REPORT OF THE LAKE TANGANYIKA BIODIVERSITY INSTITUTION AND RESOURCES ASSESSMENT MISSION TO TANZANIA, ZAÏRE AND ZAMBIA - 8 AUGUST TO 3 SEPTEMBER 1996

Authorship in alphabetical order:
Allison, E. H., Bailey-Watts, A. E., Duck, R. W., Foxall, C., Patterson, G. and Petit, P.

SUMMARY

Over a period of approximately 6 weeks (August to September) in 1996, this 6-man mission assessed the institutional strengthening and resources needed for various aspects of the three main 'ecological' Special Studies of the Lake Tanganyika Biodiversity Project (LTBP): Pollution and its effects on biodiversity; Sediment Pollution and its impacts; and broader aspects of biodiversity *per se*. The current status was assessed by way of man-power, field and laboratory equipment; laboratory space and layout; facilities for analysing and reporting on the data gathered; and general back-up such as libraries.

Some 40 centres were visited, including large Ministries, non-University research bodies, University Departments and much smaller, though significant NGOs involved in wildlife conservation, for example. A number of especially exciting links were made in relation to the broad area of Environmental Education, with schools, wildlife Societies, national parks and museums.

The teams representing the three Special Studies worked in a very closely integrated way. Indeed, without the division of labour cutting across the main focuses of pollution, sedimentation and related biodiversity issues, the mission could not have visited people based as far north as Uvira in the Zairian sector of the lake catchment, and Mpulungu and Lusaka (Zambia) in the south. This approach proved eminently successful too, in providing the opportunity to see, at close range (and even take samples in some cases) a wide selection of potential sampling sites. These ranged from pelagic areas to shallow and littoral situations and habitats, with mud, through silt, sand, pebble, cobble and boulder substrates; some of these sites appear very suitable for assessing pollution and sediment pollution status, and the associated diversity in the biological communities. This is likely to prove particularly so, during the first year of practical work - which the teams suggest strongly is viewed primarily for training, and establishing one major laboratory in each country (i.e. Bujumbura, Kigoma, Mpulungu and Uvira/Kalemie). In addition to the main institutions, some 30 other NGOs would be invited to collaborate (with LTBP resources and funding) on specific areas of research, training and environmental education.

The type and amount of resources needed, vary with institution - and of course, with the area of work in which they will be involved. Certainly for the 4 main laboratory complexes, and probably in a number of the other institutions involved in field sampling and materials analysis, a 'basic' range of equipment for carrying out the following tasks should be introduced into the region:

- travelling to sampling sites; land rover/equivalent; inflatable craft plus outboard engines - and life-jackets and gear for safe anchoring; storage of fuel; maps.

- environmental recording: waterproof cameras, GPS; pH, temperature, conductivity and dissolved oxygen probes.

- sampling: water bottles, tubes, grabs, nets, ropes/cables; containers; fixatives, cool boxes.

- laboratory analyses: traditional chemical determinations: glassware and reagents (mainly in preference to 'Hach' type instruments except for remote sites); filtration kits and filters. The examination of biological materials: centrifuges, microscopes; and a range of personal computers with software for data entry, analysis, and the graphing and reporting of the results.

The mission was very successful in firstly identifying the most likely organisations to fund and bring onto the LTBP. Secondly, it was able to increase considerably (see below) the region's awareness of the project by circulating copies of the ToR of the mission, and the summaries of

elevation of the status of the project is required and this would depend on the SLO being out in the region far more than hitherto, contacting and establishing a rapport with all persons potentially involved/interested in the project. His lack of supervision over the refurbishment of the '*RV Echo*', did not bode well for the future role of the SLO in his primary responsibility of equipment maintenance and care.

