D-Rodeo	1st plot Moorhouse. Pictures start East side.
E-Rodeo	Moorhouse

IN-LAKE HERBICIDE TRIALS AQUATICS UNLIMITED SAMPLING DATA FORM

WATER HYACINTH CONTROL PROGRAM

Efficacy:	March 4th, 1997
Sample Day: 30	Time: 9.00 a.m.
Plot	Location 1
Observations	
A-Rodeo	Outer fringe of mat disintegrated, inner portion still present but most leaves brown, petioles green/yellow. No daughter plants growing. Surrounding vegetation normal 10-20% brown papyrus.
B-Weedar 64	Mostly brown leaves, yellow stems, largely dessicated plots. Some abnormal growth still visible. Also some flowers surrounding vegetation normal.
C-Weedar 64	Mostly brown dessicated leaves/stems. Some brown/dead leaves with green/yellow stems, however, some irregular elongated stem growth visible. Small percentage small buds growing, flowers visible in plot dying plants.
D-Rodeo	Mostly brown, dessicated leaves, falling of petioles, bu petioles still standing. Surrounding vegetation still normal
E-Control	Healthly tall plants, surrounding plant normal (Hippograss brown below green above, 20% papyrus brown).
Evaluation Scale 1-10 (10-Best)	
A-Rodeo	1
B-Weedar 64	1
C-Weedar 64	1
D-Rodeo	1
E-Control	10+
Photos	
A-Rodeo	Started pictures East side, shooting into sun West sid of plot.
B-Weedar 64	Pictures North to South
C-Weedar 64	Pictures East to West
D-Rodeo	Pictures North to South
E-Rodeo	Pictures North to South

Discussion and Conclusion

Efficacy trials.

Application of Radeo at 6.99 litres/ha or 4.56 kg/ha - active ingredient was effective to control the water hyacinth. Results were visible within seven days. Total dessication of the plants was achieved by the end of the 3rd week.

Application of weedar 64 - 2,4-D Amine at 9.34 litres/ha or 4.47 kg/ha a.i. was also effective. Burning or scotching effect on the sprayed water hyacinth was achieved within a week after application.

The intake herbicide trials were very successful and showed that both Radeo (glyphosate, and weedar 64, (2, 4-D amine) are efficatious in as for as the chemical control of water hyacinth is concerned. If the trials are accepted by Environmental Impact Assessment team, use of herbicides to control water hyacinth could complement the existing methods of manual, mechanical and biological control, already in use.

ANNEX 10

REVIEW OF USAID PESTICIDE PROCEDURES

A review of Pesticide Procedures in responses to the IEE and USAID Environmental Procedures for Project Assistance (22 CFR 216.3 (b)(2), requires that "all proposed projects involving assistance for the procurement or use, or both, of pesticides shall be subject to the procedures prescribed in Section 216.3(b)(l)(i) through (v). These procedures shall also apply, to the extent permitted by agreements entered into by A.I.D. before the effective date of these pesticide procedures.

> (i) When a project includes assistance for procurement or use, or both, of pesticides registered for the same or similar uses by USEPA without restriction, the Initial Environmental Examination for the project shall include a separate section evaluating the economic, social and environmental risks and benefits of the planned pesticide use to determine whether the use may result in significant environmental impact. Factors to be considered in such an evaluation shall include, but not be limited to the following:

a) The USEPA registration status of the requested pesticides; the proposed herbicides/pesticides Rodeo (Glyphosate) and Weedar 64 (2, 4-D) are registered by USEPA for use in aquatic systems to control aquatic plants including water hyacinth;

b) The basis for selection of the requested pesticide; the proposed pesticides were selected because they are the only USEPA registered products that will effectively control water hyacinth and they are USEPA registered for this purpose in aquatic systems;

c) The extent to which the proposed pesticide use is part of an integrated pest management program; the operational program to control water hyacinth, if approved following the PEA/EIS process, will be an integrated program including use of herbicides to reduce initial biomass and to control subsequent regrowth, the use of mechanical equipment to remove water hyacinth in areas where herbicides are not appropriate or where machines can effectively open waterways to boat traffic, and use of biological control agents in the majority of infested areas where appropriate, especially where biomass can be reduced before it enters Lake Victoria;

d) The proposed method or methods of application, including the availability of appropriate application and safety equipment; aquatic herbicides (if approved) will be applied by hand-held spray wand, using a boat mounted spray pump and motor, and or by aerial application techniques. Boat mounted application equipment will be supplied from the US in accordance with USEPA procedures, including all necessary safety equipment as required by each products label. Aerial application equipment will be supplied by a qualified firm in the region, if available;

e) Any acute and long-term toxicological hazards, either human or environmental, associated with the proposed use and measures available to minimize such hazards; under application conditions required by each label, no acute nor long-term toxicological hazards, either human or environmental, are associated with proposed use of these products. Appropriate safety equipment, use of trained personnel (applicators certified for aquatic herbicide application by a state agency in the US, or other Federal or National Authority), identification of medical support, and adherence to label requirements will minimize possible hazards. . The In-Lake Herbicide Trials Report confirms this requirement can be met;

f) The effectiveness of the requested pesticide for the proposed use; all products requested (Rodeo and Weedar 64) have been shown to be very effective in controlling water hyacinth;

g) Compatibility of the proposed pesticide with target and non target ecosystems; the requested herbicides (Rodeo and Weedar 64) can be used effectively without negative impacts to the target ecosystems. Impacts to nontarget ecosystems will be minimized by adherence to label requirements, including mixing and loading provisions, careful application by trained personnel, and proper disposal of material and containers. The In-Lake Herbicide Trials Report confirms this requirement can be met;

h) The conditions under which the pesticide is to be used, including climate, flora, fauna, geography, hydrology, and soils; the conditions of herbicide use in the Integrated Water Hyacinth Control Program are outlined under Section 2.1 of the PEA/EIS;

i) The availability and effectiveness of other pesticides or nonchemical control methods; there are no other pesticides registered by USEPA to control water hyacinth in aquatic systems that are as effective and that have under gone environmental review in Lake Victoria. Mechanical removal is an effective method to control water hyacinth, is tremendous expensive, and has been initiated in Lake Victoria as part of the Integrated Control Program. The decision to use pesticides to control water hyacinth in Lake Victoria is based in significant part on the cost of alternatives, and the time required to implement them. Mechanical control will be a significant component of the integrated control program. Biological control can provide reduction in biomass, but has not been shown to be a reliable means to reduce impacts of water hyacinth below economic thresholds. Biological has also been initiated as a significant component of the Integrated Control Program;

j) The requesting country's ability to regulate or control the distribution, storage, use and disposal of the requested pesticide; the Agricultural Chemicals (Registration and Control) Regulations, 1993, of the Ugandan code of regulations contains specific provisions for the regulation, control, distribution, storage, use and disposal of the requested pesticides. This project is being coordinated through the offices of the Ministry of Agriculture, Animal Industry, and Fisheries which has regulatory authority over the use of pesticides, and has the ability to regulate and control pesticide distribution, storage, use and disposal;

k) The provisions made for training of users and applicators; for the demonstration trials, trained applicators licensed by the State of California (USA), Department of Food and Agriculture application of herbicides in aquatic environments were used. Recommendations for the training of users and applicators will be a component of the operational control program;

l) The provisions made for monitoring the use and effectiveness of the pesticide; a remotely-sensed monitoring program is being implemented to determine effectiveness of the herbicide applications. Site visits and visual observations will be used to record the effectiveness of the herbicide component as well as the overall Integrated Control Program.

"In those cases where the evaluation of the proposed pesticide use in the Initial Environmental Examination indicates that the use will significantly effect the human environment, the Threshold Decision will include a recommendation for the preparation of an Environmental assessment or Environmental Impact Statement, as appropriate. In the event a decision is made to approve the planned pesticide use, the Project Paper shall include to the extent practicable, provisions designed to mitigate potential adverse effects of the pesticide. When the pesticide evaluation section of the Initial Environmental Examination does not indicate a potentially unreasonable risk arising from the pesticide use, an Environmental Assessment or Environmental Impact Statement shall nevertheless be prepared if the environmental effects of the project otherwise require further assessment". In this regard, an Environmental Impact Study has been carried out and will go for public review and comment in June 1997, followed by an Environmental Impact Statement from the Government of Uganda, National Environmental Management Authority.

ANNEX 11

RESPONSE TO COMMENTS RECEIVED FROM THE PUBLIC HEARING OF JULY 30TH 1997

RESPONSES TO COMMENTS RECEIVED DURING THE PUBLIC HEARING OF 30TH JULY, 1997 ON THE DRAFT ENVIRONMENTAL IMPACT STUDY.

REPORT OF THE PUBLIC VIEWS PRESENTED AT THE PUBLIC HEARING ON THE ENVIRONMENTAL IMPACT STUDY FOR THE WATER HYACINTH CONTROL PROGRAMME FOR LAKE VICTORIA AND OTHER REGIONAL WATERWAYS HELD AT INTERNATIONAL CONFERENCE CENTRE - KAMPALA ON 30TH JULY, 1997

PRESIDING OFFICER: **Prof. John Ssebuwufu**
RAPPORTUERS: **Mr. Robert A. Wabunoha**
Mr. Justin Ecaat
Mr. E. Rukunya

CHAPTER ONE

A. Introduction

A Public Hearing on the Environmental Impact Statement (herein after called EIS) submitted to NEMA was held at the International Conference Centre on the 30th July, 1997 starting at 9.00a.m. to seek public comment and views on the proposed water hyacinth control options and mitigation measures contained in the EIS. The Public Hearing was attended by the major stakeholders, including government agencies, the general public, interested persons, riparian districts and donor agencies. Those who signed the attendance roster are attached as Annex 1.

As required under sections 20-23 of the National Environment Statute, 1995 and guidelines issued by NEMA, public participation in the EIA process is a very crucial element.

This is particularly important in soliciting the wider views of the public so that these views can assist the Authority in arriving at a **fair and just decision** on the Environment Impact Statement. The Public Hearing was being conducted in fulfillment of the requirement to involve the public in the EIA process. I was invited by the Executive Director of NEMA to preside over this public hearing. A copy of my invitation letter is attached to this report as Annex II.

The Ministry of Agriculture, Animal Industry and Fisheries (hereinafter called MAAIF), as a Developer had conducted an Environmental Impact Assessment (EIA) on the proposed Water Hyacinth Control Programme for Lake Victoria and other Regional Waterways (hereinafter called the Control Programme) that included the various control options of biological, physical (manual and mechanical) as well as chemical control. At the outset, I must thank MAAIF for her efforts to initiate moves of controlling the noxious weed.

In summary, the following are the major control options contained in the EIS:

1 **Physical Control:**

a) **The Manual Control** methods were recommended at some of the Fish Landing Sites as well at the temporary boom site on the Kagera River. Prior to the arrival of mechanical equipment, physical removal was being done at the Owen Falls Dam site. It is envisaged that physical control will continue alongside other control options.

b) **The Mechanical Control** methods were recommended for areas where chemical methods are restricted due to water use concerns, and where physical methods are not possible due to large plant volumes. These areas include the Water Works Sites (Entebbe, Jinja and Ggaba) where water use restrictions for potable water prohibit use of chemicals within 0.80 kilometers of water intake points; and other sensitive areas where community interests such as domestic water supply, fishing and bathing restrict or prohibit use of herbicides.

2 **Chemical Control:**

Some aquatic herbicides were recommended for use in open waters and shoreline areas where water use restrictions will not affect community needs. The restricted areas include the water intake sites and other highly sensitive areas of community interest. The aquatic herbicides which where recommended are 2,4-dichlorophenoxyacetic acid (commonly known as Weedar 64 (2,4-D Amine) and phosphonomethyl glycine (commonly known as Rodeo or glyphosate).

These were recommended for use in all open water and shoreline treatments where potential impacts are considered low. Rodeo was recommended for treatments in and around sensitive and populated shoreline areas.

3 **Biological Control:**

Biological agents were recommended for introduction at the source of the problem areas up to the Kagera River and all suitable bays in Lake Victoria. Recommended biological agent release areas are to include areas within 0.08 kilometers of Water Works sites and other intake points for domestic water uses. The EIS envisaged that biological control would play a long term role in the control efforts on much wider areas of hyacinth coverage.

In broad terms, the Report recommends an Integrated Water Hyacinth Control Programme involving the use of chemicals, mechanical and physical methods during the Emergency Action Programme (EAP) and expanding the programme to include use of Biological agents during the Intermediate and Long Term Plan.

B. The Public Hearing

The objective of the hearing was to discuss the important subject of the proposed Water Hyacinth Control Programme. The Government and the public at large, are

deeply concerned about problems associated with water hyacinth infestation in Lake Victoria and other water bodies of Uganda. In my view, some of the proposed control methods are benign and not controversial, while others are.

At the above Public Hearing, an opening statement was made by the Executive Director of NEMA, Prof. J.O. Okedi, who extended gratitude to all for having come to participate in the public hearing, and noted that this was a demonstration of their concern for the Environment and the water hyacinth problem in particular. He allayed public fears that no spraying has yet been done except for the experimental tests which were carried out in Wazimenya bay, whose results were incorporated as part of the EIS being reviewed. He informed the participants that the decision on whether to approve or otherwise deal with the EIS will be made based on the following factors, among others:

a) technical soundness of the recommendations in the EIS;
b) socio-economic and ecological benefits of the proposals to Uganda,
c) long term sustainability of the proposals;
d) the soundness of the mitigation measures to achieve desired success;
e) the validity of identified mitigation measures;
f) aggregate public opinion on acceptance or rejection of the proposals by the public, particularly those directly affected.

According to the Executive Director, the expectations of NEMA on this public hearing include the following:-

a) accurate and scientifically valid study description;
b) honest reference to literature cited;
c) honest references to experiences in other parts of the world;
d) honest and frank discussion by the participants;
e) participants to avoid emotional outbursts;
f) mutual respect of all the participants by all the participants;
g) due regard to alternative views and opinions.

At the beginning of this public hearing, NEMA issued Rules of Procedure to be followed by everybody including the Developer. These Rules of Procedure are attached as Annex III for ease of reference. Members of Public Hearing were requested to feel free to present their views and accept any constructive criticisms and not to feel inhibited. However, the Executive Director when arriving at the decision of approving the EIS or any part thereof, may not bound to follow the views of the public.

Chapter two of this Report presents the technical findings of the EIS. Chapter Three will present the public views and comments. Chapter Four will contain the reply from the EIS authors and Chapter five will contain the conclusions and the major issues necessary to enable the NEMA arrive at a fair and just decision.

CHAPTER TWO

TECHNICAL PRESENTATIONS OF STUDY FINDINGS

Technical reports on thematic areas were presented by the members of the EIA Study Team and these formed the basis for the public discussions of the EIS.

In this Report, I will only summarize the highlights of the presentations made on thematic areas of the EIS as most of the information is contained in the detailed EIS. The following were the presentations:

1 **Mr. Dick Nyeko** *of the Water Hyacinth Unit, MAAIF* presented a summary of the EIS as well as the biological and physical control options. He gave a historical background of the water hyacinth infestation problem and observed that the weed is not native to Uganda and that the main source of the weed is the Kagera River from where it flows and settles in most bays of Lake Victoria. He talked about the problems of the weed in the lake which included threatening hydropower generation; interference with water intake points; disruption of socio-economic activities; affecting the biological ecosystem, etc. He also gave a brief background of the initiatives that led to the environmental impact assessment (EIA). That these included setting up a Technical Committee for the Control and Management of the Water Hyacinth by the Agricultural Policy Committee and subsequent scoping to determine issues for the detailed EIS.

On the Biological Control Option, he observed that the weevils are host specific and cannot attack any other plants. He informed the hearing that the weevils have been released in Lake Kyoga and Kajansi Pan Lake. He further observed that biological control can only reduce the biomass to about 30%. That feeding scars were shown on slide, and were noted to be a characteristic feature on the water hyacinth in Lake Kyoga. That the distribution of biological agents is ongoing and the local communities are being involved.

On the Manual Control option, he stated that this was costly requiring about Ug.Shs.2 million per day. In his view, this option has not been able to achieve tangible results. That at Owen Falls Dam, manual control was attempted but could not achieve much impact.

On the Mechanical Option, he reported that Operation Dam Hyacinth has involved use of tractors, and the small harvester fabricated by UEB. This was later boosted with aid from the Netherlands Government when two mechanical harvesters were made available.

That mechanical control has the problem of management of dumping sites, and distant location of dumping sites from the source of the harvested weed.

On the Chemical Control Option, he reported that the chemical verification sub-committee conducted experiments on use of chemicals at the Kajansi Ponds. That the results showed no effect on fish. That this was followed by in-lake trials at Wazimenya

Bay in Mukono District. He further stated that a 30 day sampling regime was used in the in-lake trials at this Bay.

He also presented a table comparing the costs of the various control options. In summary, Mechanical Control was approximated at Ug.Shs.2.5 million per ha., Manual Control at Ug.Shs.2,769 million per ha., while chemical control was estimated at Ug.Shs.300,000/= per ha.

In conclusion, Mr. Nyeko informed participants of the strategy was maintenance control involving reducing the 6,000 ha mass of weed to a manageable level. He stated that the concept of spraying was not new in Uganda as previous spraying had been done on River Malaba. That because attempts at blocking the weed at the Kagera and failed, yet the weed is multiplying rapidly, there is need to "knock" the weed using chemicals and then eventually adopt maintenance control. That during the EIS preparation, alternatives eliminated from further study included single method of control alone; herbicides not properly registered for aquatic use and no action alternative.

2 **Dr. J. Nyangababo** *on Herbicide Fate*

In his introductory remarks, the presenter observed that all over the world there are many herbicide formulations from which to choose. Initially 3 candidate herbicides were selected - Glyphosate, Diquat and 2,4-D. The presenter noted that there has been some confusion surrounding 2,4-D, brought about by its sister chemical 2,4-5T. According to this presenter, 2,4-D as a herbicide has no problem but its sister chemical 2,4,-5T which has a contaminant by-product which is very difficult to separate should not be applied. That 2,4-D has 3 forms, i.e. as an acid form, salt form or ester form. That the amine (*salt form)* was the one used in the experiments and can easily degrade in a water medium.

That the results at Kajansi showed a breakdown of 2,4-D and Glyphosate to be faster than that of Diquat, hence they eliminated Diquat from further studies. That the results of 2,4-D analysis showed non-detectable levels, while Glyphosate was detectable from level 0.05 ppm to non detectable levels.

That at the in-lake trials, pre and post spraying analysis was done, with the former showing no herbicide presence. Post herbicide application showed a breakdown of 2,4-D after 14 days to be very fast. That the 2,4-D break down in the environment was aided by bacterium *globiforme* which exists naturally in the environment, and this break down continues under enzyme reactions into stable forms of the molecules.

In conclusion, his analysis showed that the critical concern about chemicals in the environment is their persistence and migration and that after 14 days, the chemicals could not be detected.

In summing up the representation, I as Presiding Officer observed that the concern of the public is not so much spraying per se but rather the fate of the chemicals in the environment.

3 **Mr. Vivian Matagi** *on Effects of 2,4-D and Glyphosate on Water Quality.*

His methodology was that five sampling sites were used. A.B.C.D.& E with E being the control plots. That Plots A & D were sprayed with Glyphosate. That the parameters tested included secchi depth, temperature, pH, dissolved oxygen, phosphorus, total phosphate, nitrite and nitrate.

He observed that according to experimental results:

a) there was no observable difference between trends in the open water and the water hyacinth mat region.
b) the comparison between 2,4-D, Glyphosate and the control plots showed no change *(i.e. no. significant difference).*
c) at Kajansi, after spraying, there was no change in water quality and the same applied in the lake.

He also made reference to the WHO facts on Glyphosate i.e., it is not carcinogenic, mutagenic, not toxic to birds, and does not accumulate in aquatic systems.

4 **Dr. Yusufu Kizito** *On Herbicide Residues in Microfauna.*

In his introduction, he highlighted the causes of water hyacinth proliferation in lake Victoria. This included, unabated raw sewage and nutrient input which is causing a fertile environment for water hyacinth proliferation. That if the source of the problem is not controlled the problem may become worse. That is addition, the problem should be looked at in a more holistic ecosystem approach.

He mentioned short comings of the experiments which included:

a) no control over the parameters that were being tested;
b) that presence or absence of organisms does not mean much in terms of arriving at a conclusion.

That based on the above shortcomings and the nature of the results, the interpretation could not necessarily be attributed to chemical application, after all, even the control experiment showed lower microorganism figures in some instances. He further stated that the application of chemicals could trigger some nutrient enrichment which could become an environmental concern in future. The presenter left this as a big question mark for the participants to deliberate on.

In summing up the representation, I as Presiding Officer, noted that we are dealing with a very complicated system with a lot of variables that could make the analysis complex.

5 **Mr. Byarujali Stephen** *on Herbicide Residues in Phytoplankton.*

The presenter conducted an assessment on the effect of selected herbicides on phytoplankton at Wazimenya Bay. He underscored the importance of phytoplankton in the ecosystem as they have chlorophyll which captures light energy that is

converted into carbohydrates that forms the primary basis of the food chain. He further noted that any environmental disturbance of these algae can potentially disrupt the entire aquatic system.

On his methodology, pre and post spray sampling was one. Samples were collected 1 meter and 5 meters into the water hyacinth mat respectively.

The results showed three main types of algae i.e. Blue green algae, Diatoms and the Greens with 85% being blue greens and 15% diatoms. Further, the results of sampling at all stations showed algae counts to be lower in the water hyacinth mat the higher away from the mat. The Glyphosate Stations on plots A & D showed counts not to be statistically different from those sprayed with 2,4-D. Glyphosate Spay areas showed higher algal counts than in areas where it was not sprayed. That the different stations did not show any obvious trends.

The presenter noted the following shortcomings:

a) Wazimenya bay remained part of the larger Lake Victoria and hence control of outside influences was difficult;

b) even under the water hyacinth mat there was water movement that could have interfered with the parameters being observed; and

c) the dilution effect could not be controlled.

In his view, the chemical spraying approach could probably not cause adverse impact into the environment and that the chemical if applied are not poured but are spraying on the leaf surface.

6 **Dr. Timothy Twongo** *on Response of Algae, Invertebrates and Fish to the Herbicide Application.*

On methodology, he stated that the experiment was done in two parts. The first part in the ponds at Kajansi and the second in the Wazimenya Bay. In-lake trials sampling was done in experimental plots 5 meters into the mat and 1 meter off the water hyacinth mat. The objective of the study was to assess how herbicides influence multiplication of algae, their impact on fish including determining herbicide residues in the fish flesh. Behavioral aspects were also studied.

The results showed the following:

a) Glyphosate tended to induce faster multiplication of phytoplanktons. Glyphosate adds nutrients (*phosphate)* to the water and causing algae to multiply faster.

b) 2,4-D showed no change in tiny plants, micro-invertebrates and in fish behaviour.

c) Diquat showed no change in multiplication of phytoplanktons.

He however, observed that a conclusive study of this kind has to be a laboratory experiment. That fertilizing a water body could also be a big problem to the ecosystem. He further noted that Uganda's lakes are already suffering eutrophication. That while therefore the chemists did not detect change in the nutrients, the algae show as interesting response to that effect. He informed the hearing that the phenomenon of food preference is normal in all organism. That if an increase in an undesirable algae occurs, this could translate into a very serious ecological problem. He stated that there are already algal blooms in Lake Victoria that could cause anoxic conditions.

7 **Mr. Patrick Etyang** *on Efficacy of herbicides*

The stated that the objectives of the efficacy tests were to evaluate efficacy of 2,4-D and Glyphosate and their effects on non-target plants. He informed participants that Wazimenya Bay was chosen because it had resident water hyacinth and is isolated from dense human population.

He further stated that the methodology used included separating sprayed plots from non-sprayed plots using buffer zones of about 150m in length. The herbicides were applied at the rates of: Glyphosate 4.56kg/ha (active ingredient) and 2,4-D 4.47kg/ha. (active ingredient). That a hand operated spray gun was used (an HP.154/min water delivery pump). He observed that the weather conditions were taken into account in the spraying. Visual injury symptoms were observed for a period of 40 days i.e. 1,7,14,21,30 & 40.

He stated that the results of the efficacy evaluation showed that both Glyphosate and 2,4-D are efficacious as far as chemical control of water hyacinth is concerned.

CHAPTER THREE

PUBLIC COMMENTS AND VIEWS

After the technical presentations as shown in Chapter Two of this Report, the public was invited to comment, discuss and provide their views. As earlier on stated, this was intended to enable the Executive Director arrive at a fair and just decision. Participants were reminded to abide by the rules of procedure when making their presentations as contained in Annex II.

As the Presiding Officer for this public hearing, it was important that I summarized the issues at stake after the technical presentations. This was intended to guide the ensuring discussions by members of the public. In my summary of the matter at hand, the key issues relate to:

1. Physical control methods: applicability of the methods, advantages and disadvantages.

2. Biological control methods: applicability of the methods, advantages and disadvantages.

3. Chemical control methods: applicability of the methods, advantages and disadvantages. Screening of the possible herbicides, their effects on quality of water, micro fauna and flora, and their efficacy is also an issue. There is need to be sure that when these chemicals are applied they will be safe to aquatic life and human beings.

To enable one have a comprehensive picture of the outcome of the public hearing, I will divide the public comments and views into four categories. The first category will be for those who were in favour of the proposed control options. The second category will be those against a candidate option. The third category will be those who challenged the validity of the EIS and the forth category will be those whose questions remained unanswered.

Category One: Views in Support of a Proposed Control Option

A Physical Control Option

The Proposed control methods as contained in Chapter One of this Report under item 1 - Physical Control involving (a) manual removal (b) mechanical harvesting; and under item 3- Biological Control were largely supported as options which are benign and with less adverse environmental impacts.

In general terms the majority support and no objection to the applicability of physical and biological control options in the Control Programme.

B Chemical Control Option

There were **four** participants who supported the use of the candidate control option involving use of the candidate chemicals. One of these participants was from the lake region. In summary, their views were as follows:

a) that the herbicides are not toxic to flora fauna.
b) the herbicide application would reduce multiplication of the water hyacinth thus lowering the costs of control.
c) that the two chemicals would only be used as a component of an integrated control programme and that this should only be used on a limited basis.
d) that the current mechanical control initiatives have achieved success at a great cost in terms of time and money hence chemicals used once in a while in localized areas would supplement mechanical control initiatives.
e) that chemical control was more favorable given that biological control is slow. Mechanical is expensive and there is little commitment from the public for manual removal.
f) that more phosphorus from Rodeo will not make any impact on the lake.
g) that the EIS is adequate, that 2,4-D is a chemical applied to plants and not as a poison. That it merely mimics a chemical that the plants use for growth. That the toxicity of 2,4-D to other organisms is very low hence its liberal use in U.S.A.

This category recommended that at integrated approach using the three options as recommended in the EIS should be used in the control of the water hyacinth.

Category Two: Views Against a Proposed Control Option

Other than the participants whose views are represented in Category One (B) above, the rest of the participants who presented their views during the public hearing were of the view that the use of the proposed control option involving use of candidate chemicals should not be used. In summary, their views were that:

a) many countries including America no longer consider herbicide spray in weed control.

Response:-
America continues to use herbicides to control water hyacinth and does so in the states of Florida, Alabama, Mississippi and California. Glyphosate and 2,4 D are also used to control many other types of submerged and floating aquatic plants as well. In 1992 alone, for example, approximately 160,000 Ha of aquatic weeds were treated with aquatic herbicides, of which an estimated 56% or 89,000 Ha were treated with 2,4-D formulations. (Citation - Biologic and Economic Assessment of Benefits from Use of Phenoxy Herbicides in the United States, National Agriculture Pesticide Impact Assessment Program Report 1-PA-96, November 1996. Page 49).

European countries vary in their approach to controlling aquatic weeds, yet the herbicides Glyphosate and 2, 4-D are used for control in the following countries: Netherlands, Italy, Portugal, Hungary, Rumania, Yugoslavia, Germany, France, Switzerland, Austria, Great Britain, and the European states of the USSR (Pieterse, Arnold H. and Murphy, Kevin J., Aquatic Weeds. Oxford University Press 1990, pp. 314 -317).

Several countries in Africa also use these herbicides for controlling water hyacinth (Edited by Charudattan, R., Labrada R., Center T. D., Kelly- Begazo, Christine. Strategies for water Hyacinth Control. FAO, Rome 1996).

b) work done in Sudan in 1974 in areas sprayed with 2,4-D showed damage and abnormality in trees, crops etc. and that this is continuously observed and reported. These observations were made at distances between 500 - 1000 m from a 2,4-D store.
c) in the some parts of Southern Sudan communities frequently complained of stomach problems associated with 2,4-D.

Response:-
The 2,4-D formulation which was mentioned by a participant and was used in Sudan should be specified. The Sudan team used 3 forms of 2,4-D and recommended the amine form for use. It is this amine form that was used in the EIS. (Prof. Nyangababo response)

Any reports or studies showing these observations in Sudan should be submitted and reviewed since abundant research on the formulations for these tested herbicides do not indicate this to be the case when used according to the manufacturer's directions.

d) 2,4-D does not adversely affect the seeds of the water hyacinth. Germination even occurs when seeds were immersed in 2,4-D solution.

Response:-
It was not reported that 2,4 D or Glyphosate would adversely effect the seeds of water hyacinth as these herbicides are translocated through leaf surfaces. Application of herbicides to water hyacinth would prevent flower formation and thereby limit regrowth. In Lake trials reported a greater than 90% efficacy rate.

e) the use of chemicals may cause negative economic impacts on the economy.

Response:-
The proper use of these herbicides would LESSEN the negative impact of unchecked water hyacinth growth presently experienced by the society, economy, and the environment.

f) the results showed a trend of lowering of pH levels under the water hyacinth. This indicated that the chemicals increased acidity of the water and therefore repeated applications could cause more acidification or harm to the lake ecosystem. There is no evidence to indicate the impact of "minimal" acidity in the lake as a consequence of chemical application.

Response:-
The results of herbicide trials, as well as other research, do indicate that pH levels under water hyacinth can be lowered and this was attributed to different rates of carbon dioxide production by phytoplankton and due to decomposition of debris which releases humic and organic acids, thus lowering pH values. It should be noted that when left uncontrolled water hyacinth continuously sheds plant parts which also leads to lowering of pH values through the abovementioned processes. After treating water hyacinth with herbicides pH levels would decrease as it does when left uncontrolled, due to decomposition of organic matter, but would adjust to a normal range as the water hyacinth is brought under control.

g) glyphosate adds phosphorus to the lake and more addition will worsen the problem of nutrients.

Response:-
Fluctuation in Phosphorous levels may be seen during events such as rain fall and, indeed, this was observed during In-Lake herbicide trials at Day 21. Phosphorous levels on this day increased at all plots and was attributed to phosphate carried in rain water or from surface runoff of phosphate in the catchment basin. (see Annex C of In-Lake Herbicide Trials, "The effect of RODEO and WEEDAR 64 on Water Quality In the Treatment of Water Hyacinth in Wazimenya Bay, Lake Victoria).

The results of all investigations prove that the degradation of glyphosate is brought about by the microflora (Sprankle, Meggitt and Penner, 1975b; Quilty and Goegnegan. 1976; Rueppel *et al.*.1977; Torstensson and Aamisepp, 1977).

The dominant process is co-metabolism, thus microorganisms do not use the herbicide for growth (Sprankle, Meggitt and Penner, 1975b; Normura and Hilton, 1977; Torstensson and Aamisepp, 1977.

h) scientists in NARO have indicated that the water hyacinth is no longer growing exponentially and has stabilized in terms of growth rate and therefore it would be scientifically wrong to adopt a controversial control method.

Response:-
Though some scientists suggest stabilized growth of water hyacinth, the fact remains that large floating mats and extensive shoreline areas continue to be infested with weed thereby disrupting normal ecological and economic activities.

i) because 85% of Ugandans drink raw water it would not be appropriate to apply the candidate chemical control option.

Response:-
By following herbicide label directions and standard precautionary measures, the Ugandan population would not be exposed to any health risks, but would over the longer term have access to cleaner sources of lake water.

j) fish export is now second to coffee in terms of Uganda's export value hence is now an important branch of national economy. In this regard, the application of chemicals would make Uganda loose export fish markets which are needed for economic stability. The European fish consumer, on whom Uganda's exports depend, is extremely emotional to the quality of fish and that even if it proved that the chemicals are not toxic, the consumer market reacts emotionally. That the EU has hinted that they will not buy Uganda's fish if we sprayed the lake with chemicals.

Response:-
The USA has Maximum Contaminant Levels (MCL) for herbicides in fish tissue and water. MCL is the level considered protective of a person who in theory may drink water or eat fish at that level of contamination everyday of his or her life. (See data on MCL's in Annex 9, In-Lake trials results pp. 23). These levels are set by the United States Environmental Protection Agency (USEPA) to control the amounts of herbicides in USA foodstuffs and water. It is a fact that many herbicides are used worldwide in both aquatic and terrestrial environments.

With regard to the European Union consumer of Nile Perch, there are levels considered safe should residues appear in fish tissue. The EU levels were not made available during the preparation of the DEIS. For purposes of completing the EIS process and to reduce the level of concern regarding the potential EU rejection of Nile Perch imports, the EU levels should be made available to the appropriate Government of Uganda authorities. It is not expected that fish would contain any residues or if residues did appear their levels would not be sufficient to cause a rejection by European regulatory agencies, and thus the European consumer.

k) available information on toxicity is at variance with the information presented in the report. Evidence was made available and is attached as Annex V.

Response:-
The document being referred to in Annex V originally appeared in the "Journal of Pesticide Reform Fall 1995" and was authored by Caroline Cox of the Northwest Coalition for Alternatives to Pesticides (NCAP). This paper was retyped for submission to the Public Hearing and an additional author name added. This article has had wide circulation, which is most unfortunate, since this Journal in general and this article in particular has had no scientific peer review. An in depth review of Caroline Cox's article was conducted by an independent Toxicologist, Mr. Frank Dost. See the attached report in Annex 1.

l) there is no mention of precaution in chemical mixing or disposal of unwanted chemicals and containers. That appropriate mitigation measures for disposal are not indicated.

Response:-
Annex 5 of the DEIS contains Herbicide labels that provide information on mixing and disposal of containers. This information would be followed to mitigate the potential impacts.

m) the candidate chemicals are toxic, their purity is not known and not guaranteed and that the drift control agents are not named. That the analysis of transient products such as benzene was not done, noting that the problem could be from one of the transformation products.

Response:-
Proper use, as indicated on the label, mitigates against toxicity to humans or the environment. Quality control measures are mandatory and enforced under USEPA regulations for herbicide products manufactured in the USA to ensure purity of the product and to mitigate against contaminants. Manufacturers and regulatory agencies are required by law to ensure quality of the product.

n) the break down products i e. phenyls and amines are known to be toxic but were not analyzed in the EIS.

Response:-
Breakdown product processes for the herbicides were reported in the In-Lake Trial Report, Annex B, Prof Nyangababo, J.T. Studies of the Fate of WEEDAR 64 and RODEO Aquatic herbicides Following Water Hyacinth Treatments in lake Victoria" pp. 1 - 3.

o) sinking and eutrophication.

Response:-
Comment addressed in section 5.1.3.3 of the FDEIS

p) water quality

Response:-
Comment addressed in section 5.1.3 of the FDEIS

q) the Section 20-25 of National Environment Statute and Article 245 of the Constitution are very strong on the environment. Assuming that NEMA approves the spraying, any citizen will have the right to sue government. That Uganda has signed a lot of international instruments which required that other countries be consulted on this issue.

The participants in this category recommended that:

a) chemical control option be put aside and that Uganda should go ahead with biological and mechanical control options.
b) Uganda should seek improvement of existing methods of control.
c) the weed can be used for other uses including fertilizers and that this has already been tried.
d) instead of spraying the weed with chemicals. the money for such activity should be used to support riparian communities and volunteers for manual removal and biogass, crafts production.
e) the Control program should concentrate more on pollution control and physical (mechanical, manual) in areas of socio-economic concern.
f) the potential of controlling the water hyacinth at Kagera should be re-examined with a view of strengthening it.
g) Government should undertake more study on the candidate chemicals as we intensify mechanical and biological means of control.
h) Ugandan scientists should collaborate with EU scientists on the chemical control option.
i) the report is inadequate and could be improved if chemicals are to be used.

Category Three: Views Challenging the Validity of the EIS

This category of participants questioned the validity of the EIS as a sound basis for decision - making. Their position was based on the grounds that:

a) the results were not valid as the tests were a one time application of chemicals where as for the effective control of the weed, repeated applications were necessary for long term effectiveness.

Response:-
Because the herbicides proposed for use do not bioaccumulate, there was no need to multiple applications for these trials. Many studies have been carried out on these herbicides and the results are well documented. The International Program on Chemical Safety (IPCS), under a joint sponsorship between UNEP, ILO and WHO, has carried out and disseminated evaluations of the effects of chemicals on health and the environment. This has resulted in the publication of "Environmental Health Criteria" Vol. 159 on Glyphosate, and Vols. 84 and 29 on

2,4-D. This data is available at the Albert Cook Library at Mulago Hospital, Uganda and can be easily accessed for further supportive data.

b) the EIS does not consider community views i.e. those who eat fish and who drink the water. That this is a very serious omission. Hence the report invalid.

Response:-
The DEIS does consider community views. For this reason an awareness campaign was carried out prior to In-Lake Trials in the villages adjacent to Wazimenya Bay. The DEIS also states that a similar campaign would be carried out if the chemical control option were to be implemented. (See section 5.1.12.1 and Annex 9 Section 10).

c) the costs of chemicals application were deliberately downplayed such as costs for the disposal, hiring of pilots and planes etc. That the cost estimates of the different control methods were seriously "doctored" (*i.e. that they did not represent a true picture of cost analysis).*

Response:-
The costs provided present an estimate within the range of chemical application costs for the USA (Haller, William T., pp. 147. Edited by Charudattan, R., Labrada R., Center T. D., Kelly- Begazo, Christine. Strategies for Water Hyacinth Control. FAO, Rome 1996). However, in the same FAO report, a Ghanaian study estimated per hectare treatment at US$ 538 (de Graft Johnson, K. A. A., pp. 27). A South African Study, also in the same report, suggests US$ 200 (R750) for aerial control of 50 hectares and $48 (R180) per hectare for boat spraying. (Cilliers, C.J., et.al. pp. 97). Costs may vary slightly from country to country but the range is within the estimates given in the DEIS.

d) under page 20 of the EIS, no risk analysis on these three control options was done.

Response:-
A risk analysis of the three options was presented in a matrix table of comparison of impacts of the three. See Annex 1, Table 10.

e) considering the methodology used, the scientists were seriously constrained in terms of resources to the extent that they overlooked the ethics of science. That for example, only one control point was used and one treatment for each test plot.

Response:-
The study design was discussed with all parties involved and approved by NEMA. (See Section 6 Annex A for NEMA's approval). The financial constraint was evident but it was also seen that trial data results are similar to studies conducted elsewhere in the world.

f) the results were inadequate in as far as, for example, fish being judged on basis of posture.

Response:-
In addition to posture, fish were also observed for mobility and behavior. It is recognized that anthropomorphic observations may be less than ideal but these were meant to give some indication of fish activity. Therefore, fish were also analyzed for herbicide residue to lend actual evidence to any residue uptake by fish.

g) the EIS does not indicate the impact the big mass of water hyacinth will have on the water quality. That because of the already high nutrient input, it will be criminal to add more organic matter to Lake Victoria as a result of decomposition of the sprayed huge mass of water hyacinth.

Response:-
See section 5.1.3.3 on the impact of Decomposing water hyacinth to the lake bottom.

h) recent rate of water hyacinth infestation was not stated in the EIS.

Response:-
An estimated rate of water hyacinth infestation based on previous studies was stated in the DEIS. No accurate figures can be given until a Geographic Information System study to investigate the levels of infestation has been completed.

i) that the results in the EIS are questionable with regard to effects of dilution. *(ref: Page 14 of the EIS)*. It was doubted whether one would expect to get 2,4-D in water after 14 days.

Response:-
See results of laboratory residue analysis by two laboratories for the In-Lake Trials, Annex 9.

j) no reference to presence of micro-organisms in the water was made in the EIS, although the presenter indicated that micro-organisms help to break down the chemicals.

Response:-
See Annex B of In - Lake trials pages 2 and 3 for a discussion of microbial degradation of herbicides.

k) how would herbicide experiments be expected to occur to the temperature and nitrates as an effect of herbicides application?

Response:-
Question is vague and not understood. For information on nitrate levels and temperatures, refer to In-Lake herbicide trial Annex C, trial data.

l) tests were used with hand held spray guns although aerial spraying is recommended in the EIS.

Response:-
Both options are recommended in the study. Details of where and what method to use will be developed in the Operational Control Plan (OCP) and would be based on the physical environment of the area to be treated. The tests carried out were not meant to test the effectiveness of the application method but rather the efficacy of the herbicides. Studies and experiences from other countries that have used aerial spraying can be sought.

m) the EIS completely ignored all the major requirements for EIA as recommended by NEMA e.g. description of what is proposed; existing and projected environmental impacts; a complete lack of a detailed analysis of risks.

Response:-
Theses major requirements need to be specified in order for this question to be answered. A description of proposed action was clearly stated in Chapter 2. Existing and projected impacts are clearly laid out in the study and in almost every section of chapter 5 and Annexes. Analysis of risks has also been carried out in various sections of the study with matrix tables of comparison of impacts provided.

n) the EIS is a set of individual reports bound together without integration, hence contradictions are evident. That there is a flaw in linking the results to the conclusions.

Response:-
The DEIS is not a set of individual reports. The main study integrated the reports by providing conclusions and recommendations and Annexed individual reports at the end of the main document for further references.

o) the EIS does not provide a monitoring strategy: That it does not indicate who are responsible for monitoring and in the event that something goes wrong who should be responsible.

Response:-
The EIS does mention that monitoring will be conducted by the lead agency (MAAIF) assisted by NEMA. An In-Lake emergency protocol was developed during the trials indicating authorities to contact in case of emergency.

p) the cost benefit analysis of the various control options was not given. That the cost of loss of income for fish exports if chemicals are applied was not made nor was the cost of legal suits if instituted against government given.

Response:-
The cost benefit analysis was given for the No-Action Plan which reflected the loss that would be incurred if the hyacinth was not controlled and continued to impact fish. A costing of the loss of fish for export as a result of herbicide application was not done because it is not expected that herbicide residues would be present in fish tissue leading to rejection.

q) the scientists should have done better but information is insufficient. That for example, what was the effect of the algal increase in the lake.

Response:-
The effect of algal increase were considered negligible and transitory and would be an insignificant fraction of that normally found present in the lake system.

r) it was not shown whether the fish tested was the same fish present during the spraying.

Response:-
Fish collected during the In-lake trial did not reveal any herbicide residue in their tissue. These fish, whether or not they were the fish originally in or around the plot at the time of application, would have been exposed for a period sufficient to absorb residues since they were captured within the treated plot. These herbicides are not fat soluble and cannot build up or accumulate in fish tissue, and if these herbicides were ingested they would have been excreted rapidly. The fact that no residues were found in the tissue is an indication that the herbicides degrade and dissipate quickly.

s) the socio-economic component is lacking in the EIS. That the calculation of costs presented were not fair e.g. the 45 million US dollars per year Uganda earns from fish exports were not reflected.

Response:-
The Socio-economic component was addressed in the EIS in section 5.1.17

t) the EIS does not indicate how handling of chemicals with respect to the scale of the applications is to be done, how they will be stored, handled and how accidents and accidental spills will be handled. That no mention of precaution in handling the chemicals was made.

Response:-
See herbicide labels and Material Safety Data Sheets annexed in DEIS.

The participants in this category recommended that:

a) the EIS is quite incomplete and the public hearing should not be used to endorse the use of chemicals
b) the EIS appears to advance the cause for chemical control and not the other methods and therefore must be invalidated.
c) a lot of statements in the EIS should erased because the results cannot help us to draw any conclusion. These results should be used only as pointers but the findings should not be used for decision making. The EIS cannot be used as of now to recommend use of chemicals to control water hyacinth.
d) there are areas of serious insufficiency in the document which raises the question of the validity of the report for decision making.

e) the EIS should be considered inadequate with respect to conforming to NEMA guidelines; adequacy and conclusiveness; examination of positive aspects of water hyacinth.
f) the EIS be rejected and should not be used as a basis for decision making and the EIS should be re-done.

Response:-
Based on the responses given to the comments above, it is evident that the DEIS was not well read by the people who contributed to the comments. There is therefore no sufficient basis to reject the DEIS. However, additional information has been added to the final EIS strengthening the areas of concern as noted in the public views. It should also be noted that since two of the three proposed options from the DEIS have been accepted, rejecting the entire study then contradicts the validity of the decision to approve the mechanical and biological options. The third component (herbicide control) has been strengthened to reflect issues raised in the public hearing.

Category Four: Participants who Raised Questions That were not Answered

This category includes those who asked questions but did not get answers either from the presenters or the audience itself. The questions are summarized as follows:-

1. That the company which was used to carry out the EIS i.e. Aquatics Unlimited, is stated to be notorious for concocting data regarding herbicide tests. That what assurance do the people of Uganda have that Aquatics Unlimited will not end up doing the same?

Response:-
This statement is false and misleading to the public. Any proof that Aquatics Unlimited is/or has been notorious for concocted previous data should be forwarded for review.

2. What assurance do we have that this is not a plan to kill Ugandans in the future? That supposing spraying is risky to human beings who would be responsible? That if we use this report to make a decision, can we handle the eventualities?

Response:-
Aquatic herbicides are used in many parts of the world. Similar studies have been made in other parts of the world. These studies should be consulted if in doubt.

3. That water hyacinth already exists here. There are already economic activities related to water hyacinth. Would it be possible to underscore control of water hyacinth using these options other than spraying?