We are grateful to all of the people we met in Tanzania, Zaire and Zambia. Ministry principals, institute directors, researchers, technicians, boatmen and NGO personnel, all gave us much of their valuable time. During many hours of discussions, we learnt a lot. As a consequence we are in a much better position than hitherto, to assign the different groups to the various, exciting areas of monitoring, research, training and environmental education under the LTBP. We thank too, the large number of people who showed as potential field study sites in addition to their laboratories and offices. The mission has been made much more aware of the incredible challenge that the LTBP faces; however, it has also been impressed by the considerable human resource that, with our help, can surely advance knowledge on, and establish a sustainable programme for, the lake.

Nevertheless, the team is unanimous in its contention that the project will be unable to achieve its goals unless at least one highly qualified full-time scientist is placed permanently in each of the four lake countries. This would not only ensure that progress on any aspects is recorded and monitored; it would demonstrate the keenness of the funding bodies to be involved at the 'sharp end' - and not just 'swanning in' for short periods. It would also further strengthen the ties that this mission has started to establish between Africans and the UK contractors and consultants.

TABLE OF ACRONYMS

CRH	Centre Recherche d'Hydrobiologique (Zaire)
CRRHA	Centre Regional de Recherches en Hydrobiologie Appliquee (Burundi)
ECZ	Environmental Council for Zambia (Zambia)
FAO	Food and Agriculture Organisation (UN)
FINNIDA	Finnish Development Agency (Finland)
GEF	Global Environment Facility
GIS	Geographical Information System
IFE	Institute of Freshwater Ecology (UK)
IGEBU	IGEBU - l'Institut Geographique du Burundi (Bujumbura)
INECN	Institute for the Environment and Conservation of Nature (Burundi)
IRC	International Rescue Committee
LTBP	Lake Tanganyika Biodiversity Project
LTR	Lake Tanganyika Research Project
MRAG	Marine Resources Assessment Group
NC	National Co-ordinator
NEMC	National Environment Management Council (Tanzania)
NGO	Non-Governmental Organisation
NRI	Natural Resources Institute (UK)
ODEB	Organisation pour la Defense del' environment Burundi
PC	Project Coordinator
PCU	Project Coordination Unit
SENADEP	Service Nationale du Promotion et de la Development de la Peche
SLO	Scientific Liaison Officer
TACARE	Lake Tanganyika Catchment Reforestation and Education Project
TAFIRI	Tanzanian Fisheries Research Institute
TANAPA	Tanzanian National Parks Authority
UoD	University of Dundee (UK)
UEA	University of East Anglia (UK)
UK	United Kingdom
UN	United Nations
UNZA	University of Zambia (Lusaka)

1. GENERAL INTRODUCTION

This report concerns the findings of a one-month mission aimed at assessing all resources in institutions in the Lake Tanganyika region that could potentially contribute to the Lake Tanganyika Biodiversity Project (LTBP) - and especially aspects concerned with the main 'ecological' Special Studies i.e. 'Pollution in International Waters and its Effects on Biodiversity', 'Sediment Discharge and Its Consequences on Biodiversity', and 'Biodiversity' *per se*. 'Resources' thus includes people, buildings and equipment in Africa; and the services provided by the Project Co-ordination Unit (PCU). Attention is also paid to the situation obtaining with respect to resource needs in the form of technical training. While much of this mission focused on the Special Studies which will obtain results crucial to the successful management of the conservation areas and the protection of biodiversity, attention was also paid to environmental education.

The mission consisted primarily of the 6 authors, but with occasional assistance from the project PCU and considerable help from numerous resident personnel in the total of some 40 organisations visited. Owing to the thoroughly good support of many individuals in the lake countries, the group was also able to see many different areas of the lake and assess their suitability as future study sites.

1.1 Scope of Report

After outlining the Terms of Reference and preparatory arrangements for the mission, the document reports firstly on the findings of the assessments of resources in some 40 institutions including regional water authorities, research institutes, university departments and NGOs - **see next Table**. It also comments on the approximately 12 shoreline areas that were visited more or less in conjunction with the tours of laboratories, and assessed for their potential suitability as future study sites in terms of ease of access, whether impacted or 'pristine', the types of habitat represented (aspect, and whether sandy, rocky, muddy substrates, or open water). The report then turns its attention to five issues of more or less general relevance to the Lake Tanganyika Biodiversity Project (LTBP), i.e. the main research vessels, project liaison, the project 'image', health and safety, and strategies and logistics of the Special Studies. The body of the report makes numerous recommendations bearing on various aspects of the LTBP as a whole, and the strategies for the 'limnological' Special Studies in particular; these recommendations are, however, also listed in a separate section of this report. Each individual concerned with the mission has made detailed notes on their own experiences. Though this report has drawn heavily on these notes they should be consulted if further detail is required.

1.2 Summary of mission ToR (Appendix I contains full text).

The mission made a practical assessment (following the findings of the Baseline Reviews) and progressed with the drawing up of plans for detailed studies - to be initiated in Stage II, and conducted with technical support, supervision and co-ordination - by local institutions viewed as suitable by the NRI/IFE/UEA/UoD/MRAG project team.

were identified. The Inception Report (copies of which were available during the mission) summarised the priorities of the Studies which form the basis of this mission i.e. `Pollution of International Waters - and its Effects on Biodiversity', `Sediment Discharge and Its Consequences on Biodiversity', and 'Biodiversity' *per se*. The Inception Workshop endorsed proposals to assess pollution status and biodiversity at selected sites in each country. It also identified the need to incorporate `pristine' unimpacted/unpolluted sites in the surveys, and take account of the situations prevailing in open and in-shore waters, including the water column, near-bottom waters and sediments and other substrates.

All members of the mission visited Tanzania, while all but GP and CF saw Zaire, and all but TBW and RWD visited Zambia. Unfortunately, the security situation in Burundi precluded any involvement there. The mission did the following:

- investigated the capacity of each institution, and the human, infra-structural and equipment resources bearing on the requirements of the LTBP, and identified a number of institutions and people that it will recommend for involvement in the project.

- assessed the nature and scale of logistic problems - especially those related to sampling and laboratory analysis - in each country's lake sector.

- proposed arrangements for executing all stages of the work, i.e. planning of field and laboratory activities, through data analysis to reporting of the results.

- identified requirements for technical assistance, training and supervision from project external specialists for the Studies.

- for the Project Co-ordinator, reviewed the mission's interim findings back in Dar es Salaam.

The group will provide (*via* the PCU in Dar es Salaam) the National Co-ordinators and NRI with a detailed report i.e. the present document, on the findings and recommendations of the mission.

The mission did not, however, hold discussions with all National Co-ordinators as planned, nor as a consequence, properly develop country strategies for the Studies. Partly as a result of not going to Burundi, the mission was also unable to hire the `Tanganyika Explorer' as originally hoped.

1.3 General approaches adopted by the mission

The issues related to all three Special Studies are incorporated into the present, single document. This approach reflects the integrated manner in which we carried out the mission, and in which we recommend the studies eventually be carried out. Thus, from early planning through to the final execution of institutional resource assessments and site visits, the 'Sedimentation' team consisting of RWD and GP, worked closely with the 'Pollution' team of TBW and CF, and the 'Biodiversity' team of EHA and PP. An early strategy meeting in Dar

‘split’ was necessary in order to visit all of the institutions and sites intended (**next Table**) and ensure as far as possible that each 'visiting group' was capable of attending to all issues of relevance, i.e. to pollution, sediment pollution and biodiversity. This was achieved by the whole team working together in Tanzania, but just TBW and RWD working together in Zaire, and CF and GP teaming up for Zambia. All 6 were in Africa from 9.8.96 to 3.9.96, while EHA and PP arrived 7.8.96, and they stayed until 10 and 20.9.96 respectively.

Table: Organisations/institutions and main people visited during the Lake Tanganyika resource assessment mission - 8 August to 3 September 1996.