Response:-
Utilization, if proper permits are issued, can certainly be part of a manual/mechanical removal program, but should not be confused as a control measure.

4. Whether the EIS identifies areas where the Ministry of Health could help the local communities on health issues.

Response:-
The EIS in Annex 1 section 9 In-Lake Herbicide trials emergency medical protocol provides information on first aid treatment, and provides names of Doctors who can be contacted in case of emergency. As these herbicides and hundreds of others are presently in use in Uganda, it is expected that the Ministry of Health, Hospitals and medical practitioners are aware of treatments due to various exposure routes and have experience in conducting such treatment.

5. Whether herbicide degradation products were also measured other than the original chemicals?

Response:-
See above response in category 2 (o)

6. Whether the Attorney General has been consulted in case of loss/sabotage to fish exports through spraying with chemicals. Or what are the legal implications of suits being instituted against government for loss of income by Ugandans or fish exporters.

Response:-
Comment noted. This is, however, out of the scope of the study. Herbicides if properly used would not create a loss of fish revenue.

7. That the public is in a dilemma. The water hyacinth is a natural endowment. To what extent can we eradicate it or create utility out of it?

Response:-
The water hyacinth is an exotic and noxious weed and should be controlled as much as possible to bring it to maintenance levels. Any positive natural endowment the water hyacinth offers is far outweighed by negative impacts the weed imposes on the country. Eradication of the weed is not possible, utilization is addressed above.

8. The research has not put into consideration ethical considerations and the human concerns. What efforts are being put to control the source of the weed?

Response:-
Human concerns have been researched for many years by other researchers and have found when handled properly there is no threat. These herbicides, in addition to many others, are presently used in country in farming practices. A boom and conveyor have been installed at the Kagera River.

9. What practical evidence can be present on the safety of these chemicals. How will the government adjust to the loss in revenue if fish is not bought?

Response:-
Practical evidence on the safety of the chemicals was seen from the trials done in Uganda and additional material presented in the DEIS. Issue related to fish have been addressed above.

10. There was the problem of involvement of interested parties in the study hence the omission of social component, economic and other dimensions.

Response:-
Question is vague. Interested parties should be more clearly identified.

11. The Florida lakes where the chemicals spraying has been done do not contain fish of commercial value and are of no value as a water source for domestic use.

Response:-
This statement is false and misleading. Florida lakes are intensively managed, are considered to have very high aesthetic and monetary value, support commercial as well as a very lucrative sport fishery, supply industrial and irrigation water, and are important sources for replenishment of above and below ground aquifers which are sources for domestic use.

CHAPTER FOUR

REPLY BY THE PRESENTERS TO THE ISSUES RAISED BY THE PUBLIC

After the participants in the public hearing had presented their views, the presenters mentioned in Chapter Two to this Report were, one by one, given a right of reply.

The outstanding replies were that:

1. On the issue of not mentioning the fact that the chemicals are not dangerous to phytoplankton, the response was that the two candidate chemicals are not algicides. They are herbicides. They would therefore not have a direct effect on phytoplankton.

2. That the form of 2,4-D which was mentioned by a participant and was used in Sudan should be specified. To the presenter, the Sudan team used 3 forms of 2,4-D and recommended the amine form for use. It is this amine form that was used in the EIS.

3. Glyphosate does not release phosphate directly into the lake and that herbicides were monitored for 14 days and more.

4. The breakdown of the Glyphosate molecule into other components was assessed by first subjecting the samples to Qualitative analysis before the quantitative analysis. This permitted analysis of the presence of any other degradation products that could arise from 2,4-D breakdown.

5. On the fear that 2,4-D could contain a contaminant called Dioxin that could cause environmental problems. This was not the case with the candidate 2,4-D to be used under the proposed control programme.

6. They assured the participants that there is information sharing between the three East African countries under various organs, such as Lake Victoria Environmental Management Programme and Lake Victoria Fisheries Organization which is yet to start.

7. On using water hyacinth as an economic good, the problem of accessibility to the weed could limit this option.

8. On the fear that the sprayed water hyacinth could decompose under the lake, it was stated that there is also natural deposition of organic debris from the living water hyacinth even without spraying. The mixing of the lake waters could minimize the problem of localized eutrophication.

9. On the EU fish market, it was observed that this could be a marketing problem. That this could only arise if "tones and tones" of the chemical are to be applied in the water.

10. That even the water we drink from National Water and Sewerage Corporation could be potentially toxic if it were not treated to an acceptable concentration.

11. That cleaner technology should be adopted to minimize pollution of the aquatic.

12. That the toxicity of the chemicals on Fish was not addressed.

13. On the concern that the algae can increase phosphorous accumulation in the water, a presenter wondered whether Uganda should consciously add an algae stimulant to a lake already suffering from eutrophication.

14. That the resident lake-edge water hyacinth is now infringed upon by other macrophytes. Consequently, the lateral rate of expansion of the weed has not increased in both Lake Kyoga and Lake Victoria. The initial high proliferation rate is not what we observe now, the only remaining main sources of active proliferation is now in Murchison Bay. However, they noted that this should not downplay the magnitude of the problem.

15. That Uganda needs to take a long term and holistic view of the problem taking the holistic ecosystem perspective. One presenter cautioned that we don't want to control a monster with a bigger monster.

16. That the study protocol was adequately reviewed commencement of the study.

17. On regrowth and regeneration, it was observed that during the process of spraying, the suckers that are below the lush leafy plants may be missed. This represented the 10% balance of the uncontrolled weed. This would require other options including applying another spray or using another control options.

18. That there is variability on water hyacinth growth.

19. That there was not enough efforts done to integrate the EIS, the results of all the scientists, although an attempt to do so was made.

20. On the concern that the number of samples taken for water quality analysis was small, it was observed that sampling on land is two dimensional while in water it is three dimensional. The number of samples was as high enough, as up to 153 samples. That the acidity of the plots was uniform both in sprayed and unsprayed plots.

21. That after spraying the massive sinking did not occur immediately.

22. On water hyacinth multiplication rate, it was observed that one water hyacinth plant would give rise to one million plants after one year. That this should be taken into account in designing an intervention measure.

CHAPTER FIVE

CONCLUSIONS

A Summary of the Major Highlights

At the conclusion of this Public Hearing, I was also presented with a summary of the main highlights of this hearing as was seen from the point of view of the Rapporteurs. Of course this summary helps to ease the issues at hand and points of agreement. They were presented as follows:

1. Most of the presenters were of the view that no changes are observable when the candidate chemicals were applied using the different parameters mentioned.
2. Exceptions were also observed in certain areas such as use of Round-up showed faster multiplication of algae etc. The efficiency test was found sufficient to injure the plant significantly.
3. That information was received to the effect that:

    a) chemicals may be toxic;
    b) the water hyacinth proliferation has stabilized in the lake;
    c) that mechanical/manual control has proved effective;
    d) that the candidate chemicals do not kill the seeds of weeds;
    e) there is need to focus on pollution control from point sources;
    f) that in the long-term the biological control is useful;
    g) that radiation should not be used as it was not necessary;
    h) that those who can put the weed to economic use should approach the Ministry of Agriculture, Animal Industry and Fisheries for further discussions,
    i) there is need to explore collaboration efforts with Government of Uganda Scientists on the issue of exports to improve on marketing strategy with consumers of fish.

4. there was also commendation of the Ugandan Scientists for the good work done.

B Major Issues to Consider in Decision Making

Having read the main EIS Report and having presided over this Public Hearing, I wish to draw the attention of NEMA to the following major issues. among others. that may be considered when making a decision on the proposed control programme. These issues are arising out of the opinions expressed by the public in this hearing.

A. The Public Hearing indicated that mechanical/manual/biological methods were found to be environmentally safe and should be considered by the Executive Director for approval without further delay.
B. Whether Uganda's international obligation will be affected by application of the candidate chemicals. There is need to evaluate carefully the implications of legal action against the Government in case a candidate control option is used.
C. You should consider whether the EIS is adequate in the following areas:
   i) being balanced in the approach used to evaluate the various control options;
   ii) the scientific methodology was adequate to capture the required evaluations;
   iii) the results of the entire experiments were scientifically and adequately analyzed to provide an honest and accurate conclusion;
   iv) costs on or effects on exports of fish;
   v) the chemicals can cause further proliferation of the problem because of increase in nutrient levels. Whether we should increase more nutrients;
   vi) impact on organic matter accumulation;
   vii) effects of repeated chemical application;
   viii) whether the EIS should have been replicated at different sites in order to achieve better results;
   ix) whether human health and biodiversity was well considered;
   x) whether aerial spraying can be based on the results of hand held applications;
   xi) whether the Report followed NEMA guidelines.

D. Whether the costs as analyzed in the report present a correct/true picture of statistical analysis.
E. Whether mitigation plans contained in the EIS are sufficient to contain any adverse effects including risk analysis toxicity of the chemicals. The toxicity of the chemicals was also put under question.
F. Whether there was adequate input and consultation from the public or the local community on the EIS and such input reflected in the EIS.
G. Whether adequate institutional arrangements are contained in the report for monitoring.

C THE WAY FORWARD

Before the conclusion of the public hearing the Executive Director of NEMA provided the way forward by stating that the public view not withstanding, other aspects will be considered in arriving at a decision. That MAAIF is not the only Lead Agency on this matter, others include Ministry of Natural Resources. Ministry of Local Government, riparian districts. etc. NEMA, however will not be swayed to make decisions not

backed by technical soundness. That the views presented in the public hearing will be taken into serious consideration in making a decision.

Before the conclusion of the public hearing, I appealed for more public commitment in the control of the weed.

I then adjourned the public hearing at 6.10p.m.

Prof. John Sebuwufu
Presiding Officer

Date: 30th July, 1997

APPENDIX 1

MAAIF RESPONSES TO NEMA

CONFIDENTIAL

MAAIF RESPONSE TO NEMA

ON ISSUES LINKED TO APPROVAL OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED WATER HYACINTH CONTROL PROGRAMME

ENTEBBE 5TH NOVEMBER, 1997

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ENTEBBE, UGANDA

IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTE NO..... C/MIN/1/271

The Republic of Uganda

5th November, 1997

C O N F I D E N T I A L

The Executive Director
NEMA
Kampala

RE: APPROVAL OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE PROPOSED WATER HYACINTH CONTROL PROGRAMME

Your letter Ref: NEMA 8.3 (undated) received on 11th September, 1997 refers.

The Ministry of Agriculture, Animal Industry and Fisheries noted with great concern that no sooner was this confidential letter received than press statements were made by your authority before consultations could even begin on this important matter of national interest. This has needless to say, led to missed opportunities for technical discussions and has created a less enabling environment for decision making.

As a consequence of the directive by the Policy Committee on the Environment (PCE) during its meeting held on 31st October, 1997 we have been directed to reply to your correspondence on the issue.

The following are comments and responses to issues raised in your correspondence on the proposed water hyacinth control programme submitted to you by my Ministry:

1. General Comments

1.1 Your decision has been taken without an exhaustive review of the DEIS. We should have been accorded an opportunity to respond to concerns that NEMA and other stakeholders have expressed over the DEIS before reaching this decision. Indeed NEMA's draft

"Guidelines for Environmental Impact Assessment in Uganda. July 1997" provide for this (Pg. 10 Fig. 2.1 EIA Process Flow attached). The decision would thus have been taken on the basis of a Final Environment Impact Statement (FEIS) rather than the Draft Environment Impact Statement (DEIS) as was the case. **It is only appropriate to assume that a final decision has not been reached if the NEMA guidelines for EIS is anything to go by.**

Please note that the National Environment Statute (1995) from which NEMA derives its authority repeatedly emphasises: **"NEMA in consultation with the lead Agency"**, for any decision on most environmental concerns. The **law makers, in their wisdom, knew that expertise lies with the lead agency**. MAAIF is the lead agency on matters of water hyacinth control. It has the expertise and is backed up by **expert advise to eliminate any danger due to amateur operational control program.**

MAAIF notes that the **"NEMA proposed Draft EIA Regulations, 1997"** tends to undermine the role of the Lead Agency in consultation and decision making process (refer to 7(2), 18 (3), 18 (5), 24, 25, 26 and 27). It is advised that for **public projects**, the Executive Director makes a decision only after due **consultation** with the Head of the relevant Lead Agency; NEMA organs such as the NEMA Board; and the Policy Committee on Environment. **MAAIF was not bound by this draft regulations during the DEIS, but by the National Environment Statute**. It expects further consultation with NEMA before a final decision is reached as per the statute.

1.2 You **appear not to have exercised caution** when giving weight to opinions expressed by members of the public who participated during the public hearing. Such caution was essential for two reasons. First, a number of the participants who expressed their views **lacked technical knowledge** on procedures for evaluation of herbicides. Secondly, a sizable proportion of the **participants had interests on specific control options** and thus **lacked objectivity** in their criticism of the control strategy proposed by MAAIF.

Examples include:

(i) Members of such NGOs as "Keep Uganda Water Clean and Productive" who foresee **monetary gain** if resources are concentrated on manual control inspite of its shortcomings.

(ii) Members of the "Uganda Soil Association" who are developing a proposal for funding on **utilisation** of the water hyacinth for manure production.

(iii) Members of the "Uganda Environment Protection Network" who have been **shopping for funds** to develop a local water hyacinth harvester.

People belonging to such groups were likely as they indeed did, to discredit any control method which they perceive to be incompatible with their own interests (e.g. letter by Hon. Lukyamuzi attached).

1.3 NEMA's interest in the EIA process should have been ensuring that **valid and reliable data are generated that can help in informed decision making**. This was MAAIF's belief. Hence, **throughout all the stages of the EIA** and particularly the chemical verification process, **procedures and methods used were presented to you for technical review and approval**. It is therefore extremely surprising to note that NEMA approved the studies and preferred to be silent over the alleged technical flaws.

1.4 For some unexplained reason, most of the concerns you raised in your decision appear to be **based on the premise that MAAIF is proposing chemical control as the sole method to bring the water hyacinth under control**. The DEIS is very clear on the proposed **integrated control strategy** which entails limited and selective use of herbicides. One therefore finds it difficult to justify raising such questions as those in section e(i), (iv), (v), (vi) and (vii) of your letter. It would appear that NEMA adopted wholesale the attitude of those participants at the public hearing who were opposed to the integration of herbicides in the control strategy. Nearly all such participants

appeared to suggest in their contributions that MAAIF was taking chemical control as a sole preferred option. **This is not the case.** The implications of your decision could affect terrestrial crop productions as the two herbicides' active ingredients are registered in Uganda by **the authorised** body for day to day use by farmers.

2. <u>Comments on Specific Issues</u>

2 (a) "..... **technical flaws in data collection methodology at various stages of chemical verification..... there are threats of serious and irreversible damage the principle of precaution should apply.....**"

Response:

In your letter, you admit that this conclusion is largely influenced by opinions expressed by participants at the public hearing. This is rather unfortunate. As pointed out in 1.2 above, such opinions expressed ignorance of procedures employed in pesticide evaluation. Detailed comments on this issue are given in "Comments and Issues Raised at the Public Hearing" attached.

The DEIS does not identify any threat of serious and irreversible damage in the chemical control option if herbicides are used in accordance with the label guidelines, but it does mention the precautionary measures to be taken (see section 5.1.12). The principal of precaution has been applied in several sections of the study, addressing the need to abide to the herbicide labels and Material Safety Data Sheets (see section 9 Annex 5) as the main precautionary measure, as well as the use of properly trained and licensed Aquatic Herbicide applicators. Drift and spill control has also been emphasized (see section 6.0).

The precautions provided on the herbicide labels and MSDS would prevent negative economic impact from loss of income in fish export, because **herbicide residues are not expected to be found in fish tissues above acceptable level.**

2 (b) **"the socio-economic analysis as was demanded in the study protocol did not take into account the concerns of the public as was required through the scoping process. No public reactions were included in the EIS as to the viability or safety measures;"**

Response:

Concerns of the public were clearly addressed, with the first indication of public involvement beginning with the expanded scoping process, where significant issues were identified and addressed in the DEIS. Concerns of the public and reactions can be found in Annex 3 of the scoping document, (after pg. 17), with the reactions of the public in the scoping process and names of the participants in the public discussion listed. A sensitization exercise was carried out prior to the In-Lake Trials (see Annex A In-Lake herbicide Trials protocol, section 10). Section 5.1.12.1 describes the kind of sensitization that was carried out during pond trials at Kajjansi. The mentioned processes indicate that concerns of the public were taken and addressed. Public reactions to the viability or safety measures which were received during the public hearing of the DEIS of 30th July 1997 will be documented in the final EIS as the draft EIA guidelines of NEMA propose.

2 (c) **" ..... the EIS does not make reference and analysis of risks involved to the Uganda economy particularly ..... the risk of losing the fish export market ....."**

Response:

The measures recommended for control of the water hyacinth were seen to improve the fish export market in the long run. The No Action alternative was seen to have the more serious economic risks. If herbicides are used in a manner consistent with the DEIS document, and considering that EU countries which provide an important market for fish use the same herbicides in their individual member countries (see 2.1.1 par. 7), **it is assumed that rejection of fish should not occur unless residues of the chemicals are found in the fish tissues above established MCL's.**

The risk and liabilities of fish consumers or the export market were seen to be greater if the water hyacinth were allowed to continue growing at the present rate. **If there were any loss to the fish export market from herbicide control measures, it would be temporary and would likely be based on emotional reaction rather than scientific fact.** These particular herbicides have been used in many parts of the world and are approved and certified for use in aquatic environments by regulatory agencies around the world.

An overall impact on lake productivity (fisheries) was estimated in Section 2.3, page 22 of the DEIS.

It should be noted that the threat by EU to ban Ugandan fish is not correct (EU Note no. 3298.96/EGR-mk attached). EU actually endorsed "..<u>limited chemical interventions</u> **for rapid short term control...**" as provided in LVEMP Project document. Also, please note the misinformation by the fish processors through their association UFPEA in the same attachment (letter dated 3/9/96 2nd pg.) that "**....chemicals earmarked for use are 2,4-D, Glyphosate .... non-selective, ...persistent in the environment and ... toxic to animals and humans**". They do not mention dosage hence is completely out of context. UFPEA in ignorance assumed that Uganda was planning a massive use of herbicides to control the water hyacinth in its waters. It was based on the fear that under such circumstances, fish would be contaminated with herbicide residues at levels beyond acceptable limits. MAAIF in the DEIS does not propose "massive use of herbicides" and the chemical verification study has clearly shown that when used in the manner proposed by MAAIF there is no chance that fish will end up with herbicide residues beyond acceptable limits. It is also worth pointing out here **that Uganda, as a nation should strike a balance between short term and long term gains.**

2 (d) "**..... strong probability of legal suits .....**"

Response:

The DEIS does not anticipate any health mishaps or loss of income in fish trade if herbicides are used in accordance with the label instructions.

The expert view on this issue is that **"the pesticide label is the law".** In other words for any aggrieved party to succeed in such a suit, it should be proved that:

(i) the herbicide was not used in accordance with the instructions on the label;

(ii) that fish were adulterated with herbicides on the basis of a particular set standard.

2 (e) **"Insufficient information or evidence provided in compliance with Uganda's international obligations ....."**

Response:

In the Lake Victoria Environment Management Project (LVEMP) document of June 1996, the three Governments (Kenya, Tanzania **and Uganda)** and IDA, in a Tripartite Agreement reached on August 5 1994, it was agreed that **"herbicides used in the water hyacinth control program will be acceptable to IDA, they will be used sparingly, in strict, selected and confined areas, all persons applying such herbicides will be trained in their safe and appropriate handling and use, and mechanisms for careful monitoring of herbicide use will be established"** (see Part II, page 49 (g) of DEIS). In addition, Chapter 4 of the DEIS identifies international and regional agreements in place that have or may have a bearing on the water hyacinth control program.

During the public hearing of the EIS it was clearly pointed out that under the Lake Victoria Fisheries Organisation, the riparian states have consented to control the water hyacinth through an integrated

strategy involving limited use of herbicides (MoU Council of Ministers LVFO attached). In any case what is important at this stage is for Uganda as a nation to identify the most effective and environmentally friendly strategy for control of the weed before she can sell to other riparian states. The Sudan and Egypt are among the pioneers in the Nile Basin to use herbicides for aquatic weed control and cannot justifiably make an issue over the matter.

2 (e) i **"Whereas the EIS eludes to herbicides as having no significant impact ..... the same EIS ..... alludes to possible risk by stating that ..... herbicides will not be used where they will have adverse effects ....."**

Response:

This is not a serious contradiction. It should be appreciated that the safety of the herbicides are partly accounted for by factors operating in the environment in which the herbicides are being applied. **These factors render the environment self-mitigating.** In the lake ecosystem, such factors include the large volume of water, water currents, long photoperiods, ambient temperature etc. that result in high rates of dissipation of the pesticide. In a water abstraction point, however, such factors are limited and hence the risk of the herbicide having adverse effects.

In accordance with herbicide labels, it is recommended that restrictions should be observed for potable water and irrigation for a specified period of time or until water falls within acceptable herbicide residue limits (see herbicide labels in Annex A section 7 of the DEIS).

2 (e) ii **"Although a single application was used during the trials, ... it is necessary to carry out multiple herbicide application. Hence, further studies ..... to rule out ..... impacts such as accumulation of herbicide residues via the food chain."**

Response:

Section 5.1.3.2 clearly states that the herbicides proposed do not bio-accumulate via the food chain. There is an **enormous amount of information and literature available on this topic** per the references provided in the DEIS. Further studies are being referenced (see the following cited World Health Organization literature, Environmental Health Criteria 159. Glyphosate. pp 52-54; Environmental Health Criteria 29, 1994. 2,4-Dichlorophenoxyacetic acid (2,4-D) pp. 32. 1984).

It is not true to say that one has of necessity to conduct residue analysis on organisms that have been subject to multiple herbicide application in order to generate information on accumulation of herbicides via a food chain.

The key to this phenomenon is to demonstrate that:

- herbicides indeed end up in the organism's tissues;
- the concentrations of herbicides in the organism's tissues is as high or higher (by some bio-multiplication factor) than what occurs in the environment.

If the above are demonstrated especially in the storage or edible tissues of the organism even after a single herbicide application, then it is reasonable to conclude that the herbicide has a high potential to accumulate via the food chain. It was on the basis of this scientific principle that this particular aspect was studied and the information generated is thus scientifically sound. **Please note that the formulations used in the experiments were water soluble. Simple science tells us that they are not lipophilic and can not be binded to adipose or fat tissues that stores substances in any organism. They are thus excreted in the environment. Bio-accumulation is not therefore anticipated.**

2 (e) iii **"Given that the fish was not confined ....., it is not possible to draw scientific conclusions to support the results of the tests....."**

Response:

The Kajansi pond trials did include fish observation and residue sampling in an environment which was isolated and protected from outside interference. Herbicide residue analysis shows that levels never exceeded the USEPA Maximum Contaminant Levels and it was reported that no fish mortality was observed (See Annex 8, Kajjansi Pond and Kituza lab Trials Report, Table 11, Page 35 and Page 31).

The In-Lake Herbicide Trial was conducted to provide results that would be similar and expected from an actual control exercise. Prior to herbicide application attempts were made to confine fish in cages within the lake, yet this proved futile as a natural environment for survival of wild fish was not achieved. Protecting trial plots from interference's such as water currents and biota movement would not have provided a true physical lake environment situation that would be expected under a routine herbicide control program.

Fish collected during the In-lake Herbicide trial did not reveal any herbicide residue in their tissue. These fish, whether or not they were the fish originally in or around the plot at the time of application, would have been exposed for a period sufficient to absorb residues since they were captured within the treated plot. These herbicides are water soluble and do not build up or accumulate in fish tissue, and if these herbicides were ingested they would have been excreted rapidly. The fact that no residues were found in the tissue is an indication that the herbicides degrade and dissipate quickly.

Additionally, reviews by the World Health Organization reveal that "**Glyphosate is not expected to bioaccumulate in view of its high water solubility and its ionic character. This was confirmed by several laboratory experiments with fish, crustaceans, and molluscs and by field experiments.**" (Glyphosate, Environmental Health Criteria 159, International Programme on Chemical Safety, WHO, 1994.)

Please also note that the objective of the inlake trials was to evaluate the impacts of the herbicides under natural environmental conditions. It would have made no scientific sense to interfere with the natural environmental conditions while trying to determine the effects of the herbicides under natural conditions!

It is worth noting here that this phase of the chemical verification process followed the evaluation of the potential impacts of the herbicide in Kajjansi ponds where fish and other biota were within the confines of the ponds and where wave interference was non-existent. The Kajjansi pond experimental results are consistent with those of the in-lake trials and if one has doubts on the latter, surely there is no reasonable ground to doubt the former!

2 (e) iv **".... water hyacinth infestation in lake Victoria was estimated at approximately 4000 hectares at the end of 1996.....Further, the EIS does not state how many times spraying will be done ..... It is not clear whether the first application will be followed by ..... repeated applications and if so the potential cumulative impacts are not analysed."**

Response:

The actual amount and finer details of the biomass targeted for herbicide control was to be developed in the Operational Control Plan when herbicide control option had been approved and a monitoring program of the infestation is in place. The 20 times separate sprays suggested above is a mere assumption. The proposal looks at an integrated approach. Priorities and areas for control would be developed depending on the physical characteristics of the area and associated water uses. The DEIS does not state at any one time that 4,000 hectares will all be controlled by herbicides alone. (See section 5.1.3.2 Potential Impact from Repeated Chemical Control Measure).

The key to the issue of cumulative effects is the time it take the environment to clear the herbicides. The study showed that seven and fourteen days after application, glyphosate and 2,4-D respectively were non-detectable in the water. It is therefore reasonable to assume that a repeat application considerably eliminates the dangers of cumulative effects of the herbicides.

2 (e) v **"As far as the efficacy of the chemical control option is concerned, ... not effective in controlling the weed."**

The DEIS does not in any way suggest that chemical control is a magic cure to the weed problem but rather that it is a tool which if used along with others can effectively bring the weed under control. As pointed out in section 1.4 above, it is difficult to understand why NEMA makes an issue over this fact!

Careful evaluation of regrowth after herbicide application in the pond trials was recommended. As a result, further evaluation was obtained in the In-lake herbicide trials (see 5.1.3.3 Rate of Herbicide Effectiveness or Kill Rate). The In-lake results indicate that there was a 90% control achieved 30 within days after herbicide application.

It is important to note here that the water hyacinth in Lake Victoria and other water bodies of Uganda are here to stay. It is impossible to eradicate the water hyacinth. Integrated control measures will be required indefinitely as continued growth will occur whether through use of mechanical, biological or herbicide control measures.

2 (e) vi **"There was a deliberate under-costing of the chemical control option....."**

The costing done was based on the actual quotations by the **Desert Locust Control Organisation (DELCO)** and on the market values of the herbicides. All the literature that has been reviewed on the cost of control of the water hyacinth also indicated that the cheapest control method is biological, followed by chemical and in third place is mechanical. The most expensive is manual.

MAAIF's own experiences with respect to biological, mechanical and manual control methods are consistent with the information available in literature. It is not clear how NEMA came to the conclusion that there was under-costing of the chemical control option.

- The costs provided present an estimate within the range of chemical application costs for the USA (Haller, William T., pp. 147. Edited by Charudattan, R., Labrada R., Center T. D., Kelly- Begazo, Christine: Strategies for Water Hyacinth Control. FAO, Rome 1996). However, in the same FAO report, a Ghanaian study estimated per hectare treatment at US$ 538 (de Graft Johnson, K. A. A., pp. 27). A South African Study, also in the same report, suggests US$ 200 (R750) for aerial control of 50 hectares and $48 (R180) per hectare for boat spraying. (Cilliers, C.J., et.al. pp. 97). **Costs may vary slightly from country to country but the range is within the estimates given in the DEIS.**

2 (e) vii **"Whereas the experiments were conducted using hand-held spray pumps, the EIS proposes to use aerial spraying. This will involve significant drift of chemicals .....!**

Response:

Risk analysis of drift to non target crops was presented in the DEIS (see 2.1.2 and 5.1.7.2).

Please note that it is not true drift cannot be avoided during aerial spraying. Factors that are important are:

- the technology in use - kind of aircraft, booms, etc.
- weather conditions at the time of spraying;
- whether or not drift control additives are used;
- the expertise of the applicator.

2 (f) **"Information received, including that from Florida lakes in USA, Sudan and Zimbabwe indicates that intensive herbicide use has to be maintained to sustain the maintenance control of water hyacinth.....**

The effect of such observations strongly indicate that use of chemicals especially on a large lake rich in biological diversity like Victoria does not actually "knock- down" the water hyacinth infestation either with single or multiple applications".

Response:

It is true that in lakes, such as those found in Florida and other states within the USA, herbicides are used regularly to maintain low levels of water hyacinth. The fact that surface area of water hyacinth coverage have been reduced from historically high levels does, indeed, prove the success of utilizing herbicides in a an integrated control program. The fact that herbicides have been in use for over 40 years and continue to be used is a clear indication that these herbicides have no adverse effects. However, the study stresses the recommendation to reduce the weed to maintenance levels through an integrated approach as eradication is next to impossible.

2 (g) **"The use of herbicides, especially glyphosate, contributes to enriching the .....lake"**

Response:

As discussed in detail of the attached **"Comments on Issues Raised During the Public Hearing"**, there is no sound scientific justification for this assertion.

Fluctuation in phosphorous levels may be seen during events such as rain fall and, indeed, this was observed during In-Lake Herbicide Trials at Day 21. Phosphorous levels on this day increased at all plots and was attributed to phosphate carried in rain water or from surface runoff of phosphate in the catchment basin (see Annex C of In-Lake Herbicide Trials, **"The effect of RODEO and WEEDAR 64 on Water Quality In the Treatment of Water Hyacinth in Wazimenya Bay, Lake Victoria"**).

In addition to rainfall, it is worth noting that in - lake phosphorous levels will also fluctuate depending on input from several primary

sources, such as waste disposal practices, urban and agricultural runoff, or inorganic compounds produced by combustion in cooking fires and forest burning (LVEMP Project Document, June 1996, Part II Page 9). The contribution of phosphorus in a herbicide control program is therefore considered a minor, insignificant, and a temporary event.

2 (h) **"The EIS does not have an important component of a monitoring programme ....."**

Response:

The omission was not an oversight but a deliberate omission to be included in the OPUAH since the monitoring strategy would be largely based on the actual operations. The FEIS will expand on this aspect of the program due to NEMA's request.

Please note that under OPUAH, it is clearly pointed out that prior to any herbicide application, baseline data on the lake environment will be collected and that subsequent to herbicide application data on the lake environment will be collected and analysed over a period of time. It goes without saying that the variables identified as essential for study during the EIA will be the same variables that will be studies during monitoring. MAAIF has proposed **"the Water Contaminant Level Regulation"** amendment under section 107 of the Water Statute, 1997 (attached). The agency responsible for the Water Statute must therefore statutorily undertake routine monitoring. The NTCWH may assist the agency undertake this task incase they are not able.

2 (i) **"Whereas the fear for the effects of possible decomposition of water hyacinth ....."**

Response:

More than 90% of the treated water hyacinth drifted a way from the experimental plots before decomposition commenced. This not only made investigating the effect of this phenomenon futile but also

demonstrated that the fears expressed over the possibility of a large mat of the treated weed sinking and decomposing at one particular spot are unwarranted.

Additionally, Section 5.1.3.3 (The Impact of Decomposing Water Hyacinth and Sedimentation to the Lake Bottom), is based on scientific studies, and addresses this concern. During the trials it was noted that there was relatively a slow mode of herbicidal action. **It was also observed that plot size disintegrated as weakened weeds broke away from the plot and were blown around the bay and lake. Dying weeds could be seen scattered as far as 1000 meters away from the treatment plots. This scattering of dying weeds over large areas prevents oxygen depletion which might otherwise occur.**

It was also noted that organic detritus that forms after spraying is less then that which forms annually under living hyacinth due to natural growth and death of plants.

In addition, it should be noted that dissolved oxygen levels under the hyacinth mats are at such low levels that fish productivity in these areas is being prohibited (See In-Lake Herbicide Trials Report).

3. Concluding Remarks

Components of the DEIS have been approved, such as the mechanical and biological options. The entire study was based on an integrated control program using environmentally sound control options. **One option being rejected should not lead to a total rejection of the study but rather call for additional information based on the areas considered insufficient for completion of a Final Environmental Impact Statement.** In addition, NEMA Guidelines do not allow for decision/rejection of the DEIS at this stage (following the Public Hearing).

Based on the above observations, there are no substantive grounds for NEMA to reject the integration of the chemical control option into the current programme for control of water hyacinth. It is also worth noting here that a fully integrated programme offers MAAIF a greater deal of flexibility when combating the weed than the limited one you have approved. Further it is unlikely a new EIS substantially different in quality from the submitted DEIS will present better current knowledge on the concerns as you suggested.

MAAIF therefore requests NEMA to allow for **limited use of herbicides** for water hyacinth control as agreed to by the Council of Ministers, LVFO on 19th December, 1996 and per the DEIS submitted.

We take this opportunity to thank you and more specifically the PCE for allowing us to respond to this issue. **It is MAAIFs' hope that you will appreciate the importance of a flexible integrated approach in water hyacinth control for long term socio-economic development of this country**. This is more so given that **production** and possiby **health** of the riparian communities in the 23 affected districts is being impaired. Additionally, our national GDP may be impaired if the single most hydropower grid is disabled due to weed proliferation. **This threat is real and we take it very seriously**.

Yours Sincerely,

C. Kabunga
for: PERMANENT SECRETARY

c.c. H.E/VP, Minister MAAIF

c.c. The Right Hon. Prime Minister,
Chairman,
Policy Committee on the Environment

" The Hon. Minister of State (General). MAAIF.

" The Hon. Minister of State (Animal Health).
Chairman Council of Ministers,
Lake Victoria Fisheries Organisation.
MAAIF.

" The Chairman.
Parliamentary Sessional Committee Agriculture, Animal Industry and Fisheries.

" The Chairman.
Parliamentary Sessional Committee on Natural Resources.

" The Principal Private Secretary.
To H.E. the President,
State House Nakasero.

" The Chairman.
Board of Directors. NEMA.

Attch:

1. EIA Process Flow (Extracted from NEMA EIA Guidelines)
2. Letter by Hon. Lukyamuzi
3. Response to Comments and Issues Raised at the Public Hearing
   Attch:
   i) Caroline Cox, 1995: Glyphosate Part I: Toxicology
   ii) Frank N. Dost. 1997: Review of Papers by Caroline Cox
4. EU Note No. 3298.96/EGR - mk
   Attch: Letters by UFPEA
5. MoU Council of Ministers LVFO
6. Proposed Water Contaminant Level Regulation

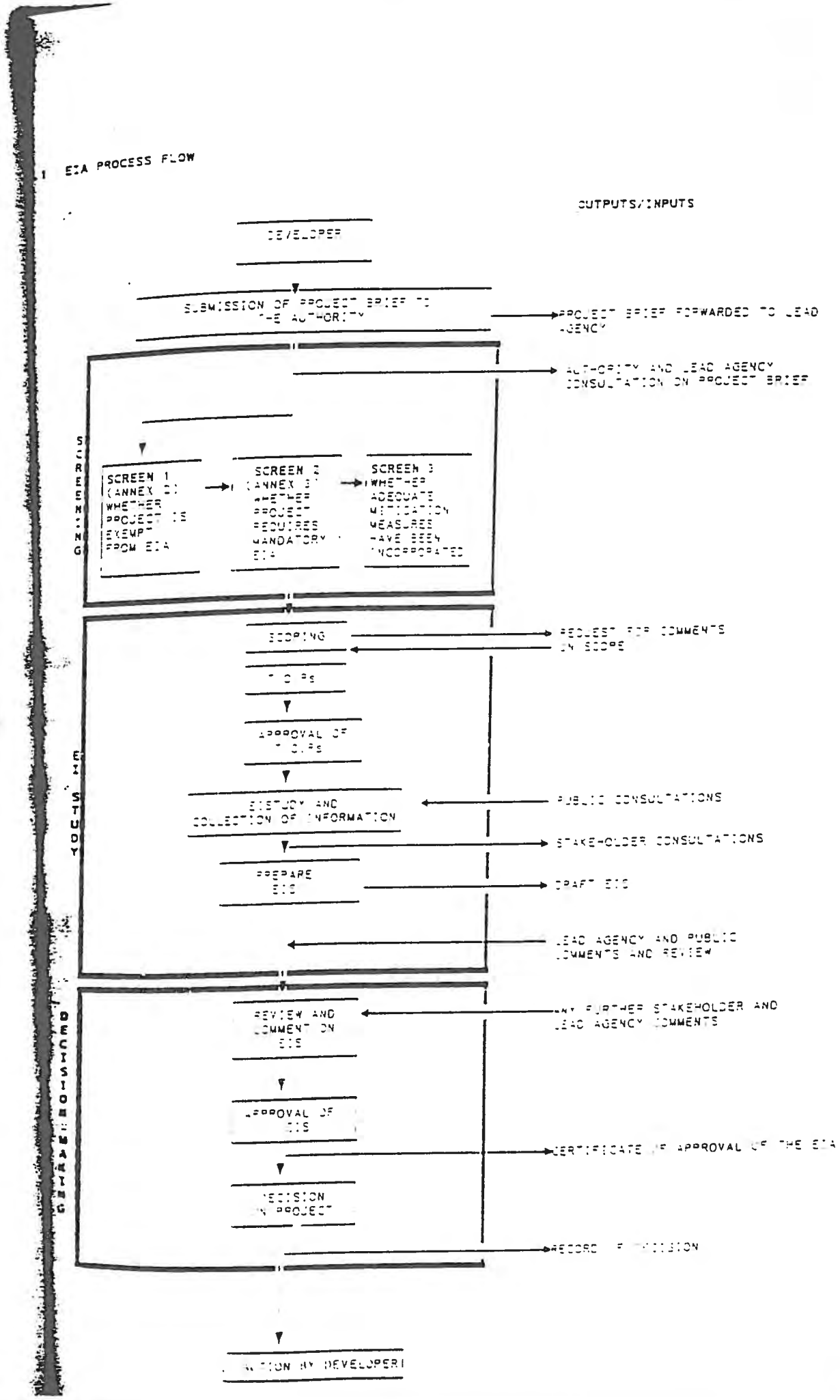
Encls.
1. WHO. 1994. Environmental Health Criteria 159 - Glyphosate
2. WHO, 1984. Environmental Health Criteria 29 - 2,4-D

EIA PROCESS FLOW

(EXTRACTED FROM NEMA EIA GUIDELINES)

5TH NOVEMBER, 1997

1 EIA PROCESS FLOW



EVIDENCE OF ULTERIOR INTERESTS

Letter by Hon. Lukyamuzi; a key participant in the public debate

THE REPUBLIC OF UGANDA

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KAMPALA
WATER HYACINTH PROGRAM

JOHN KEN-LUKYAMUZI MP.

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KAMPALA
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6-10-97

Aquatics Unlimited
Kampala Fax 257824
attn: Mr. Moorhouse

I refer to our telephone conversation this morning. I would like you to assist me obtain an air ticket to enable me attend and address a conference on uganda in San francisco USA between 12th and 14th October 1997. I shall also deliver a paper on how to fight the hyacinth sustainably. I need your assistance. I need to get some information on the harvester technologies in USA and an air ticket to enable me travel to the USA. There are many things we could collectively explore in the course of the expedition.

Yours sincerely,

John Ken-Lukyamuzi MP
Natural Resources Committee

P.S.
That conversation was useful to all of us.

General, Conservative Party, Uganda Nature Conservation Society and the Pan-African Network Chairman, Crusade for Constitutional Governance and Winner of 1997 Environmental Award (East & Central Africa)

RESPONSE TO COMMENTS AND ISSUES RAISED AT THE PUBLIC HEARING

5TH NOVEMBER, 1997

COMMENTS ON WATER HYACINTH CONTROL PROGRAMME EIS AND ISSUES RAISED DURING THE PUBLIC HEARING

A. GENERAL

The public hearing brought forward certain issues that deserve general comments before specific comments to specific issues are addressed. The general issues include: Flawed study design: Toxicity of herbicides: Nutrient enrichment/ eutrophication: Magnitude of the weed: Utilisation: Pesticide handling application methods and Biological control in Zimbabwe.

1. Study Design

1.1 Experimental Setting

Contrary to the opinions expressed, the procedure followed was correct. **It is standard practice that a pesticide that is intended for use in the environment is evaluated in three phases.** Phase I - bio-assay studies in the laboratory. Phase II - evaluation under semi-natural environmental conditions and Phase III - evaluation under natural environmental conditions (usually referred to as field trials). This was the approach adopted in the study. Phase I was in Kituza research laboratories. Phase II was the Kajansi pond experiments and finally. Phase III was the in-lake trials. The only shortcoming in this respect is that the bio-assay studies in Kituza were limited to efficacy. This is not, however, a serious flaw in the design since **a literature search can yield a lot of data derived from bio-assay studies and these are normally carried out under standard conditions and on standard indicator taxa.** The scientists should have used such data when discussing their own findings.

It is also worth noting that **it makes a lot of scientific sense to evaluate a pesticide under natural environmental conditions.** Frequently, toxicologists have found pesticides which appear to be harmless to test organisms under laboratory conditions exerting extremely toxic effects on the same organisms when tested under natural environmental conditions. The explanation for this is that **organisms in the natural environment are subject to a number of vagaries of nature which exert considerable stress on them and increase their susceptibility to toxic substances.** It is therefore important that an evaluation of

the potential harmful effects of a herbicide on non-targeted organisms is done under natural environmental conditions. In any case at the end of the day, the water hyacinth will be controlled under natural conditions that prevail in the lake and not under laboratory conditions !

1.2 Duration of the Study

The Kajansi pond studies could have been conducted over a longer period of time. This could have helped to generate data especially on the potential of the rotting weed to cause entrophication and the extent to which the ecosystem recovers from this phenomenon if it ever occurs. **This however would not have reflected the actual situation as it is a static ecosystem with limited impact of other operating environmental variables (wind, waves, seiches, currents, coriolis effects, etc.) that are features of an open lake ecosystem.**

The duration of the in-lake trials was adequate for the following reasons:

(i) Wazimenya bay was interacting with the rest of the lake and **any negative impacts of the herbicides on the bay were continually being watered down by the "un-sprayed" and larger portion of the lake.** The only period that one would reasonably expect to record the negative impact was therefore the very first few days after herbicide application.

(ii) It would not have made any scientific sense (as was suggested by some) to have had the study prolonged for the purpose of determining the effects to non-target organisms of long-term exposure to herbicides. **Such long-term exposure could never have occurred under the experimental setting. The herbicide dissipation rates were simply too high!** Prof. Nyangababo's findings attest to this. Indeed one would have expected them to be high, considering the **volume of water involved**, the **wave action**, **long photoperiods** and other environmental factors such as **high tropical temperatures** and **high diversity and abundance of micro-organisms** that can serve as bio-degradation agents. Secondly, with the exception of benthos, **most of the organisms investigated are either motile or can be moved about by wave currents.** It is therefore most unlikely that they could get exposed to herbicides for a long period of time. The scientists were thus investigating **what effects, if any, short herbicidal exposure has**

on diversity and abundance of the organisms. It is the laboratory studies and to some extent the Kajansi pond studies that can provide information on chronic and sub-chronic exposure of the organisms to the herbicides. To some extent this information is provided in the report.

(iii) It was equally unreasonable (as was also suggested by some) for the lake study to have been prolonged for the purpose of observing the effects of decomposing weed.

Considering the wind regimes and the associated waves that develop over L. Victoria. it is unlikely that a significant proportion of the killed weed ever remained and sunk in Wazimenya bay. Most of it must have drifted a way before it could sink and decompose. This was clearly reflected in the photographs shown by Mr. D. Nyeko.

(iv) The scientists should have been able to make predictions (qualified ones) on indirect effects of the herbicides (what one scientist termed "chain-reaction events") if they had observed the initiation and start of such events. Indeed some of them. such as Dr. Twongo. did so. It was a weakness on the part of one scientist (Dr. Y. Kizito) who failed to do so on the grounds that he never stayed at the study site long enough to record them. The scientist was recommended by NEMA to undertake the study and his work did not measure up to his acclaim.

1.3 Interpretation of the Results

Close scrutiny of the study design clearly reveals that care had been taken to ensure that. at any one time. the investigating scientist could establish whether or not there was a correlation between changes in the parameter under his investigation and the presence and concentration of herbicide in the environment. This ingredient in the design was meant to take care of the dynamics of the lake ecosystem. It involved Prof. Nyangababo collecting water samples for residue analysis from each sampling station and on every occasion. It was therefore always possible for the scientist to tell the concentration of herbicide present in the medium from which he took his sample. He could therefore make a deduction on whether or not that concentration of herbicide was tolerable (at least over a short period of time) to the organisms under his

investigation.

2.0 Toxicity of Herbicides

It is very difficult to make reasonable responses to questions raised because the information contained in the allegations was inadequate. In nearly all cases, the circumstances under which the herbicides are alleged to have caused harmful effects were not given, neither were the herbicide dosages, critical for evaluation of their toxicity given. This is particularly true of Mr. Moses Kagoda's rather alarming Sudan report and to some extent Dr. J. Kabayo's paper.

Mr. Kagoda's report (evidence) was not even remitted and therefore no comment is warranted. However, evidence from Dr. Kabayo (attached by you) was aped or plagiarised from an article by Caroline Cox that appeared in the Journal of Pesticide Reform 1995, vol. 15 No. 3 titled "Glyphosate, Part I: Toxicology". ***It was fraudulently submitted as authored by Caroline & Kabayo. The worst case of intellectual dishonesty! It gave the false impression to the audience that Dr. Kabayo was an authority on the subject.*** This article, along with another by the same author titled "Glyphosate, Part 2: Human Exposure and Ecological Effects" that appeared in vol. 15 No. 4 of the same journal were the basis of intent to sue Government by one, Askia Mohammad II. Subsequent to Askia's threat, some independent toxicologists in USA, where the journal is published, were requested to make their comments on the two articles. Please find attached a rather lengthy review of the two articles and the publications and reports referenced in the articles by Dr. Frank W. Dost, one of the persons who positively responded to the requests. Dr. Dost's opinion on the articles is that ***"they contain a serious and consistent misrepresentation of both published research and official regulatory reviews of the subject matter".*** **For ease of reference, I have also attached the two papers and WHO Environmental Health Criteria 159. It is not surprising since the paper is authored by an antipesticide group against the use of any herbicides.**

3.0 Nutrient Enrichment/Eutrophication

3.1 Direct Nutrient Enrichment by Herbicides

Concern was expressed over the potential of the herbicide glyphosate enriching the lake with the nutrient element phosphorous. The scientific basis for this concern is weak. Glyphosate (*N-phosphonomethyl glycine)* has a molecular weight of 169.1 and is 31 % phosphorous. **When used at the maximum recommended rate of 4.5 kg/ha will contribute 810g of phosphorous to each hectare sprayed.** If one considers the dilution factor in L. Victoria, the concentration of phosphorous added is extremely low. It is not surprising that Mr. Matagi (responsible for water quality analysis) **could not detect any significant changes in the concentration of phosphorous that he could attribute to herbicide application.**

There is therefore need to cautiously interpret the results of Dr. Twongo and Mr. Byarugyali on phytoplankton. **There is a strong possibility that changes in micro-climatic conditions at the treated plots may have significantly contributed to changes in phytoplankton biomass in the treated plots.** As pointed out by Mr. Byarugyali, areas under the mat of the water hyacinth were characteristically unsuitable for algae due to little light reaching them. After herbicide application, it is likely that as the weed was wilting, the exposure of water to light was improving favouring algal growth and multiplication. It is **significant to note that, three weeks after herbicide application, the plots treated with 2,4-D had higher phytoplankton biomass than those treated with glyphosate - the phosphorous containing herbicide.** This clearly suggests that other factors other than direct nutrient enrichment of the lake by the herbicide were responsible for changes in phytoplankton.

3.2 Nutrient Enrichment Through Decomposition of the Water Hyacinth

This problem should be examined in a broader ecological perspective than most discussants tended to present it. **The water hyacinth tended to be viewed by many as an external element as far as the lake ecosystem is concerned. This is not true. The weed is now an integral component of the lake ecosystem.** To assert that, due to its presence, the lake is now experiencing a net-nutrient loss is thus misleading. What is now happening is that **nutrients in the ecosystem are being recycled.** From the water they enter the weed and from the weed, when part or the whole of it dies due to natural or other causes, they enter the water. **This**

also implies that the nutrients in the water hyacinth are nutrients that came from no where else other than the lake water from whatever source (rainfall, runoffs, effluents, etc.).

When viewed in this perspective, **decomposition of the sprayed water hyacinth and subsequent release of nutrients into the water does not in any way represent addition of nutrients into the lake ecosystem. It merely represents the transfer of nutrients in the plant component of the ecosystem en masse into the water component.**

The real threat to our water bodies is the living, dying, growing and multiplying water hyacinth coupled by the failure to adopt at the earliest opportunity an effective strategy to bring it under control. The weed is certainly, though slowly, drastically altering the ecology of our water bodies. The **wetlands, for example, are progressively "eating up" the lakes through a process of succession and colonisation being initiated and promoted by the weed.** Any suggestions that the weed should rather be left to stay and act as a nutrient sink, are certainly absurd! **We nevertheless do agree that the ideal solution to the problem would be to harvest the weed from the lakes. Unfortunately it is an option that we cannot afford to meet the costs. Not even countries such as the USA, with their financial and technological might could do it. This leaves integrated management as the workable alternative.**

4.0 Has the Water Hyacinth Stabilised in Uganda's Waters ?

We do not think so! And we doubt that it is likely to stabilise in the near future. Proponents of this school of thought argue that the initial exponential multiplication of the water hyacinth was favoured by the high nutrient load in the lake. The weed has, however, multiplied to a point when the available nutrients cannot sustain any substantial increases to its population. **The trouble with this hypothesis is that it overlooks the fundamental problem of L.Victoria and indeed other lakes in Uganda.** This is the problem of constant discharge of nutrients into the lake from its catchment and from factories. Until this problem is solved, it is unlikely that the water hyacinth will run short of nutrients to sustain a fairly high rate of multiplication. This is particularly so considering that the weed is efficient in extracting nutrients.

One may argue, as indeed Dr. Ogutu did, that data from Dr. Twongo's surveys indicate that the weed is indeed stabilising. To his credit, Dr. Twongo has made some effort to monitor the status of the water hyacinth in Uganda's waters. Unfortunately, however, he is a lone scientist who has to monitor Lakes Victoria, Kyoga, Albert and R. Nile and by means of a boat! **With due respect to Dr. Twongo, considering the fact that floating mats of the weed are themselves highly dynamic, it is very unlikely that Dr. Twongo's surveys are generating accurate and reliable data.**

5.0 Utilisation

There is a tendency to equate utilisation with control. This is not correct. It is against the basic principles of pest management to advocate for utilisation of a weed. This tends to spread and perpetuate the problem rather than bring it under control. This explains why it is standard practice to put in place legislation restricting the movement of a plant from one place to another once it has been classified as a weed. It is quite obvious that the current level of utilisation of the weed literally has no impact whatsoever. The reasons for this state of affairs are obvious. We simply do not have enough livestock or farms along our lake shores to consume the weed in significant quantities. Due to its bulky nature, but low dry matter content, farmers who are far from the lake find it not cost effective to harvest and transport the weed to their farms. Similarly, the feasibility of a major undertaking or investment utilising water hyacinth is doubtful as they practically have to chase large mats of the weed across the lake. MAAIF has passed two major investment proposals but none has been operationalised.

It is true that there are many documented cases in a number of countries including Thailand, USA, Nigeria and Indonesia where trials have been conducted to utilise the water hyacinth as a means of generating funds to finance mechanical control operations. **We do not, however, know of any single case where such trials were found to be a success and the strategy adopted. Certainly not in a huge aquatic ecosystem setting as is the case for Lakes Victoria, Kyoga, Albert and Albert Nile. More often utilisation is undertaken by adjacent households to irrigation canals and small water bodies.**

6.0 Pesticide Handling Application Methods

True, the DEIS does not give details on pesticide handling. Reference to the Department of Plant Protection in MAAIF overseeing the chemical control operations was to suggest that personnel who will be involved are well trained in pesticide handling. **The Department statutorily handles pesticides including the two herbicides on routine basis and is responsible (through the Pesticide Control Board) for drawing up regulations on the use of pesticides in the country.** It has a cadre of well trained staff who are conversant with all the procedures regarding storage, transportation, mixing and application of herbicides and procedures for disposal of containers. **What was considered unique in this case was the use of the herbicides in the aquatic environment and mitigation measures to forestall possible spillage are given in the DEIS.**

The DEIS indicates application methods will be decided on a case by case basis. Within sensitive environments requiring surgical operations boat sprays with hand-held equipment will be employed. In the less sensitive environments aerial applications with fixed wing aircraft specifically designed for the purpose will be employed.

7.0 Biological Control in Zimbabwe

Zimbabwe is one of the countries in Africa that have adopted and implemented integrated management of the water hyacinth. If it is true that the bio-agents are effectively keeping the weed under control, it is likely due to the fact that Zimbabwe initially knocked down a significant proportion of the weed with herbicides. **Infact herbicidal control for water hyacinth is regular in Southern Africa.** Zambia for instance, conducts routine spraying of the weed every summer (Source: Israel Zandonda, Inspector Water Pollution Control - Environmental Council of Zambia; e-mail: necz@zamnet.zm) supported by bio-agents. In the Republic of South Africa, biological control is also supported by herbicidal control in summer (Source: Carina Cilliers Ph.D. - Entomologist, Plant Protection Research Institute, Agricultural Research Council; e-mail: rietcjc@plant2.agric.za).

B. SPECIFIC RESPONSE TO CONCERNS RAISED - CHEMICAL

The following are responses to concerns by persons at the public hearing who were of the view that the use of the proposed control option involving use of

candidate chemicals should not be used:

1. *many countries including America no longer consider herbicide spray in weed control.*

Response:

America continues to use herbicides to control water hyacinth and does so in the states of Florida. Alabama. Mississippi and California to name a few. Glyphosate and 2.4 D are also used to control many other types of submerged and floating aquatic plants as well. In 1992 alone, for example. approximately 160.000 Ha of aquatic weeds were treated with aquatic herbicides. of which an estimated 56% or 89.000 Ha were treated with 2.4-D formulations. (Citation - Biologic and Economic Assessment of Benefits from Use of Phenoxy Herbicides in the United States. National Agriculture Pesticide Impact Assessment Program Report 1-PA-96. November 1996. Page 49).

European countries vary in their approach to controlling aquatic weeds. yet the herbicides Glyphosate and 2. 4-D are used for control in the following countries: Netherlands. Italy. Portugal. Hungary. Rumania. Yugoslavia. Germany. France. Switzerland. Austria. Great Britain. and the European states of the USSR (Pieterse. Arnold H. and Murphy. Kevin J.. Aquatic Weeds. Oxford University Press 1990. pp. 314 -317).

Several countries in Africa also use these herbicides for controlling water hyacinth (Edited by Charudattan. R.. Labrada R.. Center T. D.. Kelly- Begazo. Christine. Strategies for water Hyacinth Control. FAO. Rome 1996).

2. *work done in Sudan in 1974 in areas sprayed with 2,4-D showed damage and abnormality in trees, crops etc. and that this is continuously observed and reported. These observations were made at distances between 500 - 1000 m from a 2.4-D store.*
3. *in the some parts of Southern Sudan. communities frequently complained of stomach problems associated with 2.4-D.*

Response:

The 2,4-D formulation which was mentioned by a participant and was used in Sudan should be specified. The Sudan team used 3 forms of 2,4-D and recommended the amine form for use. It is this amine form that was used in the EIS. (Prof. Nyangababo response)

Any reports or studies showing these observations in Sudan should be submitted and reviewed since abundant research on the formulations for these tested herbicides do not indicate this to be the case when used according to the manufacturer's directions.

This problem has not been found to occur when appropriate herbicides are used and applied per the label directions. From the comments made, and without proper documentation to backup these statements, it would appear that improper application procedures contributed to these undocumented claims.

4. *2,4-D does not adversely affect the seeds of the water hyacinth. Germination even occurs when seeds were immersed in 2,4-D solution.*

Response:

It was not reported that 2,4 D or Glyphosate would adversely effect the seeds of water hyacinth as these herbicides are translocated through leaf surfaces. Application of herbicides to water hyacinth would prevent flower formation and thereby limit regrowth. In Lake trials reported a greater than 90% efficacy rate.

5. *the use of chemicals may cause negative economic impacts on the economy.*

Response:

The proper use of these herbicides would not cause negative impacts of unchecked water hyacinth growth presently experienced by the society,

economy, and the environment. The water hyacinth are causing negative economic and environmental impacts on the economy. The WHO is providing additional information on this subject and the safety of the herbicides if used properly.

6. *the results showed a trend of lowering of pH levels under the water hyacinth. This indicated that the chemicals increased acidity of the water and therefore repeated applications could cause more acidification or harm to the lake ecosystem. There is no evidence to indicate the impact of "minimal" acidity in the lake as a consequence of chemical application.*

Response:

The results of herbicide trials, as well as other research, do indicate that pH levels under water hyacinth can be lowered and this was attributed to different rates of carbon dioxide production by phytoplankton and due to decomposition of debris which releases humic and organic acids, thus lowering pH values. It should be noted that when left uncontrolled water hyacinth continuously sheds plant parts which also leads to lowering of pH values through the above mentioned processes. After treating water hyacinth with herbicides pH levels would decrease as it does when left uncontrolled, due to decomposition of organic matter, but would adjust to a normal range as the water hyacinth is brought under control.

7. *glyphosate adds phosphorus to the lake and more addition will worsen the problem of nutrients.*

Response:

Fluctuation in Phosphorous levels may be seen during events such as rain fall and, indeed, this was observed during In-Lake herbicide trials at Day 21. Phosphorous levels on this day increased at all plots and was attributed to phosphate carried in rain water or from surface runoff of phosphate in the catchment basin. (see Annex C of In-Lake Herbicide

Trials. "The effect of RODEO and WEEDAR 64 on Water Quality In the Treatment of Water Hyacinth in Wazimenya Bay, Lake Victoria).

The results of investigations show that the degradation of glyphosate is brought about by the microflora (Sprankle, Meggitt and Penner, 1975b; Quilty and Goegnegan. 1976; Rueppel *et al*..1977; Torstensson and Aamisepp, 1977). The dominant process is co-metabolism, thus microorganisms do not use the herbicide for growth (Sprankle, Meggitt and Penner, 1975b; Normura and Hilton. 1977; Torstensson and Aamisepp, 1977.

8. *scientists in NARO have indicated that the water hyacinth is no longer growing exponentially and has stabilized in terms of growth rate and therefore it would be scientifically wrong to adopt a controversial control method.*

Response:

Though some scientists suggest stabilized growth of water hyacinth, the fact remains that large floating mats and extensive shoreline areas continue to be infested with water hyacinth thereby disrupting normal ecological and economic activities. There are no reports available to support claims of reduction in water hyacinth in Lake Victoria. The monitoring method used by the scientist is questionable. The weed is mobile. The water bodies affected are vast. The scientist used on-water approach and covered the lake in several months. An aerial approach could have given more accurate real time information that is reliable.

9. *because 85% of Ugandans drink raw water it would not be appropriate to apply the candidate chemical control option.*

Response:

By following herbicide label directions and standard precautionary measures, the Ugandan population would not be exposed to any health risks, but would over the longer term have access to cleaner sources of

lake water. See review of WHO information on file.

10 fish export is now second to coffee in terms of Uganda's export value hence is now an important branch of national economy. In this regard, the application of chemicals would make Uganda loose export fish markets which are needed for economic stability. The European fish consumer, on whom Uganda's exports depend, is extremely emotional to the quality of fish and that even if it proved that the chemicals are not toxic, the consumer market reacts emotionally. That the EU has hinted that they will not buy Uganda's fish if we sprayed the lake with chemicals.

Response:

Meeting with the EC and WHO during the week of October 27, 1997 in Brussels and Geneva have shown that standards have been established for use by the World Trade Organization for settling disputes in this regard. In addition, WHO has classified Rodeo as a Class 4 substance, thus safe for use per label directions without associated contamination problems. A full report on these finding will be presented that will further dispel these fears.

The USA has Maximum Contaminant Levels (MCL) for herbicides in fish tissue and water. MCL is the level considered protective of a person who in theory may drink water or eat fish at that level of contamination everyday of his or her life. (See data on MCL's in Annex 9, In-Lake trials results pp. 23). These levels are set by the United States Environmental Protection Agency (USEPA) to control the amounts of herbicides in USA foodstuffs and water. It is a fact that many herbicides are used worldwide in both aquatic and terrestrial environments.

With regard to the European Union consumer of Nile Perch, there are levels considered safe should residues appear in fish tissue. The EU levels were not made available during the preparation of the DEIS. For purposes of completing the EIS process and to reduce the level of concern regarding the potential EU rejection of Nile Perch imports, the

EU levels should be made available to the appropriate Government of Uganda authorities. It is not expected that fish would contain any residues or if residues did appear their levels would not be sufficient to cause a rejection by European regulatory agencies, and thus the European consumer.

11 available information on toxicity is at variance with the information presented in the report. Evidence was made available and is attached as Annex V.

Response:

The document being referred to in Annex V originally appeared in the "Journal of Pesticide Reform Fall 1995" and was authored by Caroline Cox of the Northwest Coalition for Alternatives to Pesticides (NCAP). This paper was retyped for submission to the Public Hearing and an additional author name added. This article has had wide circulation, which is most unfortunate, since this Journal in general and this article in particular has had no scientific peer review. An in depth review of Caroline Cox's article was conducted by an independent Toxicologist, Mr. Frank Dost.

12 there is no mention of precaution in chemical mixing or disposal of unwanted chemicals and containers. That appropriate mitigation measures for disposal are not indicated.

Response:

Annex 5 of the DEIS contains Herbicide labels that provide information on mixing and disposal of containers. This information would be followed to mitigate the potential impacts.

13 the candidate chemicals are toxic, their purity is not known and not guaranteed and that the drift control agents are not named. That the analysis of transient products such as benzene was not done, noting that the problem could be from one of the transformation products.

16 water quality

Response:

Comment addressed in section 5.1.3 of the FDEIS. It is mentioned that herbicides if applied in accordance with the label directions, and the necessary safeguards made to contain spill, no adverse impacts to the water quality are expected. However, mitigation in the event of accidental spill has been proposed in Section 6 of the DEIS.

C. SPECIFIC RESPONSE TO CONCERNS RAISED - DEIS VALIDITY

The following are responses to concerns by persons at the public hearing who questioned the validity of the EIS as a sound basis for decision - making::

1 the results were not valid as the tests were a one time application of chemicals where as for the effective control of the weed, repeated applications were necessary for long term effectiveness.

Response:

Because the herbicides proposed for use do not bio-accumulate, there was no need to multiple applications for these trials. Many studies have been carried out on these herbicides and the results are well documented. The International Program on Chemical Safety (IPCS), under a joint sponsorship between UNEP, ILO and WHO, has carried out and disseminated evaluations of the effects of chemicals on health and the environment. This has resulted in the publication of "Environmental Health Criteria" Vol. 159 on Glyphosate, and Vols. 84 and 29 on 2,4-D. This data is available at the Albert Cook Library at Mulago Hospital, Uganda and can be easily accessed for further supportive data.

2 *the EIS does not consider community views i.e. those who eat fish and who drink the water. That this is a very serious omission. Hence the report invalid.*

Response:

The DEIS does consider community views and approximately 50 agencies and community groups were present during the July 10 1996 Expanded Scoping Meeting (Hearing) chaired by NEMA (See Annex 3, Scoping Document and the "Scoping Document Expanded Committee Meeting Minutes July 10, 1996). The purpose of this Expanded Scoping Meeting was to determine additional areas to be reviewed as part of the EIS process to insure that the views of the community were properly incorporated. In addition, it was for this reason that an awareness campaign was carried out prior to In-Lake Trials in the villages adjacent to Wazimenya Bay. The DEIS also states that a similar campaign would be carried out if the chemical control option were to be implemented. (See section 5.1.12.1 and Annex 9 Section 10).

3 *the costs of chemicals application were deliberately downplayed such as costs for the disposal, hiring of pilots and planes etc. That the cost estimates of the different control methods were seriously "doctored" (i.e. that they did not represent a true picture of cost analysis).*

Response:

The costs provided present an estimate within the range of chemical application costs for the USA (Haller, William T., pp. 147. Edited by Charudattan, R., Labrada R., Center T. D., Kelly- Begazo, Christine. Strategies for Water Hyacinth Control. FAO, Rome 1996). However, in the same FAO report, a Ghanaian study estimated per hectare treatment at US$ 538 (de Graft Johnson, K. A. A., pp. 27). A South African Study, also in the same report, suggests US$ 200 (R750) for

aerial control of 50 hectares and $48 (R180) per hectare for boat spraying. (Cilliers. C.J.. et.al. pp. 97). Costs may vary slightly from country to country but the range is within the estimates given in the DEIS.

4 *under page 20 of the EIS. no risk analysis on these three control options was done.*

Response:

A risk analysis of the three options was presented in the "Action matrix of Alternatives". (See Annex 1. Table 10). The section presents the various alternatives with a discussion of comparative Impacts. offering a detailed description of impacts and potential means of minimizing these impacts.

5 *considering the methodology used. the scientists were seriously constrained in terms of resources to the extent that they overlooked the ethics of science. That for example. only one control point was used and one treatment for each test plot.*

Response:

The study design was discussed with all parties involved and approved by NEMA and the participating scientists (See Section 6 Annex A for NEMA's approval). The financial constraint was evident but it was also seen that trial data results are comparable to studies conducted elsewhere in the world.

6 *the results were inadequate in as far as. for example. fish being judged on basis of posture.*

Response:

In addition to posture. fish were also observed for mobility and behavior. It is recognized that anthropomorphic observations may be less than ideal but these were meant to give some indication of fish

activity. Therefore, fish were also analyzed for herbicide residue to lend actual evidence to any residue uptake by fish. In addition, studies have been conducted around the world that clearly show that the herbicides do not pose a problem to fisheries, but rather the water hyacinth impacts will result in reduced spawning habitat. WHO information further supports the safety of the herbicides on fish under proper use procedures.

7 *the EIS does not indicate the impact the big mass of water hyacinth will have on the water quality. That because of the already high nutrient input, it will be criminal to add more organic matter to Lake Victoria as a result of decomposition of the sprayed huge mass of water hyacinth.*

Response:

See section 5.1.3.3 on the impact of Decomposing water hyacinth to the lake bottom. The contribution of nutrient inputs from the herbicide control program would be minor, insignificant and temporary.

8 *recent rate of water hyacinth infestation was not stated in the EIS.*

Response:

An estimated rate of water hyacinth infestation based on previous studies was stated in the DEIS. More accurate figures will be documented following the final development and implementation of a Geographic Information System (GIS) study to determine the exact levels of infestation. The GIS procedures and resources for implementation are currently being completed for incorporation into the Operational Control Program to document and track control efforts.

9 *that the results in the EIS are questionable with regard to effects of dilution. (ref: Page 14 of the EIS). It was doubted whether one would expect to get 2,4-D in water after 14 days.*

Response:

This comment is not clear. It should be noted however that herbicide trials were repeated/conducted three time: in the lab. in the ponds and in the lake. The results all indicate that 2.4-D is not persistent in the environment because of its ability to dissipate rapidly as scientific studies referenced in the DEIS further document.

10 no reference to presence of micro-organisms in the water was made in the EIS, although the presenter indicated that micro-organisms help to break down the chemicals.

Response:

Annex D and Annex F of In - Lake trials discuss the presence of micro-organisms in the water.

11 how would herbicide experiments be expected to occur to the temperature and nitrates as an effect of herbicides application?

Response:

Question is vague and not understood. For information on nitrate levels and temperatures. refer to In-Lake herbicide trial Annex C. trial data.

12 tests were used with hand held spray guns although aerial spraying is recommended in the EIS.

Response:

Both options are recommended in the study. Details of where and what method to use will be developed in the Operational Control Plan (OCP) and would be based on the physical environment of the area to be treated. The tests carried out were not meant to test the effectiveness of the application method but rather the efficacy of the herbicides. Studies and experiences from other countries that have used aerial spraying were reviewed and the method has been found to be safe when

properly conducted.

13 *the EIS completely ignored all the major requirements for EIA as recommended by NEMA e.g. description of what is proposed; existing and projected environmental impacts; a complete lack of a detailed analysis of risks.*

Response:

NEMA was involved in the review and approval process of three Draft EIS documents prior to the completion of the final DEIS. (See NEMA comments to the various drafts as there was no mention of ignoring NEMA's major requirements). As NEMA was involved through out he complete process, these concerns should have been address prior to the Final Draft Completion. (See Written Responses to Comments from NEMA, Annex 7, page 3-8 of the DEIS)

These major requirements need to be specified in order for this question to be answered. A description of proposed action was clearly stated in Chapter 2. Existing and projected impacts are clearly laid out in the study and in almost every section of Chapter 5 and Annexes. Analysis of risks has also been carried out in various sections of the study with matrix tables of comparison of impacts provided.

14 *the EIS is a set of individual reports bound together without integration, hence contradictions are evident. That there is a flaw in linking the results to the conclusions.*

Response:

The DEIS is not a set of individual reports. The main study integrated the reports by providing conclusions and recommendations and Annexed individual reports at the end of the main document for further references and documentation of the findings so that the reader could evaluate all of the facts that are required to make scientific decisions based on scientific facts.

15 *the EIS does not provide a monitoring strategy: That it does not indicate who are responsible for monitoring and in the event that something goes wrong who should be responsible.*

Response:

The EIS states that monitoring will be conducted by the lead agency (MAAIF) assisted by NEMA. An In-Lake emergency protocol was developed during the trials indicating authorities to contact in case of emergency. As NEMA was involved in the three Draft EIS reviews, further information required for inclusion should have been discussed at that time.

16 *the cost benefit analysis of the various control options was not given. That the cost of loss of income for fish exports if chemicals are applied was not made nor was the cost of legal suits if instituted against government given.*

Response:

The cost benefit analysis was clearly provided (see Table 2. Matrix Comparison of Alternatives Cost Benefits, page 21 of the DEIS) which reflected the loss that would be incurred if the hyacinth was not controlled and continued to impact fish. A costing of the loss of fish for export as a result of herbicide use was not provided as the proposed program is not expected to result in herbicide residues present in fish tissue that would lead to rejection by consumers.

the scientists should have done better but information is insufficient. That for example, what was the effect of the algal increase in the lake.

Response:

effect of algal increase were considered negligible and transitory would be an insignificant fraction of that normally found present lake system. In addition, the scientists followed the NEMA

approved Protocol (In-Lake Herbicide Trials) and did an excellent job reviewing and documenting their findings as can be seen from a review of the documents included in the DEIS Annex.

18 it was not shown whether the fish tested was the same fish present during the spraying.

Response:

The Kajjansi experiments and residue analysis results of fish confined in space largely takes care of this concern. Also, fish collected during the In-lake trial did not reveal any herbicide residue in their tissue. These fish, whether or not they were the fish originally in or around the plot at the time of application, would have been exposed for a period sufficient to absorb residues since they were captured within the treated plot. These herbicides are not fat soluble and cannot build up or accumulate in fish tissue, and if these herbicides were ingested they would have been excreted rapidly. The fact that no residues were found in the tissue is an indication that the herbicides degrade and dissipate quickly as the scientific literature on the subject clearly shows.

19 the socio-economic component is lacking in the EIS. That the calculation of costs presented were not fair e.g. the 45 million US dollars per year Uganda earns from fish exports were not reflected.

Response:

The Socio-economic component was addressed in the EIS in section 5.1.17. This section will be expanded to include further information for the reader.

20 the EIS does not indicate how handling of chemicals with respect to the scale of the applications is to be done, how they will be stored, handled and how accidents and accidental spills will be handled. That no mention of precaution in handling the chemicals was made.

Response:

It is clearly stated in the DEIS that any use of herbicides would be used in accordance with Uganda and USEPA Laws and Regulations (see page 13 of the DEIS). That would include strict compliance with the manufacturers label recommendations (see Herbicide Labels and Material Safety Data Sheets. Annex 5 of the DEIS).

It should also be noted that herbicides are in use in Uganda and measures/regulation for storage and handling have been put in place by the Agricultural Chemicals Board. These measures would also apply for this case. Accidents and control of spillage is addressed in the mitigation section in chapter 6.

21 The participants in this category recommended that:

a) the EIS is quite incomplete and the public hearing should not be used to endorse the use of chemicals
b) the EIS appears to advance the cause for chemical control and not the other methods and therefore must be invalidated.
c) a lot of statements in the EIS should erased because the results cannot help us to draw any conclusion. These results should be used only as pointers but the findings should not be used for decision making. The EIS cannot be used as of now to recommend use of chemicals to control water hyacinth.
d) there are areas of serious insufficiency in the document which raises the question of the validity of the report for decision making.
e) the EIS should be considered inadequate with respect to conforming to NEMA guidelines; adequacy and conclusiveness; examination of positive aspects of water hyacinth.
f) the EIS be rejected and should not be used as a basis for decision making and the EIS should be re-done.

Response:

Based on the responses given to the comments above, it is evident that the DEIS was not well read by the people who contributed to the

comments. There is therefore no sufficient basis to reject the DEIS. However, additional information has been added to the final EIS strengthening the areas of concern as noted in the public views. It should also be noted that since two of the three proposed options from the DEIS have been accepted, rejecting the entire study then contradicts the validity of the decision to approve the mechanical and biological options. The third component (herbicide control) has been strengthened to reflect issues raised in the public hearing.

D. SPECIFIC RESPONSE TO QUESTIONS NOT ANSWERED

The following are responses to those who asked questions but did not get answers either from the presenters or the audience itself:

1. *That the company which was used to carry out the EIS i.e. Aquatics Unlimited, is stated to be notorious for concocting data regarding herbicide tests. That what assurance do the people of Uganda have that Aquatics Unlimited will not end up doing the same?*

Response:

This statement is false and misleading to the public. Any such documents that provide information to back up claims that Aquatics Unlimited is/or has been notorious for concocted previous data should be forwarded for review and documentation, as Aquatics Unlimited has not been charged with this claim since its establishment in 1974.

2 *What assurance do we have that this is not a plan to kill Ugandans in the future? That supposing spraying is risky to human beings who would be responsible? That if we use this report to make a decision, can we handle the eventualities?*

Response:

Aquatic herbicides are used in many parts of the world. Similar studies have been made in other parts of the world. For an understanding of

the implications associated with the use of aquatic herbicides, the DEIS should be read and studied along with the reference material provided.

3 *That water hyacinth already exists here. There are already economic activities related to water hyacinth. Would it be possible to underscore control of water hyacinth using these options other than spraying?*

Response:

Utilization, if proper permits are issued, can certainly be part of a manual/mechanical removal program, but should not be confused as a control measure.

4 *Whether the EIS identifies areas where the Ministry of Health could help the local communities on health issues.*

Response:

The EIS in Annex 1 section 9 In-Lake Herbicide trials emergency medical protocol provides information on first aid treatment, and provides names of Doctors who can be contacted in case of emergency. As these herbicides and hundreds of others are presently in use in Uganda, it is expected that the Ministry of Health, Hospitals and medical practitioners are aware of treatments due to various exposure routes and have experience in conducting such treatment.

5 *Whether herbicide degradation products were also measured other than the original chemicals?*

Response:

Herbicide degradation issue is addressed in the DEIS Section 5.1.3.1 "Herbicide Breakdown and Environmental Persistence", and again in Annex 9 of In-lake Trials, (Annex B) Prof. Nyangababo's study.

6 *Whether the Attorney General has been consulted in case of loss/sabotage to fish exports through spraying with chemicals. Or what are the legal implications of suits being instituted against government for loss of income by Ugandans or fish exporters.*

Response:

Comment noted. Consulting the Attorney General in case of loss/sabotage of fish is considered to be out of the scope of the study. This is a political decision that is not deemed necessary in this study. However, it is worth noting that herbicides if properly used are not expected to create a loss of fish revenue as the spread of water hyacinth is currently doing.

7 *That the public is in a dilemma. The water hyacinth is a natural endowment. To what extent can we eradicate it or create utility out of it?*

Response:

The water hyacinth is an exotic and noxious weed and should be controlled as much as possible to bring it to maintenance levels. Any positive natural endowment the water hyacinth offers is far outweighed by negative impacts the weed imposes on the country. Eradication of the weed is not possible, utilization is addressed above. It is hard to determine the level of endowment associated with the major environmental and economic impacts associated with the water hyacinth problem.

8 *The research has not put into consideration ethical considerations and the human concerns. What efforts are being put to control the source of the weed?*

Response:

Human concerns have been researched for many years by other researchers and have found when handled properly there is no threat. These herbicides, in addition to many others, are presently used in country in farming practices. A boom and conveyor have been installed at the Kagera River source.

9 *What practical evidence can be present on the safety of these chemicals. How will the government adjust to the loss in revenue if fish is not bought?*

Response:

Practical evidence on the safety of the chemicals was seen from the trials done in Uganda and additional material presented in the DEIS. Issue related to fish have been addressed above and show no negative impacts.

10 *There was the problem of involvement of interested parties in the study hence the omission of social component, economic and other dimensions.*

Response:

Refer to the Scoping Document and the various Scoping Meetings including the July 10, 1996 Expanded Scoping Meeting where these issues were address. A list of interested parties who participated and their comments were incorporated into the EIS review process.

11 *The Florida lakes where the chemicals spraying has been done do not contain fish of commercial value and are of no value as a water source for domestic use.*

Response:

This statement is false and misleading. Florida lakes are intensively managed, are considered to have very high aesthetic and monetary value, support commercial as well as a very lucrative sport fishery, supply industrial and irrigation water, and are important sources for replenishment of above and below ground aquifers which are sources for domestic use.

E. REPONSE TO CONCLUDING REMARKS

The following are responses to the concluding remarks:

a) Most of the presenters were of the view that no changes are observable when the candidate chemicals were applied using the different parameters mentioned.
b) Exceptions were also observed in certain areas such as use of Round-up showed faster multiplication of algae etc. The efficiency test was found sufficient to injure the plant significantly.

1 That information was received to the effect that:
i. chemicals may be toxic;

Response:

Toxicity studies on the candidate herbicides have been done and documented in scientific literature referenced in the DEIS. The WHO literature on the candidate herbicides is recommended for review as the most impartial studies. It is therefore advised to consult available literature on these issues. The WHO publication of "Environmental Health Criteria" Vol. 159 on Glyphosate, and Vols. 84 and 29 on 2,4-D data is available at the Albert Cook Library at Mulago Hospital, Uganda and can be easily accessed for further supportive data. A copy of the documents is enclosed at no cost for your information. It is true that chemicals may be toxic if not properly used. However, it is utter lack of seriousness to talk about toxicity without reference to the dose of any chemical be it aspirin.

ii. the water hyacinth proliferation has stabilized in the lake:

Response:

There are no reports available to support claims of reductions or the stabilization of water hyacinth infestations in Lake Victoria.

iii. that mechanical/manual control has proved effective:

Response:

The mechanical/manual control has proved effective in certain areas such as infestations at the Owen Falls Dam and Port Bell at removing water hyacinth. However, reinfestation was experienced immediately. The process is slow, expensive and laborious and will not deal with the problem on a large scale bases as is required in Lake Victoria.

iv. that the candidate chemicals do not kill the seeds of weeds:

Response:

Controlling the weed with herbicides reduces seed production and slows down the seeding process.

v. there is need to focus on pollution control from point sources:

Response:

The need for control of pollution from point sources is evident and so is the need to control the hyacinth that has already established itself.

vi. that in the long-term the biological control is useful;

Response:

Yes. Biological control has been recommended as a long term control strategy and this control measure has been implemented.

vii. that radiation should not be used as it was not necessary;

Response:

This comment is not understood.

viii. that those who can put the weed to economic use should approach the Ministry of Agriculture, Animal Industry and Fisheries for further discussions:

Response:

Utilization of harvested weeds is encouraged alongside control. However, utilization should be regulated by law to avoid reinfesting the lake with the harvested weed.

2 there is need to explore collaboration efforts with Government of Uganda Scientists on the issue of exports to improve on marketing strategy with consumers of fish.

Response:

Plans are underway for collaboration efforts with the EU countries which are the main importers of Ugandan fish.

3 there was also commendation of the Ugandan Scientists for the good work done.

Response:

Good

MAAIF REPLY
TO NEMA

ATTACHMENT
No. 6

PROPOSED WATER CONTAMINANT LEVEL REGULATIONS

"..Provides protection for a person who in theory may drink water or eat fish at that (permissible) level of (herbicide) contamination everyday of his or her life (and is not adversely affected)..."

UNREVIEWED 1007

ANNEX VI

SAMPLE STATUTORY INSTRUMENTS

NO..... ....

THE WATER CONTAMINANT LEVEL REGULATIONS (SAMPLE)
(Under Section 107 of the Water Statute, 1997)

Statute No. 9 of 1997

IN EXERCISE of the powers conferred upon the Minister by Section 107 of the Water Statute 1995, these Regulations are made this..... day of ..... 1997.

Citation

1. These Regulations shall be cited as the Water Contaminant Level Regulations, 1997.

Interpretation

2. In these Regulations, unless the context otherwise requires - "MCL" means the Maximum permissible level considered protective of a person who in theory may drink water or eat fish at that level of contamination everyday of his or her life.

Section 35 Statute No.MCL for Uganda to be stipulated

1. The Water Policy Committee shall in Consultation with the Uganda National Bureau of Standards from time to time stipulate the MCL of Water for domestic use and Fish or Shellfish, in respect to aquatic herbicides used for aquatic weed control.

Schedule

4. The MCLs for Uganda with respect to regulation 3 is set out in the schedule to these Regulations.

SCHEDULE

Name of herbicide	MCL for fish/shell fish	MCL for Domestic water
1. Glyphosate	1.00/1.00	0.7 mg/l
2. 2,4-D	0.25/3.0	0.07 mg/l

v) the chemicals can cause further proliferation of the problem because of increase in nutrient levels. Whether we should increase more nutrients;

Response:

Increased nutrient levels involved in herbicide use would be very low and temporary compared to current imputes to Lake Victoria.

vi) impact on organic matter accumulation;

Response:

This has been addressed in the DEIS. Organic matter accumulation leading to reduction of oxygen levels can be avoided through proper spraying techniques which are outlined in the herbicide label instructions. Over a long term period. after achieving maintenance control. the amount of organic matter going down would be much less. Scientific data referenced in the DEIS clearly shows that organic matter accumulation is greater when water hyacinths are left uncontrolled.

vii) effects of repeated chemical application;

Response:

No impact from repeated application is anticipated since herbicides do not accumulate in the environment.

viii) whether the EIS should have been replicated at different sites in order to achieve better results;

Response:

Replicated studies were not necessary since similar studies have been conducted around the world over the past few decades as referenced in the EIS.

ix) whether human health and biodiversity was well considered;

Response:

Human health and biodiversity were well considered as can be seen from a review of Section 5.1.12 "Human Health" of the DEIS and the referenced scientific information.

x) whether aerial spraying can be based on the results of hand held applications;

Response:

Mechanisms for using aerial spraying were elaborated on in the DEIS. Use of either option would not have a direct impact on the efficacy of the herbicides. The only difference in the aerial and hand held spray mechanisms would be in the amounts of hyacinth controlled per application as aerial allows for greater coverage per day.

xi) whether the Report followed NEMA guidelines.

Response:

The report followed NEMA guidelines from beginning to the end following guidelines provided by NEMA (see Guidelines for Environmental Impact Assessment in Uganda November 1996). The flow chart provided on page 10 of the guidelines was followed. Also, in accordance with the guidelines, it is assumed by the authors of the DEIS that an opportunity will be provided for the completion of the Draft into a FEIS, in fulfilment of NEMA requirements. The process is therefore still ongoing. In addition, NEMA was involved in the review of each draft and provided comments as outlined above. NEMA should have made it clear if they felt the guidelines were not being followed.

x) Whether the costs as analyzed in the report present a correct/true picture of statistical analysis.

Major Issues to Consider in Decision Making.

- *Whether Uganda's international obligation will be affected by application of the candidate chemicals. There is need to evaluate carefully the implications of legal action against the Government in case a candidate control option is used.*

Response:

The inaugural meeting of the Council of Ministers for the Lake Victoria Fisheries Organisation (LVFO) endorsed limited application of chemicals after an EIS. The signatories to the memorandum of understanding were ministers responsible for fisheries in Kenya, Tanzania and Uganda (attached). This was as recent as 19th December, 1996. Legal action from these countries is a long shot. They await leadership from Uganda. There is almost no likelihood that herbicides will be detectable in these countries given the limited dose and the dilution factor. Formulations used are water soluble hence not lipophilic. They can not therefore be bio-accumulated in storage tissues (read adipose or fat tissues). They are excreted and bio-degrade in the environment.

- *You should consider whether the EIS is adequate in the following areas:*

  i) *being balanced in the approach used to evaluate the various control options;*

Response:

The chemical control option was seen to have the potential for greater significant impacts over other control options, and was thus emphasized in greater detail so that sufficient information was available for review during the scoping process, and overall decision making. Thus the chemical option required a more detailed and in-depth study and review than did the Biological and Mechanical options.

ii) the scientific methodology was adequate to capture the required evaluations;

Response:

Scientific information that was available for the study was provided. The methodology that was used in the trials that was used to provide supportive data for the chemical control option was seen to be adequate by both NEMA and the scientists that participated in the study at that time. The results obtained from the study indicate that there was no necessity for prolonged studies given that herbicides degraded very quickly and could not be detected after short periods as was found in the studies and further supported by scientific reviews that are referenced throughout the DEIS.

iii) the results of the entire experiments were scientifically and adequately analyzed to provide an honest and accurate conclusion;

Response:

Data obtained from the experiments can be compared with available scientifically sound literature in order to eliminate doubts of the author of this comment.

iv) costs on or effects on exports of fish;

Response:

Long term benefits are seen to supersede any short term losses. This issue is being seriously considered and pursued with the relevant authorities to eliminate a question of loss of revenue from fish export. Countries which import fish, some whom happen to use the same herbicides and still consume their fish, are being asked to give further guidance on this issue.

Response:

Yes, the costs present a true picture of the statistical analysis. Other literature can be cited on this issue in case of doubt.
Some of the literature that provides further supportive data include studies from the US and South Africa cited below.

1. Haller, William T., pp. 147. Edited by Charudattan, R., Labrada R., Center T. D., Kelly - Begazo, Christine. Strategies for Water Hyacinth Control. FAO, Rome 1996.
2. Cilliers, C. J., et.al.pp. 97.

xi) Whether mitigation plans contained in the EIS are sufficient to contain any adverse effects including risk analysis toxicity of the chemicals. The toxicity of the chemicals was also put under question.

Response:

The Mitigation Section is being expanded to include all the concerns the public addressed in the public hearing. Toxicity of the two herbicides has been discussed. Further review on toxicity of the herbicides can be conducted (as advised above) by the authors of this question if they are not satisfied with the literature provided in this study.

xii) Whether there was adequate input and consultation from the public or the local community on the EIS and such input reflected in the EIS.

Response:

See Scoping Document and Process and the 10 July 1996 Scoping Meeting information.

There was also adequate input from the public and local communities prior to conducting trials and compiling this document. A list of all persons contacted and who were instrumental in compiling the study

is provided at the end of the study. More consultations and sensitization exercises with the public and communities impacted is suggested in the study in the event that the herbicide control option is approved.

xiii) Whether adequate institutional arrangements are contained in the report for monitoring.

Response:

Routine monitoring was suggested to be performed by the project implementers who in this case is MAAIF. Directorate of Water Resources is statutorily charged with monitoring of water quality in Uganda. A draft amendment to the Water Bill has been prepared by MAAIF to enable them better achieve this objective.

F. THE WAY FORWARD

Before the conclusion of the public hearing the Executive Director of NEMA provided the way forward by stating that the public view not withstanding, other aspects will be considered in arriving at a decision. *That MAAIF is not the only Lead Agency on this matter, others include Ministry of Natural Resources, Ministry of Local Government, riparian districts, etc.* NEMA, however will not be swayed to make decisions not backed by technical soundness. That the views presented in the public hearing will be taken into serious consideration in making a decision.

Response:

It is not a matter for the Executive director of NEMA to decide. MAAIF has always been recognized as the lead agency as long as the project has been in existence. The other agencies mentioned do have a stake in the problem, but the decision for them to be lead agencies is quite new and hence there was no mention or recognition of these other parties in relation to the roles to be played by the lead agency. The Executive Director could formalise his contention by forwarding this to the cabinet.

This ministry (MAAIF) will continue to be the lead agency unless advised otherwise by the cabinet. Note that all of the GoU agencies were involved in the Scoping Process. and were members of the Scoping Committee.

AUTHENTIC AUTHOR

Caroline Cox, 1995: Glyphosate Part I: Toxicology

Published by an extremist lobby group against use of any form of pesticides

NOT

Caroline Cox & Kabayo submitted as evidence

GLYPHOSATE, PART 1: TOXICOLOGY

Glyphosate is a broad-spectrum herbicide widely used to kill unwanted plants both in agriculture and in nonagricultural landscapes. Estimated use in the U.S. is between 19 and 26 million pounds per year.

Most glyphosate-containing products are either made or used with a surfactant, chemicals that help glyphosate to penetrate plant cells.

Glyphosate-containing products are acutely toxic to animals, including humans. Symptoms include eye and skin irritation, cardiac depression, gastrointestinal pain, vomiting, and accumulation of excess fluid in the lungs. The surfactant used in a common glyphosate product (Roundup) is more acutely toxic than glyphosate itself; the combination of the two is yet more toxic.

In animal studies, feeding of glyphosate for three months caused reduced weight gain, diarrhea, and salivary gland lesions. Lifetime feeding of glyphosate caused excess growth and death of liver cells, cataracts and lens degeneration, and increases in the frequency of thyroid, pancreas, and liver tumors.

Glyphosate-containing products have caused genetic damage in human blood cells, fruit flies, and onion cells.

Glyphosate causes reduced sperm counts in male rats, a lengthened estrous cycle in female rats, and an increase in fetal loss together with a decrease in birth weights in their offspring.

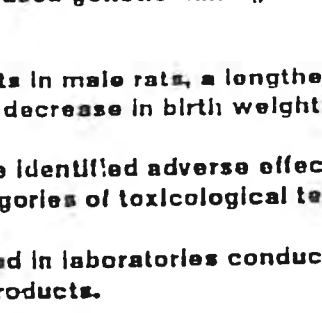
It is striking that laboratory studies have identified adverse effects of glyphosate or glyphosate-containing products in all standard categories of toxicological testing.

Two serious cases of fraud have occurred in laboratories conducting toxicology and residue testing for glyphosate and glyphosate-containing products.

BY CAROLINE COX

Advertised as herbicides that can kill weeds and unwanted grasses effectively with a high level of environmental safety, glyphosate-based herbicides can be a silver bullet to those dealing with unwanted vegetation. However, an honest, accurate evaluation of their health and environmental hazards can draw a picture very different than those presented in these advertisements. The following discussion of glyphosate's hazards is intended to serve that purpose. It will appear in two parts. Part 1 discusses the toxicology of glyphosate, its metabolites, and the other ingredients in glyphosate products and Part 2 discusses human exposure to glyphosate and its ecological effects.

Figure 1
Glyphosate



glyphosate
N-(phosphonomethyl)glycine

isopropylamine salt of glyphosate

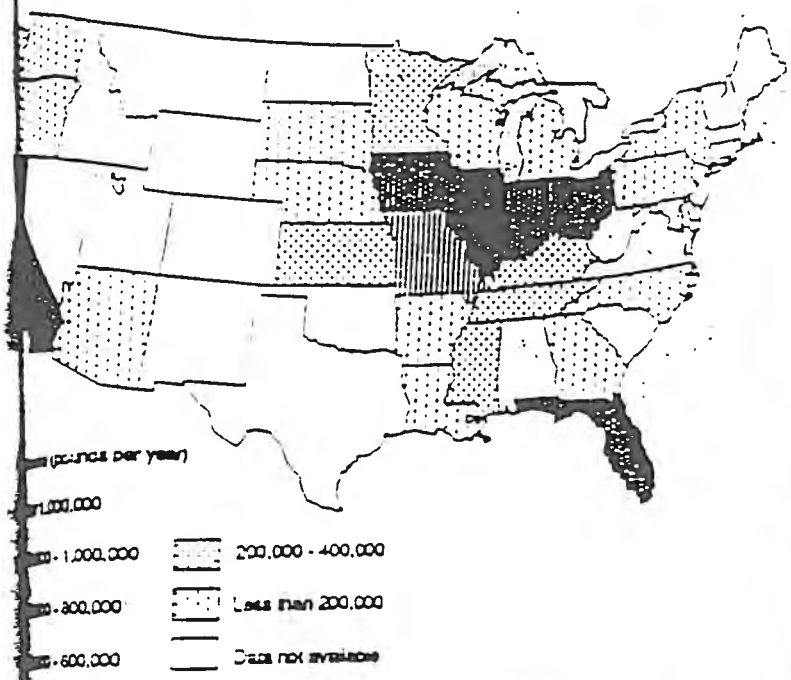
Glyphosate, N-(phosphonomethyl) glycine (Figure 1), is a post-emergent, systemic, and non-selective herbicide used to kill broad-leaved, grass, and sedge species.[2] It has been registered as a broad spectrum herbicide in the U.S. since 1974 and is used to control weeds in a wide variety of agricultural, lawn and garden, aquatic, and forestry situations.[3]

Most glyphosate herbicides contain the isopropylamine salt of glyphosate. A different chemical, the sodium salt of glyphosate, is used as a growth regulator in sugar cane and peanuts and is marketed for that purpose. The monoammonium salt of glyphosate is also marketed as an herbicide and growth regulator.[4]

Glyphosate products are manufactured by Monsanto Company worldwide. The herbicide is marketed under a variety of trade names: Roundup (including Roundup D-Pak, Roundup Lawn and Garden Concentrate, and Roundup Ready-to-Use), Rodeo are the most common U.S. trade names.[2] The sodium salt is sold as Quotamaster. The monoammonium salt is sold as Deploy Dry.[2] Other brand names are used for the isopropylamine salt and

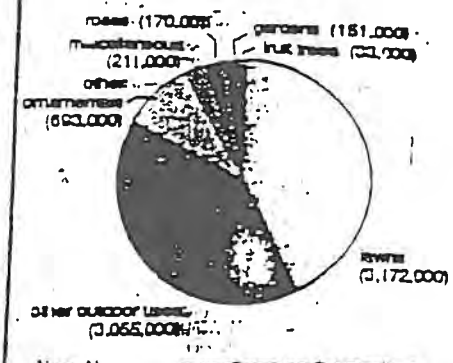
NORTHWEST COALITION FOR ALTERNATIVES TO PESTICIDES/NCAP
P.O. BOX 1393, EUGENE, OREGON 97440 / (503)344-5044

ural Use of Glyphosate in the U.S.



ulture. National Agricultural Statistics Service, Agricultural Statistics Board. 1994. cide usage: 1993 field crops summary. Washington, D.C. (March).
ulture. National Agricultural Statistics Service, Economic Research Service. 1992. cide usage: 1991 fruits and nuts summary. Washington, D.C. (June).
ulture. National Agricultural Statistics Service, Economic Research Service. 1995. cide usage: Vegetables 1994 summary. Washington, D.C. (July).
mental Protection Agency. Dept. of Pesticide Regulation, Information Services Branch. ales report: Annual 1992, indexed by chemical. Sacramento, CA. (February)

Figure 3
Glyphosate Use by U.S. Households (1992)



Note: Numbers in parentheses are the numbers of products used annually.
Source: Whitmore, R.W., J.E. Kelly, and P.L. Reading. 1992. National home and garden pesticide use survey. Research Triangle Park, NC: Research Triangle Institute.

Treatment of lawns, roses and other ornamentals, gardens, and fruit trees account for over half of the glyphosate used by U.S. households.

used in agriculture in California, the Midwest, and Florida.

, and Sting.[5]

compound, glyphosate essentially no structurally show any herbicidal ac-

ough most commonly agriculture (see Fig- use) and the second used herbicide in Estimated annual U.S. Environmental PA) is between 15 and agriculture and be- pounds elsewhere.[7] uses are in the pro- and pasture, corn,

About 25 million applications per year are made in U.S. households, most of these are made on lawns or outdoor areas where a total vegetation kill is wanted.[8] (See Figure 3)

In California, where pesticide use reporting is more comprehensive than in other states, about 3.4 million pounds were used in 1992; about 25 percent of this was used along rights-of-way, while 15 percent was used on almonds and 10 percent was used on grapes.[9] (See Figure 4.)

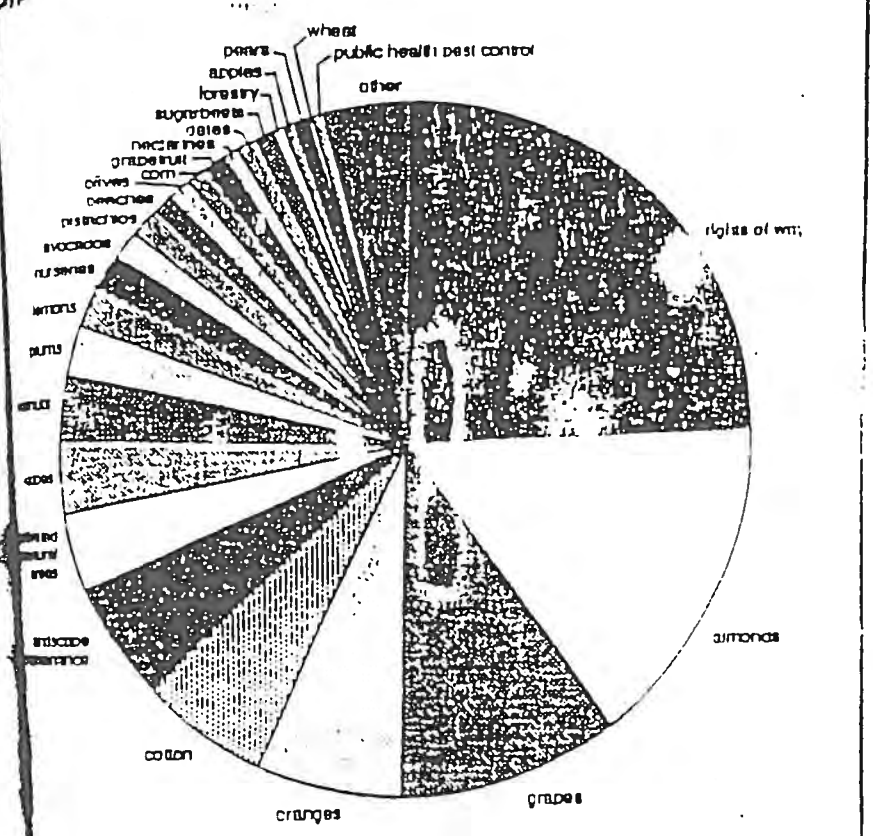
Mode of Action

The mode of action of glyphosate is "not known at this time,"[4] according to EPA. However, "herbicidal action probably arises from the inhibition of the biosynthesis of aromatic amino acids."[10] These amino acids (phenylalanine, tyrosine, and tryptophan) are used in the synthesis of proteins and are the essential for growth and survival of most plants. One particular enzyme important in aromatic amino acid synthesis, called 5-enolpyruvylshikimate-3-phosphate synthase, is inhibited by glyphosate.[10] Glyphosate also "may inhibit or repress" two other enzymes, chorismate mutase and prephenate hydratase, involved in other steps of the synthesis of the same amino acids. These enzymes are all part of what is called the shikimic acid pathway, present in higher plants and microorganisms but not in animals.[11]

Two of the three aromatic amino acids, tryptophan and phenylalanine, are essential amino acids in the human diet because humans, like all higher animals, lack the shikimic acid pathway, cannot synthesize these amino acids, and rely on their foods to provide these compounds. Tyrosine is synthesized in animals through another pathway.[12]

Glyphosate can affect enzymes not connected with the shikimic acid pathway. In sugar cane, it reduces the activity of one of the enzymes involved in sugar metabolism, acid invertase. This reduction appears to be

Figure 4
Glyphosate Use in California (1992)



Environmental Protection Agency, Dept of Pesticide Regulation, Information Services Branch, 1994, use report Annual 1992, Indexed by chemical, Sacramento, CA. (February.)

Pesticide use reporting requirements document the enormous variety of glyphosate

by auxins, plant hormones.[13] Glyphosate also affects enzyme systems in animals and humans. In rats, injection into the abdomen decreases the activity of detoxification enzymes, cytochrome P-450 and a monooxygenase, and increases the intestinal activity of the enzyme glucuronidase (another detoxification enzyme).[14]

Ingredients in Glyphosate-containing Products

Almost every pesticide product contains something other than what is called the active ingredient(s), those designed to produce the killing action. Their purpose is to make the product easier to use or more efficient. These ingredients are called "inert," although they are often not biologically, chemically, or toxicologically inert. In general, they are not identified on the label of the pesticide product.

In the case of glyphosate products, many "inerts" have been identified. Roundup contains a polyethoxylated tallowamine surfactant (usually abbreviated POEA), related organic acids of glyphosate, isopropylamine, and water. Both Rodeo and Accord contain glyphosate and water.[15] (However, label instructions usually require adding a surfactant during use.[15]) See "Toxicology of 'Inert' Ingredients of Glyphosate-containing Products," p. 17, for basic information about these "inert" ingredients.

Many of the toxicology studies that will be summarized in this factsheet have been conducted using glyphosate, the active ingredient, alone. Some have been conducted with commercial products containing glyphosate and "inert" ingredients. When toxicology testing is not done with the product as it is actually used, it is impossible to accurately assess its hazards.

We will discuss both types of studies and will identify insofar as is possible exactly what material was used to conduct each study.

Acute Toxicity to Laboratory Animals

Glyphosate's acute oral median lethal dose (the dose that causes death in 50 percent of a population of test animals, or LD_{50}) in rats is greater than 4,320 milligrams per kilogram (mg/kg) of body weight. This places the herbicide in Toxicity Category III (Caution).[4] Its acute dermal toxicity (dermal LD_{50}) in rabbits is greater than 2,000 mg/kg of body weight, also Toxicity Category III.[4]

If animals are given glyphosate in other ways, it is much more acutely toxic. When given intraperitoneally (the dose applied by injection into the abdomen), glyphosate is between 10 and 20 times more toxic to rats (with an LD_{50} between 192-467 mg/kg)[2,16] than it is when given orally. Intraperitoneal injection also caused fever, cessation of breathing, and convulsions.[17] While this kind of exposure is not one that would be encountered under conditions of normal use, these studies indicate the kinds of effects glyphosate can potentially cause in mammals.

Commercial glyphosate-containing products are more acutely toxic than glyphosate alone. Two recent (1990 and 1991) studies compared the amount of Roundup required to cause death in rats with the amount of either glyphosate alone or POEA alone that would cause death. The studies found that in combination, the amount of glyphosate and POEA required to kill was about 1/3 of a lethal dose of either compound separately. The Roundup formulation tested was also more toxic than POEA alone.[18,19]

As with glyphosate alone, glyphosate-

NTP concluded the lesions were related by the adrenal hormone [illegible].[29]

The NTP study also found evidence of effects on the liver: increase in bile acids as well as two liver enzymes were found in both male and female. Other effects found in this study were reduced weight gain in male and female rats and mice; diarrhea in male and female rats and changes in the relative weights of kidney, liver and thymus in male rats and mice.[29]

Other subchronic laboratory tests found reduced weight gains (using doses of 2500 mg/kg per day)[30] along with an increase in relative weights of brain, hearts, kidney, and liver in mice.[3] In rats, blood levels of potassium and phosphorus increased at all dose levels (60-1600 mg/kg/day) in both sexes. There was also an increase in pancreatic lesions in males.[4]

In acute toxicity tests, glyphosate-containing products are more toxic than glyphosate alone in subchronic tests. In a 7-day study with calves, 790 mg/kg of Roundup caused labored breathing, pneumonia and death of 1/3 of the animals tested. At lower doses decreased food intake and diarrhea were observed.[3]

Chronic Toxicity

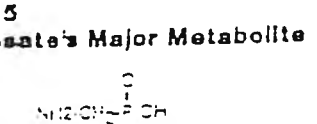
Glyphosate is also toxic in long-term tests. The following effects were found in chronic glyphosate feeding studies using rats: decreased body weight, excessive growth of particular liver cells, death of the liver cells, and chronic inflammation of the kidney. Effects were significant only in male and at the highest dose tested (1600 mg/kg of body weight per day). In female, excessive growth of some kidney cells occurred.[31] At a lower dose (814 mg/kg of body weight per day) excessive cell growth in the urinary bladder occurred.[3]

Chronic feeding studies with rats found the following effects: decreased body weight gain, an increased incidence of cataracts, less degeneration in males and more liver weight in males. These effects were significant at the highest dose (900-1200 mg/kg of body weight per day).[31] At a lower dose (400 mg/kg of body weight per day) inflammation of the stomach's mucous membrane occurred in both sexes.[3]

Carcinogenicity

The potential of glyphosate to cause cancer has been a controversial subject since the first lifetime feeding studies were analyzed in the early 1980s. The first study (1979-1981) found an increase in testicular interstitial tumors in male rats at the highest dose tested (30 mg/kg of body weight per day),[32] as well as an increase in the frequency of a thyroid cancer in females.[33] The second study (completed in 1983) found dose-related increases in the frequency of a rare kidney tumor in male mice.[34] The most recent study (1988-1990) found an increase in the number of pancreas and liver tumors in male rats together with an increase of the same thyroid cancer found in the 1983 study in females.[35]

Figure 5
Glyphosate's Major Metabolite



aminomethylphosphonic acid (AMPA)

All of these increase in tumor incidence are "not considered compound-related"[35] according to EPA. In each case, different reasons are given for this conclusion. For the testicular tumors, EPA accepted the interpretation of an industry pathologist who said that the incidence in treated groups (12 percent) was similar to those observed in other control (not glyphosate-fed) rat feeding studies (4.5 percent).[36] For the thyroid cancer, EPA stated that it was not possible to consistently distinguish between cancers and tumors of this type, so that the incidences of the two should be considered together. The combined data are not statistically significant.[35] For the kidney tumors, the registrants reexamined slides of kidney tissue, finding an additional tumor in untreated mice so that statistical significance was lost. This was despite a memo from EPA's pathologist stating that the lesion in question was not really a tumor.[34] For the pancreatic tumors, EPA stated that there was no dose-related trend and no progression to malignancy. For the liver tumors and the thyroid tumors, EPA stated that pairwise comparisons between treated and untreated animals were not statistically significant and there was no progression to malignancy.[35]

EPA concluded that glyphosate should be classified as Group E, "evidence of noncarcinogenicity for humans."[35] They added that this classification "is based on the available evidence at the time of evaluation and should not be interpreted as a definitive conclusion that the agent will not be a carcinogen under any circumstances."[35] From a public health perspective, the results of the laboratory tests leave many questions unanswered. An EPA statistician wrote in a memo concerning one of the carcinogenicity studies, "Viewpoint is a key issue. Our viewpoint is one of protecting the public health when we see suspicious data."[36] Unfortunately, EPA has not taken that conservative viewpoint in its assessment of glyphosate's cancer-causing potential.

There are no studies available to NCAP evaluating the carcinogenicity of Roundup or other glyphosate-containing products. Without such tests, the carcinogenicity of glyphosate-containing products is unknown.

Mutagenicity

Laboratory studies of a variety of organisms have shown that glyphosate-containing products cause genetic damage.

- In fruit flies, Roundup and Ponchmaster (an aquatic herbicide consisting of glyphosate and a trade secret surfactant)[37] both increased the frequency of sex-linked, recessive lethal mutations. (These are mutations that are usually visible only in male because two damaged genes are required in order to be expressed in females.) In this study, the frequency of lethal mutations was between 3 and 6 times higher in fruit flies that had been exposed to glyphosate products during their larval development than in unexposed flies.[38]
- A laboratory study of human lymphocytes (one type of white blood cell) showed an increase in the frequency of sister chromatid exchanges following exposure to high

...oses of Roundup.[39] (Sister chromatid exchanges are exchanges of genetic material during cell division between members of a chromosome pair. They result from point mutations.)

• In *Salmonella* bacteria, Roundup was weakly mutagenic at high concentrations. In onion root cells, Roundup caused an increase in chromosome aberrations.[40]

Glyphosate alone has rarely caused genetic damage in laboratory tests. None of the mutagenicity studies required for registration of glyphosate have shown it to be mutagenic. Tests included studies of mutations in hamster ovary cells, bacteria, and mouse bone marrow cells.[4] Glyphosate was also not mutagenic in other studies of rats, mice,[2] and onion cells[40] but caused chromosome stickiness and fragmentation in Chinese hyacinth root cells.[41]

Reproductive Effects

Laboratory studies have demonstrated a number of effects of glyphosate on reproduction, including effects on mothers, fathers, and offspring.

In rat feeding studies, glyphosate reduced sperm counts (at the two highest doses tested) and lengthened the estrous cycle (how often a female comes into heat) at the highest dose tested).[29] Other effects on rats in laboratory tests include [illegible], diarrhea, breathing rattles, red discharge, reduced activity, growth depression, decreased body weights, and increased mortality.[2] Effects on offspring included an increase in fetal loss, a decrease in the number of embryos successfully implanted into the uterus, a decrease in the number of viable fetuses, a slight decrease in fetal size, a decrease in fetal and pup weights, and an increase in problems with skeleton formation.[2] Effects were observed at the highest doses tested (1500 and [illegible] mg/kg of body weight per day).[2]

A study of rabbits using doses that were lower than those used in the rat study found glyphosate caused diarrhea, nasal discharge, and death in mothers.[2] The only effect on offspring was a decrease in fetal weight in treated groups.[42]

In a study in which glyphosate was fed to rats for three generations after which the offspring were examined for birth defects, [illegible] found kidney damage at a relatively low dose (30 mg/kg of body weight). However, a second study (only two generations long) did not find similar effects, and EPA called the damage in the first study "spurious."[4] From a public health perspective, however, a new three generation study is crucial.

> **"It is also somewhat difficult not to doubt the scientific integrity of a study when the IBT [Industrial Biotest Laboratories] stated that it took specimens from the uteri (of male rabbits) for histopathological examination."**
>
> **—Krystyna Locke**
> **EPA toxicologist**

Toxicology of Glyphosate's Major Metabolite

In general, studies of the breakdown of glyphosate find only one metabolite, aminomethylphosphonic acid (AMPA).[2] (See Figure 5.) Although AMPA has low acute toxicity (its LD_{50} is 8,300 mg/kg of body weight in rats,[20] and is only slightly irritating to eyes,[43] it causes a variety of toxicological problems. In subchronic tests on rats, AMPA caused decreased weight gain in males; an increase in the acidity of urine in both males and females; an increase in the activity of an enzyme, lactic dehydrogenase, in both sexes; a decrease in liver weights in males at all doses tested; and excessive cell division in the lining of the urinary bladder and in part of the kidney in both sexes.[20] AMPA is much more persistent than glyphosate: studies in eight states found that the half-life in soil (the time required for half of the original concentration of a compound to break down or dissipate) were between 119 and [illegible]

Quality of Toxicology T[illegible]

Tests done on glyphosate to [illegible] tration requirements have been [illegible] with fraudulent practices.

Laboratory fraud first made h[illegible] 1983 when EPA publicly announ[illegible] 1976 audit had discovered "se[illegible] ciencies and improprieties" in [illegible] studies conducted by Industri[illegible] Laboratories (IBT).[44] Problems [illegible] "countless deaths of rats and mice [illegible] not reported," "fabricated dat[illegible] and "routine falsification of da[illegible]

IBT was one of the largest la[illegible] performing tests in support of [illegible] registrations.[44] About 30 tests on g[illegible] and glyphosate-containing prod[illegible] performed by IBT, including 11 [illegible] chronic toxicology studies.[45] A c[illegible] example of the poor quality of [illegible] comes from an EPA toxicologist w[illegible] "It is also somewhat difficult not [illegible] the scientific integrity of a study [illegible] IBT stated that it took specimens [illegible] *uteri* (of *male* rabbits) for histopa[illegible] examination."[46] (Emphasis added.)

In 1991, laboratory fraud ret[illegible] the headlines when EPA alleged [illegible] ven Laboratories, a company that p[illegible] contract studies for 262 pesticide[illegible] nies including Monsanto, had fals[illegible] results.[47] "Tricks" employed by Cra[illegible] included "falsifying laboratory [illegible] entries" and "manually manipul[illegible] entific equipment to produce [illegible] ports."[48] Roundup residue studies o[illegible] potatoes, grapes, and sugarbeets we[illegible] the tests in question.[49]

The following year, the owner [illegible] of Craven Laboratories and three [illegible] ees were indicted on 20 felony c[illegible] number of other employees agree[illegible] guilty on a number of related [illegible] The owner was sentenced to five [illegible] prison and fined $50,000; Craven [illegible] fined 15.5 million dollars, and o[illegible] pay 3.7 million dollars in restitut[illegible]

Although the tests of glyphosa[illegible] fied as fraudulent have been repla[illegible] practices cast shadows on the entire [illegible] registration process.

EXPERT REBUTTAL REVIEW OF COXs' PAPER ON GLYPHOSATE TOXICOLOGY

"..AS CONTAINING SERIOUS AND CONSISTENT MISREPRESENTATION OF BOTH PUBLISHED RESEARCH AND OFFICIAL REGULATORY REVIEWS OF THE SUBJECT MATTER.."

ENTEBBE 5TH NOVEMBER 1987

BACKGROUND

JPR is a magazine published by the Northwest Coalition for Alternatives to Pesticides (NCAP), known earlier as the Northwest Coalition Against Pesticides. NCAP is headquartered in Eugene, Oregon. JPR is not a peer-reviewed journal; articles submitted to the magazine are not sent to independent scientists for review of technical content and interpretation. Neither is it supported by the reputation of any established scientific society or association. It is best described as a house organ and conduit for the opinions and philosophy of the organization. Neither NCAP nor its journal can be presumed a priori to be a valid source of scientific information.

The best overviews of the toxicology of glyphosate and its formulations, and risks associated with its use may be found in the USEPA Reregistration Eligibility Document for glyphosate, and in the World Health Organization (WHO) Environmental Health Criteria 159. These documents are prepared by panels of expert scientists who have reviewed the published research and the registration data. They state the official positions of the US regulatory system and of WHO, and are consistent with international regulatory positions. Both describe the very limited toxicity and environmental impact of glyphosate, and the minute risks associated with its use. They lay out the basis for the universal official conclusion that glyphosate is not carcinogenic or mutagenic, and is highly unlikely to cause reproductive or systemic toxicity.

GENERAL COMMENTS

Fragments of information from the USEPA Reregistration Eligibility Document for glyphosate, and the WHO Environmental Health Criteria 159 are quoted several times by Cox. However, she has avoided reference to the mass of basic information and conclusions in these documents that contradicts her contention that use of glyphosate imposes serious risks on humans and the environment. Indeed, Cox suggests that these conclusions are flawed, but offers no supportable evidence to the contrary.

The articles certainly do not satisfy the statement by the author in Part I, on page 14, column 1, relating to evaluation of glyphosate-based herbicides: "However, an independent, accurate evaluation of their health and environmental hazards can draw conclusions very different from those presented by these advertisements. The following summary of glyphosate's hazards is intended to serve that purpose."

It is difficult to accept a claim of independence, accuracy or

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January 10, 1997

TO: John Brodie, Manager, Environmental Services, B.C.Rail.
FROM: Frank Dost

You asked me to evaluate the validity of two articles in the Journal of Pesticide Reform (JPR) purporting to describe the toxicology, human exposure and ecological effects of glyphosate.

Both articles are apparently being presented as a source of information to persons concerned about the BC Rail vegetation management program.

They are: Glyphosate, Part I: Toxicology, JPR 15(3):14-20, 1995.
Glyphosate, Part II: Human Exposure and Ecological Effects, JPR 15(4):14-20, 1995

The author of both papers is Caroline Cox, editor of JPR.

This discussion is a review of Part I.

Because the two papers may be discussed independently, I have included the following prefatory comments with my remarks about both articles.

I was unprepared for what I found in these papers. I believe these articles contain serious and consistent misrepresentation of both published research and official regulatory reviews of the subject matter. I do not believe the faults in the presentations can be attributed to inadequate understanding, even though the author has no professional qualifications. Because of the severity of my criticism and the political sensitivity of the issue, you may wish to discuss some parts or all of my review with other qualified toxicologists. Dr. Gail Bellward at UBC ((604) 822-4103), Dr. David Eaton at the University of Washington ((206) 685 3785), Dr Ian Ritter of the Canadian Network of Toxicology Centers ((519) 837 3800) or Dr. Ian Tinsley of Oregon State University ((541) 737 1789) should be able to help identify competent persons.

As with any review of bad work, an unexpected amount of detail and time has been required to finish this evaluation. It has become necessary to reread and reanalyze almost every publication and report referenced in the articles.

objectivity of an article about a controversial subject in an advocacy magazine, written by its editor, with no review by any recognized authority.

Given the social sensitivity of this issue a responsible author/editor would have sought the assistance of experts to review these papers. There are many nationally recognized toxicologists and environmental chemists close at hand, at Oregon State University, Washington State University and the University of Washington. Some or all of these scientists would have been willing to provide advice. On a broader scale, the Society of Toxicology, the Society for Environmental Toxicology and Chemistry or the Society of Toxicology of Canada would probably respond to a request for peer evaluation of these papers.

The most consistent lapse is failure to recognize the relationship between dose and effect in most of the discussions in the articles. An evaluation of risk is impossible without examination of the relation between the dose and the effects, both in the laboratory and in the field. That information is available throughout the references quoted as evidence of harmful consequences of glyphosate use, but is ignored. There is no excuse for avoiding this fundamental principle, and there is no excuse for failing to explain it to audiences that may not be familiar with it.

The concept is very simple: As the dose or intake (or concentration in air or water) increases, the effect increases, and as the intake decreases, so does the effect. This is a universal principle and describes every interaction between chemicals and biological systems, whether at the level of humans or bacteria or plants. There are no exceptions.

A critical part of this principle is the fact that for effects other than cancer, there will be a level below which no effect occurs. This is a threshold or No-Observed Effect Level (NOEL). Anyone who has consumed several cups of coffee or who has observed a person drinking alcohol has studied the dose-response relationship and the idea of a threshold at first hand.

The same ideas apply to the use of therapeutic medicines, which are intended to exert effects on specific mechanisms in the body. Even these chemicals with their specific physiological and biochemical targets must be given in relatively large doses to cause the desired changes in the body. If the dose, or amount taken in is too low, the medicine is useless; if too high it wil cause unintended effects, or toxicity.

The JPR article has also avoided informing readers of the great differences between occupational or environmental exposures and

the most sensitive No-Observed-Effect Levels (NOEL). This difference is usually called the safety factor or margin of safety, and is the basis of regulatory assessment of systemic risk. The NOEL is the lowest dose rate in long term experiments that causes no detectable response. The idea is to be sure that any exposures result in doses that are much, much lower than the lowest dose that causes no effect. A figure of 100 fold is generally recognized as sufficient to assure that no adverse effects will occur.

Those differences are absolutely elemental in judging the potential effects of any substance that has no genetic or carcinogenic potential, such as glyphosate, for which safety factors are very large. It is not possible to judge risk of any kind for any chemical without that information; it is available in the literature quoted in the JPR articles and was not discussed.

Just as important, it must be understood that every substance that exists, whether synthetic or found in nature, is able to produce illness at some dose. Whether it is an essential component of the diet or a hazardous waste, every chemical has the capacity to cause harm. Conversely, there are no magic chemicals. Chemicals can do nothing that is not governed by the basic natural laws of chemistry and physics.

An earlier article on glyphosate by the same author (Jour. pesticide Reform, Summer 1991, pp 35-38), while omitting some significant information, in general did not do harm with incorrect statements. In the present papers, fundamental principles of toxicology have been disregarded. The author is not a toxicologist, but does understand these concepts. A discussion that ignores them cannot be considered competent.

The abstracts of Cox's more recent articles contain very general statements implying that glyphosate is severely toxic. There is no evidence in any source she quoted that supports that idea. Neither can such evidence be found in the numerous studies she has failed to discuss. An unqualified statement that a chemical can cause harm, with out reference to the dosage and the dose-response relationship for effects of the chemical, has no meaning.

That the effects mentioned in these articles often occur only at massive doses approaching those that cause death, and that they are quite non-specific, is usually not discussed. Neither is the fact that acquisition of such doses is virtually impossible without deliberate intent.

The reason that information exists about toxic effects at high

doses is the fundamental requirement that studies supporting registration of any pesticide must include a range of dose rates, the highest of which is expected to cause observable toxicity. The lowest should produce no evidence of toxicity.

In the JPR articles, numerous important research studies on glyphosate have been missed or ignored and several clearly incompetent publications are used. There are examples where publications have clearly been misread. These faults further compromise the claim of objectivity and accuracy of these articles. (I have no intention of reviewing the missing literature for the purposes of this critique.)

The author should be aware not only of the principles that govern the science of toxicology, but also the principles of responsible reviews of the scientific literature. A reviewer has the same responsibility to evaluate the strengths and weaknesses and implications of a published paper as does the editor who reviews it prior to publication.

This two-part review has not met that obligation. When the established data and the conclusions of authors reviewed here are compared with the tenor of the abstracts and texts written by Cox, it is difficult to avoid a conclusion that the purpose of these papers is political, not informative.

COMMENTS ON GLYPHOSATE, PART 2: HUMAN EXPOSURE AND ECOLOGICAL EFFECTS.

There are six statements made in what may be presumed to be an abstract at the beginning of the article. They are generalizations that have a grain of qualitative truth, but presented, convey to readers a serious misunderstanding of research findings. These statements also are contrary to the conclusions of official reviews and national and international regulatory organizations.

The specific research reports and scientific reviews quoted in the article and the interpretations in JPR are discussed in detail below. All too frequently, the impression of specific research conveyed by Cox is at variance with the data and the conclusions of the scientists who did the work.

Page 14, col 2. Human Exposure. Qualitatively, the routes of exposure listed are correct. The same statement can be made for virtually all chemicals. In most cases they are not all "important". In the case of glyphosate herbicides, workplace exposure on the skin represents the most important potential source; the World Health Organization Environmental Health Criteria 159 (ref 1) notes that basic full coverage work clothin

is adequate protection. Residues on food are minor and are discussed in detail in the USEPA Reregistration Eligibility Document (ref 4).

Page 14, col 3. Contamination of food, para 1. World Health Organization Environmental Health Criteria 159 (ref 1) does in fact state that glyphosate analysis is "in general laborious, complex and costly". It does not state that this is the reason it is not included in government monitoring of residues in food, as claimed by Cox. There are dozens of laboratories capable of these analyses, and the literature is replete with development of methods for glyphosate residue analysis. The EPA Reregistration Eligibility Document, which Cox chooses to reference when she believes it suits her purpose, states, "An adequate enforcement method is available for analysis of residues of glyphosate and its metabolite AMPA in or on plant commodities and in water."

Cox implies that residues in food are not well known and are potentially dangerous, using the USEPA Reregistration Eligibility Document to support her contention. She chooses to ignore the enormous body of residue data discussed in that document. The Reregistration Eligibility Document contains reference to data for 50 or more specific food crops, as well as processed commodities. Reference is also made to studies of residues in meat, poultry, eggs, fish and milk. Residues in drinking water and irrigation water and in plants resulting from irrigation have been done as well. Market basket surveys have not been done, but these are generally conducted for pesticides that for some reason represent a health concern. Glyphosate is not seen by regulatory -authorities as a health concern.

Page 14, col 3. Contamination of food, para 2.
These statements are qualitatively correct; however no reference is made to the levels found, which are critical to any evaluation of health effects.

Again, the Reregistration Eligibility Document is instructive: "Studies with a variety of plants, including corn, cotton, soybeans, and wheat indicate that uptake of glyphosate or its metabolite, AMPA, from soil is limited." The paragraph then goes on to discuss translocation or movement in plants.

Cessna and Cain (ref 2) found a maximum of 0.04 ppm glyphosate on strawberry fruit, and point out that many of the samples contained residues at levels less than the limit of detection. Translocation of glyphosate within plants has been known for many years.

The allowable tolerances for berries is usually 0.2 ppm, substantially more than was found by Cessna and Cain.

Cox has misread the work of Roy et al (ref 3), who did not study translocation to fruit. They treated brush with the herbicide, then examined its direct deposition on and penetration into the berries. They found that some penetration did take place, and that residues persisted after 60 days at levels higher than 0.01 ppm. This residue level exceeds the Canadian automatic default permissible residue for foods for which no formal tolerance has been established, but is far below formal tolerances for berry crops. Roy et al remark that because the equipment and spray methods differed from standard application methods that the results "should not be considered as residue levels that would be expected from operational-spraying of glyphosate." At the same time, the 2 kg/ha application rate is typical.

Page 14, col 3 bottom and page 15, col 1, top. The Reregistration Eligibility Document (ref 4) is quoted as showing that glyphosate is taken up by plants and moved to edible portions, to be found in those parts a year after application Lettuce, carrots and barley are the crops of interest.

The Reregistration Eligibility Document has been careless with the term "glyphosate residues". The experiments did not identify intact glyphosate. The observations were of radioactive carbon that originated from 14C-labelled glyphosate and has been almost entirely incorporated into other entities.

When a chemical degrades as a result of microbial action, as is the case with glyphosate, the carbons will either be oxidized to carbon dioxide or will form other small molecules that will eventually transfer that carbon to other organic or inorganic compounds. Some of the carbon dioxide will be lost to the atmosphere, some will be utilized by the plants themselves or by other organisms for energy or structural material. Depending on how tightly closed the experimental growing system may be, some or all of the carbon will remain in the plants, but it is no longer glyphosate.

EPA has acknowledged this misstatement but has not published it. I don't expect Cox to be familiar with radiotracer methods or metabolic pathways. However, as is pointed out elsewhere in the Reregistration Eligibility Document, glyphosate degrades relatively rapidly except in cold climate, and these studies were done in greenhouses, where turnover may be expected to be relatively rapid.

Page 14, col 3, bottom. Fish are included in a paragraph describing examples of glyphosate uptake in plants. I think I understand that the article is saying that glyphosate can be found in fish from water treated with glyphosate.

Neither of these references (refs 5,6) supports the idea that significant residues will be found in fish, nor does any of the other literature on the question.

Ref 5 (Wang et al) is a paper in which radiocarbon labeled glyphosate was used, with no analysis of specific chemical residues. As in the work discussed just above, because there were no chemical analyses, the chemical identity of the labeled material is not defined. As a result we have no idea of the nature of material that was found.

The experiments are poorly described. The aquaria were apparently non-flowing, and distilled water was added to maintain levels. There is no statement about the character of the original water. The amounts of glyphosate added were stated to be based on fractions of the median lethal concentration, but those levels as stated were much less than other research has found for warm water fish, with no explanation for this difference from other findings. Perhaps most important, there apparently was no control aquarium with glyphosate added but no fish, so there is no indication of what happened to the material independently of the fish. If this paper had been sent to me as a review editor, I would have declined to publish until these and other shortcomings were resolved.

The paper by Folmar et al (ref 6) reported a bioaccumulation study in fish as a minor part of other research. Twelve hour exposure to Roundup resulted in a bioaccumulation factor of 0.04. In other words, the concentration in edible tissues was four percent of the concentration in the water. This is consistent with other work reviewed in World Health Organization ~nvironmental Health Criteria 159 (Ref 1) and is considered to be ~a very low figure, representing no bioaccumulation. WHO also ~points ~ut that the rate of disappearance after removal to clean ~water is rapid. The Folmar paper contains a misprint, in which - a conc~ntration of 80 micrograms per kg (80 ppb) is printed as 80 - milligrams (80 ppm.)

Page 15, col 1, Occupational exposure. Every person working with a chemical will have some finite level of exposure. However, a statement that workers are exposed to a chemical has no meaning without figures, the extent of exposure and the resulting absorbed dose. Those figures must be related to no-effect levels, including safety factors, if they are to be useful.

In the Abstract, and in the second paragraph of this section a statement is made about a high rate of injury associated with use of glyphosate: "In California, ---glyphosate exposure was the third most common cause of illness among agricultural workers."

This statement is a direct quote from the abstract of the JPR article, and is discussed on page 15, col 1. The references are Pease et al (ref 9) and Robinson et al (ref 10). Pease et al discuss at some length the weaknesses and strengths of the California reporting system. Unfortunately, the article in JPR did not discuss these. There are problems of under-reporting as well as misreporting. A major difficulty in the system is that physicians have little experience with pesticides and often are unable to identify exposures.

It is useful to note here that because of misuse of its data, the California Department of Pesticide Regulation issued a statement about glyphosate with a recent annual report on pesticide-related illnesses. Only 13 glyphosate related cases were reported in 1994, 11 of which were minor irritant effects. The statement also said, "of the 515 pesticide-related hospitalizations recorded over the 13 years on file, none was attributed to glyphosate."

There is no mention of the nature of injuries in the JPR article, but the term "illness" suggests serious responses to exposure. Almost all of the observed incidents were skin and eye irritation, not systemic effects.

There can be no doubt that preventable exposures occur frequently among workers in agriculture, and they range from serious poisonings by certain insecticides to the minor skin and eye irritations such as may be caused by glyphosate formulations.

Page 15, col 1, Drift.

Several papers are quoted here as showing very large displacement (drift) of glyphosate after application. Each of these research reports is a discussion of the effect of different aerial application practices, including attention to wind speed. Each shows that inappropriate practices result in unacceptable drift, and that proper methods limit significant drift to the width or reasonable buffer zones.

In each case Cox presents only the findings resulting from poor practices, and are stated in such a way that they may be seen as representing all applications. She also ignores the stated conclusions of the researchers.

Payne (ref 12/22; this paper is also quoted later as ref 22) is incorrectly quoted as stating that "Its wide use means that ther is a correspondingly large potential for drift." What Payne wrote was this: "The herbicide glyphosate is widely used in Nort American forestry. and consequently the potential for environmental impact resulting from off-target deposits is of

interest." He evaluated differences among application methods and meteorological conditions and concluded that appropriate practices and buffers would assure absence of adverse effect.

Atkinson (ref 13) followed the development of perennial plants after exposure to non-lethal drift damage and found, as pointed out by Cox, persistent effects. As did others, he identified methods that minimized drift, adding that careful attention to adjacent sensitive crops and plantings is essential.

There are several allusions on page 15 to a paper by Freedman (ref 15, particularly relative to the variability of deposition after application. Freedman makes the same point others do, that management of methods and attention to conditions mitigates most unusual drift situations, and that inappropriate methods are responsible for cost unintended impact. The deposition rates, quoted by Cox do not seem to correspond to the numbers in Freedman's paper.)

Freedman devotes considerable comment to the disparity between public perception of risks associated with herbicide use, and risks as estimated from factual information. Cox would have served her audience a little better by showing some understanding of this problem, instead of amplifying it by her manner of massaging the meaning of the literature.

Breeze, et al (ref 14) identified several species of wild plant that are highly sensitive to glyphosate, and modeled ground application drift data in combination with dose-response findings obtained in glasshouse experiments. They concluded that "only glyphosate sprayed at the highest recommended concentration might be unsafe to some of the species examined." In their discussion, they "suggest that a 10 m wide boundary is usually adequate."

Page 15, col 3, top. (Yates et al (ref 17) are quoted as showing that "glyphosate residues have been measured 400 meters downwind from ground applications. Yates' work was done nearly 20 years ago, when glyphosate was just entering use. The objective was to evaluate various application techniques. The nozzle and pressure configuration that produced such extensive drift did not represent typical applications then, and certainly does not at the present time. Other configurations reduced drift on the order of 150 fold. The same kind of relationship was found in examination of damage to potted grapes and wheat plants in the drift zone. It is not clear why Cox did not discuss all of the findings in the paper.

Page 15, col 3, helicopter applications. Riley et al (ref 18) and Payne et al (ref 19) are sources for data on the distance glyphosate drifted after helicopter application. Cox does not

discuss the rapid decrease in deposition with distance from the target, or the very low residues at the more extreme sites.

The work of Riley et al (ref 18) shows a very sharp early drop in deposition, followed by very low residues extending for some distance. The real issue is not whether some herbicide is present at those distances, but whether those amounts represent significant adverse impact. One objective of the authors was to "interpret observed deposit data with regard to published toxicity data for sensitive aquatic organisms---". (The authors are employed by the Province of New Brunswick.)

The comment by Riley et al at the end of their abstract is informative: "Given these results there are no plans to change the current buffer zone recommendation." (The current buffer at

the time of publication was 65 metres.)

The observations of Payne et al (ref 19) were similar. The greater drift distances were with less satisfactory equipment. Using a "realistic worst case scenario", Payne et al concluded that a 25 metre buffer would adequately protect aquatic life. (They accept a real but minimal effect which would probably disappear at a slightly wider buffer width.) They also concluded that there were no characteristics of glyphosate sprays that make for behavior different from that of other herbicides.

Page 15, col 3, fixed wing aircraft.

Similar statements about long drift distances are made, referring to additional work by Payne and his collaborators. (Ref 22 is the same as ref 12, discussed above.) Payne and Thompson (ref 20) examined the effects of meteorological conditions, rather than testing several types of application equipment. It should be no surprise that the herbicide was detected at substantial distances in this experimental situation. The paper is an .interesting account of behavior of large and small droplets, among other factors. Their work suggests that controllable applications can be made in a broader range of wind speeds.

Their concluding remarks were apparently ignored by Cox: "--by -- using a buffer-zone width adequate to prevent excessive off target deposits caused by large drop drift (50-100 m~ forestry herbicides could be applied in a wider range of wind speeds (>2.2 m s⁻¹ than that currently used without causing increased environmental impact in sensitive areas."

Yates (ref 17) is again quoted, this time as finding glyphosate

residues 800 metres downwind of an aircraft application. As pointed out earlier, these workers were evaluating application techniques and the consequences of poor methodology.

Payne (ref 12/22) describes certain practices that would require very large buffers of up to 1200 metres for sensitive non-target vegetation, but also shows that sensible management brings buffers down to 75 metres for vegetation and 50 metres for water bodies.

Page 16, col 1, persistence. Cox is correct in remarking on the wide variation in degradation rates for glyphosate. The persistence of detectable levels of any pesticide must be considered in the light of the availability of the herbicide, and the ability of those low levels to cause harm. Many of the figures quoted by Cox are from studies of conditions that lead to longer persistence, particularly cold climates and soil that is not biologically active. The description of a rapid initial degradation followed by a slower second phase is typical of many chemical reactions in the environment.

Persistence and half-time have quite different meanings. A substance may be said to persist as long as any can be found in the medium under examination. The half-time or half-life is a measure of rate of loss, and is much more important. This is shown nicely by Newton et al (ref 24). The 55 day period mentioned by Cox was the duration of the study; the half-time measured in soil was about the same duration. Feng and Thompson (ref 26) found half-times in British Columbia of 45 to 60 days. Roy et al (ref 27) found half-times in Ontario to be about 24 days. Torstensson et al (ref 28) comment that the very long persistence of small amounts of glyphosate in the north could be attributed to the frozen soil and to slow release from vegetation. Frozen vegetation would retain any herbicide until thawing and restart of microbial activity.

Page 16. col 2, top. Glyphosate adsorption to soil particles. Piccolo et al (ref 29) are quoted as evidence that the general understanding of glyphosate adsorption and immobility in soil may be incorrect, and that glyphosate may desorb easily.

A reading of this paper shows that it emphatically refutes the very argument Cox claims that it supports. It actually demonstrated the remarkable binding capability of glyphosate to soils.

I am not certain that the researchers understood the implications of their own work, given their statement, quoted by Cox, that "this herbicide can be extensively mobile in the environment".

Most important in considering this question, of course, is the extensive body of literature on the field behavior and physical chemistry of glyphosate that shows conclusively that it does not migrate to any appreciable extent.

This work did not really address the behavior of glyphosate in soil, but rather dealt with its behavior in water containing suspended soil. If it may be related to any environmental context, it is much more a model of behavior in sediments in ponds and streams than soils as such, and shows that a small amount of soil can remove large amounts of glyphosate from water.

The experiments were done with one gram of soil, shaken with 25 ml of a solution containing 50, 100, 150, 200 and 300 mg glyphosate per litre (ppm). In other words the system was 96% water. Soil moisture varies widely, but a typical soil sample will contain on the order of 10% water and capacity to hold water may be above 100%.

Desorption was assessed by filtering the soil out of the suspension and resuspending it in 10 ml of glyphosate-free solution, and measuring the amount of glyphosate that was released from soil into the solution. Without trying to describe the physical chemistry of-the soil-glyphosate equilibrium, I suspect that this is the behavior to be expected at the low soil concentrations and high glyphosate concentrations.

The concentrations of glyphosate were very high. A two kilogram per hectare application directly to water 30 cm (one foot) deep will produce a hypothetical concentration in water of about 0.7 ppm. Fifty ppm, the lowest concentration tested by Piccolo et al, is about 70 times higher.

If glyphosate available is related to soil available for binding, 1.25 mg glyphosate is present in the solution per gram of soil. If all of the glyphosate was in fact bound to soil, the concentration in soil would be 1250 ppm. In the 300 ppm solution the concentration would be 7500 ppm.

These figures may be compared with concentrations in the field measured by Roy et al (ref 27) which were roughly 200 ppm in the ~rganic layer and zero in the upper mineral layers of a cleared forest floor. Feng and Thompson (ref 26) reported a concentration of about 2500 micrograms per core (30 cm deep x 10 cm diameter) in soil with the highest levels just after : application. If the core is of density one its weight would be - over 2000 gm, so in this extreme case the concentration in soil would be somewhat over 1 ppm.

It is remarkable that glyphosate has such a high affinity for

soil in such a dilute aqueous system.

Page 16, col ~, ground and surface water contamination. It is difficult to resist being amused by this paragraph. Certainly it is a fact that glyphosate has been found in surface water. Several papers have already been discussed in which the herbicide applied in forestry has been measured in stream water. The measurements by Frank et al (ref 30) hardly qualify as a suggestion that glyphosate is likely to be found in water. They report two incidents in rural ponds with glyphosate, one of runoff from a field leading to a concentration of 42 ppb and the other a spill resulting in 112 ppb. Neither is acceptable; neither will harm organisms in or using the water. These are among a multitude of other pesticide incidents that contaminated ponds, over a 14 year period.

In World Health Organization Environmental Health Criteria 159 (ref 1) is a list of findings of glyphosate in various environmental media around the world. Why the Netherlands was chosen from this list by Cox as an example is difficult to judge. One sample was reported, at a concentration of one ppb. Some others elsewhere in the world were as high as a part per million.

I suppose the best response here is to suggest that a more faithful use of the findings reported in the review by the World Health Organization would have provided a better service to the reader than the rather odd selection of comments used here.

Page 16, col 3, Effects on non-target animals.

The report by Hassan et al (ref 35) is a summary of a multilaboratory effort to assess effects of some 21 pesticides on beneficial organisms. It is difficult to interpret because exposure conditions were not clearly indicated and control data were not included. Roundup (1%) was apparently applied to a surface occupied by the test species and allowed to dry. There was no indication of the duration of exposures, and it is not certain whether the material was applied on a glass or leaf surface. There were no control data presented. The organisms were stated to be of a common life-stage, but the stage was not specified, nor was there indication that the stage was of high or low sensitivity.

Of the 21 pesticides, including four herbicides, Roundup appeared to cause the least effect, within the rather broad criteria for ~effect.

Page 16, col 3. Bottom
The term "similar impacts" used by Cox implies that glyphosate is toxic to the beetles, referring to Brust (ref 36). Brust clearly

states that the effect is due to the change in vegetation following treatment. The maximum effect in field plots was a decrease to 72% of control at 14 days. In terms of population biology, this is not a serious decrease.

He also conducted direct toxicity studies that raise questions about the toxicity to carabid beetles indicated in ref 35. Rearing boxes were sprayed at a field rate with Roundup, the beetles were dipped in the same tank mix, then maintained for one year. The author's conclusion is that "The results of this study demonstrate no direct acute or chronic toxic effect of the herbicides atrazine, simazine, glyphosate or paraquat to the five common carabid species tested."

Page 17, col 1, top. The same implication of toxicity to carabids seems to be made in reference to Asteraki et al (ref 37). As the title of the report shows, the effects were on habitat, and the treatment was intended to "kill all flora at the base of the hedge". The effects were substantial, but they had nothing to do with insect toxicity.

Similarly, the report by Santillo et al (ref 38) discusses habitat change, not toxicity.

page 17, col 1, aquatic insects. The discussion of midge larvae starts with a statement that the insects are killed by glyphosate in amounts that vary widely. Reference is made to Buhl and Faerber (ref 39) for the fact that these larvae are important to breeding waterfowl, and further in the paragraph to their finding of a median lethal concentration (LC~) of 5600 ppm for glyphosate. Cox might have added that Buhl and Faerber also state that glyphosate is "practically nontoxic".

The report by Folmar et al (ref 6) is also cited, with an LC50 of 55 ppm after 48 hours of exposure. There is no possibility of such a level unless a direct spill of concentrate occurs. Direct application of 2 ~g/ha on water 30 cm deep would result in a concentration of about 0.7 ppm.

Henry et al (ref 40) sum up the answer to this question well, with the statement in their abstract: "The use of Rodeo (applied as a tank mixture with X-77 Spreader and Chem-Trol) as a management tool in wetlands does not pose an acute hazard to native aquatic invertebrates because the concentrations of ~odeo, X-77 spreader and Chem-Trol found to be acutely toxic to these invertebrates were much higher than their expected or measured concentrations in water from wetlands treated with the RTM." (RTM is Rodeo tank mixture.

One may speculate why Cox chooses to suggest that this herbicide

puts aquatic invertebrates at risk when such abundant evidence to the contrary is in her hands.

Page 17, col 1, bottom. The 1986 guide for reregistration of glyphosate (ref 41) is cited as indicating that an endangered species of longhorn beetle would be jeopardized by use of glyphosate. As the guidance document points out, this is a habitat question and is to be mitigated by appropriate labeling.

Of more importance, the Reregistration Eligibility Document (ref 4), to which Cox has made reference several times earlier, states: "Based on the toxicity data and the estimated exposure, it is not expected that endangered terrestrial or aquatic organisms will be affected from the use of glyphosate on the registered uses since the EEC's are well below the endangered species criteria (birds = 1/10 LC_{50}. Aquatic organisms=1/20 LC_{50}". The document goes on to discuss endangered plants, and the habitat of the Houston Toad.

Page 17, col 2. The report by Hassan et al (ref 35) has been discussed above (Page 16, col 3). The woodlouse studied by Mohamed et al (ref 42), is a species inhabiting non-irrigated soil. The exposures were in glass chambers 9.3 cm in diameter. Filter papers saturated with solutions of 25 or 50 ppm glyphosate were placed in the bottom of the dishes and the subjects placed in the chambers with appropriate nourishment. Exposure duration was 7 days. At 25 ppm there was a slight effect, but no lower doses were used. How this kind of exposure relates to a typical soil concentration on the order of a part per million in most cases is difficult to say, since the dose response data was not obtained, but the results suggest that glyphosate at concentrations that may occur in soil (see ref 4) will not be sufficient to harm insects.

The authors comment that it is likely that effects in the field are probably due to microhabitat alteration.

The aquatic effects mentioned in the same paragraph are evident only at concentrations higher than will occur in typical operational spraying.

Page 17, col 3, bottom; 18, col 1, top. Effects on fish. The information in this section is fractional but not incorrect, as far as it goes. However, the implication is still obvious that use of this herbicide represents a significant risk to fish populations. The details and conclusions of the referenced papers, as well as the official regulatory documents do not support that idea.

Mitchell et al (Ref 46) conclude with respect to Roundup and

Rodeo that "No acute toxicity hazard to aquatic environments would be expected during the course of normal usage."

Wan et al (ref 47, 48) observed both species and water quality differences, but the LC50 for 96 hour exposure to Roundup for the most sensitive species and condition was 10 ppm as mg of product per litre. This level can only be accomplished through a spill.

Holdway and Dixon (ref 49) observed differences between fed and starved fish, but as they state in the abstract to the report: "Glyphosate proved to be relatively non-toxic to flagfish up to 30 mg L^{-1}.

Holtby (ref 50) found increased temperatures for two years, not "several". His comment about repeated use concerned application to several sites on a main stem stream over a relatively short span of years, with a cumulative loss of cover and consequent increase in river temperature. Changes observed were small with respect to potential changes in toxicity. Most important, the experiment was a deliberate overspray, not an operational treatment. Buffers are intended to prevent temperature changes, and are successful.

Morgan et al (ref 51) also illustrates that effects of glyphosate or its formulations on fish are unlikely. Observing avoidance and behavioral responses, they found thresholds of effect much higher than concentrations that will be found in operational treatments: "Nominal concentrations of the herbicides causing threshold changes in fish behavior were 37.5 ppm Vision-10% surfactant, 13.5 ppm Vision-15% surfactant,---". It is obvious that these responses will not occur in any situation other than near a spill of concentrate.

Page 18, col 1, bottom, Effects on birds. As indicated in JPR the impacts on birds are secondary to habitat change, but they appear overdramatized. MacKinnon and Freedman (ref 53) remark: "Overall, the data presented here suggest that there are relatively small and short term effects of the silvicultural use of glyphosate on the prominent bird species of regenerating clearcuts. In comparison, considerably larger effects on the avifauna are associated with stand harvesting, especially by clearcutting." Santillo et al (ref 54) convey much the same message: "Leaving untreated patches and staggering herbicide treatments on large clearcuts will maintain bird populations similar to those on untreated clearcuts."

The study of black grouse by Eggestad et al (ref 55) followed si males and four females with radio collars in late spring and early summer, in an region in which several plantations had been treated with glyphosate, during various prior years. They were

not able to establish statistical significance because of the small number of birds and naturally erratic movement. They found that both sexes avoid sprayed areas for one to two years after treatment, that females use treated areas regularly by four to six years after treatment, but similar information for males is equivocal.

Page 18, col 2, bottom The "strong reduction" noted (ref 58) was in hare fecal pellet count, and lasted for one year. Second and third year counts were lower than before treatment but not significantly different.

Page 18, col 2, bottom, Earthworms. The report by Springett and Gray (ref 59) is rather difficult to understand. Single worms were placed in culture vessels 11 cm in diameter and one cm deep, and sprayed every two weeks for 100 days, with about 0.05, 0.1 and 0.2 times what was stated to be a "commercial" rate of application. However, that commercial rate was stated to be 14.4 grams per hectare, which is about 1 200 of a typical rate. This level is far below any amount known to affect other organisms. The fractional doses all produced the same response in decreased weight gain; in other words there was no dose response.

There is no information in this paper. I do not understand how it was published, let alone used as evidence.

Page 18, col 3, Nitrogen fixation
A series of papers (ref 61-63) are used by Cox as evidence that glyphosate interferes with nitrogen fixation and related reactions. The implication is that these effects are to be expected when glyphosate is used. The quoted work uniformly shows that such effects are not to be expected.

Martens and Bremner (ref 61) evaluated the amounts of urea hydrolyzed and nitrate and nitrite formed in four soils, treated with 5 and 50 mg active ingredient per kg soil (50 and 500 ppm). There was no effect on urea hydrolysis. At 50 ppm, nitrification was inhibited to the extent of 57%, which decreased to 7% at 21 days. There was apparently no effect at 5 ppm. Soil concentrations operationally are far below that level.

The authors conclude that "the 13 herbicides studied are not likely to substantially affect nitrification when they are applied to soils in conjunction with urea fertilizers."

Eberbach and Douglas (ref 62) did find an effect of glyphosate on Rhizobia at 2 ppm in soil, which approaches levels that may be found after application. They did not establish whether the effect was on the bacteria directly or on the plants they depend on for energy. The latter seems more likely, given knowledge

from other experiments.

The use of the work of the Stratton (ref 63) or Tu (ref 64) as evidence that glyphosate has a significant inhibitory effect on nitrification is gross misrepresentation. Stratton treated soil at "field rates" (FR) (9.63 to 29.26 ppm) and at levels up to 100 times higher. "Glyphosate had no deleterious effect on nitrification in any soil when tested at FR concentrations. In the sandy loam soil nitrification was significantly stimulated at a glyphosate level 50 times higher than FR." Levels above 199 times FR were required for inhibition. "The use of glyphosate in agriculture and forestry should have no toxic effects on nitrification in soil."

Tu (ref 64) found somewhat greater sensitivity, with soil containing 10 ppm glyphosate transiently inhibiting formation of nitrate and nitrite from reduced nitrogen such as ammonia to the extent to about 70% of control. The formation of ammonia from organic nitrogen, an denitrification were not affected significantly. Tu stated that "The microorganisms recovered rapidly." And "There is little evidence to suggest that these pesticide treatments have any prolonged deleterious effect on the soil microbial activities."

Carlisle and Trevors (ref 65) evaluated nitrogen fixation, denitrification and nitrification in soil, with ad without glucose added as an energy source for microorganisms. There was no effect on nitrogen fixation, even at concentrations of formulation up to 635 ppm, an astronomic level. Denitrification was affected slightly at the lowest concentration (12.7 ppm) in terms of both N_2O production and consumption, but not at higher concentrations. Nitrate and nitrite formation were affected at the highest concentrations, but not at 76.7 ppm.

As did other researchers, Carlisle and Trevors concluded that no effects are likely to result from the use of glyphosate: "In all cases, inhibition and stimulation occurs at herbicide levels far greater that those involved in normal field application of glyphosate." and "Thus at recommended application rates of this herbicide, no effects on soil N cycling activities should be observed."

Moorman et al (ref 66) studied the effect in culture of glyphosate at concentrations ranging from 116 to 2332 ppm, on inhibition of aromatic amino acid synthesis by nitrogen fixing Rhyzobium. These concentrations vastly greater than would be found in soil, but Moorman et al express concern that glyphosate might concentrate in plant roots at concentrations sufficient to have an effect.

Märtensson (ref 67) did not examine nitrogen fixation as such, but did study components of the system, at concentrations of 10-100 ppm in the medium. At the lowest concentration there seemed to be little effect on growth of Rhizobium species in broth, on growth of small seeded legumes, root hairs of red clover, or dry matter production of clover roots. Nodule formation of red clover roots was inhibited, however.

The author remarks that the concentration used are not likely in normal application, but, like Moorman et al (ref 66), expresses concern that unique situations of localized high concentration could occur. It should be noted that these studies were in culture media, where there is free distribution of added chemical and no degradation by microorganisms. As several authors quoted by JFR point out, such conditions enhance toxicity to cultured organisms. (see below)

Eberbach and Douglas (ref 68) also are quoted as evidence for effects on nitrogen fixation. Their comment is useful: "—the predictions in Table 3 suggest that at field application rates, these herbicides would cause little damage to legume nodulation."

Page 19, col 1, Toxicity to mycorrhizial fungi.
Estok et al (ref 70) evaluated glyphosate toxicity to ectomycorrhizial fungi in agar culture. One of the three species was inhibited nearly 50% at a concentration of one ppm. The other species were not affected at 10 ppm. Estok et al qualify the finding with a caution, that agar medium represents a very different condition from the environment of the forest floor:

1. Uptake of herbicide in the hyphae.
2. The organisms used are laboratory stocks grown for many generations on specific enriched media and are highly susceptible to environmental change, unlike wild organisms.
3. Agar is an aqueous medium with no barriers to diffusion of chemicals to sensitive sites, unlike the soil, where a large fraction of the material is immobilized.
4. No degradation of herbicides takes place in the agar medium, nor is there any other mechanism of removal.

Chakravarty and Chatarpaul (ref 71) treated a sandy soil with glyphosate at 0.54 and 3.23 kg a.i./ha and observed the effect on microbial populations and metabolism. They found a short term (1 month) decrease in fungal and bacterial population which recovered by the six-month measurement. Curiously, overall metabolic activity did not change at any time.

There is an error in notation in presentation of data for effects on ectomycorrhizial fungi in liquid medium. They state the concentrations of formulation to be 0.1 to 1000 micrograms per

litre of medium (0.001 - 1.1 ppm), but in Table 4 these are stated to represent 35.9 to 359,900 micrograms of active ingredient per liter (0.036 - 360 ppm). Given findings in other work, the active ingredient amounts are probably correct and the statement of formulation amounts should be in <u>milligrams</u> per litre, a thousand fold difference.

The threshold of effect is therefore between 50 and 100 ppm, concentrations that cannot be achieved in the field, even if the caveats expressed by Estok et al (ref 70) are ignored. The authors point out that where effects were seen the herbicide rates were many times higher than would be expected to occur with operational use.

In related work, Sidhu and Chakravarty (ref 72) conducted tests of glyphosate and other herbicides on seedling growth and ectomycorrhizial development under aseptic conditions. According to their notation, an effect was seen at a concentration of 0.1 microlitre of formulation per litre of medium, or 0.039 micrograms per litre. This is 0.4 parts per billion, which makes no sense in the light of all other work, particularly an earlier paper by the same authors (ref 73) in which effects were not observed at concentrations below 10 ppm. I am concerned that the same confusion of notation may have occurred that was seen in ref 71, by one of the same authors. In short, it is not possible to tell at this time what the work in reference 72 means.

EU LETTER DID NOT THREATEN BAN ON FISH.... ..CONCURRED WITH LVEMP ON WISE USE OF CHEMICALS....

Note No. 3298/EGR-mk

Fax no: 2

EUROPEAN UNION

DELEGATION OF THE EUROPEAN COMMISSION
IN THE REPUBLIC OF UGANDA

FOR MR. OBE

Note no. 3298.96/EGR-mk

The National Authorising Officer
Ministry of Finance
Kampala

10 October 1996

Subject: Control of Water hyacinth on Lake Victoria

Ref.: (a) Note from UFPEA dated 03/09/96
(b) Fax Message from UFPEA dated 26/09/96

Dear Sir

Please find attached copy of the above referenced correspondence received from Uganda Fish Processors and Exporters Association (UFPEA), for you information and action to be taken.

Following consultation with my Headquarters in Brussels, please find hereafter my comments:

Reports received and communication in the Uganda media indicate the intention to use 2, 4D, Glyphosate and Diquat for the control of water hyacinths in Lake Victoria. The UFPEA draws the attention on a number of possible negative impacts which could result from the use of these chemicals.

The following possible negative impacts have been mentioned:

- non-selective herbicides will also destroy other non-target weeds such as phytoplankton, which being the first link in the food chain will affect higher consumer levels and more in particular algivorous fish (Tilapia);

- because of aerial drifting non-selective herbicides may also provoke crop damage;

- sinking decaying week masses after treatment will create anoxic conditions in the water and thus affect all aquatic life;

- chemical residues in the water makes in unsuitable as drinking water. The lakes and other natural water bodies in Uganda are the main source of drinking water and water for domestic uses and for bathing of the riparian populations. Lake Victoria is supplying water for drinking and domestic use for the major cities of the country Kampala, Jinja, Entebbe and the coastal communities;

- chemical residues makes the water also unsuitable for irrigation;
- chemical residues can build up through the food chain in fish and finally in humans;
- several adverse effects on human and animal health have been reported in toxicological testing;
- alternative utilisation of water hyacinth as for instance soil additive or animal feeds is excluded when contaminated with herbicides.

The Commission of the European Union is most concerned about these possible effects of herbicides in Lake Victoria and other water bodies and strongly recommends to apply an extremely careful approach.

A large number of donors, including the European Commission, have supported in the past and are now supporting a vast range of approaches for the control of water hyacinths in Lake Victoria. I am aware that some of these donors have addressed those priority environmental concerns listed in the UFPEA note.

In this context, I am in particular thinking of the large scale Lake Victoria Environmental Management Project (77.6 M US$), financed by the World Bank. The World Bank Financing Report states that 20% of the total project costs will be directed toward studies, 42% towards capacity building and 38% towards direct actions.

The control of water hyacinths figures in a prominent position in this report (US$ 8.31 million) from which I quote ... "This will be achieved by an integrated effort involving intensified publicity, legislation and integrated pest management with community involvement. The control programme will rely on mechanical methods and limited chemical interventions for rapid short term control in restricted areas and biological agents for longer term control. Reducing nutrient inflows into the lake will be a vital element in long term approaches".

As you will certainly understand, I am much concerned with the possibility of duplicating efforts with another donor, except if there is an unequivocal expression of interest from the Ugandan Government, which will also specifically determine the need for the Commission's involvement.

Only in such a case would I support a request to finance a project particularly aiming at:

- the actual application of various ways of mechanical removal and the use of biomass for composting, biogas production, pig feeding etc.. and

- the use of those weevil species that have been used and foun effective and without risks in other parts of the world includin Kenya and Uganda, but not in the particular environment of Lak Victoria.

As, to my knowledge, the Heads of Mission of the Member States of the Europea Union accredited to Uganda have been seized by the water hyacinths problem, a cop of this letter will be addressed to each of these Heads of Mission.

Yours faithfully

Antonio Marongiu
Head of Delegation

Encl: (a) Note from UFPEA dated 03/09/96
(b) Fax Message from UFPEA dated 26/09/96

c.c. Uganda Fish Processors and Exporters Association
P.O. Box 7318
Kampala

Attn.: Mr. Philip Borei de Bitche, Chairman

ATTEMPTS TO ADVISE EU BY UFPEA ... INCORRECT INFORMATION

Pg. 2 second last Chapter "... All of them (herbicides) .. non-selective, ..persistent in the environment and to be toxic to animals and humans."

UFPEA Uganda Fish Processors and Exporters Assoc

Delegation of the Commission of the European Communities in Uganda	
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C/o P.O. Box 7318
Tel: 243122
243066
220793
KAMPALA, UGANDA

Our Ref:

Your Ref:

Date:

To: Mr. Caisso
The Delegation of the CEC
Kampala, Uganda

3 September 1996

Dear Sir,

Our Association groups the companies that process and export fisheries products from Uganda. The main markets for both our chilled and frozen products are located in the EU member states.

We are worried about the latest turn of events in relation to the use of chemicals to control the water hyacinth in the natural water bodies of Uganda.

Great concern has risen over the infestation of water hyacinth in the natural waters of Uganda. Presently the serious negative implications of the development of water hyacinth have become apparent such as the interference with hydro-electricity production at the Owen Falls Dam in Jinja, interference with water intake points (Gaba, Entebbe), hindrance of boat traffic and docking in the lake (Port Bell), blocking of landing sites of fishermen, interference with net fishing. Further the large water hyacinth mats affect the water quality for example by decreasing oxygen in the water and cause oxygen deficiency and anaerobic conditions when decomposing thus affecting the bio-diversity of the ecosystem and fish production. It also increases waterborne diseases because it harbours disease vectors such as snails, insects.

Three methods are available for the control of the water hyacinth, physical removal (manual and mechanical), biological control and chemical control.

So far, only unco-ordinated activities have been undertaken by the Government, parastatal organisations and donors.
The Fisheries Department has made arrangements to procure 2 weed harvesters plus trucks, barges and spares (donated by the Netherlands government). This equipment has not yet arrived.
The World Bank provided funds for the introduction of bio-agents (the weevil species *Nicotine eichhorniea* and *Neochtina Bruchi*), but currently the level of release is insufficient and testing for the host specificity of the weevils is still underway.
URC, UEB and NW&SC are physically clearing the weed to protect their installation. The engineers of UEB have built their own harvester locally, which is presently operated successfully near the Dam in Jinja in combination with manual removal by labourers.
Also in the private sector, some small initiatives were launched with fishing communities to clear fish landing sites manually with varying success.

UFPEA
Uganda Fish Processors and Exporters Ass

C/o P.O. Box 7
Tel: 243122
243066
220733
KAMPALA, UGA

Our Ref:

Your Ref:

Date:

The responsibility to co-ordinate, supervise, monitor and implement all activities for the control of the water hyacinth have been placed with the Fisheries Department of MAAIF. Recently to this effect a National Technical Committee on the Control of the Water Hyacint (NTCWH) has been set up to facilitate the co-ordination of all concerned ministries, donors and private sector contribution.

Also just recently UNDP is assisting the Fisheries Department with an Emergency Water Hyacinth Reduction Programme aimed at co-ordinating all intervention by the Government and donors, conducting feasibility studies of all recommended programmes, sensitising communities and the general public on the methods to be adopted, preparing a preliminary frame work for the long-term management of the water hyacinth.

Further some regional programmes for the management of natural resources exist Kagera Basin Organisation (KBO), TECONILE and Lake Victoria Environment Management Programme(LVEMP). The LVEMP has been set up to look into the problems of management of Lake Victoria environmental resources in the medium and long-term perspective. Also the control and management of the water hyacinth has been integrated into the project.
Concerations with and consent of all riparian countries of the Nile Basin is needed for the use of chemical and biological control methods.

Several donors have expressed interest and preference to fund certain items of the Emergency Action Plan such as Japan (harvesters), ODA (weed barriers), USAID (herbicides, aerial survey, regional co-ordination, Akagera River weed barrier).
At present of all the proposed strategies, only the use of herbicides is under study. USAID has provided 1 million US$ of funds through a US-based consultancy firm Aquatics Unlimited, which was appointed to conduct trials with chemicals and an impact assessment study on the use of chemicals and to install a weed barrier on the Akagera River. The first chemical trials have already been carried out in Kajjansi.

The chemicals earmarked for use are 2,4 D, Glyphosate and Diquat. All of them are known to be non-selective, to be persistent in the environment and to be toxic to animals and humans.

The following possible negative impacts have been reported:
- non-selective herbicides will also destroy other non-target weeds such as phytoplankton, which being the first link in the food chain will affect higher consumer levels and more in particular algivorous fish(Tilapia)
- because of aerial drifting non-selective herbicides will also provoke crop damage
- sinking decaying weed masses after treatment will create anoxic conditions in ... thus affect all aquatic life

UFPEA Uganda Fish Processors and Exporters Assc

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Our Ref:

Your Ref:

Date:

- chemical residues in the water makes it unsuitable as drinking water. The lakes and other natural water bodies in Uganda are the main source of drinking water and water for domesti uses and for bathing of the riparian populations. Lake Victoria is supplying water for drinking and domestic use for the major cities of the country Kampala, Jinja, Entebbe and th coastal communities.
- chemical residues makes the water also unsuitable for irrigation
- chemical residues can build up through the food chain in fish and finally in humans
- several adverse effects on human and animal health have been reported in toxicological testing
- alternative utilisation of water hyacinth as for instance soil additive or animal feeds is excluded when contaminated with herbicides

Considering the possible risk to human health, it is questionable that the first trials to test application strategies have been carried out in Kaijansi of all places, a very populated centre near Kampala. Also in-lake trials are already planned. And the impression exists that the Fisheries Department wants already to go ahead with implementation of a full programme of chemical spraying without waiting for the completion of the trials and the impact assessment and the testing and appraisal of other methods of control.

In the light of all these possible negative impacts of the use of chemicals, the fish processors are also very concerned about the reaction of the consumers on the EU market, their sole export destination. We fear the possible accumulation of residues in fish.
We therefore believe that there is a need to bring in a team of independent qualified experts from Europe to conduct a more comprehensive impact assessment study on the aquatic environment and on public health, including also this aspect of residue accumulation in food/fish; and also to stress EU regulations on the use of herbicides in aquatic environments and on the presence of chemical residues in food products and fish products.
We also feel that more efforts need to be done to study and develop environmentally friendly methods and to explore the possible utilisation of water hyacinth as soil additive, animal feed for instance.
And we intend to take steps to put a stop to any further trials in the lake and in populated areas until all aspects have been thoroughly investigated and assessed.

We hope that the EEC can give some assistance and valuable recommendations in these extremely urgent matters.

Yours sincerely

Philip Borel de Bitche
President

Delegation of the Commission of the European Communities in Uganda
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UGANDA FISH PROCESSORS AND EXPORTERS ASSOCIATION

FAX

DATE : 25/09/96
FROM : MR. PHILIP BOREL
TO : THE DELEGATION OF THE EUROPEAN UNION TO UGANDA
ATTN : MR. CAISSO
FAX : 041 233708

Dear Sir,

Following our phone conversation of this morning, I wish to re you that we sent a note of three pages, dated 03/09/96, regard the issue of utilization of chemical herbicides to control the water hyacinth on Lake Victoria, by the Uganda Authorities.

It appears that trial sprays will very soon be conducted on wat hyacinth in Lake Victoria, prior to completing the Environment [illegible] of trial sprays on the ponds in Kajansi.

We consider therefore that it has become extremely urgent to receive expert advice requested in our note of September 3rd, 1996.

Would it be possible to receive without delay an official European Union position in addition to the expert advise we are seeking?

We also wish to inform you that a fisheries consultant with the Centre for Development of Industry (C.D.I), based in Brussels, Mr. Erik Botsaert, has expressed full willingness to assist with any move geared at clarifying the points mentioned in our note.

Mr. Botsaert has visited Uganda several times on mission for the CDI within the assistance provided by this organization to our fish processing industries.

CDI TELEPHONE : +32-2-6781933
FAX : +32-2-6752803

We thank you in anticipation and remain.

Yours sincerely,
UGANDA FISH PROCESSORS AND EXPORTERS ASSOCIATION

Philip Borel
CHAIRMAN

24/9/96

→ MK = please forward to Borel's services (same as previous fax + reminder)

LVFO COUNCIL OF MINISTERS..

Pg. 4, Chp. 11: Adoption of Management and Conservation measures

"... On the control of water hyacinth the Council of Ministers adopted the recommendation made in Nairobi for LVEMP which is an integrated approach involving manual, mechanical, biological and chemical methods... limited application in restricted areas for short periods...."

LVFO/CM.1/REP

LAKE VICTORIA FISHERIES ORGANIZATION

COUNCIL OF MINISTERS

First Regular Session

Kampala, Uganda, 19 December 1996

Report of the First Regular Session of the Council of Ministers

1. The First Session of the Council of Ministers of the Lake Victoria Fisheries Organization, convened by the Director General of FAO, was held in Kampala on 16 December 1996. Kenya and Uganda were represented by Hon. Darius M. Mbela, Minister of Tourism and Wildlife and Hon. Lawrence Kezimbira-Miyingo, Minister of State for Agriculture Animal Industry and Fisheries respectively. The United Republic of Tanzania was represented by Ms Rose Lugembe, Principal Secretary, Ministry of Natural Resources and Tourism. The list of all participants to the Session comprising, the delegations of the three countries concerned, representatives of FAO as well as observers of countries, intergovernmental organizations and other entities invited to attend as observers is given in Annex 1.

List of documents

2. The list of documents of the Session (document LVFO/CM/1/2) is attached as Annex 2.

Opening of the Session

3. The Session was opened by the Guest of Honour, H.E. Dr. Speciosa Wandira Kazibwe the Vice-President and Minister of Agriculture, Animal Industry and Fisheries. Mr. N.A.L. Lexander, FAO Representative in Uganda, who chaired the session until the Chairman was elected, delivered a speech, on behalf of the Director General of FAO. In his speech, he emphasized the importance of regional collaboration in the management of the fisheries of Lake Victoria and the urgent need of the International Donors Community in assisting the three countries to save the Lake from further environmental deterioration and depletion of fish.

The Vice President of the Republic of Uganda and Minister of Agriculture, Animal Industry and Fisheries H.E. Dr.Speciosa Wandira Kazibwe on behalf of the Host Government, Uganda, addressed the Session. The Vice President welcomed the Honourable Ministers and delegates from the sister states as well as, FAO, and the International Organisations who have assisted the three countries in solving the fisheries management problems. H.E. emphasized the importance of the lake as a source of protein and food security. In addition, the Vice President stressed the following:

- the importance of Lake Victoria which produces over 500 000 tons of fish for the population of the three countries.
- Lake Victoria as a corridor for transport between the states.
- this regional asset being threatened by the changing environment.
- the inflows into Lake Victoria impacting on the lake itself and requiring

consultation with the neighbouring states.

: the need for sustainable methods of harvesting of fish

: the need to improve the rural income of the poor people

: reduction of the post-harvest loss

: need for harmonizing fisheries legislation and regulations

: establishment of pollution guidelines for industrial and domestic sources

: education of the fisherfolk

: encouragement of fish farming to reduce pressure on fish stocks in the lakes. and

: establishment of a gene bank for the fauna and flora of the lake.

The speech of the Vice President is attached as Annex 3

4. The First Session adopted the agenda and timetable shown in Annex 4

Adoption of the Rules of Procedure of the Council of Ministers

5. The Council adopted the Rules of Procedure attached as Annex 5.

Election of the Chairman and the Vice Chairman of the Council of Ministers.

6. In accordance with Article V.3 of the Convention and Rule IV.1 of the Rules of Procedure of the Council of Ministers, Uganda was elected as Chairman of the Council of Ministers to serve for a two-year term until the Second Regular Session starts. Hon. Lawrence Kezimbira-Miyingo, Minister of State for Agriculture Animal Industry and Fisheries in Uganda took the Chair. The Council of Ministers elected Tanzania as Vice Chairman; Ms Rose Lugembe, Principal Secretary, Ministry of Natural Resources and Tourism of Tanzania took the Chair.

Approval of the Organization's Programme of Work and Budget .

7. The Council of Ministers adopted the Programme of Work and Budget as Annex 6 covering the two coming years from First January 1997. The equal contributions to be paid by each of the three countries, in accordance with Article XIV.1 of the Convention is US dollars 70,000= for each year of the biennium. The contributions for the year 1997 should be paid by 31 March 1997.

Decisions regarding the Organization's Financial Regulations and Appointment of the External Auditor.

8. The Council of Ministers adopted the provisional Financial Regulations to be attached as Annex 7. In accordance with Rule XII.1 of the Financial Regulations the Auditor General of Uganda was appointed as External Auditor of the LVFO on a permanent basis.

Decisions regarding the General Standards and Guidelines for the Management of the Organization.

9. The Council of Ministers adopted the General Standards and Guidelines attached as Annex 8.

Decision regarding the Organization's Staff Regulations.

10. The Council of Ministers adopted the Draft Provisional Staff Regulations with amendments in Rules 51 and 52. The Provisional Staff Regulations are attached as Annex 9.

Adoption of Management and Conservation Measures

11. The Council of Ministers adopted with minor changes the fish management and Conservation measures proposed. The list of the measures is attached as Annex 10. In accordance with Article XII.1 of the Convention, the Member States of LVFO will take all necessary measures, including legislative measures when appropriate, in accordance with their respective constitutional procedures and national laws, to implement these measures. On the control of water hyacinth the Council of Ministers adopted the recommendation made in Nairobi for the Lake Victoria Environmental Management Project which is an integrated approach involving manual, mechanical, biological and chemical methods. With respect to chemical control, there should be limited application in restricted areas for short periods. It was however, agreed that any information on control activities should be circulated to all member countries.

Adoption of the Rules governing the appointment of the Executive Secretary and of the Deputy Executive Secretary of LVFO.

12. The Rules attached as Annex 11 were adopted.

Appointment of the Executive Secretary and the Deputy Executive Secretary of LVFO.

13. Dr. M.J. Ntiba of Kenya was appointed as Executive Secretary. The Council of Ministers decided that the post of Deputy Executive Secretary should be occupied by a national of Tanzania. In the absence of nomination from this country for this post, it was decided that the Government of Tanzania should propose nominations to the Executive Committee in the next few weeks. The Permanent/Principal Secretaries will exchange notes and advise the Council of Ministers on the nomination, after which the Ministers will exchange notes and confirm the appointment.

14. The Council of Ministers noted that the Principal/Permanent Secretaries of the Ministries responsible for Fisheries should be more closely associated with the work of LVFO. It was proposed that the Convention establishing LVFO be amended, in accordance with its Article XX, to provide that the Principal/Permanent Secretaries constitute a policy steering committee which would be above the Executive Committee. In addition it was proposed that the Heads of the National Secretariat of LVEMP, be members of the Executive Committee as ex-officio.

Date and place of the next regular Session.

15. The Second Regular Session of the Council of Ministers will be held in Kenya in November, 1998 at a Venue to be communicated by the Government of Kenya.

16. The report adopted by the council of Ministers is duly signed by the following Ministers:

for Kenya

Hon. Darius M. Mbela, EGH, MP.,
Minister of Tourism and Wildlife.

for Tanzania

for

Hon. Dr. Juma Ngasongwa, MP.,
Minister of Natural Resources and Tourism.

for Uganda

Hon. Dr. Lawrence Kezimbira-Miyingo, MP.
Minister of State for Agriculture,
Animal Industry and Fisheries.

APPENDIX 2

ADDITIONAL INFORMATION ON THE MITIGATION SECTION

Impact Mitigation Matrix for Areas of Significant Concern Related to Aquatic Herbicide Use (Continued)

Large herbicide spills on land and water	Accidental spillage or leakage: Improper trans-portation. storage or handling	Potential air. soil and water contamination.	Contain. Control and Cleanup. Temporary evacuation or implement activity restrictions for persons living near to spill zones. Provide temporary accommodation with the help of the local authorities and compensate for damages. Mandate contractor risk insurance for liabilities as a result of spillage and cleanup. Abide by label guidelines and Ugandan laws for transport. storage and disposal of Agricultural Chemicals. (See Agricultural Chemical Reg.. 1993 Statutory Inst. Supplement No. 23. Part VI. Sect. 27 Transportation (1-8). Sect. 30-33 Storage. Use and Safety. and Part IX. Sect. 34 Disposal).
Use of waters for potable water (ground and surface). irrigation. recreation. industrial and livestock purposes.	Ignoring label guidelines. poor application techniques. unqualified applicators. and spill or leaks.	Possible short term contamination of water beyond maximum allowable levels.	Treatments that involve public water supplies waters or their tributaries should be referred to proper authorities for approval permit issuance. Inform users of application areas. times and any water use restrictions information. Follow label guidelines and any available water quality standards approved by Ugandan authorities.
Fishing activities	Ignoring label guidelines. poor application techniques. unqualified applicators.	Herbicide contaminat-ion of fish above allowable levels leading to rejection of fish and subsequent revenue loss for fishing communities government.	Follow label guidelines. practice good pesticide application techniques. and employ qualified applicators. In the event that herbicide residue levels in fish tissue exceed permissible regulatory limits. fish harvesting should cease until levels fall within acceptable limits. Compensation to fish exporters and local fishermen by government should be considered in the event of prolonged herbicide residues in fish. This situation is unlikely to occur unless there has been gross negligence by applicators.

Impact Mitigation Matrix for Areas of Significant Concern Related to Mechanical Equipment Operation

Area of Concern	Causes	Potential Negative Impact	Mitigation Measures
Fuel, lubricant, or coolant spills	Lack of care when adding fluids or carrying out mainten-ance activities. Loose fittings, worn out or damaged parts or hoses. Vessels capsize or sink. Fire.	Water contamination. Damage to macro/micro flora and fauna.	Carefully add all fuels and lubricants. Mop up any spills and dispose of properly. Adhere to maintenance schedules, carry out continuous spot checks on machinery. Repair or replace damaged or worn parts. Collect and discard used lubricants and containers in responsible manner. Ensure vessels are mechanically and physically sound. Do not overload nor perform operations which are not specified by manufacturer. Keep fire extinguishers in accessible areas, provide emergency contact numbers to operators or site managers. Keep oil containment booms and absorbent materials available or on board equipment at all time.
Fish, wildlife, and plants	Normal operation of mechanical equipment.	Harvest, injury, death to macro/micro flora and fauna. Collection of various species from harvested weed by workers for nutrition or financial supplement. Extermination of so called undesirable fauna (i.e. snakes, lizards, crocodiles) by workers.	Return all undamaged, harvested non target species to the water body. Injured or dead wildlife should be reported to the nearest District Forest Officer or to the Uganda Wildlife Authority for proper action.

Impact Mitigation Matrix for Areas of Significant Concern Related to Mechanical Equipment Operations

Extraction points, haul roads and dumpsites	Erosion of landing sites, roads and dumpsites. Soil instability.	Erosion, runoff and siltation at various points. Inappropriate or improper manage-ment of the various sites	Proper selection and layout of multiple sites allowing for optimum heavy equipment operation taking into account physical site factors such as soil, slope, drainage,.... Conscientious use of heavy equipment by personnel or management during various seasons (i.e. wet/dry seasons). Proper management and maintenance for the various sites.

Impact Mitigation Matrix for Areas of Significant Concern Related to Biological Control Techniques

Area of Concern	Causes	Potential Negative Impact	Mitigation Measures
Host specificity	Inappropr-iate agent selection. Poor testing techniques.	Damage to non target plants or crops.	Test wide variety of plants or crops. Follow Ugandan law with regard to biological testing and introduction.
Disease introduct-ion	Release of unquarant-ined insects.	Introduction of new plant or crop damaging pathogens.	Source only quarantined and certified disease free insects. Follow Ugandan laws with regard to biological testing and introduction.
Pollution due to excreta . Increased organic matter accumulat-ion.	Over population, toxic excreta, or mass insect die offs. Increased weed growth to counter herbivory by insect.	Water quality degradation. Stimulated growth and increased organic material deposition	Review literature, carry out tests to verify suitability of insect in program

APPENDIX 3

ADDITIONAL INFORMATION ADDRESSING FISH EXPORT CONCERNS

Codex Alimentarius (continued)

persistent pesticides no longer registered for use, but whose residues continue to appear in the environment or foodstuffs; the JMPR refers to the Joint FAO/WHO Meeting on Pesticide Residues). Only one country responded positively to the 3 questions, yet the Committee after reviewing all responses agreed that at present there was no need to recommend or adopt MRL's for fish poducts.

Lome Convention

Lome Conventions that govern development cooperation between the European Union and ACP (African, Caribbean, and Pacific Countries) administered through the European Development Fund states "the Lome Conventions give free trade treatment to most ACP exports (including fisheries, processed fruits, and vegetables) without reciprocal obligations on the ACP side".

This indicates that should fisheries products meet hygenic or any other standards, including pesticide residue limits, their free trade will be allowed. As no pesticide MRL's have been established for fisheries products by the Codex Alimentarius, continued trade should be ensured.

Rio Declaration on Environment and Development

Principle 15 of this Declaration states " In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation."

As the water hyacinth infestation can be considered as threatening serious irreversible damage and cost-effective measures (i.e. herbicide control option) has been identified, this Principle, therefore, in theory, supports the herbicide control option.

Furthermore, Principle 12 states " States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade. Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus.

World Health Organization (WHO) - International Programme on Chemical Safety (IPCS)

Information available in the Environmental Health Criteria Series indicate that no adverse affects are expected when the herbicides 2,4 D and Glyphosate are used in accordance with manufacturer's directions and applied by qualified applicators These documents are available for review at Mulago Hospital - Albert Cook Medical Library, 2nd Floor; the Ministry of Agriculture, Animal Industries, and Fisheries - Water Hyacinth Unit; and WHO Office in Entebbe. Refer to IPCS Environmental Health Criteria 159 - Glyphosate and Environmental Health Criteria 29 and 84 - 2, 4 D

World Bank Regulations

The World Bank follows the World Health Organization's *The WHO recommended Classification of Pesticides by Hazard and Guidelines to Classification* as part of it's activities in Agricultural Pest Management. In the 1992 -93 edition, Glyphosate is classified as a Class IV, Unlikely to Present Acute Hazard in Normal Use pesticide ; while 2, 4 D is classified as an Class II - Moderately Hazardous pesticide

In addition, "The Bank does not finance formulated products that fall in WHO Classes IA and IB, or formulations of products in Class II, if (i) the country lacks restrictions on their distribution and use: or (ii) they are likely to be used by, or be accessible to, lay personnel, farmers, or others without training, equipment, and facilities to handle, apply and store these products properly."

As both these herbicides are presently used in agricultural productions schemes in Uganda it assumed that Glyphosate and possibly both herbicides would meet the approval of any World Bank funded program under the World Health Organization criteria and, thus continuing exports of fish to European markets should be ensured.

Lake Victoria Environmental Management Program

As part of the development of the Lake Victoria Environmental Management Program (LVEMP), the Governments of Kenya, Tanzania, and Uganda on August 5, 1997, together with the International Development Association (IDA, a funding agency) agreed, among other things, that steps would be taken during project implementation, to minimise the possibilities of negative impacts or mitigate their effects. It was specifically agreed that, " herbicides used in the water hyacinth control program will be acceptable to IDA..."

As the IDA follows the same classification as World Bank which in turn refers to *The WHO recommended Classification of Pesticides by Hazard and Guidelines to*

Lake Victoria Environmental Management Program (continued)

Classification system, it appears that these herbicides satisfy the necessary requirements for use in a water hyacinth control program and the continued exports of fish to Europe.

Lake Victoria Fisheries Organization

The Lake Victoria Fisheries Organization, during their First Regular Session in Kampala (19 December 1996) and opened by the Director General of FAO, "adopted the recommendation made in Nairobi for the LVEMP which is an integrated approach involving manual, mechanical, biological, and chemical methods. With respect to chemical control, there should be limited application in restricted areas for short times".

The concerns of the region in regard to herbicide use and fish export issues seem to be, therefore, well addressed by the LVEMP and LVFO regional agreements.

ATTACHMENT 100

Joint FAO/WHO Food Standards Programme
Programme mixte FAO/OMS sur les normes alimentaires
Programa Conjunto FAO/OMS sobre Normas Alimentarias
CODEX ALIMENTARIUS COMMISSION
COMMISSION DU CODEX ALIMENTARIUS
COMISION DEL CODEX ALIMENTARIUS

VOLUME/VOLUMEN 2B

CODEX ALIMENTARIUS

Pesticide residues in food – Maximum residue limits
Résidus de pesticides dans les denrées alimentaires – Limites maximales de résidus
Residuos de plaguicidas en los alimentos – Límites máximos de residuos

SECOND EDITION (Revised 1996) | DEUXIÈME EDITION (Révisée 1996) | SEGUNDA EDICION (Revisada 1996)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
ORGANIZACION DE LAS NACIONES UNIDAS PARA LA AGRICULTURA Y LA ALIMENTACION

WORLD HEALTH ORGANIZATION
ORGANISATION MONDIALE DE LA SANTE
ORGANIZACION MUNDIAL DE LA SALUD

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WORLD HEALTH ORGANIZATION
ORGANISATION MONDIALE DE LA SANTÉ
ORGANIZACION MUNDIAL DE LA SALUD
Rome, Roma 1996

THE CODEX ALIMENTARIUS

Preface

The Codex Alimentarius Commission is the international body responsible for the execution of the Joint FAO/WHO Food Standards Programme. Created in 1962 by FAO and WHO the Programme is aimed at protecting the health of consumers and facilitating international trade in foods.

The Codex Alimentarius (Latin, meaning Food Law or Code) is a collection of international food standards adopted by the Commission and presented in a uniform manner. It includes standards for all the principal foods, whether processed or semi-processed or raw. Materials for further processing into foods are included to the extent necessary to achieve the purposes of the Codex Alimentarius as defined. The Codex Alimentarius includes provisions in respect of the hygienic and nutritional quality of food, including microbiological norms, provisions for food additives, pesticide residues, contaminants, labelling and presentations, and methods of analysis and sampling. It also includes provisions of an advisory nature in the form of codes of practice, guidelines and other recommended measures.

This is the second publication of the Codex Alimentarius. The first publication was in 1981. Prior to 1981 standards adopted by the Codex Alimentarius were published individually as Recommended Standards (CAC/RS series).

The Second Edition of the Codex Alimentarius is now being revised and updated to take into account decisions made by the 21st Session of the Codex Alimentarius Commission, July 1995.

INTRODUCTION

STATUTES OF THE CODEX ALIMENTARIUS COMMISSION AND IMPLEMENTATION OF THE FOOD STANDARDS PROGRAMME BY THE COMMISSION

The Codex Alimentarius Commission was established to implement the Joint FAO/WHO Food Standards Programme, the purpose of which is, as set down in the Statutes of the Commission, to protect the health of consumers and to ensure fair practices in the food trade; to promote coordination of all food standards work undertaken by international governmental and non-governmental organizations; to determine priorities and initiate and guide the preparation of draft standards through and with the aid of appropriate organizations; to finalize standards, and, after acceptance by governments, publish them in a Codex Alimentarius either as regional or world-wide standards[1].

The Statutes of the Codex Alimentarius Commission have been approved by the Governing bodies of the FAO and WHO. The Commission is a subsidiary body of these two parent Organizations. The Statutes and Rules of the Commission are to be found in the Procedural Manual of the Commission.

THE CODEX ALIMENTARIUS

Purpose

The Codex Alimentarius is a collection of internationally adopted food standards presented in a uniform manner. These food standards aim at protecting consumers' health and ensuring fair practices in the food trade. The Codex Alimentarius also includes provisions of an advisory nature in the form of codes of practice, guidelines and other recommended measures to assist in achieving the purposes of the Codex Alimentarius. The publication of the Codex Alimentarius is intended to guide and promote the elaboration and establishment of definitions and requirements for foods, to assist in their harmonization and, in doing so, to facilitate international trade.

Scope

The Codex Alimentarius includes standards for all the principal foods, whether processed, semi-processed or raw, for distribution to the consumer. Materials for further processing into foods are included to the extent necessary to achieve the purposes of the Codex Alimentarius as defined. The Codex Alimentarius includes provisions in respect of the hygienic and nutritional quality of food, including microbiological norms, provisions for food additives, pesticide residues, contaminants, labelling and presentation, and methods of analysis and sampling. It also includes provisions of an advisory nature in the form of codes of practice, guidelines and other recommended measures. Codex standards contain requirements for food aimed at ensuring for the consumer a sound, wholesome food product free from adulteration, correctly labelled and presented.

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[1] The Codex Alimentarius Commission decided, at its 14th Session in July 1981, that its standards, which are sent to all Member States and Associate Members of FAO and/or WHO for acceptance, together with details of notifications received from governments with respect to the acceptance or otherwise of the standards and other relevant information, constitute the Codex Alimentarius.

Acceptance

The standards and maximum residue limits adopted by the Codex Alimentarius Commission are intended for formal acceptance by governments in accordance with its General Principles.

The standards and maximum limits for residues of pesticides and veterinary drugs in foods and feeds, accompanied by an appropriate communication, are sent for action to Ministries of Agriculture or Ministries of Foreign Affairs, as appropriate, of Member Nations of FAO and to Ministries of Health of Member States of WHO. The standards and maximum limits for pesticide residues and veterinary drugs, accompanied by the communication referred to, are also sent to national Codex Contact Points, FAO and WHO Regional Offices, FAO Representatives, Embassies in Rome and Permanent Missions to the UN in Geneva.

The standards and maximum limits for residues of pesticides and veterinary drugs in foods and feeds, which have taken a number of years to develop, are the product of a wide measure of international agreement and cooperation. They are compatible with the norms considered by FAO and WHO as best guaranteeing the protection of the health of consumers and the facilitation of international trade in food.

Current volume

This volume contains Codex Maximum Residue Limits for Pesticides and Codex Extraneous Maximum Residue Limits adopted by the Commission up to and including its 21st Session based on the advice of the Codex Committee on Pesticide Residues. The Codex Maximum Residue Limits and Codex Extraneous Maximum Residue Limits are generally consistent with the recommendations of the Joint FAO/WHO Meeting on Pesticide Residues (JMPR).

The JMPR is composed of independent scientists who serve in their individual capacities as experts, but not as representatives of their governments or organizations. The goal of JMPR evaluation of pesticide residues is to establish safe levels of intake by setting Acceptable Daily Intakes (ADIs) and to develop maximum residue limits when pesticides are used in accordance with good agricultural practices.

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LISTS OF
CODEX MAXIMUM RESIDUE LIMITS FOR PESTICIDES AND CODEX EXTRANEOUS MAXIMUM RESIDUE LIMITS

LISTES DES
LIMITES MAXIMALES CODEX POUR LES RESIDUS DE PESTICIDES ET DES LIMITES MAXIMALES CODEX POUR LES RESIDUS D'ORIGINE ETRANGERE

LISTAS DE
LOS LIMITES MAXIMOS DEL CODEX PARA RESIDUOS DE PLAGUICIDAS Y LOS LIMITES MAXIMOS DEL CODEX PARA RESIDUOS EXTRAÑOS

EXPLANATORY NOTES

In the following lists the pesticides are listed in numerical order of the Codex code number. The missing numbers represent pesticides (a) for which Maximum Residue Limits (MRLs) or Extraneous Maximum Residue Limits (EMRLs) are being elaborated, (b) residues of which are covered by Codex MRLs for related compounds, (c) Codex MRLs or Codex EMRLs of which previously established have been withdrawn, or (d) for which only "guideline levels" have been recommended by the Joint Meeting on Pesticide Residues pending toxicological clearance of the pesticide and its residues.

The Codex MRLs or EMRLs for a pesticide are arranged in the alphabetical order of code letters of commodities and then numerical order of code numbers of commodities. Codes and names of commodities are found in the Codex Classification of Foods and Animal Feeds (Section 2 of Codex Alimentarius, Second Edition, Volume 2 (1993) or Section 1 of Codex Alimentarius, Second Edition, Volume 2A (1995)).

BASIS FOR ESTABLISHMENT OF CODEX MAXIMUM RESIDUE LIMITS FOR PESTICIDES

Codex Maximum Residue Limits are recommended on the basis of appropriate residue data obtained mainly from supervised trials. The residue data thus obtained reflect registered or approved usage of the pesticide in accordance with "good agricultural practices". These may vary considerably from region to region owing to differences in local pest control requirements which are due to a variety of reasons. Consequently, residues in food, particularly at a point close to harvest may also vary. In establishing Codex MRLs, these variations in residues due to differences in "good agricultural practices" are taken into consideration, as far as possible on the basis of available data.

As Codex MRLs cover a wide spectrum of use patterns and "good agricultural practices" and need to reflect residue levels closely following harvest, they may occasionally be higher than the levels of residues found in national surveillance activities. This may be especially so with easily degradable pesticides and when analysis is carried out at a point in the distribution chain far removed from the last application of the pesticide.

Codex MRLs are established only where there is supporting evidence concerning the safety to humans of the resulting residues as determined by the Joint FAO/WHO Meeting on Pesticide Residues and this means that Codex Maximum Residue Limits represent residue levels which are toxicologically acceptable.

BASIS FOR ESTABLISHMENT OF CODEX EXTRANEOUS MAXIMUM RESIDUE LIMITS

Another type of Codex Maximum Limit, the Codex Extraneous Maximum Residue Limit refers to residues of compounds, which were used as pesticides but are not any more registered as pesticides, arising from environmental contamination (including former agricultural use of pesticides) or uses of these compounds other than agricultural uses. These residues are treated as contaminants. Recommendations of EMRLs are mainly based on residue data obtained from national food control or monitoring activities. Codex EMRLs need to cover widely varying residue levels in food reflecting differing situations in respect of contamination of food by environmental and persistent pesticide residues. For this reason, Codex EMRLs cannot always reflect strictly the actual local residue situation existing in given countries or regions. Codex EMRLs represent acceptable residue levels which are intended to facilitate international trade in food while protecting the health of the consumer.

They are established only when there is supporting evidence concerning the safety to humans of the residues as determined by the Joint FAO/WHO Meeting on Pesticide Residues.

CODEX MAXIMUM RESIDUE LIMITS/EXTRANEOUS MAXIMUM RESIDUE LIMITS AND CONSUMER PROTECTION: DETERMINATION OF TOTAL DAILY INTAKE OF PESTICIDE RESIDUES

The primary purpose of setting maximum limits for pesticide residues in or on food and in some cases, in animal feeds, is to protect the health of the consumer. Codex MRLs and EMRLs serve that primary purpose as they help to ensure that only the minimum amount of pesticide is applied to food consistent with real pest control needs. Codex MRLs are based on residue data from supervised trials and not directly derived from Acceptable Daily Intakes (ADIs), which are a quantitative expression of acceptable daily amounts of residue which persons may ingest on a long term basis and which are established on the basis of appropriate toxicological data mainly from animal studies.

The acceptability of Codex MRLs is judged on the basis of a comparison of the acceptable daily intake with estimated daily intakes, as determined on the basis of suitable intake studies. Intake data from such studies, compared with acceptable daily intakes, help in determining the safety of foods in respect of pesticide residues. Guidelines for predicting Dietary Intakes of Pesticide Residues have been prepared under the joint sponsorship of UNEP, FAO and WHO.[1]

CODEX MAXIMUM RESIDUE LIMITS/EXTRANEOUS MAXIMUM RESIDUE LIMITS FOR MILK AND MILK PRODUCTS

Codex MRLs/EMRLs for fat-soluble pesticide residues in milk and milk products are expressed on a whole product basis.

For a "milk product" with a fat content less than 2%, the MRL applied should be half those specified for milk. The MRL for "milk products" with a fat content of 2% or more should be 25 times the maximum residue limit specified for milk, expressed on a fat basis.

Fat soluble pesticide residues to which the above general provision applies are indicated with the letter "F" in conjunction with the MRL specified for milk. However, in case of an MRL or EMRL set at or about the limit of determination, the letter "F" is not used.

CODEX MAXIMUM RESIDUE LIMITS/EXTRANEOUS MAXIMUM RESIDUE LIMITS FOR PROCESSED FOODS

As a rule, Codex MRLs and EMRLs are established for raw agricultural commodities. However, where it is considered necessary for consumer protection and facilitation of trade, MRLs and EMRLs are also established for certain processed foods on a case-by-case basis, taking into consideration information on the influence of processing on residues.

Guidelines for Predicting Dietary Intake of Pesticide Residues, Joint UNEP/FAO/WHO, World Health Organization, Geneva 1989.

EXPLANATORY NOTES TO THE LISTS OF CODEX MAXIMUM RESIDUE LIMITS AND CODEX EXTRANEOUS MAXIMUM RESIDUE LIMITS

The foods listed in the columns marked "commodity" shall not contain more than the maximum amount (in mg/kg) stated in the columns marked "MRL" or "EMRL", of the pesticide residue (defined in each individual case in the definition of residue) at (a) the point of entry into a country or (b) at the point of entry into trade channels within a country. This maximum limit shall not be exceeded at any time thereafter.

The Codex Maximum Residue Limits (MRLs) and Codex Extraneous Maximum Residue Limits (EMRLs) apply to the residue content of the final sample representative of the lot and of the portion of commodities which is analyzed.

Dates of Estimation of Acceptable Daily Intakes (ADIs)

ADIs - The year of estimation or confirmation is shown in parenthesis.

TADIs - The period from the year of estimation or most recent extension to the year by which data needed for the estimation of a full ADI are required, is shown in parenthesis.

Notes on the MRLs and EMRLs

(*)	(following MRLs or EMRLs)	:	At or about the limit of determination.
E	(following MRLs)	:	The MRL based on extraneous residues.
F	(following MRLs or EMRLs for milks)	:	The residue is fat soluble and MRLs for milk products are derived as explained earlier in this Section.
(fat)	(following MRLs or EMRLs for meat)	:	The MRL/EMRL applies to the fat of meat.
Po	(following MRLs)	:	The MRL accommodates post-harvest treatment of the commodity.
PoP	(following MRLs for processed foods)	:	The MRL accommodates post-harvest treatment of the primary food commodity.
T	(following MRLs or EMRLs)	:	The MRL/EMRL is temporary, irrespective of the status of the ADI, until required information has been provided and evaluated.
V	(following MRLs for products of animal origin)	:	The MRL accommodates veterinary uses.

INDEX OF PESTICIDES IN CODE ORDER

1 ALDRIN AND DIELDRIN
2 AZINPHOS-METHYL
3 BINAPACRYL
4 BROMOPHOS
5 BROMOPHOS-ETHYL
6 CAPTAFOL
7 CAPTAN
8 CARBARYL
9 CARBON DISULPHIDE
10 CARBON TETRACHLORIDE
11 CARBOPHENOTHION
12 CHLORDANE
13 CHLORDIMEFORM
14 CHLORFENVINPHOS
15 CHLORMEQUAT
16 CHLOROBENZILATE
17 CHLORPYRIFOS
18 COUMAPHOS
19 CRUFOMATE
20 2,4-D
21 DDT
22 DIAZINON
23 1,2-DIBROMOETHANE
24 1,2-DICHLOROETHANE
25 DICHLORVOS
26 DICOFOL
27 DIMETHOATE
28 DIOXATHION
29 DIPHENYL
30 DIPHENYLAMINE
31 DIQUAT
32 ENDOSULFAN
33 ENDRIN
34 ETHION
35 ETHOXYQUIN
36 FENCHLORPHOS
37 FENITROTHION
38 FENSULFOTHION
39 FENTHION
40 FENTIN
41 FOLPET
42 FORMOTHION
43 HEPTACHLOR
44 HEXACHLOROBENZENE
45 HYDROGEN CYANIDE
46 HYDROGEN PHOSPHIDE
47 BROMIDE ION
48 LINDANE
49 MALATHION
50 MANCOZEB
51 METHIDATHION
52 METHYL BROMIDE
53 MEVINPHOS
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56 2-PHENYLPHENOL
57 PARAQUAT
58 PARATHION
59 PARATHION-METHYL
60 PHOSALONE
61 PHOSPHAMIDON
62 PIPERONYL BUTOXIDE
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73 DEMETON-S-METHYL
74 DISULFOTON
75 PROPOXUR
76 THIOMETON
77 THIOPHANATE-METHYL
78 VAMIDOTHION
79 AMITROLE
80 CHINOMETHIONAT
81 CHLOROTHALONIL
82 DICHLOFLUANID
83 DICLORAN
84 DODINE
85 FENAMIPHOS
86 PIRIMIPHOS-METHYL
87 DINOCAP
88 LEPTOPHOS
89 SEC-BUTYLAMINE
90 CHLORPYRIFOS-METHYL
91 CYANOFENPHOS
92 DEMETON
93 BIORESMETHRIN
94 METHOMYL
95 ACEPHATE
96 CARBOFURAN
97 CARTAP
98 DIALIFOS
99 EDIFENPHOS
100 METHAMIDOPHOS
101 PIRIMICARB
102 MALEIC HYDRAZIDE
103 PHOSMET
104 DAMINOZIDE
105 DITHIOCARBAMATES
106 ETHEPHON
107 ETHIOFENCARB
108 ETHYLENE THIOUREA (ETU)
109 FENBUTATIN OXIDE
110 IMAZALIL
111 IPRODIONE
112 PHORATE
113 PROPARGITE
114 GUAZATINE
115 TECNAZENE
116 TRIFORINE
117 ALDICARB
118 CYPERMETHRIN
119 FENVALERATE
120 PERMETHRIN
121 2,4,5-T
122 AMITRAZ
123 ETRIMFOS
124 MECARBAM
125 METHACRIFOS
126 OXAMYL
127 PHENOTHRIN
128 PHENTHOATE
129 AZOCYCLOTIN
130 DIFLUBENZURON
131 ISOFENPHOS
132 METHIOCARB
133 TRIADIMEFON
134 AMINOCARB
135 DELTAMETHRIN
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116 TRIFORINE
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159 VINCLOZOLIN

20 2,4-D / 2,4-D / 2,4-D

ADI/DJA/IDA: 0.3 mg/kg body weight (1975) / mg/kg de poids corporel (1975) / mg/kg de peso corporal (1975)

Residue: 2,4-D.
Résidu: 2,4-D.
Residuo: 2,4-D.

Commodity/Produit/Producto	MRL/LMR (mg/kg)	
AO3 0001 Milk products Produits laitiers Productos lácteos	0.05	(*)
FB 0019 Vaccinium berries, including bearberry Baies du genre Vaccinium, y compris la Busserolle ou Raisin Bayas del gen. vaccinium, arándano, incl. aguavillas	0.1	
FB 0264 Blackberries Mûres de ronce Moras	0.1	
FB 0272 Raspberries, Red, Black Framboises (y compris les framboises de Virginie) Frambuesas, rojas, negras	0.1	
FC 0001 Citrus fruits Agrumes Frutos cítricos	2	
GC 0640 Barley Orge Cebada	0.5	
GC 0645 Maize Maïs Maíz	0.05	(*)
GC 0647 Oats Avoine Avena	0.5	
GC 0649 Rice Riz Arroz	0.05	(*)
GC 0650 Rye Seigle Centeno	0.5	
GC 0651 Sorghum Sorgho Sorgo	0.05	(*)
GC 0654 Wheat Blé Trigo	0.5	
ML 0106 Milks Laits Leches	0.05	(*)
MM 0095 Meat (from mammals other than marine mammals) Viande (de mammifères autres que les mammifères marins) Carne (de mamíferos no mamíferos marinos)	0.05	(*)

158 GLYPHOSATE / GLYPHOSATE / GLIFOSATO

ADI/DJA/IDA: 0.3 mg/kg body weight (1986) / mg/kg de poids corporel (1986) / mg/kg de peso corporal (1986)

Residue: Glyphosate.
Résidu: Glyphosate.
Residuo: Glifosato.

Commodity/Produit/Producto	MRL/LMR (mg/kg)	
AL 0541 Soya bean fodder Fourrage de soja Forraje seco de soja	20	
AL 1265 Soya bean forage (green) Soja fourrager (en vert) Forraje verde de soja	5	
AS 0081 Straw and fodder (dry) of cereal grains Paille et fourrage (sec) de céréales Paja y forraje seco de cereales	100	
AS 0162 Hay or fodder (dry) of grasses Foin ou fourrage (sec) de graminées Heno o forraje seco de gramíneas	50	
CF 1211 Wheat flour Farine de blé Harina de trigo	0.5	
CF 1212 Wheat wholemeal Farine complète de blé Harina integral de trigo	5	
CM 0654 Wheat bran, Unprocessed Son de blé non transformé Salvado de trigo, sin elaborar	20	
FI 0341 Kiwifruit Kiwi Kiwi	0.1	(*)
GC 0640 Barley Orge Cebada	20	
GC 0645 Maize Maïs Maíz	0.1	(*)
GC 0647 Oats Avoine Avena	20	
GC 0649 Rice Riz Arroz	0.1	(*)
GC 0651 Sorghum Sorgho Sorgo	0.1	(*)
GC 0654 Wheat Blé Trigo	5	

ML	0812	Cattle milk Lait de bovins Leche de vaca	0.1 (*)
MM	0812	Cattle meat Viande de bovins Carne de vacuno	0.1 (*)
MM	0818	Pig meat Viande de porcins Carne de porcino	0.1 (*)
MO	0812	Cattle, Edible offal of Abats comestibles de bovins Vacuno, despojos comestibles	2
MO	0818	Pig, Edible offal of Abats comestibles de porcins Despojos comestibles de porcino	1
PE	0112	Eggs Oeufs Huevos	0.1 (*)
PM	0110	Poultry meat Chair de volaille Carne de aves	0.1 (*)
SO	0495	Rape seed Graine de colza Semillas de colza	10
SO	0691	Cotton seed Graine de coton Semillas de algodón	0.5
VD	0071	Beans (dry) Haricots (secs) Frijoles (secos)	2
VD	0072	Peas (dry) Pois (secs) Guisantes (arvejas) (secos)	5
VD	0541	Soya bean (dry) Soja (sec) Soja (seca)	5
VO	0447	Sweet corn (corn-on-the-cob) Maïs doux (maïs en épi) Maíz dulce (maíz en mazorca)	0.1 (*)
VP	0541	Soya bean (immature seeds) Soja (graines immatures) Soja (semillas inmaduras)	0.2

EXTRACT FROM CX/PR 97/2 (working document for the 29th Session of the Codex Committee on Pesticide Residues)

A. MAXIMUM RESIDUE LIMITS OF PESTICIDES IN FISH

1. The Codex Alimentarius Commission at its 21st Session referred to this Committee a proposal to elaborate MRLs in fish. The Committee at its 28th Session agreed to send a Circular Letter soliciting information on the need to establish MRLs for fish. The Codex Circular Letter, CL 1996/37 was distributed with three specific questions: (a) whether there is a need to establish Codex MRL/EMRL(s) for fish; if there is, for which pesticide/species combinations; (b) whether MRLs have been set for fish at the national level; and if there are MRLs, for which pesticide/species combinations; and (c) data availability for the JMPR to propose MRL/EMRL(s).

2. In response to the Circular Letter, comments were received from the following countries:

Australia, Canada, Denmark, France, South Africa, Spain and USA.

These comments are summarised below.

Country	(a)	(b)	(c)	Notes
Australia	-	-	-	No comment
Canada	-	-	-	The developing aquaculture industry is reviewing pest management strategies including the use of a pesticides. Canada has registered the use of permethrin and azamethaphos, and is presently evaluating a use of cypermethrin, on farmed salmon. In most of these cases, no residues are detectable in the fish at harvest. Although these appears to be no potential for trade problems as a result of these treatments, this situation could change as new uses are proposed. These comments are also applicable to other aquaculture crops such as shellfish. Notwithstanding the above, there is policy issue which should be discussed regarding the need to establish international MRLs at the limit of detection. We not illustrations of this trend in recent MRLs established for compounds such as bendiocarb, ethoprophos, and much of terbufos and 2,4,5-T. The implications with respect to theoretical dietary intake assessments and the range of residue limits that can be established for a given active ingredient need to be further considered.
Denmark	*	No	Yes*[2]	* The need to establish MRLs for fish is mainly related to organochlorine pesticides in fat containing species. In order to evaluate the global need for Codex MRLs a further collection of data on residues in fish and fisheries products from world will be welcomed. However, the need for MRLs for fish from the Nordic area is not pronounced at present. *[2] *Provided monitoring data of organochlorines in various kinds of fish from various areas.*
France	*[3]	No	-	*[3] Possible need for MRLs in fish in general for compounds which may contaminate aqueous environment and concentrate in fat tissue; if the intake may exceed the ADI. Possible adoption of setting an MRL at the limit of detection as done for meat in the EC. Need to collaborate with the CCFFP on the Code of Practice for the Products of Aquaculture.

Country	(a)	(b)	(c)	Notes
South Africa	-	No	-	Will investigate this issue.
Spain	No	No	No	
USA	Yes*[illegible]	Yes*[illegible]	Not yet	*[illegible] Need for a carefully selected set of Codex MRLs/EMRLs arising from the growing importance in the international trade in fish and fishery products and three situations which may result in pesticide residues in these commodities, and to ensure that fish and fishery products in international trade do not present unacceptable or unnecessary health risks to consumers: (1) International, sanctioned use of pesticides applied directly to water for aquatic weed control or used in farm raised/aquaculture fish and fishery products likely to enter international trade. (2) Contamination from environmentally persistent organo-chlorine pesticides which are no longer used in most countries, but which may still be persistent in fish harvest and production areas. (3) Unintentional, inadvertent residues in food dish due to surface water contamination from runoff of currently used pesticides from crop production areas. *[illegible] EPA tolerances for aquaculture products and FDA action levels for the situation (2) above (not species specific levels; many under review). *Provided a list of existing EPA Tolerances and FDA Action Levels for pesticide residues in fish and fishery products.*

3 It seems apparent from the above that if there is any need for Codex MRLs/EMRLs for fish, it will be for Codex EMRLs for organochlorines in fish and fishery products in general. The Committee should reply to the Codex Alimentarius Commission on what action, if any, should be taken on the original proposal made at the 21st Session of the Commission. In doing so, the comments submitted and oral comments made at the 29th Session of the Committee as well as data availability should be taken into consideration.

EXTRACT FROM ALINORM 97/24A (report of the 29th Session of the Codex Committee on Pesticide Residues)

- **MAXIMUM RESIDUE LIMITS OF PESTICIDES IN FISH**

5 The Committee recalled that the 21st Session of the Codex Alimentarius Commission had referred to it a proposal to elaborate MRLs in fish. The Committee at its last Session had discussed this proposal briefly and agreed to send a circular letter[1] requesting information on the need for MRLs in fish.

6 The establishment of MRLs for chemicals used as pesticides in feed or aquaculture, and EMRLs for chemicals previously registered as pesticides is the responsibility of this Committee, while that for MRLs for chemicals used as veterinary drugs in aquaculture is the responsibility of the CCRVDF.

7 Several delegations and WHO reported that surveys demonstrated that the estimated intakes of pesticide residues, especially certain organochlorine compounds, were low. Some delegations expressed the view that there might be a need to elaborate EMRLs for persistent organochlorine compounds in fish in the future; however, the limited data availability was pointed out. The Committee **agreed** that at present there was no need to establish MRLs/EMRLs for fish as there were neither significant problems in

[1] CL 1996/37-PR

trade of fish nor apparent health concerns arising from uses of pesticides in aquaculture, or from environmental contamination. The Committee also **agreed** that it might consider this issue in the future.

EXTRACT FROM ALINORM 97/37 (report of the 22nd Session of the Codex Alimentarius Commission)

147. The Commission concurred to the Committee's opinion that the elaboration of MRLs for honey, low-fat meat and fish was of low priority. The Delegation of Germany stated that residues of pesticides in fish was a growing problem, especially in relation to increasing amount of organochlorine compounds in water. The Commission requested the Committee to monitor the gravity of the problem for necessary action.

* Principle 12 & 15 *

THE RIO DECLARATION ON ENVIRONMENT AND DEVELOPMENT (1992)

Preamble

The United Nations Conference on Environment and Development,

Having met at Rio de Janeiro from 3 to 14 June 1992,

Reaffirming the Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972, and seeking to build upon it,

With the goal of establishing a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people,

Working towards international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system,

Recognizing the integral and interdependent nature of the Earth, our home,

Proclaims that:

Principle 1

Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature

Principle 2

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 3

The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

Principle 4

In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 5

All States and all people shall cooperate in the essential task of eradicating poverty as an

indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world.

Principle 6

The special situation and needs of developing countries, particularly the least developed and those most environmentally vulnerable, shall be given special priority. International actions in the field of environment and development should also address the interests and needs of all countries.

Principle 7

States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

Principle 8

To achieve sustainable development and a higher quality of life for all people. States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.

Principle 9

States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.

Principle 10

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle 11

States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply. Standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries.

Principle 12

States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the

problems of environmental degradation. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade. Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus.

Principle 13

States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle 14

States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any activities and substances that cause severe environmental degradation or are found to be harmful to human health.

Principle 15

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Principle 16

National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

Principle 17

Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

Principle 18

States shall immediately notify other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States. Every effort shall be made by the international community to help States so afflicted.

Principle 19

States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse transboundary environmental effect and shall consult with those States at an early stage and in good faith.

Principle 20

Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development

Principle 21

The creativity, ideals and courage of the youth of the world should be mobilized to forge a global partnership in order to achieve sustainable development and ensure a better future for all.

Principle 22

Indigenous people and their communities, and other local communities, have a vital role in environmental management and development because of their knowledge and traditional practices. States should recognize and duly support their identity, culture and interests and enable their effective participation in the achievement of sustainable development.

Principle 23

The environment and natural resources of people under oppression, domination and occupation shall be protected.

Principle 24

Warfare is inherently destructive of sustainable development. States shall therefore respect international law providing protection for the environment in times of armed conflict and cooperate in its further development, as necessary

Principle 25

Peace, development and environmental protection are interdependent and indivisible.

Principle 26

States shall resolve all their environmental disputes peacefully and by appropriate means in accordance with the Charter of the United Nations

Principle 27

States and people shall cooperate in good faith and in a spirit of partnership in the fulfilment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development.

* * * *

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Agricultural Pest Management

I. Issues in Pesticide Use

1. Because pesticides are handled by large numbers of people with different levels of skill, stored for varying lengths of time, and purposely released into the environment, and because they have potential to create substantial environmental and health problems, they are a significant issue for society. Misused pesticides can cause severe illness or death, contamination of soil and water, harm to livestock and wildlife, and reduction or elimination of pests' natural enemies in the field. Furthermore, use of the wrong pesticides, or the wrong dosage, can lead to potentially dangerous residues in foods. Given the rapidly changing nature of practice and legislation in this field, it is strongly recommended that expert advice be sought if any uncertainty exists.

Toxicity

Acute Mammalian Toxicity

2. Many chemical pesticides are toxic to humans and animals when absorbed by ingestion, through the skin, or by inhalation. Some are corrosive, explosive, or irritating to the skin; others contain hazardous inert ingredients or contaminants.

3. Acute toxicity of pesticides is measured in terms of LD50 (a statistical estimate of the dose, in milligrams of the material per kilogram of body weight, that will kill 50 percent of a group of test animals). Both oral and dermal LD50s are used, since many pesticides are absorbed almost as readily through the skin as by ingestion. (Toxicity through inhalation is also sometimes a hazard, but the measurement and evaluation of this property are more complex.)

4. The World Health Organization (WHO) periodically revises and reissues *The WHO Recommended Classification of Pesticides by Hazard* and *Guidelines to Classification*. The 1992-93 edition lists active ingredients of pesticides (plus synonyms), classified as follows:

(a) *Class IA, Extremely Hazardous* (oral LD50=5 mg/kg or below for solids, 20 mg/kg or below for liquids; dermal LD50=10 mg/kg or below for solids, 40 mg/kg or below for liquids);

(b) *Class IB, Highly Hazardous* (oral LD50=5-50 for solids, 20-200 for liquids; dermal LD50=10-100 for solids, 40-400 for liquids);

(c) *Class II, Moderately Hazardous* (oral LD50=50-500 for solids, 200-2,000 for liquids; dermal LD50=100-1000 for solids, 400-4,000 for liquids);

(d) *Class III, Slightly Hazardous* (oral LD50 over 500 for solids, over 2,000 for liquids; dermal LD50 over 1,000 for solids, over 4,000 for liquids); and

(e) *Class IV, Unlikely to Present Acute Hazard in Normal Use.*

5. The appearance of a given pesticide in WHO Class IA or IB should trigger closer evaluation. However, the WHO classification is for *technical products* (i.e., active ingredients, or a.i.), whereas most pesticides reach the user as *formulated products*, in which the active ingredient is diluted with

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carriers, emulsifiers, and so forth. It is the classification of the formulated product that is the relevant factor. If the acute toxicity of a given formulation has not been reported, it can be estimated using the following formula:

LD50 of formulated product =

$$\frac{\text{(LD50 of a.i.)} \times 100}{\text{\% of a.i. in formulated product}}$$

Chronic Health Effects

6. For some products, routine occupational exposure causes adverse chronic health effects, or these products may accumulate in body fats following incidental exposure to pesticides in air, water, soil, and food. Chronic and incidental exposures raise the possibility of carcinogenic, teratogenic, mutagenic, and reproductive effects.

Environmental Persistence

7. Some products (mainly organochlorine pesticides such as DDT) have long-term effects on wildlife and aquatic organisms because of their persistence, mobility, solubility in lipids, or concentration in food chains. Experiments and field experience have shown that even very low levels of exposure to such products can have serious toxic effects on fish and birds. Through erosion and runoff from soil applications, drift from spray and dust formulations, and volatilization, such products find their way into rivers, lakes, marshes, and other habitats for wildlife and aquatic organisms.

Toxicity to Nontarget Organisms

8. Toxicity to nontarget organisms is an important concern, particularly where important economic or biological resources (e.g., commercial or subsistence fisheries, honeybees, endangered species, natural forests, or orchards) may be at risk. The possible impact of insecticides on animals is well known; however, herbicide drift is of equal concern because it can damage or destroy susceptible crops or natural vegetation in nontarget areas. In addition, pesticides vary in relation to their impact on beneficial insects, spiders, and other organisms; and pesticides with a broader range of toxicity are more likely to lead to pest resurgence and the development of secondary pest species. The potential hazards are greatest where pesticide use is likely to impinge upon important nontarget species (e.g., where irrigation drainage enters important water bodies, or in areas adjacent to nature reserves).

Hazards Related to Pesticide Use

9. In addition to the toxic characteristics of the materials themselves, the hazards associated with pesticide use depend on how the pesticides are applied. Proper application involves selecting the right application methods (based on the cropping system, target pests, the environmental setting, and prospective users) and using well-designed equipment in good working order. The most common application methods are spraying with liquid formulations and dusting with powders. Common spray equipment is either carried by hand or backpack or mounted on a tractor or aircraft. Various low-volume and ultra-low-volume (LV and ULV) methods have been developed that greatly reduce the total amount of spray liquid applied per hectare. Other pesticide delivery systems include seed dressings, baits, granules or liquid drenches applied to the soil, vaporization (outdoor fogging or indoor fumigation), and controlled-release formulations.

10. Liquid pesticides are commonly sold as concentrates to be diluted before or while loading the product into the sprayer. Mixing and loading are usually the most hazardous steps in pesticide handling. Furthermore, inaccurate dilution can reduce pesticide effectiveness or can increase residues and accelerate the development of pesticide resistance. To minimize the risk of handling

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particularly hazardous pesticides, it may be advisable to purchase products at working strength (requiring no dilution) and use closed loading systems or integrated container/nozzle systems, which completely bypass the loading step.

11. Fumigation of stored products, using toxic materials at high vapor pressures, is hazardous because of the difficulty of handling and containing toxic gases and the danger of toxic residues on food. Fumigation has become common even at the farm level because of the availability of aluminum phosphide and magnesium phosphide tablets, which are relatively easy to use—exposure to moisture in the air triggers release of toxic hydrogen phosphide gas. To carry out the procedure safely, however, requires special equipment and training, an air-tight storage container, and a post-treatment period during which people have to be protected from exposure to the vapors. Therefore, this option can present a serious hazard if users are untrained and poorly equipped.

12. Low-concentration granular, seed dressing, and bait formulations generally present the lowest level of hazard to the users and thus are particularly appropriate for small-scale farmers unfamiliar with pesticide use. They also cause minimal environmental contamination and, for the most part, minimal adverse effects on nontarget organisms. However, they may be harmful to domestic animals and wildlife, particularly granivorous birds, and to humans who may eat the treated material.

13. In spray applications, the size of spray droplets produced is critical. Droplets that are too small drift away, and those that are too large run off the plant onto the ground. In either case, waste and environmental contamination result. Conventional hydraulic backpack sprayers, though widely available and easy to use and maintain, produce a wide range of droplet sizes and are relatively inefficient. LV and ULV methods have gained popularity because they reduce labor costs by eliminating the need to carry large volumes of water, and they allow large areas to be sprayed rapidly. However, LV and ULV methods are more sensitive to errors in dosage calibration, and they often use more concentrated pesticides, which can increase hazards to the operator (although the elimination of the mixing step is a benefit).

14. Spraying or dusting from aircraft is convenient for covering large areas quickly, but the blanket coverage and extensive spray drift can lead to environmental contamination, impact on nontarget organisms, and human exposure. A further source of hazard is the fact that aerial application is often carried out by contractors who are paid by the volume sprayed, a practice that can provide an incentive for carelessness and haste. For these reasons, aerial spraying is used only when absolutely necessary.

15. One of the most common causes of pesticide intoxication is poorly functioning or leaking equipment. Farmers often continue to use old equipment because they cannot afford to replace it. Also, spare parts and knowledgeable technicians are often hard to find.

16. Many pesticides are readily absorbed through the skin and can be used safely only if the operator wears protective clothing. However, using protective clothing improperly can be more hazardous than using none at all. For example, clothing that is not washed and becomes saturated with pesticides through repeated use, or rubber gloves or boots that are contaminated on the inside, can greatly increase pesticide absorption through the skin. Proper hygiene—regular washing of both the skin and protective clothing (separately from household laundry)—is a critical element of safe pesticide handling.

Registration

17. Many countries have legislation regulating the importation, production, and sale of pesticides and the ways in which they can be used. Under such legislation, individual pesticides (usually specific commercial products) may be refused registration, banned (have existing registration withdrawn), or restricted to use by certified or licensed operators or with safety equipment. Individual pesticides are normally registered for specified uses (specific crops, soil treatment, protection of structures, etc.) and specified practices (such as application methods, dosage levels, and preharvest intervals). Pesticides that may be used only for limited purposes or under exceptional circumstances are sometimes called "severely restricted," although there is no clear consensus about the meaning of this term. Governments also set limits (called tolerances—usually expressed as parts per million or milligrams per kilogram) on the levels of pesticide residues permitted on, or in, agricultural commodities (domestic or imported) after harvest or processing. Registered use practices are established in part on the basis of the residue levels.

18. Restricting the use of a given pesticide to specified crops is important, because different crops absorb and metabolize pesticides differently and have different residue levels. Furthermore, residue tolerances vary depending on the way crops are used or processed. The tolerances set by prospective importing countries are an important concern in the case of export crops. Where no tolerance has been set for a given pesticide/commodity combination, it is generally assumed to be zero. Information on tolerances set by different countries is available from the countries' agricultural or trade agencies, various published compendia, and pesticide manufacturers. The Bank's Sectoral Library has a representative listing on microfiche (AIDPEST DATABASE). Private industries that purchase and process agricultural commodities may have their own residue requirements. These guidelines, which are usually based on consumer pressure, may be more restrictive than the national legislation.

19. In 1985, the Food and Agriculture Organization (FAO) adopted an "International Code of Conduct on the Distribution and Use of Pesticides". (updated in 1991), which represents a global consensus on minimum acceptable standards. In 1989, an amendment on "Prior Informed Consent" (PIC) was adopted. The amendment specifies that certain hazardous pesticides may not be exported unless the government of the importing country agrees to the import after receiving from the exporting country full information concerning the regulatory status of that pesticide in the country of export. A similar PIC resolution (relating to toxic chemicals in general) was adopted by the Governing Council of the United Nations Environment Programme (UNEP) in May 1989. Both resolutions are intended to apply to pesticides (or chemicals) that have been "banned or severely restricted" for environmental or health reasons in five or more countries. The list of products to which the PIC will apply is currently being developed, and issues such as the precise definition of these terms and whether certain other hazardous, but less regulated, pesticides should be included in the PIC scheme have not been resolved. When the internationally accepted PIC list has been developed, it will be used as an indicator that there is significant concern over the hazards presented by the materials included in it. The PIC concept ought to be incorporated or reflected in the domestic law of the importing countries.

Nonchemical Pest Control Methods

20. Several kinds of pest control pose little or no hazard to humans and nontarget plants and animals. Biological control agents include arthropod predators and parasites; microbial pathogens such as *Bacillus thuringiensis* (B.t.); and vertebrates—

for example, sheep and goats in orchards and ducks in paddies to control weeds, and frogs or birds to control insects. Pheromones may be used to attract and trap insects or to confuse them and interrupt their reproductive cycles. An effective way to reduce populations of insects of which the females mate only once is to release large numbers of sterile males: few of the females will produce offspring.

21. One effective instrument for controlling insect damage in stored products is an inert atmosphere that is low in oxygen and high in carbon dioxide (CO_2). This environment can be created passively through hermetic sealing (the inert atmosphere develops in a few days) or actively by pumping in CO_2. It can be created in a warehouse or, on a smaller scale, in air-tight plastic silos and cubes, which are available commercially. Heat and radiation treatments are also effective methods for large-scale operations, but they are not practical at the farm level. On a more basic level, an extract from the leaves or seeds of the *neem* tree (*Azadirachta indica*), which has long been used in India to protect stored grains, is a low-cost, low-toxicity option for on-farm storage.

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GLOBAL
ENVIRONMENT
FACILITY

Kenya, Tanzania, Uganda

Lake Victoria Environmental Management Project

Project Document
June 1996

THE WORLD BANK

6. AGREEMENTS REACHED AND RECOMMENDATIONS

6.1 On August 5, 1994, the Governments of Kenya, Tanzania and Uganda signed a Tripartite Agreement jointly to *prepare and implement* a Lake Victoria Environmental Management Program (LVEMP). That important agreement provided for organizational arrangements for project preparation, some of which will be continued into project implementation. In particular, the Agreement provided for a Regional Policy and Steering Committee, which has functioned during project preparation with a membership of nine at the level of Permanent Secretary, three from each country, drawn from the main Ministries dealing with environment, water, fisheries, and agriculture. The existence of this Agreement reduced, but did not eliminate the need for further assurances, which complemented and supplemented those already obtained under the Tripartite Agreement.

6.2 The three Government s and IDA have agreed the following:

(a) the National Secretariats will prepare annual work programs, training plans, and related financing plans and submit them to the Regional Policy and Steering Committee for its approval by March 31 of each year; the annual work programs will include details of the procurement of goods and services and the procedures to be adopted for such procurement within the limits given earlier and agreed by IDA;

(b) in its review of the annual work programs, training plans and related financing plans, the Regional Policy and Steering committee will ensure that all project components with regional implications will be implemented at a comparable pace in all three countries; following its approval of the annual programs and plans, the Regional Policy and Steering Committee will submit them, along with its proposals for ensuring coordinated implementation, to IDA for review by May 15 of each year;

(c) a high level panel of internationally renowned scientists, with 7 members satisfactory to IDA, will be appointed by the Regional Policy and Steering Committee to serve as an advisory group for the scientific studies in the lake; they will meet at least once a year to review scientific issues arising from project implementation, maintain an up-to-date inventory of international scientific research pertinent to LVEMP programs, assist with identifying international training opportunities for researchers from the riparian countries, and be available, at the request of the Regional and Policy Steering Committee, to provide advice about specific issues;

(d) the Lake Victoria Fisheries Organisation (LVFO) will be established by November 30, 1996;

(e) national steering committees will be established in all three countries for the water hyacinth control program, by November 30, 1996;

(f) any changes in the policies, procedures and core membership of the Regional Policy and Steering Committee will be acceptable to IDA;

(g) herbicides used in the water hyacinth control program will be acceptable to IDA, they will be used sparingly, in strictly selected and confined areas, all persons applying such herbicides will be trained in their safe and appropriate handling and use, and mechanisms for careful monitoring of herbicide use will be established;

(h) with the exception of the biological control agents for water hyacinth, no new species will be introduced into the lake without first carrying out an environmental impact assessment;

(i) prior to implementation of any intervention likely to have a negative impact on fish ecology (such as changes in net sizes or other controls over the fishing effort), the proposed intervention will be subjected to an environmental impact assessment, with provision for public comment;

(j) prior to implementation of any project component related to pollution control, a project - specific environmental assessment will be carried out to guard against the possibility that any uncontrolled dumping of domestic and industrial wastes would take place;

(k) the three Governments will have the records and accounts of the project, including those for the Special Accounts, and Statements of Expenditure (SOEs), audited each fiscal year by independent auditors acceptable to IDA; and will submit to IDA the audit reports within six months after the close of the respective fiscal year; the audit reports will include a statement on the adequacy of the accounting systems and internal controls;

(l) National Workshops coordinated by the National Secretariats and a Regional Workshop coordinated by the Regional Secretariat in Tanzania will be held in June of each year to assess implementation progress and agree on any adjustments needed;

(m) prior to the end of July, 1997, a comprehensive review will be held with the donors, to consider the annual work plan and new financial procedures and arrangements for the forthcoming fiscal year; modifications of project design and/or procedures will be introduced as appropriate; similar reviews will be carried out annually;

(n) prior to the end of March, 1999 a Mid-Term Review will be carried out, during which the performance of the Lake Victoria Fisheries Organisation, the three National Secretariats, and the Regional Policy and Steering Committee will be reviewed and appropriate changes made; the

Report No. 15541-AFR

KENYA, TANZANIA, UGANDA

Lake Victoria
Environmental Management Project

Project Document

June 1996

Agriculture and Environment Operations Division
Eastern Africa Department
Africa Region

Fish Levy Trust [US$2.03 million]

3.20 This component will study and implement a system to collect levies from the fishing industry and use them in support of fisheries and ecosystem management in the lake and its catchment. In the first year of the project a study will be carried out of mechanisms for revenue collection and disbursement already in operation in each country, and additional possibilities for revenue collection. In the second year of the project the findings of the study will be discussed and agreed among the three governments, and a system to collect and disburse levies will be established in the third year of the project. The study will be carried out by consultants under the supervision of the Fisheries Departments of the Ministry of Tourism and Wildlife (Kenya), Ministry of Natural Resources (Tanzania), and Ministry of Agriculture, Animal Industry and Fisheries (Uganda), in collaboration with the Lake Victoria Fisheries Organization. It will be financed by IDA (90 percent). The project will finance vehicles; office equipment; training and workshops; technical assistance; personnel costs, and operation and maintenance expenditures.

Water Hyacinth Control [US$8.31 million]

3.21 The aim of the program is to establish sustainable long-term capacity for maintaining control of water hyacinth and other invasive weeds in the Lake Victoria Basin. This will be achieved by an integrated effort involving intensified publicity, legislation, and integrated pest management with community involvement. The control program will rely on mechanical methods and limited chemical interventions for rapid short term control in restricted areas, and biological agents for longer term control. Reducing nutrient inflows into the lake will be a vital element in long term approaches to dealing with the problem. The biological control program will rely initially on multiplication and release of two weevil species that have been used and found effective world-wide, and have already been imported, reared and released in Kenya and Uganda. The species are the chevroned water hyacinth weevil (*Neochetina bruchi* Hystache) and the water hyacinth weevil (*Neochetina eichorniae* Warner). These two species are complementary in their action. The possibilities will be explored for supplementing the weevils by later releases of the moth *Sameodes albiguttalis*. The main elements of the biological control program will be establishment of mass rearing capacity in units around the shores of the lake as rapidly as possible, a coordinated field release program involving local community participation, monitoring performance of biological control agents in the field, and development of a monitoring and evaluation protocol and training program.

3.22 Implementation of the water hyacinth control program will be led by the agricultural research organizations of the three countries, namely the Kenya Agricultural Research Institute (KARI) in the Ministry of Research, Technical Training and Technology, the Uganda National Agricultural Research Organization (NARO) in the Ministry of Agriculture, Animal Industry and Fisheries, and the Tanzania Department of Research and Training in the Ministry of Agriculture, Livestock, Cooperatives and Development. The agricultural research institutions will be responsible, in particular, for the program to multiply and disperse the biological control agents. National Water Hyacinth Steering Committees will be established in

APPENDIX 4

RECORD OF INTERAGENCY/FORUM/CONSULTATION MEETINGS CARRIED OUT DURING THE ENVIRONMENTAL IMPACT STUDY AS PART OF EVIDENCE OF PUBLIC INVOLVEMENT/CONSULTATION, DURING THE EIS PROCESS, AND IN ACCORDANCE WITH EIS REQUIREMENTS.

The following groups and individuals made up the Expanded Scoping Committee

Name	Institution
Y.S. Kizito	Zoology Makerere University
Odrek Rwabwogo	Journalist
B.H. Ogwang	National Environment Management Authority
Deo B. Nkunzingoma	Lawyer
Agaba Patrick	Aquatics Unlimited
Muttu David	Journalist-UTV
F. Masanvu	Jengo Production
M. Beaudet	French Embassy
Fredrick Baruzalire	For Resident District Council -Mpigi
Timothy Twongo	PRO-FIRI
Bazira .H.	Makerere University
Kangana .J.	WHC/EPI
Muhumuza Ronald	S.M.A.C.A Makerere
Edward Kalanzi Ssewannyana	D.E.O. Representing RDC-Mukono
Paul Nkata	AGAPE
Kaddu .K. Sebunya	IVCM
Tom Moorhouse	Aquatics Unlimited
Jim Roberts	National Environment Management Authority
Syambi A.N.	Food Agriculture Organization
Okurut Tom	National Water Sewerage Corporation
David Byarugaba	Jengo Production
Askia Muhamed II	Askia Muhamed II Water Hyacinth Control and Environmental Production
Justin Ecaat	National Environment Management Authority
Dr. F.L. Orach-Meza	Ministry of Agriculture, Animal Industry and Fisheries
Julius Arinaitwe	MUIENR
Jim Dunn	USAID
D.M. Byarujali	Makerere University
Zitta Mugisha	For RDC-Jinja
S.A.K. Magezi	Department of Meteology
Kamese Geoffrey	Makerere Institute of Environment Development and Practical Skills
Etyang P.E.	Uganda Fisheries Department
Mutekanga David R.	E.A.W.L.
B.N.K. Wadda	Water Hyacinth Unit
S.V. Matagi	NTCWH
Tom McNabb	Aquatics Unlimited
Frank Turyatunga	National Environment Management Authority
B.Z. Dramadri	Ministry of Natural Resources
John .Y. Okedi	National Environment Management Authority

WORKSHOP TO DISCUSS THE SCOPING DOCUMENT OF THE UGANDA WATER HYACINTH CONTROL PROGRAM HELD ON 10TH JULY, 1996 AT INTERNATIONAL CONFERENCE CENTER, COMMITTEE ROOM A:

ATTENDANT LIST:-

NO.	DATE	NAME	TITLE/COMPANY	ADDRESS	TELEPHONE
1.	10/7/96	Dr. Y.S. Kizito	Lecturer - Zoology Makerere University	P.O.Box 7062 Kampala	531902
2.	"	Odrek Rwabwho	Journalist	New Vision	235209
3.	"	Prof. B.H.Ogwang	NEMA	P.O.Box 22255 Kampala	236817
4.	"	Deo B. Nkunzingoma	Lawyer	P.O.Box 1188 Kampala	257031
5.	"	Agaba Patrick	Local Coordinator Aquatics Unlimited	P.O.Box 7057 Kampala	250550
6.	"	Muttu David	Journalist - UTV	P.O.Box 4260 Kampala	256453
7.	"	F. Masanvu	Jengo Production	P.O.Box 5731 Kampala	244658
8	"	M. Beaudet	French Embassy	P.O.Box 7212 Kampala	242120
9.	"	Fredrick Baruzalire	For RDC Mpigi	P.O. Box 172 Mpigi	
10.	"	Timothy Twongo	PRO - FIRI	P.O.Box 343 Jinja	043-3307
11.	"	Bazira .H.	Makerere University	P.O.Box 7062 Kampala	54070
12.	"	Kangana .J.	WHC/EPI	P.O.Box 8867 Kampala	53086
13.	"	Muhumuza Ronald	S.M.A.C.A. Makerere	P.O.Box 10136 Kampala	5319
14.	"	Edward Kalanzi Ssewannyana	D E.O. Representing RDC Mukono	P.O.Box 152 Mukono	2903
15.	"	Helen Bugaari		P.O.Box 2870 Kampala	2208
16.	"	Eng. Paul Nkata	AGAPE	P.O. Box 157 Kampala	267
17.	"	Kaddu .K. Sebunya	IVCM	IVCM Kampala	23
18.	"	Tom Moorhouse	Aquatics Unlimited	P.O. Box 7057 Kampala	250
19.	"	Jim Roberts	NEMA	P O.Box 22255 Kampala	236
20.	"	Syambi A.N.	FAO	P.O Box 521 Kampala	2505
21.	"	Okurut Tom	NWSC	P.O.Box 7056	25
22.	"	David Byarugaba	Jengo Productions	P.O Box 5737 Kampala	24
23	"	Askia Muhamed II	Askia Muhamed II Water Hyacinth Control and Environmental Production	P.O.Box 887	53

NO.	DATE	NAME	TITLE/COMPANY	ADDRESS	TELEPHONE
24.	10/7/96	Justin Ecaut	EIA Specialist NEMA	P.O.Box 22255 Kampala	236817
25.	-	F L. Orach-Meza	Commissioner of Fisheries MAAIF	P O.Box 4 Entebbe	20496
26.	-	Julius Arinaitwe	MUIENR	P.O.Box 10066 Kampala	530135
27.	-	Jim Dunn	USAID	P.O.Box 7007 Kampala	
28.	-	D.M. Byarujoli	Lecturer - Botany (MUK)	P.O.Box 7062 Kampala	531902
29.	-	Zitta Mugisha	For RDC Jinja	P.O.Box 1551 Kampala	20201/21092
30.	-	S.A.K. Magezi	Ag. Commissioner Department of Meteology	P.O.Box 7025 Kampala	251798
31.	-	Kamese Geoffrey	Makerere I.I. of Environment Development and practical Skills	P.O.Box 10136 Kampala	531979
32.	-	Etyang P E.	UFD	P.O.Box 4 Entebbe	
33.	-	Mutekanga David .R	E.A.W.L.	P.O.Box 7422 Kampala	233061
34.	-	B.N.K. Wadda	Water Hyacinth Unit	P.O.Box 4 Entebbe	20578
35.	-	S.V. Matagi	NTCWH	C/o P.O.Box 9257 Kampala	257548
36.	-	Tom McNabb	President Aquatics Unlimited	P.O.Box 7057 Kampala	250550
37.	-	Frank Turyatunga	Director of Information & Monitoring - NEMA	P.O.Box 22255 Kampala	236817
38.	-	B.Z. Dramadri	Permanent Secretary - Ministry of Natural Resources	P.O.Box 7070 Kampala	242550
39.	-	Prof. John .Y. Okedi	Executive Director - NEMA	P.O.Box 22255 Kampala	236817

The following people provided significant information for the completion of the E.A. Draft

Name	Institution	Expertise
Julius Arinaitwe	Makerere Univ. Inst. of Env. & Nat. Resources	Ornithologist
Frank Kansiime	Makerere Univ. Inst. of Env. & Nat. Resources	Biologist
Robert Kityo	Makerere Univ. Inst. of Env. & Nat. Resources	Mammalogist
Hilary Bakamwesiga	Makerere University Institute of Env. & NR	Dendrologist
Joshua Tumuheirwe	Geological Survey and Mines Department	Geologist
Justin Ecaat	NEMA	EIA Specialist
Frank Turyatunga	NEMA	Information/Monitoring
Ignatius B. Nakishero	Uganda Tourist Board	Manager
Desire Lubega	Early Warning Unit MAAIF	Agriculturalist
Joseph M. Tumwesigye	Surveys & Mapping Department	Surveyor
Rose Mugidde	Fisheries Research Institute	ResearchAssistant
Dr. R. Olwayo	Fisheries Research Institute	Research Assistant
Callist Tindimugaya	Directorate of water Development	Hydrogeologist

MUKONO OFFICIALS CONTACTED DURING WAZIMENYA BAY SENSITIZATION EXERCSE .

1.	Chairman L.C 111 (Ntenjeru Sub-County)	-	Kyejjes S.B
2.	Vice Chairman L.C 111 (Ntenjeru Sub-County)	-	Jane Mukasa Sozi
3.	RDC Mukono	-	Erusmus Kyalimpa
4.	Sub- Accountant (Ntenjeru)	-	Lubega G Willie Anders
5.	Headmaster Mubanda P/School	-	Mr. Katongole
6.	Headmaster Butere Primary School	-	Mr J.A Ojangole
7.	Local Leader Ntenjeru	-	Herbert Wamala
8.	UFFCA Representative	-	Vincent Majjo
9.	Headmaster Mugomba Primary School	-	Katerega David
10.	Sub-County Chief Ntenjeru	-	Edward Bintubizibu

TELEGRAMS: _____

TELEPHONE 20303 & 20076 (CODE 0421)
20496 (DIRECT)

IN ANY CORRESPONDENCE ON
THIS SUBJECT PLEASE QUOTE NO. _____

THE REPUBLIC OF UGANDA

OFFICE OF THE COMMISSIONER
FISHERIES DEPARTMENT,
P.O. BOX 4,
ENTEBBE, UGANDA.

26th November, 1996

The Chairman LC5
Mukono District

Dear Sir,

RE: PUBLIC SENSITIZATION

Subsequent to the visit paid to your District by a Government official from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and officials from Aquatics Unlimited, I wish to request you to permit the Public Sensitization exercise to be conducted in your district. The purpose of the exercise is to sensitize the people about the intended In-lake trials due to take place in Wazimenya bay. The small scale trials will enable us to complete an Environmental Impact Assessment which is nearing completion. The trials will provide additional supportive data from that obtained from the lab and pond trials earlier conducted.

It is in the interest of the Government to have a well informed community about the intended exercise and to give a forum to the public to air their concerns. We hope that through this exercise, we will have a well informed community and that the exercise will stimulate community awareness in control efforts and in the importance of eradicating the water hyacinth.

With your permission, we would like to conduct the exercise on Friday 29th December, 1996. The first exercise will be at Mubanda Primary School at 12.00 p.m. and the second at Butere at 2.00 p.m. We would appreciate if you could assist in mobilizing the community in the areas. Your support in this exercise will be greatly appreciated.

Yours faithfully.

COMMISSIONER FOR FISHERIES
P.O. BOX 4, ENTEBBE - UGANDA
TEL: 20496

F. L. Orach-Meza (Dr.)
COMMISSIONER FOR FISHERIES

c.c. Per. Sec, MAAIF, Entebbe.
c.c. CAO, Mukono
c.c. DFO, Mukono
c.c. Mr. S. B. Kyejjwe - L.C. III Ntenjeru
c.c. Sub County Chief, Ntenjeru
c.c. Headmaster Mubanda Primary School
c.c. Headmaster Butere Primary School

TELEGRAMS: _____

TELEPHONE 20503 & 20576 (CODE 041)
20406 (DIRECT)

IN ANY CORRESPONDENCE ON
THIS SUBJECT PLEASE QUOTE NO. _____

THE REPUBLIC OF UGANDA

FISHERIES DEPARTMENT.
P.O. BOX 4
ENTEBBE, UGANDA.

26th November, 1996

The Resident District Commissioner
Mukono District

Dear Madam,

RE: PUBLIC SENSITIZATION EXERCISE

A Government official from MAAIF and officials from Aquatics Unlimited, contracted by MAAIF, visited your District yesterday, and had the opportunity to discuss with your assistant on the above topic. Subsequent to discussions held with the various authorities in the District, we were cleared to carry out a sensitization exercise in your District.

In view of the above, I wish to request you to officiate at the sensitization function due to take place at Mubanda Primary School on 29th December, 1996 at 12.00 p.m. and at Butere at 2.00 p.m. We shall be honoured to have you as our Guest of Honour at this function.

Your cooperation will be greatly appreciated.

Yours faithfully,

COMMISSIONER FOR FISHERIES
P.O. BOX 4 ENTEBBE - UGANDA
TEL. 20576

F. L. Orach-Meza (Dr.)
COMMISSIONER FOR FISHERIES

c.c. Hon. MOS/General, MAAIF

c.c. Permanent Secretary, MAAIF, Entebbe

TENTATIVE PROGRAMME FOR THE PUBLIC SENSITIZATION FUNCTION
MUKONO DISTRICT - 29th ~~December~~ November, 1996

Venue: - Mubanda Primary School

11.30 a.m.	-	School children assist to organise venue
11.45 a.m.	-	Parent arrive and are seated
11.50 a.m.	-	District Officials seated
11.55 a.m.	-	L.C. 5 Chairman arrives
12.00	-	RDC arrives - National Anthem Buganda/Uganda
12.05 p.m.	-	Headmaster welcomes guests
12.10 p.m.	-	L.C. I welcomes guests
12.15 p.m.	-	L.C. III brief speech
12.20 p.m.	-	L.C. V brief speech
12.30 p.m.	-	MAAIF Official - Water Hyacinth Control in Uganda
1.00 p.m.	-	Aquatics Unlimited - In-lake trials film and brief
1.30 p.m.	-	Public Discussion
2.00 p.m.	-	RDC closing remarks

Venue: - Butere Primary School

2.30 p.m.	-	School children assist to organise venue
2.45 p.m.	-	Parent arrive and are seated
2.50 p.m.	-	District Officials seated
2.55 p.m.	-	L.C. 5 Chairman arrives
3.00	-	RDC arrives - National Anthem Buganda/Uganda
3.05 p.m.	-	Headmaster welcomes guests
3.10 p.m.	-	L.C. I welcomes guests
3.15 p.m.	-	L.C. III brief speech
3.20 p.m.	-	L.C. V brief speech
3.30 p.m.	-	MAAIF Official - Water Hyacinth Control in Uganda
4.00 p.m.	-	Aquatics Unlimited - In-lake trials film and brief
4.30 p.m.	-	Public Discussion
5.00 p.m.	-	RDC closing remarks

BRIEF ON

1996/97 WATER HYACINTH CONTROL PROGRAMME OF THE GOVERNMENT OF UGANDA

Prepared for the
MEETING WITH MUKONO DISTRICT OFFICIALS
25TH NOVEMBER 1996

By

The Water Hyacinth Unit (WHU).
Fisheries Department
Ministry of Agriculture, Animal Industry & Fisheries

P.o. Box 4
Entebbe

25th November, 1996

BRIEF ON WATER HYACINTH CONTROL STATUS IN UGANDA

1. Invasion and Distribution

Water hyacinth, *Eichhornia crassipes*, was first noticed as a problem in Uganda on Lake Kyoga in 1987. Since then, the plant has continued to multiply at an alarming rate and to colonise extensive areas of shoreline not only on Lake Kyoga, but also on Lake Victoria, Lake Albert and on the River Nile. It is well established in some areas and is already blocking sheltered bays and inlets. The source has been identified as River Kagera.

2. Impacts of Water Hyacinth

Our lakes and rivers are host to the richest fisheries of the country with an estimated annual production of some 240,000 tonnes; and they are also important corridors for movement of passengers and goods. These are in addition to the benefits we get from the hydro-electric power and the domestic and industrial water supply requirements.

Water Hyacinth is fully recognised by the Government of Uganda as an environmental and socio-economic menace in our water ways that must be brought under control. The rapid reproductive potential and the efficient dispersal mechanisms of the weed have already enabled it to cover extensive nearshore portions of our water bodies. The extensive mats of water hyacinth currently carpeting fishing grounds, fish breeding, nursery and feeding beds in the lakes and rivers will in time drastically impair fish production. It already obstructs water transport, domestic water sources, hydro-electric power generation, touristic and recreational attractions; the weed also harbours disease vectors e.g. snails that transmit bilharzia.

3. Control Programme at National Level

An Emergency Action Plan for control of water hyacinth at National level is being implemented.

Objective

The objective of the Emergency Action Plan (EAP) is to reduce weed biomass to levels that do not pose socio-economic threat both for riparian communities and to vital national economic support infrastructure systems and health. The EAP one year control plan was formulated by the National Technical Committee on Water Hyacinth (NTCWH) under the auspices of the Agriculture Policy Committee (APC). It attracted mainly donor in-kind funding (Annex I) for 1996/97 financial year. The program is being implemented by the Water Hyacinth Unit (Annex II), in accordance with the implementation schedule in Annex III.

Strategy

The short term strategy of the EAP allows for fast relief and remedial measures such as:

(i) implementation of appropriate physical/mechanical methods where measures for control is urgently required (Kagera, Owen Falls Dam, Portbell, major landing sites nation-wide);

(ii) application of herbicides after a statutory permit from the National Environmental Management Authority (NEMA) following a chemical (herbicide) verification process.

Its long term strategy is to introduce bio-agents on Lakes Victoria and Albert; Rivers Kagera and Albert Nile through a mass rearing programme initially by the FAO intervention component of EAP and later under the Lake Victoria Environmental Management Programme (LVEMP). This strategy offers future cost effective, permanent and environmentally friendly solution to the problem.

All the above strategies for control will be monitored to ensure that the interests of the stake holders is met without negative impact on the environment that supports aquatic life including fish and other riparian biota inclusive of humans.

4. Control Activities

Manual/Physical Control Method

Manual control is on-going where possible through the affected organised communities who are continuously assisted, supervised and mobilised by the staff of the Unit. Groups involved are URC, UEB and fishermen organisations. Limited number of hand tools, and protective covers are being distributed to the organised fishermen communities through their LCs. An emergency action at the Owen Falls Dam was executed during the months of July to October 1996 following a resolute political will boost by H.E. the Vice President/Minister of Agriculture Animal Industry and Fisheries. It Involved manual removal by Special Services (SS), a veterans' business company contracted to support mechanical removal at the Dam. But it became apparent that at the rate of UShs. 50 million per month at the Dam only, this exercise could not be sustained. Implements imported for manual removal have been stranded at Nakawa (from Kenya) and Entebbe Airport (from South Africa) owing lack of resources to clear for Customs and stringent procedures in force. Arrangements are underway to procure more implements through the UNDP intervention component of the EAP.

Mechanical Control Method

The Owen Falls intervention involved also the use of Excavators/backhoes, wheel loaders, crawler tractors and tipping trucks. It was estimated that 700 tonnes of weed was removed per day but about the same quantity of weed was also received at the dam per day.

Mechanical harvesting systems procured from Holland were assembled at Port Bell and deployed at the Dam. Four Ten tonne 4WD truck meant for the harvesting systems are stranded at Jinja Customs awaiting tax clearance: also, another weed harvesting system through the Japanese Non-project Aid Grant is expected by March, 1997.

Machineries for the barrier on the River Kagera are being assembled in California for delivery to Uganda by Aquatics Unlimited. Meanwhile a temporary boom was constructed and is operating with mean output of 260 t per day using manual removal and trailer tractor transfer to dumpsites.

Biological Control Method

Implementation schedule incorporating the interventions by FAO/UN and USAID has been prepared and is undergoing review. Otherwise the weevils released in Lake Kyoga are establishing themselves. Multiplication of the bioagents is on-going at Namulonge Research Institute by researchers from FIRI and NAARI of NARO.

Chemical Control Method

Steps taken:

The following steps have been taken or are planned to ensure safe to health and the environment in respect to various multiple users and stake holders:

i) Certificates were issued by the National Chemicals Control Board (DCR, MAAIF) for all chemicals imported into Uganda after a scientific verificatior process. All Chemicals anticipated for chemical control of water hyacinth are already registered in Uganda and have been used in terrestrial ecosystems before to contain crop weeds. The Board certified the Rodeo brand o Glyphosate and Weedar 64 brand of 2,4-D to be used by the AU in-lake trial recently. The Board did not certify Reward brand of Diquat and hence AU wil use only two chemicals for the in-lake trials.

ii) The Chemical Verification Committee of the National Technical Committe for Control of Water Hyacinth (NTCWH) conducted experiments to verif efficacy, safety to health and environment inclusive of fish. The draf report indicates no apparent effect of the chemicals on fish and other aquati biota. The chemical exerted a high kill rate on the weeds (Av. 80%);

iii) Candidate chemical samples from MAAIF stock were submitted to the Deser Locust Control Organisation (DLCO) for matching the sample chemicals with th standard provided by the manufacturer. The samples were found to match. Th applicators in DLCO are trained and experienced in case aerial spraying considered in the near future. A ground scientific monitoring team was to b assembled at short notice;

iv) Aquatics Unlimited is to further conduct in-lake trials of the candida herbicides. The herbicides (Glyphosate and 2,4-D) were importe Certification by the Chemical Control Board is complete. NEMA has given t

go-ahead for the trials but have not vetted the extend and scope of the study as they favour a wider spectrum of variables/parameters while Aquatics Unlimited contents on a very restricted one consisting only efficacy and water quality. A meeting of the core EIA committee was held by NEMA upon which a number of parameters were agreed on for the in-lake trials. AU were given two months in which to complete the in-lake trials w.e.f. mid November 1996.

Procedures being followed:

The following procedures are being followed to ensure effective integrated weed control that include use of herbicides; hence attendant safety to health and the environment in respect to various multiple users and stake holders:

i) An Emergency Action Plan (EAP) for the Control of Water Hyacinth in Uganda was sanctioned by the Agriculture Policy Committee (APC) in November 1995. It recommended an integrated approach including manual/mechanical, chemical and Biological approach to weed control;

ii) Since the EAP recommended actions that will have an impact on Environment, MAAIF/AU closely working with NEMA, produced a scoping document approved by an extended Scoping Committee to identify aspects of the EAP intervention that will require an Environmental Impact Assessment (EIA) as per the Uganda National Environmental Statute (20-22);

iii) The Chemical Intervention Aspect was found to require an EIA before any large scale application. Accordingly, NEMA authorised use of chemicals on the lake only for experimental purposes for the limited in-lake trials on restricted bays. Mechanical/manual control was deemed not to require an EIA before commencement of control operations. NEMA waived the necessity for an EIA before the Kagera AU mechanical/Manual removal intervention.

iv) MAAIF through Aquatics Unlimited (AU) drafted an Environmental Impact Assessment document soon to be reviewed by the Extended EIA Committee to be convened by NEMA. The final report of the Chemicals Verification Committee is to be an important input to EIA as well as further in-lake trial studies to be conducted by AU.

v) The EIA document will thence be subjected to public scrutiny and a certificate granted by NEMA for lake-wide herbicide application.

vi) On receipt of the NEMA certification, MAAIF/AU will then conduct herbicide administration on target weed bicmass in Lake Victoria, Kyoga, Albert and Albert Nile.

5. Control Programme at International level

Resolution of the hyacinth problem in Lake Victoria will require close collaboration between all the states concerned: Uganda, the United Republic of Tanzania, Kenya (for Lake Victoria littoral), Burundi and Rwanda (for River Kagera catchment area). The initiative already in place is being stepped up in order to formulate an agreement on an intervention programme involving all

countries concerned. A regional meeting of decision/policy makers at Permanent Secretary level is scheduled for mid November 1996 in Uganda on the subject.

The Lake Victoria Environmental Management Project is scheduled to start on 1st November, 1996. An assurance was given at negotiations that National Steering Committees would be established in all the three countries for the water hyacinth control programme estimated at US$ 8.31 million for five years.

6. Constraints Affecting Control Programme

Slow realisation of the dangers posed by water hyacinth on the part of policy decision makers with respect to funding control activities. Also, cost of control is often prohibitive as to demand external donor financing. Comparative data exists on estimated cost implications of control methods.

Manual control	-	9m Ushs./ha
Mechanical	-	8.5m Ushs./ha
Chemical	-	4.4m Ushs./ha
Biological	-	2.5m Ushs./ha

Mobilisation of resources led to slow pace of procurement of mechanical systems of weed removal.

Rate of multiplication of bioagents used in biological control is apparently slow but this approach offers the best long-term control strategy that is cost effective and environmentally friendly.

Public antipathy with respect to herbicide application despite scientific evidence to the contrary. In effect, a plaint to restrain the Government from spraying the weed with any herbicide has already been served on the Attorney General.

7. Conclusion

Water Hyacinth is already causing detrimental impacts to our aquatic environments and hindering the use of our valuable water resources. Efforts to control the plant are already underway and hence the need to proceed as prudently as possible taking account of existing information and opportunities.

MESSAGE FROM MAAIF - GOVERNMENT OF UGANDA ON WATER HYACINTH CONTROL PROGRAM
IN-LAKE HERBICIDE TRIALS

5 February 1997

AS YOU ARE AWARE, THE PROLIFERATION OF WATER HYACINTH HAS REACHED LARGE PROPORTIONS THROUGHOUT MUCH OF THE UPPER NILE SYSTEM, INCLUDING LAKE VICTORIA, CAUSING PROBLEMS FOR THE LIFE, ECONOMY, AND ENVIRONMENT OF UGANDA AND ITS NEIGHBORING COUNTRIES. AS IN MANY OTHER LOCATIONS IN THE WORLD, WATER HYACINTH PROBLEMS IN UGANDA INCLUDE OBSTRUCTION OF BOAT TRAFFIC, INTERFERENCE WITH WATER SYSTEMS, IMPACTS TO HYDROELECTRIC POWER PRODUCTION, AND INTERFERENCE WITH FISHING AND FISHING ACCESS. THE WEED AFFECTS FISH AND WILDLIFE RESOURCES, REDUCES WATER QUALITY, AND INCREASES SEDIMENT ON THE LAKE BOTTOM.

IN ORDER TO REDUCE WATER HYACINTH PROBLEMS IN THE LAKE, SOME MEASURES ARE BEING UNDERTAKEN BY THE GOVERNMENT TO CONTROL THE MULTIPLICATION OF THE WEED. THESE MEASURES INCLUDE AN INTEGRATED APPROACH TO CONTROLLING THE HYACINTH THROUGH USE OF HERBICIDES, BIOLOGICAL AND MANUAL/MECHANICAL METHODS OF CONTROL.

THE HERBICIDES FOR USE, DURING THE IN-LAKE TRIALS ARE GLYPHOSATE AND 2, 4-D. THESE HERBICIDES ARE USED PRESENTLY IN NORMAL DAY TO DAY OPERATIONS ON OUR FARMS TO CONTROL AGRICULTURAL WEEDS, AND WIDELY USED AROUND THE WORLD. THEY CAN ALSO BE SAFELY USED ON THE WATER HYACINTH.

THESE HERBICIDES ARE NOT NEW. THEY HAVE BEEN USED IN OTHER COUNTRIES LIKE AMERICA, IN AFRICAN COUNTRIES SUCH AS NIGERIA, SOUTH AFRICA AND SUDAN, AND IN SOUTHEAST ASIA WHERE THEY HAVE PROVED EFFECTIVE IN CONTROLLING WATER HYACINTH.

THE HERBICIDE TRIALS WILL BE CARRIED OUT ON A SMALL SCALE AT WAZIMENYA BAY ADJACENT TO MUBANDA PARISH, NTENJERU SUB COUNTY MUKONO DISTRICT. SPRAYING DURING TRIALS WILL OCCUR ONCE ON 11 FEBRUARY, 1997.

1. STAY **100 METERS** AWAY FROM THE SPRAYED WATER HYACINTH FOR 30 DAYS
2. **DO NOT** COLLECT WATER, BATH OR WASH CLOTHES WITHIN 100 METERS FOR 30 DAYS
3. **DO NOT** PLACE FISHING NETS OR CATCH FISH WITHIN 100 METERS FOR 30 DAYS
4. **DO NOT** ALLOW LIVESTOCK TO DRINK THE WATER WITHIN 100 METERS FOR 30 DAYS

YOUR COOPERATION WILL BE HIGHLY APPRECIATED AND WILL ALSO ENABLE US TO COLLECT VITAL DATA INPUT FOR A SOUND ENVIRONMENTAL IMPACT ASSESSMENT.

OBUBAKA OKUVA MU MAAIF - GAVUMENTI YA UGANDA OKULWANYISA EKIDDO KUNYANJA

5 February 1997

NGABWEMUMANYI, OKWAALA KWEKIDO KWALIILA DALA EBITUNDU BINENE NYO MUMAMBUKA GOMUGA KIYIRA, NGAMWOTADE NENYANJA NALUBAALE, NEKIRETELA DALA OBUZIBU BUNGI ERI OBULAMU, EBYENFUNA, N'OBUTONDE BWA UGANDA WAMU NAMAWANGA AMALALA. NGABWEKIRI AWALALA WONA MUNSI, OBUZIBU BWEKIDO MU UGANDA BUTWALIRAMU OKUKYANKALANYA ENTAMBULA YAMATO, OKUSUMBUWA EMIDUMU GYAMAZI, AKABENJE MU KUKOLA KWAMASANYALAZE, N'OKUKYANKALANYA OBUVUBI NABAVUBI. EKIDO KYAKABAATE ERI EBYENYANJA NE BISOLO EBYOMUNSIKO, KIKENDEEZA OMUTINDO GWAMAZI, ATE KYONGERA N'OMUWENDO GWE TTOSI WANSI MUNYANJA.

OKUSOBOLA OKUKENDEEZA KUBUZIBU BWEKIDO MUNYANJA, ENKOLA EZIMU ZITESEZEBWAKO GAVUMENTI OKUSOBOLA OKUFUGA OBUFUKUNYA BWEKIDO. ENKOLA ZINO ZIJAKUTWALILAMU ENKOLA EYOBWESIMBU OKUSOBOLA OKUFUGA EKIDO OKUYITA MU NKOZESA YAMALAGALA, ENZAALA, EMIKONO N'EBYUMA. ENWANYISA EY'EBYUMA NENFUGAYOKUZALA KWEKIDO YO YATANDIKA DDA OKUKOLA.

KYETAGISA OKUSAAKO OMWOYO NTI AMALAGALA AGATESEBWAKO OKUKOZESEBWA MUKUGEZESA KU NYANJA GEGA GLYPHOSATE NE 2, 4-D. AMALAGALA GANO GAKOZESEBWA MUBULAMU NAKATI MUMASAMBA GAFFE OKUFUGA EMIDO EGYOMUNIMIRO, ATE NGA GAKOZESEBWA NE MUNSI NYINGI. MUBWEGENDEREZA GASOBOLA OKUKOZESEBWA KUKIDO.

AMALAGALA GANO SIMAPYA. GABADDE GAKOZESEBWA MUMAWANGA AMALALA NGA AMERICA, MUMAWANGA G'AFRICA GAKOZESEBWAKO MU-NSI NGA NIGERIA, SOUTH AFRICA NE SUDAN NEMUMASERENGETA GOBUVANJUBA BWA ASIA, GYE GAZULIDWA OKUBA AGOMUGASO MUKUFUGA EKIDO. OKUFUYIRA KUBERAWO OMULUNDI GUMU NGA 11/02/1997.

OKUGEZESA KWAMALAGALA KUJAKOLEBWA KUMUTINDO OGWAWANSI KUKYEBEEYA KYE WAZIMENYA OKULIRANA KU MUBANDA PARISH, NTENJERU, MUKONO DISTRICT.

OKUMALA EBANGA LYANAKU AMAKUMI ASATU (30) OLUVANYUMA LWOKUFUYIRA EDODO, TUBASABA:

1. MUBEERE EBIFUBA KIKUMI (100) OKUVA AWAFUYIDWA EKIDO
2. TEMUKIMA MAZI, KUNAABA, OBA KWOZA ENGOYE MUBIFUBA EBYO EKIKUMI OKUVA MU BIFO EBIFUYIDDWA.
3. TEMUTEGA BUTIMBA BUVUBA OBA OKUVUBA MUBIFUBA EBYO EKIKUMI (100) OKUVA MU BIFO EBIFUYIDDWA.
4. TEMUKIRIZA BISOLO KUNYWA MAZI MU BEFUBA EBYO EKIKUMI (100) OKUBA MU BIFO EBIFUYIDDWA.

BAMBI MANYA NTI OKUSALAWO OKUKUSABA OBEERE WALA OKUVA MUKIFO EKYO, KWEKUTUSOBOZESA OKWEKAANYA EKIGENDERERWA AWATALI KUTATANYIZIBWA. ERA KINO KIJAKUTUYAMBA OKWEYONGERA OKUKAKASA ENKOLA EYO.
ERA KINO KIJA KUTUYAMBA OKWEYONGERA OKUKAKASA ENKOLA EYO
ENKOLAGANA YO NAFFE EJAKUSIIMIBWA MUKIKA KYAWAGULU. KINO KIJJA KUTUYAMBA OKUMALILIZA EKITABO EKIKWATA KUBUTONDE BWENSI

HERBICIDE TRIALS
PLEASE KEEP OUT

OKUGEZESA
EDDAGALA
TOSEMBERA WANO

WATER HYACINTH UNIT (MAAIF)

NEW VISION 20/6/97

which specializes in country music world over, and it is based in Paris-France. Out of 6000 African contestants, Basudde was number two. His song, *Abaddugavu Twalya ki?* was the winning song. It mobilizes Ugandans not to

Guitar Singers which was being led by the late Livingstone Kasozi and Moses Katende. While with Lukwata, Basudde released five tapes, *Mukyala Mugerwa* which became a household name and is believed to have

and *Ekiwuka*.

Following the demise of Katende, Basudde quit Lukwata and formed up his group in 1992 which he named Kabuladda Professional Singers which he kept till his death.

THE REPUBLIC OF UGANDA
THE NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

PUBLIC NOTICE

The Public is hereby notified that the National Environment Management Authority (NEMA) has received a draft Environment Impact Statement (EIS) for the proposed NATIONAL HYACINTH CONTROL PROGRAMME IN LAKE VICTORIA AND OTHER REGIONAL WATERWAYS and is available for public scrutiny and comment. The proposed control programme was prepared by Aqualics Unlimited on behalf of the Ministry of Agriculture, Animal Industry and Fisheries, Uganda.

Some of the proposed control measures were found likely to have adverse impacts on the water bodies and the environment. The proponents of the said programme intend to control those likely impacts by implementing mitigation measures contained therein. It is also proposed that the programme may bring the water hyacinth under control and hence be of positive significance to aquatic resources and the environment.

Copies of the said draft EIS can be found or accessed from the following places:

1. NEMA Library, 5th Floor EDDB Building
2. Kampala Public Library, Buganda Road.
3. Makerere University, Main Library.
4. Fisheries Department Library, Entebbe.
5. The Permanent Secretary, Ministry of Agriculture, Entebbe.
6. Mukono Dsitrict Administration Hqts, Mukono
7. NARO Library, Entebbe.

THE PUBLIC IS FURTHER NOTIFIED that the outcome of the public review and hearing will contribute to the making of a final decision of either to approve or otherwise deal with the proposed control measures contained in the programme.

The public is therefore invited to send comments, suggestions, reasons for any objections on the proposed programme or components thereof. Such comments, suggestions or objections should be sent to NEMA within a period of 21 days from the date of publication hereof.

NEMA shall thereafter proceed to hold a Public Hearing on the 30th July, 1997 at the International Conference Centre, Kampala beginning at 8.00 a.m to hear presentations on the said draft EIS and any useful views. Views or inquiries should be addressed or hand delivered to:

The Executive Director, NEMA
5th Floor, EADB Building, Plot No. 4 Nile Avenue
P.O. Box 22255, Kampala
Tel: No. 256 (41) 251964/5/6 Fax: 257521 or 232660,
Email: neic@l.starcom.co.ug

Dated this 19 day of June, 1997

Prof John Y.Okedi
EXECUTIVE DIRECTOR

marriag

AFTER a four-and-a-half-year romance, top country singer Kenny Rogers and Wanda Miller, a glamorous ex-waitress 28 years his junior, are looking forward to the future as man and wife.

The two have been living together since they first met in the Atlanta restaurant where Wanda was working. And six months ago Kenny, 58, took the plunge with an on-stage proposal.

Interviewed at his home in Branson, Missouri, the four-times-married singer talks about the love he has found with Wanda, the life he lead as a highly successful businessman and entertaine and the future of country music.

Kenny, tell us a little bit about Wanda

"When I met her in the restaurant I kinda stayed away from her at first, because she looked like sh was 14. I just couldn't do i Then someone said she wa 26, and I said; 'I can do that!' So we became good friends and we've been seeing each other since.

"She'll be 31 in Septem and it's been really good me, and I think for her to think she's grown. It's be good for me having her energy around. It's a gre support system. I'm not really a person who gets and does things by himse it's that old saying of hou trophies are no good un you have someone to sh them with. So it's kinda for me, travelling and sharing with her. She's ju great isn't she?"

When did you decide get married?

"Last Christmas. It was during a show in Las Ve invited her onto the st proposed and then ded cated a song to her."

You have made a hug success of your busine

Annex I

LIST OF PARTICIPANTS
JULY 30, 1997 PUBLIC HEARING

	NAME	INSTITUTION	ADDRESS
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11.	Ms. Helien Bugeri	AU	P.O.Box 7057. Kampala.
12.	Mr. Tumusiime Mwije	Nkumba Univesity	P.O.Box 237. Entebbe
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32.	Dr. Aryamanya-Mugisha	NEMA	P.O.Box 22255. Kampala
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35.	Mr. E. Mubagadhi	Makerere University	P.O.Box 7062. Kampala
36.	Mr. Joshua Kyalimpa	Capital Radio	

37.	Dr. J. Arusi Akusi	Zoology Dept. MUK	P.O.Box 7062. Kampala
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54.	Mr. Isaac Wassajja	S.B. Research Centre	P.O.Box 7062. Kampala
55.	Mr. M.S. Kawooya	Makerere University	P.O.Box 7062. Kampala
56.	Mr. J.O'Brien	African Resources	P.O.Box 2496. Mbale
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398.	Mr. Peter Jomba	PROI	Kampala
399.	Ms. Mary Nalumor	Uganda Tech. Inst.	Kampala
400.	Ms. Rose Adikin	Mutungo	
401.	Mr. Eriastu Mukiibi	Nansana	P.O.Box 1599. Kampala
402.	Mr. John Wambede	LVEMP	P.O.Box 19. Entebbe
403.	Mr. Robert Eseggo	UBM	P.O.Box 8202. Kampala
404.	Mr. Fox Okongo	FTI	P.O.Box 124. Entebbe
405.	Mr. Lubulwa	DFO Mpigi	P.O.Box 172. Mpigi
406.	Prof. Tom Crismas	University of Florida	Florida. USA
407.	Mr. T. Kyode Mubiru	YMCA	P.O.Box 2871. Kampala
408.	Mr. Nsobya Nathan Kasolo	UCEPA	P.O.Box 6370. Kampala
409.	Mr. Mateete Bekunda	Makerere University	P.O.Box 7062. Kampala
410.	Mr. S.M. Byarujali	Botany Makerere	P.O.Box 7062. Kampala
411.	Mr. Dick Nyeko	MAAIF	P.O.Box 102. Entebbe
412.	Mr. Fred Nasaba		
413.	Ms. Florence Khanakwa		
414.	Ms. Betty Atim		
415.	Mr. J.E. Sentongo	NEMA	P.O.Box 22255. Kampala
6.	Mr. A. Agaba	KCC	Kampala
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420.	Mr. Dickson Magembe	Uganda Green Belt	P.O.Box 2437. Kampala
421.	Mr. Plity Bozel	UFPEA	Kampala
422.	Mr. Robert Nabanyumya	UNDP/GEF	Kampala
423.	Ms. M.J.N Okwakol	EAWLS	Kampala
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425.	Mr. Gumila Mbuga	BWOCC	P.O.Box 2386. Kampala
426.	Mr. Charles Wanda	Nile Dev. Centre	P.O.Box 4163. Kampala
427.	Ms. Christine Mubiru	MOF - EACD	P.O.Box 8147. Kampala
428.	Mr. Richard Nyenje	KARI/NARO	P.O.Box 7065. Kampala
429.	Mr. George Oratunge	Jinja Municipal Council	P.O.Box 720. Jinja
430.	Ms. Ashie K. Mukungo	Makerere University	P.O.Box 7062. Kampala
431.	Mr. Francis Odoi		
432.	Mr. Peter Okot	NARFOD	
433.	Mr. Timwine		
434.	Mr. E. Kintu	Katamba & Co. Ad.	Kampala
435.	Ms. Rose Kintu	Katamba & Co. Ad.	Kampala
436.	Mr. Moses Ojota	Student	
437.	Mr. Maxwell Adriko	Student	
438.	Mr. Edmond Owor	Student	
439.	Mr. Michael Bengo	Uganda Coffee Farmers	P.O.Box 1941. Kampala
440.	Dr. Peter Mukasa	WHYMA	P.O.Box 431. Kampala
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446.	Mr. B. Bosl	GTZ	
447.	Mr. Ogunwa	Makerere University	P.O.Box 7062. Kampala
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449.	Mr. J. Kyaterekera	UCBC	Nakawa
450.	Mr. J. Nserikomawa	Student	UMU - Nki

APPENDIX 5

USEPA COMMENTS ON GLYPHOSATE AND 2,4 - D USE IN LAKE VICTORIA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 11 1998

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Mr. Thomas J. McNabb, President
Aquatics Unlimited, Inc.
827 Arnold Drive, Suite 80
Martinez, California 94553

Dear Mr. McNabb:

This is in response to your letter of January 6, 1998 to Mr. Steve Johnson, Deputy Director of the U.S. Environmental Protection Agency (EPA), Office of Pesticide Programs (OPP), requesting information regarding the pesticide products Rodeo (glyphosate, EPA Reg. No. 524-343) and Weedar 64 (2,4-D, EPA Reg. No. 264-2-AA). You described the water hyacinth control program your company has been contracted to implement in Lake Victoria and the possible concerns of the European Commission about the use of these products in that control program.

As you requested, I am enclosing information to help characterize the registration status of these products in the U.S. and the possible considerations affecting their suitability for use in the control of water hyacinth in developing countries. I hope that the enclosed information will be helpful. If you need further information, feel free to contact my office at (Tel) 703-305-7102, (Fax) 703-305-6244, or you may also invite European Commission staff to contact us with any questions they may have.

Sincerely,

Anne E. Lindsay

Anne E. Lindsay, Director
Field and External Affairs Division
Office of Pesticide Programs

Enclosures

cc: U.S. Ambassador Nancy J. Powell (Kampala Uganda), by fax
Mr. Irving A. Williamson, Office of the United States Trade Representative, by fax
David Shark, Dep. Assistant for Environment and Natural Resources, USTR, by fax
Mr. Carl M. Gallegos, USAID Africa Bureau Environmental Coordinator, by fax
Mr. Walter Knausenberger, USAID Environmental Analyst and Adviser, by fax
Irving (Pep) Fuller, USEPA Office of Prevention, Pesticides, and Toxic Substances

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USEPA Comments on Glyphosate and 2,4-D Use in Lake Victoria

Background: EPA Pesticide Responsibilties

The EPA is responsible for registering pesticide products in the U.S. under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Pesticides to be used on food or feed are also regulated under the Federal Food, Drug, and Cosmetic Act (FFDCA). Under these laws, all pesticides must be thoroughly tested before they are registered and appropriate tolerances, or maximum residue limits, are set to ensure their use will not pose an unreasonable risk to people or the environment.

Registration status of Glyphosate and 2,4-D

Both of these products are registered with EPA for use in the U.S. in lakes for the control of water hyacinth, and EPA has established a tolerance for both glyphosate and 2,4-D in fish. Enclosed for your reference is the latest product label for each of these pesticides, as well as a copy of the Code of Federal Regulation citation listing the tolerance for each of these products; the glyphosate tolerance is set at 0.25 ppm, and the 2,4-D tolerance is set at 1 ppm.

Based upon the best evidence available to EPA at the time these registration actions were taken (2,4-D's tolerance is from before 1978 and glyphosate's was reevaluated in 1993), when these products are used in the U.S. as directed on the label, EPA does not expect that concentrations of the product will be seen in fish at levels exceeding the tolerance level. EPA has recently reevaluated the risks of glyphosate and has an ongoing reassessment of 2,4-D. In addition, EPA plans to review its labeling for aquatic uses. The current requirements place great responsibility on the applicator, and the Agency is considering whether or not these requirements need to be clarified or strengthened.

Toxicity and Environmental Effects

Glyphosate

Enclosed for your information is the Fact Sheet for the glyphosate Reregistration Eligibility Decision (RED) document, which is EPA's most comprehensive evaluation of the effects of this pesticide. As explained, EPA's greatest risk concern for this chemical is for potential skin and eye irritation during mixing and loading of some products. The label indicates the type of protective equipment required as a precaution against this potential.

2,4-D

No RED has been completed for 2,4-D. EPA has been concerned for a number of years about the potential carcinogenicity of this pesticide. However, EPA concluded, after conducting a fourth review of the chemical's carcinogenicity in 1997, that the evidence available of human carcinogenicity is inadequate and cannot be interpreted as showing either the presence or absence of a carcinogenic effect from this pesticide. All uses and tolerances will be reassessed in the near future as part of the ongoing EPA reregistration program.

2,4-D will be reassessed under the more stringent requirements of the 1996 Food Quality Protection Act (FQPA), which mandate consideration of exposures from all sources, including drinking water, and additional uncertainty factors for women and children where needed. The 1996 FQPA also requires consideration of cumulative risks from similar pesticides with common mechanisms of toxicity.

Label prohibitions against treating potable water

Glyphosate: The EPA glyphosate label warns, "Do not apply this product within ½ mile of an active potable water intake in a standing body of water such as lake, pond or reservoir. To make aquatic applications around and within ½ mile of active potable water intakes, the water intake must be turned off for a minimum period of 48 hours after the application [or until the glyphosate level has dropped to below 0.7 ppm...]"

2,4-D: The 2,4-D label warns, "Delay the use of [2,4-D] treated waters for domestic purposes for three weeks after treatment or until such time as an approved assay shows that the water does not contain more than 0.1 ppm 2 4-D acid."

These precautions are part of the conditions EPA deems necessary for safe use of these pesticides. As noted earlier, they depend on compliance by the applicator. The ability to monitor and enforce applicator compliance in the Lake Victoria region is an important consideration governing national decisions on use of either pesticide. Residents along the lake's shores may use the water for domestic purposes, and without treatment.

Interpreting EPA Registration

It should be emphasized that EPA registers pesticides based upon an evaluation of the risks and benefits of a pesticide's expected use in the U.S. To the extent that there are substantial differences between use conditions in the U.S. and in Kenya, Tanzania or Uganda, the potential impacts on both the environment and human health may also be different. Principal areas of difference are described in the following sections.

Potentially different dietary exposure – The exposure of individuals living around Lake Victoria to local fish and water may be different from the exposure in the U.S. for a number of reasons, including the following:

- the possible differences in fish consumption patterns
- differences in water purification or treatment practices (see description of label prohibitions against potable water treatment, above)

Potentially different exposure from handling, storage, and transport – Unless adequate precautions are taken with regard to mixing, loading,

application, transport, and storage of pesticides, use of pesticides may present an increased risk to human health and the environment than a U.S. risk assessment would indicate.

Potentially different environmental impact -- As you have explained, Lake Victoria is very biodiverse, with complex ecodynamics. Special consideration should therefore be given to the potential impacts that the aquatic herbicides could have on non-target plant and animal life and lake ecosystems. Disruption of these balances could have harmful results, including potential outbreaks of endemic water-borne diseases that can affect humans and livestock.

United States Environmental Protection Agency
Prevention, Pesticides And Toxic Substances (7508W)
EPA-738-F-93-01
September 1993

EPA

R.E.D. FACTS

Glyphosate

Pesticide Reregistration

All pesticides sold or distributed in the United States must be registered by EPA, based on scientific studies showing that they can be used without posing unreasonable risks to people or the environment. Because of advances in scientific knowledge, the law requires that pesticides which were first registered years ago be reregistered to ensure that they meet today's more stringent standards.

In evaluating pesticides for reregistration, EPA obtains and reviews a complete set of studies from pesticide producers, describing the human health and environmental effects of each pesticide. The Agency imposes any regulatory controls that are needed to effectively manage each pesticide's risks. EPA then reregisters pesticides that can be used without posing unreasonable risks to human health or the environment.

When a pesticide is eligible for reregistration, EPA announces this and explains why in a Reregistration Eligibility Decision (RED) document. This fact sheet summarizes the information in the RED document for glyphosate.

Use Profile

Glyphosate is a non-selective herbicide registered for use on many food and non-food field crops as well as non-crop areas where total vegetation control is desired. When applied at lower rates, glyphosate also is a plant growth regulator.

Glyphosate is among the most widely used pesticides by volume. It ranked eleventh among conventional pesticides used in the U.S. during 1990-91. In recent years, approximately 13 to 20 million acres were treated with 18.7 million pounds of glyphosate annually. The largest use sites include hay/pasture, soybeans and field corn.

Three salts of glyphosate are used as active ingredients in registered pesticide products. Two of these active ingredients, plus technical grade glyphosate, are contained in the 56 products that are subject to this RED.

The isopropylamine salt, an active ingredient in 53 registered products, is used as a herbicide to control broadleaf weeds and grasses in many food and non-food crops and a variety of other sites including ornamentals, lawns and turf, residential areas, greenhouses, forest plantings and industrial rights-of-way. It is formulated as a liquid, solid or pellet/tablet, and is applied using ground or aerial equipment.

The sodium salt of glyphosate, an active ingredient in two registered pesticide products, is used as a plant growth regulator for peanuts and sugarcane, to modify plant growth and hasten the ripening of fruit. It is applied as a ground spray to peanut fields and as an aerial spray to sugarcane. Preharvest intervals are established for both crops.

The monoammonium salt of glyphosate is an active ingredient in an additional seven herbicide/growth regulator products. This form of glyphosate was initially registered after November 1984, so it is not subject to reregistration or included in this RED. However, in reassessing the existing glyphosate tolerances (maximum residue limits in or on food and feed), EPA included those for the monoammonium salt.

Regulatory History

EPA issued a Registration Standard for glyphosate in June 1986 (NTIS PB87-103214). The Registration Standard required additional phytotoxicity, environmental fate, toxicology, product chemistry and residue chemistry studies. All of the data required have been submitted and reviewed, or were waived.

Human Health Assessment

Toxicity

Glyphosate is of relatively low oral and dermal acute toxicity. It has been placed in Toxicity Category III for these effects (Toxicity Category I indicates the highest degree of acute toxicity, and Category IV the lowest). The acute inhalation toxicity study was waived because glyphosate is non-volatile and because adequate inhalation studies with end-use products exist showing low toxicity.

A subchronic feeding study using rats showed blood and pancreatic effects. A similar study with mice showed reduced body weight gains in both sexes at the highest dose levels. A dermal study with rabbits showed slight reddening and swelling of the skin, decreased food consumption in males and decreased enzyme production, at the highest dose levels.

Several chronic toxicity/carcinogenicity studies using rats, mice and beagle dogs resulted in no effects based on the parameters examined, or resulted in findings that glyphosate was not carcinogenic in the study. In June 1991, EPA classified glyphosate as a Group E oncogen--one that shows evidence of non-carcinogenicity for humans--based on the lack of convincing evidence of carcinogenicity in adequate studies.

In developmental toxicity studies using pregnant rats and rabbits, glyphosate caused treatment-related effects in the high dose groups including diarrhea, decreased body weight gain, nasal discharge and death.

One reproductive toxicity study using rats showed kidney effects in the high dose male pups; another study showed digestive effects and decreased body weight gain. Glyphosate does not cause mutations.

In one metabolism study with rats, most of the glyphosate administered (97.5 percent) was excreted in urine and feces as the parent compound; less than one percent of the absorbed dose remained in tissues and organs, primarily in bone tissue. Aminomethyl phosphonic acid (AMPA) was the only metabolite excreted. A second study using rats showed that very little glyphosate reaches bone marrow, that it is rapidly eliminated from bone marrow, and that it is even more rapidly eliminated from plasma.

Dietary Exposure

The nature of glyphosate residue in plants and animals is adequately understood. Studies with a variety of plants indicate that uptake of glyphosate or AMPA from soil is limited. The material which is taken up is readily translocated throughout the plant and into its fruit. In animals, most glyphosate is eliminated in urine and feces. Enforcement methods are available to detect residues of glyphosate and AMPA in or on plant commodities, in water and in animal commodities.

85 tolerances have been established for residues of glyphosate and its metabolite, AMPA, in or on a wide variety of crops and crop groups, as well as in many processed foods, animal feed and animal tissues (please see 40 CFR 180.364, 40 CFR 185.3500 and 40 CFR 186.3500). EPA has reassessed the existing and proposed tolerances for glyphosate. Though some adjustments will be needed, no major changes in existing tolerances are required. EPA also has compared the U.S. tolerances with international Codex maximum residue limits (MRLs), and is recommending certain adjustments to achieve greater compatibility.

EPA conducted a dietary risk assessment for glyphosate based on a worst-case risk scenario, that is, assuming that 100 percent of all possible commodities/acreage were treated, and assuming that tolerance-level residues remained in/on all treated commodities. The Agency concluded that the chronic dietary risk posed by glyphosate food uses is minimal.

A reference dose (RfD), or estimate of daily exposure that would not cause adverse effects throughout a lifetime, of 2 mg/kg/day has been proposed for glyphosate, based on the developmental toxicity studies described above.

Occupational and Residential Exposure

Occupational and residential exposure to glyphosate can be expected based on its currently registered uses. However, due to glyphosate's low acute toxicity and the absence of other toxicological concerns (especially carcinogenicity), occupational and residential exposure data are not required for reregistration.

Some glyphosate end-use products are in Toxicity Categories I or II for primary eye irritation or skin irritation. In California, glyphosate ranks high among pesticides causing illness or injury to workers, who report numerous incidents of eye and skin irritation from splashes during mixing and loading.

EPA is not adding any personal protective equipment (PPE) requirements at this time, but any existing PPE label requirements must be retained.

The Worker Protection Standard (WPS) for Agricultural Pesticides (please see 40 CFR 156 and 170) established an interim restricted entry interval (REI) of 12 hours for glyphosate. The Agency has decided to retain this REI as a prudent measure to mitigate risks to workers. During the REI, workers may reenter areas treated with glyphosate only in the few, narrow exceptions allowed in the WPS. The REI applies only to glyphosate uses within the scope of the WPS, so homeowner and commercial uses are not included.

Human Risk Assessment

EPA's worst case risk assessment of glyphosate's many registered food uses concludes that human dietary exposure and risk are minimal. Existing and proposed tolerances have been reassessed, and no significant changes are needed to protect the public.

Exposure to workers and other applicators generally is not expected to pose undue risks, due to glyphosate's low acute toxicity. However, splashes during mixing and loading of some products can cause injury, primarily eye and skin irritation. EPA is continuing to recommend PPE, including protective eye wear, for workers using end-use products that are in Toxicity Categories I or II for eye and skin irritation. To mitigate potential risks associated with reentering treated agricultural areas, EPA is retaining the 12 hour REI set by the WPS.

Environmental Assessment

Environmental Fate

Glyphosate adsorbs strongly to soil and is not expected to move vertically below the six inch soil layer; residues are expected to be immobile in soil. Glyphosate is readily degraded by soil microbes to AMPA, which is degraded to carbon dioxide. Glyphosate and AMPA are not likely to move to ground water due to their strong adsorptive characteristics. However, glyphosate does have the potential to contaminate surface waters due to its aquatic use patterns and through erosion, as it adsorbs to soil particles suspended in runoff. If glyphosate reached surface water, it would not be broken down readily by water or sunlight.

Ecological Effects

Glyphosate is no more than slightly toxic to birds and is practically non-toxic to fish, aquatic invertebrates and honeybees. Due to the presence of a toxic inert ingredient, some glyphosate end-use products must be labeled "Toxic to fish," if they may be applied directly to aquatic environments. Product labeling does not preclude off-target movement of glyphosate by drift. EPA therefore is requiring three additional terrestrial plant studies to assess potential risks to nontarget plants.

EPA does not expect that most endangered terrestrial or aquatic organisms will be affected by the registered uses of glyphosate. However,

many endangered plants as well as the Houston toad (due to its habitat) may be at risk. EPA is deferring any use modifications or labeling amendments until it has published the Endangered Species Protection Plan and has given registrants guidance regarding endangered species precautionary labeling.

Ecological Effects Risk Assessment

Based on current data, EPA has determined that the effects of glyphosate on birds, mammals, fish and invertebrates are minimal. Under certain use conditions, glyphosate may cause adverse effects to nontarget aquatic plants. Additional data are needed to fully evaluate the effects of glyphosate on nontarget terrestrial plants. Risk reduction measures will be developed if needed, once the data from these studies are submitted and evaluated.

Additional Data Required

EPA is requiring three generic studies (Tier II Vegetative Vigor, Droplet Size Spectrum, and Drift Field Evaluation) which are not part of the target data base and do not affect the reregistration eligibility of glyphosate. The Agency also is requiring product-specific data including product chemistry and acute toxicity studies, as well as revised Confidential Statements of Formula and revised labeling.

Product Labeling Changes Required

All end-use glyphosate products must comply with EPA's current pesticide product labeling requirements. In addition:

- **Protection of Aquatic Organisms**

Non-Aquatic Uses - End-use products that are not registered for aquatic uses must bear the following label statement:

Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters and rinsate.

Aquatic Uses - End-use products registered for aquatic uses must bear the following label statement:

Do not contaminate water when disposing of equipment washwaters and rinsate. Treatment of aquatic weeds can result in oxygen loss from decomposition for dead plants. This loss can cause fish kills.

- **Worker Protection Standard (WPS) Requirements**

Any product whose labeling permits use in the production of an agricultural plant on any farm, forest, nursery or greenhouse must comply with the labeling requirements of:

- PR Notice 93-7, "Labeling Revisions Required by the Worker Protection Standard (WPS)," and

- PR Notice 93-11, "Supplemental Guidance for PR Notice 93-7."

Unless specifically directed in the RED, all statements required by these two PR Notices must appear on product labeling exactly as instructed in the Notices. Labels must be revised by April 21, 1994, for products distributed or sold by the primary registrant or supplementally registered distributors, and by October 23, 1995, for products distributed or sold by anyone.

- **Personal Protective Equipment (PPE)**

No new PPE requirements must be added to glyphosate labels. However, any existing PPE requirements on labels must be retained.

- **Entry Restrictions**

Products Not Primarily Intended for Home Use:

o Uses Within the Scope of the WPS - A 12-hour restricted entry interval (REI) is required for all products with uses within the scope of the WPS, except products intended primarily for home use. The PPE for early entry should be that required for applicators of glyphosate, except any applicator requirement for an apron or respirator is waived. This REI and PPE should be inserted into the standardized statements required by PR Notice 93-7.

- Sole Active Ingredient End-Use Products - Labels must be revised to adopt the entry restrictions set forth in this section. Any conflicting entry restrictions on current labeling must be removed.
- Multiple Active Ingredient Products - Registrants must compare the entry restrictions set forth in this section to those on their current labeling and retain the more protective. A specific time period in hours or days is considered more protective than "until sprays have dried" or "dusts have settled."

o Uses Not Within the Scope of the WPS - No new entry restrictions must be added. However, any entry restrictions on current product labeling with these uses must be retained.

Products Primarily Intended for Home Use:

o No new entry restrictions must be added. However, any entry restrictions on current product labeling must be retained.

Regulatory Conclusion

The use of currently registered pesticide products containing the isopropylamine and sodium salts of glyphosate in accordance with the labeling specified in this RED will not pose unreasonable risks or adverse effects to humans or the environment. Therefore, all uses of these products are eligible for reregistration.

These glyphosate products will be reregistered once the required product-specific data, revised Confidential Statements of Formula and revised labeling are received and accepted by EPA.

Products which contain active ingredients in addition to glyphosate will not be reregistered until all their other active ingredients also are eligible for reregistration.

For More Information

EPA is requesting public comments on the Reregistration Eligibility Decision (RED) document for glyphosate during a 60-day time period, as announced in a Notice of Availability published in the Federal Register. To obtain a copy of the RED document or to submit written comments, please contact the Pesticide Docket, Public Response and Program Resources Branch, Field Operations Division (7506C), Office of Pesticide Programs (OPP), US EPA, Washington, DC 20460, telephone 703-305-5805.

Following the comment period, the glyphosate RED document will be available from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, telephone 703-487-4650.

For more information about EPA's pesticide reregistration program, the glyphosate RED, or reregistration of individual products containing glyphosate, please contact the Special Review and Reregistration Division (7508W), OPP, US EPA, Washington, DC 20460, telephone 703-308-8000.

For information about the health effects of pesticides, or for assistance in recognizing and managing pesticide poisoning symptoms, please contact the National Pesticides Telecommunications Network (NPTN). Call toll-free 1-800-858-7378, between 8:00 am and 6:00 pm Central Time, Monday through Friday.

03/13/98 FRI 12:10 FAX 703 308 1850 U.S. EPA OPP PSPS

ities.

Commodity	Parts per million
Almonds (POST-H)	1
Apples (POST-H)	1
Barley (POST-H)	3
Beans (POST-H)	1
[illegible]	[illegible]
Blackberries (POST-H)	1
Blueberries (huckleberries) (POST-H)	1
Boysenberries (POST-H)	1
Buckwheat (POST-H)	3
Cattle, fat	0.1(N)
Cattle, mbyp	0.1(N)
Cattle, meat	0.1(N)
Cherries (POST-H)	1
Cocoa beans (POST-H)	1
Copra (POST-H)	1
Corn (including popcorn) (POST-H)	3
Cottonseed (POST-H)	1
Crabapples (POST-H)	1
Currants (POST-H)	1
Dewberries (POST-H)	1
Eggs	0.1(N)
Figs (POST-H)	1
Flaxseed (POST-H)	1
Goats, fat	0.1(N)
Goats, mbyp	0.1(N)
Goats, meat	0.1(N)
Gooseberries (POST-H)	1
Grain sorghum (POST-H)	1
Grapes (POST-H)	1
Guavas (POST-H)	1
Hogs, fat	0.1(N)
Hogs, mbyp	0.1(N)
Hogs, meat	0.1(N)
Horses, fat	0.1(N)
Horses, mbyp	0.1(N)
Horses, meat	0.1(N)
Loganberries (POST-H)	1
Mangoes (POST-H)	1
Milk fat (reflecting negligible residues in milk)	0.5
Muskmelons (POST-H)	1
Oats (POST-H)	1
Oranges (POST-H)	1
Peaches (POST-H)	1
Peanuts (with shell removed) (POST-H)	1
Pears (POST-H)	1
Peas (POST-H)	1
Pineapples (POST-H)	1
Plums (fresh prunes) (POST-H)	1
Potatoes (POST-H)	0.05
Poultry, fat	0.2
Poultry, mbyp	0.2
Poultry, meat	0.2
Raspberries (POST-H)	1
Rice (POST-H)	3
Rye (POST-H)	3
Sheep, fat	0.1(N)
Sheep, mbyp	0.1(N)
Sheep, meat	0.1(N)
Sweet potatoes (POST-H)	0.05
Tomatoes (POST-H)	1
Walnuts (POST-H)	1
Wheat (POST-H)	3

[46 FR 48656, Oct. 2, 1981]

phenylphenol and sodium o-phenylphenate, each expressed as o-phenylphenol, from postharvest application of either in or on the following raw agricultural commodities:

[illegible]	Parts per million
Apples	25
Cantaloupes (NMT 10 ppm in edible portion)	125
Carrots	20
Cherries	5
Citrus	10
Citron	10
Cucumbers	10
Grapefruit	10
Kiwifruit	20
Kumquats	10
Lemons	10
Limes	10
Nectarines	5
Oranges	10
Peppers (bell)	10
Peaches	20
Pears	25.0
Pineapples	10
Plums (fresh prunes)	20
Sweet potatoes	15
Tangerines	10
Tomatoes	10

[46 FR 27938, May 22, 1981, as amended at 6 FR 32015, July 13, 1982]

§ 180.130 Hydrogen cyanide; tolerances for residues.

Tolerances for residues of the insecticide hydrogen cyanide from postharvest fumigation are established as follows:

250 parts per million in or on the following spices: Allspice, anise, basil, bay, black pepper, caraway, cassia, celery seed, chili, cinnamon, cloves, coriander, cumin, dill, ginger, mace, marjoram, nutmeg, oregano, paprika, poppy, red pepper, rosemary, sage, savory, thyme, tumeric, white pepper.

75 parts per million in or on barley, buckwheat, corn (including popcorn), milo (grain sorghum), oats, rice, rye, wheat.

50 parts per million in or on citrus fruits.

25 parts per million in or on almonds, beans (dried), cashews, cocoa beans, peanuts, peas (dried), pecans, sesame, walnuts.

From 40 CFR Part 150-189, Revised as of July 1, 1997

fide) in or on raw agricultural commodities are established as follows:

7 parts per million in or on apples, celery, peaches, strawberries, tomatoes.

7 parts per million in or on bananas, (from prenarvest and postharvest application) of which not more than 1 part per million shall be in the pulp after peel is removed and discarded.

0.5 part per million in or on onions (dry bulb).

[36 FR 22540, Nov. 25, 1971, as amended at 37 FR 3182, Feb. 12, 1972]

§ 180.133 Lindane; tolerances for residues.

Tolerances are established for residues of the insecticide lindane (gamma isomer of benzene hexachloride) in or on raw agricultural commodities as follows:

7 parts per million in or on the fat of meat from cattle, goats, horses, and sheep.

4 parts per million in or on the fat of meat from hogs.

3 parts per million in or on cucumbers, lettuce, melons, mushrooms, pumpkins, squash, summer squash, and tomatoes.

1 part per million in or on apples, apricots, asparagus, avocados, broccoli, brussels sprouts, cabbage, cauliflower, celery, cherries, collards eggplants, grapes, guavas, kale, kohlrabi, mangoes, mustard greens, nectarines, okra, onions (dry bulb only), peaches, pears, peppers, pineapples, plums (fresh prunes), quinces, spinach, strawberries, and Swiss chard.

0.01 part per million (negligible residue) in or on pecans.

[36 FR 22540, Nov. 25, 1971, as amended at 39 FR 13776, Apr. 17, 1974]

§ 180.136 Basic copper carbonate; tolerance for residues.

The tolerance for residues of the fungicide basic copper carbonate in or on pears from post-harvest use of the chemical is 3 parts per million of combined copper.

known as diphenyl) from postharvest use on the following raw agricultural commodities:

Commodity	Parts per million
Fruits, citrus (and hybrids thereof)	110

[42 FR 9178, Feb. 15, 1977]

§ 180.142 2,4-D; tolerances for residues.

(a) Tolerances are established for residues of the herbicide, plant regulator, and fungicide 2,4-D (2,4-dichlorophenoxyacetic acid) in or on raw agricultural commodities as follows:

Commodity	Parts per million
Apples	5
Apricots	5
Citrus fruits	5
Pears	5
Potatoes	0.2
Quinces	5

(1) The tolerance on apricots also includes residues of 2,4-D (2,4-dichlorophenoxyacetic acid) from the preharvest application of 2,4-D dimethylamine salt to apricots.

(2) The tolerance on citrus fruits also includes residues 2,4-D from the preharvest application of 2,4-D isopropyl ester and 2,4-D butoxyethyl ester and from the postharvest application of 2,4-D alkanolamine salts and 2,4-D isopropyl ester to citrus fruits.

(b) Tolerances are established for residues of 2,4-D at:

Commodity	Parts per million
Barley, grain	0.5
Barley, forage	20
Blueberries	0.1
Corn, fodder	20
Corn, forage	20
Corn, fresh, sweet (K+CWHR)	0.5
Corn, grain	0.5
Cranberries	0.5
Grapes	300
Grass hay	1,000
Grasses, pasture	1,000
Grasses, rangeland	20
Millet, forage	0.5
Millet, grain	20
Millet, straw	0.2
Nuts	20
Oats, forage	20

Oats, grain	0.5
Pistachios	0.2
Rice	0.1
Rice, straw	20
Rye, forage	20
Rye, grain	0.5
Sorghum, fodder	20
Sorghum, forage	20
Sorghum, grain	0.5
Stone Fruits	0.2
Sugarcane	2
Sugarcane, forage	--
Wheat, forage	20
Wheat, grain	0.5

(1) *Salts.* Residues on all the above may result from application of 2,4-D in acid form, or in the form of one or more of the following salts:

(i) The inorganic salts: Ammonium, lithium, potassium, and sodium.

(ii) The amine salts: Alkanolamines of the ethanol and isopropanol series, alkyl (C-12), alkylk (C-13), alkyl (C-14), alkylamines derived from tall oil, amylamine, diethanolamine, diethylamine, diisopropanolamine, dimethylamine, N,N-dimethyl-linoleylamine, N,N-dimethyloleyamine, ethanolamine, ethylamine, heptylamine, isopropanolamine, isopropylamine, linoleylamine, methylamine, morpholine, octylamine, oleylamine, N-oleyl-1,3-propylenediamine, propylamine, triethanolamine, triethylamine, trilsopropanolamine, and trimethyamine.

(2) *Esters.* Residues on all the above may result from application of 2,4-D in acid form, or in the form of one or more of the following esters: amyl (pentyl), butoxyethoxypropyl, butoxyethyl, butoxypolythylene glycol butyl ether, butoxypropyl, butyl, dipropylene glycol isobutyl ether, ethoxyethoxyethyl, ethoxyethoxypropyl, ethyl, ethoxypropyl, isobutyl, isooctyl (including, but not limited to, 2-ethylhexyl, 2-ethyl-4-methylpentyl, and 2-octyl), isopropyl, metbyl, polyethylene glycol 200, polypropoxybutyl, polypropylene glycol, propylene glycol, propylene glycol butyl ether, propylene glycol isobutyl ether, tetrahydrofurfuryl, and tripropylene glycol isobutyl ether.

(c) Tolerances are established for negligible residues of 2,4-D from application of its dimethylamine salt to irrigation ditch banks in the Western United States in programs of the Bureau of Reclamation, U.S. Department of Agricultural Research Service, U.S. Department of Agriculture; and the Corps of Engineers, U.S. Department of Defense. Where tolerances are established at higher levels from other uses of 2,4-D on the following crops, the higher tolerance applies also to residues from the irrigation ditch bank use cited in this paragraph.

The established tolerances follow:

Commodity	Parts per million
Avocados	0.1 (N)
Citrus fruits	0.1 (N)
Cottonseed	0.1 (N)
Cucurbits	0.1 (N)
Forage grasses	0.1 (N)
Forage legumes	0.1 (N)
Fruiting vegetables	0.1 (N)
Grain crops	0.1 (N)
Hops	0.1 (N)
Leafy vegetables	0.1 (N)
Nuts	0.1 (N)
Pome fruits	0.1 (N)
Root crop vegetables	0.1 (N)
Seed and pod vegetables	0.1 (N)
Small fruits	0.1 (N)
Stone fruits	0.1 (N)

(d) A tolerance is established for residues of 2,4-D sodium salt and alkanolamine salts (of the ethanol and isopropanol series), calculated as 2,4-D (2,4-dichlorophenoxyacetic acid) as follows:

Commodity	Parts per million
Asparagus	5

(e) A tolerance is established for residues of 2,4-D from application of its alkanolamine salts (of the ethanol and isopropanol series) as follows:

Commodity	Parts per million
Strawberries	0.05

(f) Tolerances are established for residues of 2,4-D from application of its dimethylamine salt for water hyacinth control in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, rivers and streams that are quiescent or slow moving in programs conducted by the Corps of Engineers or other Federal, State, or local public agencies. Where tolerances are established at higher levels from other uses apply to residues from the aquatic uses cited in this paragraph. The established tolerances follow:

Commodity	Parts per million
Crops in paragraph (c) of this section	1.0
Crop groupings in paragraph (c) of this section	1.0
Fish	1.0
[illegible]	[illegible]

(g) [Reserved]

(h) Tolerances are established for residues of 2,4-dichlorophenoxyacetic acid (2,4-d) and/or its metabolite, 2,4-dichlorophenol (2,4-DCP) in food products of animal origin as follows.

Commodity	Parts per million
Cattle, fat	0.2
Cattle, kidney	2
Cattle, meat	0.2
Cattle, mbyp (exc. kidney)	0.2
Eggs	0.05
Goats, fat	0.2
Goats, kidney	2
Goats, meat	0.2
Goats, mbyp (exc. kidney)	0.2
Hogs, fat	0.2
Hogs, kidney	2
Hogs, meat	0.2
Hogs, mbyp (exc. kidney)	0.2
Horses, fat	0.2
Horses, kidney	2
Horses, meat	0.2
Horses, mbyp (exc. kidney)	0.2
Milk	0.1
Poultry	0.05
Sheep, fat	0.2
Sheep, kidney	2
Sheep, meat	0.2
Sheep, mbyp (exc. kidney)	0.2

(i) A tolerance is established for residues of 2,4-D from applications of its dimethylamine salt or its butoxyethanol ester for Eurasian Watermilfoil control in programs conducted by the Tennessee Valley Authority in dams and reservoirs of the TVA system as follows:

Commodity	Parts per million
Fish	1.0

(j) A tolerance with regional registration as defined in §180.1(n) is established for the residues of 2,4-D (2,4-dichlorophenoxyacetic acid). The tolerance includes residues from the application of 2,4-D and its N-oleyl-1,3-

Commodity	Parts per million
Raspberries	0.1

(k) A tolerance that expires on December 31, 1998, is established for residues of the herbicide 2,4-D (2,4-dichlorophenoxyacetic acid) resulting from the preplant use of 2,4-D ester or amine in or on the raw agricultural commodity as follows:

Commodity	Parts per million
Soybeans	0.1

[47 FR 620, Jan. 6, 1982, as amended at 48 FR 2323, Jan 19, 1983; 55 FR 39408, Sept 27, 1990, 61 FR 13429, Mar. 27, 1996]

§180.143 Dipropyl isocinchomeronate; tolerances for residues.

Tolerances are established for negligible residues of the insecticide dipropyl isocinchomeronate, resulting from dermal application, in raw agricultural commodities as follows:

0.1 part per million in meat, fat, and meat byproducts of cattle, goats, hogs, horses, and sheep.

0.004 part per million in milk.

[37 FR 16937, Aug. 23, 1972]

§180.144 Cyhexatin; tolerances for residues.

Tolerances are established for combined residues of the pesticide cyhexatin (tricyclohexylhydroxystannane; CAS Reg. No. 13121-70-5) and its organotin metabolites (calculated as cyhexatin) in or on the following raw agricultural commodities:

Commodity	Parts per million
Almonds	0.5
Almonds, hulls	60
Apples	2
Cattle, fat	0.2
Cattle, kidney	0.5
Cattle, liver	0.5
Cattle, mbyp (exc. kidney, liver)	0.2
Cattle, meat	0.2
Citrus fruits	2
Goats, fat	0.2
Goats, kidney	0.5
Goats, liver	0.5
Goats, mbyp (exc kidney, liver)	0.2
Goats, meat	0.2
Hogs, fat	0.2

Commodity	Parts per million
Buckwheat	1.0
Cattle, fat	0.1
Cattle, meat	0.1
Cattle, meat byproducts	5.0
Corn (except popcorn and sweetcorn)	0.1
Eggs	1.0
Goats, fat	0.1
Goats, meat	--
Goats, meat byproducts	1.0
Hogs, fat	0.1
Hogs, meat	0.1
Hogs, meat byproducts	1.0
Horses, fat	0.1
Horses, meat	0.1
Horses, meat byproducts	0.1
Milk	6.0
Millet	1.0
Mushrooms	5.0
Oats	2.0
Peanuts	40.0
Peanut hulls	1.0
Poultry, fat	0.1
Poultry, meat	0.1
Poultry, meat byproducts	5.0
Rice	5.0
Rye	1.0
Sheep, fat	0.1
Sheep, meat	0.1
Sheep, meat byproducts	5.0
Sorghum (milo)	5.0
Wheat	

[59 FR 24069, May 10, 1994]

§ 180.360 Asulam; tolerances for residues.

A tolerance is established for negligible residues of the herbicide asulam (methyl sulfanilylcarbamate) in or on the raw agricultural commodity sugarcane at 0.1 part per million.

[40 FR 25691, June 17, 1975]

§ 180.361 Pendimethalin; tolerances for residues.

(a) *General.* Tolerances are established for the combined residues of the herbicide pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] and its metabolite 4-[(1-ethylpropyl)amino]-2-methyl-3,5-dinitrobenzyl alcohol in or on the following raw agricultural commodities:

Commodity	Parts per million
Beans, lima (dry, snap)	0.1
Beans, forage	0.1
Beans, hay	0.1
Corn, fodder	0.1
Corn, forage	0.1
Corn, trash (including sweet, K+CWHR)	0.1
Corn, grain	0.1
Cottonseed	
Peanut, forage	0.1
Peanut, hay	0.1
Peanut, hulls	0.25
Peas (except field peas)	0.1
Potatoes	0.1
Rice, grain	0.05
Sorghum, fodder	0.1
Sorghum, forage	0.1
Sorghum, grain	0.1
Soybeans	0.1
Soybeans, forage	0.1
Soybeans, hay	0.1
Sugarcane	0.1
Sunflower, seeds	0.1

(b) *Section 18 emergency exemptions.* Time-limited tolerances are established for residues of the herbicide pendimethalin in connection with use of the pesticide under section 18 emergency exemptions granted by EPA. The tolerances will expire and are revoked on the dates specified in the following table:

Commodity	Parts per million	Expiration/Revocation Date
Mint hay, fresh	0.1 ppm	5/31/88
Mint oil	5.0 ppm	5/31/88

(c) *Tolerances with regional registrations.* Tolerances with regional registration, as defined in § 180.1(n), are established for the combined residues of the herbicide pendimethalin [*N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] and its metabolite 4-[(1-ethylpropyl)amino]-2-methyl-3,5-dinitrobenzyl alcohol in or on the following raw agricultural commodities as follows:

Commodity	Parts per million
Garlic	0.1

(d) *Indirect or inadvertent residues.* [Reserved]

[49 FR 15293, Apr. 18, 1984, as amended at 53 FR 3024, Feb. 3, 1988; 54 FR 13688, Apr. 5, 1989; 55 FR 26440, June 28, 1990; 58 FR 11979, Feb. 25, 1993; 58 FR 33772, June 21, 1993; 60 FR 48660, Sept. 20, 1995; 62 FR 28361, May 23, 1997]

§ 180.362 Hexakis (2-methyl-2-phenylpropyl)distannoxane; tolerances for residues.

(a) Tolerances are established for the combined residues of the insecticide hexakis [2-methyl-2-phenylpropyl] distannoxane and its organotin metabolites calculated as hexakis [2-methyl-2-phenylpropyl] distannoxane in or on the following raw agricultural commodities:

Commodity	Parts per million
Almonds	0.5
Almonds, hulls	--
Apples	15.0
Cattle, fat	0.5
Cattle, mbyp	0.5
Cattle, meat	0.5
Cherries, sour	8.0
Cherries, sweet	8.0
Citrus fruits	20.0
Cucumbers	4.0
Eggplant	6.0
Eggs	0.1
Goats, fat	0.5
Goats, mbyp	0.5
Goats, meat	0.5
Grapes	5
Hogs, fat	0.5
Hogs, mbyp	0.5
Hogs, meat	0.5
Horses, fat	0.5
Horses, mbyp	0.5
Horses, meat	0.5
Milk fat	0.1
Papayas	2
Pecans	0.5
Peaches	10.0
Pears	15.0
Plums	4.0
Poultry, fat	0.1
Poultry, mbyp	0.1
Poultry, meat	0.1
Prunes	4.0
Sheep, fat	0.5
Sheep, mbyp	0.5
Sheep, meat	0.5
Strawberries	10.0
Walnuts	0.5

(b) Tolerances with regional registration are established for residues of the insecticide hexakis [2-methyl-2-phenylpropyl] distannoxane and its organotin metabolites calculated as hexakis [2-methyl-2-phenylpropyl] distannoxane in or on the raw agricultural commodities:

Commodity	Parts per million
Blueberries, fresh	4.0
Raspberries	10.0

[48 FR 42968, Sept. 22, 1983, as amended at 46 FR 48231, Oct. 5, 1981; 47 FR 21539, May 19, 1982; 48 FR 12087, Mar. 23, 1983; 48 FR 37212, Aug. 17, 1983; 49 FR 30701, Aug. 1, 1984; 51 FR 4[illegible], Feb. 5, 1986; 51 FR 33906, Sept. 24, 1986; 58 FR 48331, Sept. 15, 1993]

(c) Tolerances are established for residues of the herbicide chlorethal, 2,[illegible]-fluoro-2,6-dinitro-*N*-propyl-*p*-toluidine] in or on the following raw agricultural commodities:

Commodity	Parts per million
Cottonseed	0.05
Peanuts	0.05
Peanut, forage	0.05
Peanut, hay	0.05
Peanut, hulls	0.1
Seed and pod vegetables (dry/succulent)	0.05
Seed and pod vegetables, forage	0.1
Seed and pod vegetables, hay	0.1
Soybeans	0.05
Sunflower seeds	0.05

[47 FR 30487, July 14, 1982]

§ 180.364 Glyphosate; tolerances for residues.

(a) *General.* Tolerances are established for the combined residues of (N-(phosphonomethyl)glycine) and its metabolite aminomethylphosphonic acid resulting from the application of the isopropylamine salt of glyphosate and/or the monoammonium salt of glyphosate in or on the following agricultural commodities:

Commodity	Parts per million
Acerola	0.2
Alfalfa	200.0
Alfalfa, forage	75.0
Alfalfa, fresh and hay	0.2
Alfalfa, hay	200.0
Almonds, hulls	1
Almond hulls	25
Artichokes, Jerusalem	0.2
Asparagus	0.5
Aspirated grain fractions	200.0
Atemoya	0.2
Avocados	0.2
Bahiagrass	200.0
Bananas	0.2
Beets	0.2
Beets, sugar	0.2
Bermudagrass	200.0
Blueberries	[illegible]
Breadfruit	0.2
Bromegrass	200.0
Canistel	0.2
Carambola	0.2
Carrots	0.2
Cattle, kidney	4.0
Cattle, liver	0.5
Celeriac	0.2
Cherimoya	0.2
Chickory	0.2

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Commodity	Parts per million
Citrus, fruits	0.5
Citrus molasses	1.0
Citrus pulp, dried	1.8
[illegible]	200.0
Cocoa beans	0.2
Coconut	0.1
Coffee beans	1
Corn, field, forage	1.0
Corn, field, grain	1.0
Corn, field, stover	100.0
Cotton, forage	15
Cotton, hay	15
Cotton gin byproducts	100.0
Cottonseed	15
Cranberries	0.2
Dates	0.2
Fescue	200.0
Figs	0.2
Fish	0.25
Forage grasses	0.2
Forage legumes (except soybeans and peanuts)	0.4
Fruits, small, and berries	0.2
Ginseng	0.2
Goats, kidney	4.0
Goats, liver	0.5
Grain crops (except wheat, corn, oats, and grain sorghum)	0.016
Grapes	0.2
Grasses, forage	0.2(N)
Guavas	0.2
Hogs, kidney	4.0
Hogs, liver	0.5
Horseradish	0.2
Horses, kidney	4.0
Horses, liver	0.5
Jabolticaba	0.2
Jackfruit	0.2
Kiwifruit	0.2
Leafy vegetables	0.2(N)
Longan	0.2
Lychee	0.2
Mamy sapote	0.2
Mangoes	0.2
Molasses, sugarcane	30.0
Nuts	0.2
Oats, grain	20.0
Oil, palm	0.1
Olives	0.2
Olives, imported	0.1
Orchardgrass	200.0
Papayas	0.2
Parsnips	0.2
Passion fruit	0.2
Peanut, forage	0.5
Peanut, hay	0.5
Peanut, hulls	0.5
Peanuts	0.1
Peppermint	200
Persimmons	0.2
Pineapple	0.1
Pistachio nuts	0.2
Pome fruits	0.2
Pomegranates	0.2
Potatoes	0.2
Poultry, kidney	0.5
Poultry, liver	0.5
Radishes	0.2
Rutabagas	0.2
Ryegrass	200.0
Salsify	0.2
Sapodilla	0.2
Sapote, black	0.2
Sapote, white	0.2

Commodity	Parts per million
Seed and pod vegetables	0.2(N)
Seed and pod vegetables, forage	0.2(N)
Seed and pod vegetable, hay	0.2(N)
Sheep, kidney	4.0
Sheep, liver	[illegible]
Shellfish	3.0
Sorghum, grain	15.0
Sorghum, grain, stover	40.0
Soursop	0.2
Soybean, hulls	100.0
Soybeans	20.0
Soybeans, aspirated grain fractions	50.0
Soybeans, forage	100.0
Soybeans, grain	20.0
Soybeans, hay	200.0
Spearmint	200
Stone fruit	0.2
Sugar apple	0.2
Sugarcane	2.0
Sunflower seed	0.1
Sweet potatoes	0.1
Tamarind	0.2
Tea, dried	1.0
Tea, instant	7.0
Timothy	200.0
Tree nut crop group	1.0
Turnips	0.2
Vegetables, bulb	0.2
Vegetables, cucurbit	0.6
Vegetables, fruiting (except cucurbits) group	0.1
Vegetables, leafy, Brassica (cole)	0.2
Wheat, grain	5.0
Wheat, straw	65.0
Wheat milling fractions (excluding flour)	20.0
Wheatgrass	200.0
Yams	0.2

(b) *Section 18 emergency exemptions.* [Reserved]

(c) *Tolerances with regional registrations.* [Reserved]

(d) *Indirect or inadvertent residues.* Tolerances are established for the combined residues of glyphosate (N-phosphonomethylglycine) and its metabolite aminomethylphosphonic acid, resulting from the use of irrigation water containing residues of 0.1 ppm following applications on or around aquatic sites, at 0.1 ppm on the crop groupings citrus, cucurbits, forage grasses, forage legumes, fruiting vegetables, grain crops, leafy vegetables, nuts, pome fruits, root crop vegetables, seed and pod vegetables, stone fruit, and the individual commodities cottonseed, hops, and avocados. Where tolerances are established at higher levels from other uses of glyphosate in or on the subject crops, the higher tolerance should also apply to residues from the aquatic uses cited in this paragraph.

[45 FR 64911, Oct. 1, 1980; 62 FR 17729, 17730, Apr. 11, 1997]

EDITORIAL NOTE: For FEDERAL REGISTER citations affecting § 180.364, see List of CFR Sections Affected in the Finding Aids section of this volume.

§ 180.366 Octhilinone; tolerances for residues.

Tolerances are established for residues of the fungicide octhilinone (2-octyl-3(2H)-isothiazolone; CAS Reg. No. 26530-20-1) in or on the following raw agricultural commodities derived from plants grown from treated seed:

Commodity	Parts per million
Cotton, forage	0.01
Cottonseed	0.01

[41 FR 12012, Mar. 23, 1976, as amended at 52 FR 32306, Aug. 27, 1987; 53 FR 23396, June 22, 1988]

§ 180.367 n-Octyl bicycloheptenedicarboximide; tolerances for residues.

Tolerances are established for residues of the insecticide n-octyl bicycloheptene-dicarboximide, resulting from dermal application, in raw agricultural commodities as follows:

Commodity	Parts per million
Cattle, fat	0.3
Goats, fat	0.3
Hogs, fat	0.3
Horses, fat	0.3
Milk, fat	0.3
Sheep, fat	0.3

[41 FR 31207, July 27, 1976; 41 FR 32426, Aug. 3, 1976]

§ 180.368 Metolachlor; tolerances for residues.

(a) *General.* Tolerances are established for the combined residues (free and bound) of the herbicide metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methylethyl)acetamide] and its metabolites, determined as the derivatives, 2-[(2-ethyl-6-methylphenyl)amino]-1-propanol and 4-(2-ethyl-6-methylphenyl)-2-hydroxy-5-methyl-3-morpholinone, each expressed as the parent compound, in or on the raw agricultural commodities.

Commodity	Parts per million
Almond hulls	0.3
Barley, fodder	0.5
Barley, forage	0.5
Barley, grain	0.1
Buckwheat, fodder	0.5
Buckwheat, forage	0.5
Buckwheat, grain	0.1
Cabbage	1.0
Cattle, fat	0.02
Cattle, kidney	0.2
Cattle, liver	0.05
Cattle, meat	0.02
Cattle, mbyp (except kidney and liver)	0.02
Celery	0.1
Corn, fresh (inc. sweet K+CWHR)	0.1
Corn, forage and fodder	8.0
Corn, grain	0.1
Cottonseed	0.1
Eggs	0.02
Goats, fat	0.02
Goats, kidney	0.2
Goats, liver	0.05
Goats, meat	0.02
Goats, mbyp (except kidney and liver)	0.02
Hogs, fat	0.02
Hogs, kidney	0.2
Hogs, liver	0.05
Hogs, meat	0.02
Hogs, mbyp (except kidney and liver)	0.02
Horses, fat	0.02
Horses, kidney	0.2
Horses, liver	0.05
Horses, meat	0.02
Horses, mbyp (except kidney and liver)	0.02
Legume vegetables group foliage (except soybean forage and soybean hay)	15.0
Milk	0.02
Millet, fodder	0.8
Millet, forage	0.5
Millet, grain	0.1
Milo, fodder	0.5
Milo, forage	0.5
Milo, grain	0.1
Nongrass animal feeds (forage, fodder, straw, and hay) group	3.0
Oats, fodder	0.5
Oats, forage	0.5
Oats, grain	0.1
Peanuts	0.5
Peanut, forage and hay	30.0
Peanut, hulls	8.0
Peppers, bell	0.1
Potatoes	0.2
Poultry, fat	0.02
Poultry, liver	0.05
Poultry, meat	0.02
Poultry, mbyp (except liver)	0.02
Rice, fodder	0.5
Rice, forage	0.5
Rice, grain	0.1
Rye, fodder	0.5
Rye, forage	0.5
Rye, grain	0.1
Safflower seed	0.1
Seed and pod vegetables (except soybeans)	0.3
Sheep, fat	0.02
Sheep, kidney	0.2
Sheep, liver	0.05
Sheep, meat	0.02
Sheep, mbyp (except kidney and liver)	0.02
Sorghum, forage and fodder	2.0
Sorghum, grain	0.3
Soybeans	0.2