Institutions assessed and/or sites visited
13.8 Kigoma: Regional Water Department (Tanzania): Mr Michael Baragwiha (Regional Water Engineer), Mr C E L Rubabwa (Geologist) and Mr Theodore Mpyalimi (Hydrologist In Charge).
13.8 Kigoma: TAFIRI (Tanzania): Mr Chitamwebwe (Station Director), Mr Katonda (Deputy Director) and Mr U Kisisiwe (Field operative and Boatman).
13.8: LTR (FAO FINNIDA) (Tanzania): Mr P Mannini (Head of Station and fisheries biologist), Mr A Kalangali (Zooplankton researcher), Mr Muhoza (Zooplankton technician), Dr J Craig (Project Statistician), Ms Els Bosma (Zooplankton, nekton and fish), Mr P Verburg (Hydrologist and fisheries biologist).
14.8: Kigoma High School (Tanzania): Mrs Fatima Mashaka (Deputy Head Mistress, Mr Kunga (Head, Department of Biology).
15-16.8: Uvira: Centre de la Recherche Hydrobiologique, and Kalimabenge and Mulongwe Rivers (Zaïre): Mr S Kimbadi (Chemist), Mr M Mbemba (nutritionist), Mr K Tshibangu (Chemist/Invertebrate zoologist), Mr M Risasi (Taxonomist - Cichlidae), Mr M Kamalebo (algologist - mainly epilithon). Phytoplankton net-tow sample collected in approach to Uvira Bay.
15.8: Kipili (Tanzania): small natural bay - with defunct but potentially restorable Fisheries Department buildings.
16.8 and 20.8: Mbala at Mpulungu: Department of Fisheries (Zambia): Mr Mwape, Mr D Kabakwe (Senior Fisheries Development Officer)
16.8 and 20.8: Mpulungu: LTR (FAO FINNIDA) (Zambia): Mr V Landenberg and Ms P Pfaffer (Researchers).
17.8: Mbala, Mpulungu: Motomoto Museum (Zambia): Mr E Nkole Sosala (Keeper of Pre-History Department).
18-19.8: Sumbu: Lufubu River, Sumbu National Park, and Department of Fisheries (Zambia): Mr Mwape (as above), Mr T Miti (Head Wildlife Service, Sumbu).
20.8 Malagarasi Delta (offshore zone) (Tanzania): seine-net fishermen and boys. Samples collected: submerged and emergent macropytes, and bottom muds/silts/sands.
21.8 Mahale: Mountains National Park (Tanzania): Mr J Wakibara (Park Ecologist), Mr A H Seki (Senior Park Warden)., Mr W Daniel (Park Warden, Law Enforcement) and Mr F I Malisa (Park Warden, Tourism and Community Conservation Service). Phytoplankton net-tow samples collected at five points during return journey to Kigoma.
21.8: Mpulungu: Water Engineer's Department (Zambia): Mr B J Kasonde (District Water Engineer).
22.8: Kasama: Provincial Water Department (Zambia): Mr S C Ngambi (Water Engineer).
22.8: Kasama: Northern Province Development Programme (NPDP) Irish Aid (Zambia): Mr C Chizango (Deputy Director).

22-23.8: Lusaka : UNDP (Zambia): Dr Chipungu (Sustainable Development Director).
22-23.8: Lusaka (Zambia): Environmental Council of Zambia: Mr J S Phiri (LT Project National Co-ordinator).
24.8: Kigoma (Tanzania): Field visit and sampling of epilithon, epipsammon and epiphyton in two local ('Jacobson's') bays.
26.8: Lusaka (Zambia): Fisheries Department: Mr G Mudende (Director at Chilanga).
26.8: Lusaka (Zambia): Department of National Parks and Wildlife, Ministry of Tourism: All staff at seminar in Kafue.
26.8: Lusaka, National Council for Scientific Research (Zambia): Mr C Mwambe (Acting Secretary General) and Dr M Nomai (NCSR, Radio-isotope Unit).
27.8: Kigoma, Tanzania: visit from Dattomax Sellanyika (Warden, Gombe National Park).
27.8: Lusaka, University of Zambia: Professor D D Theo (Dean, School of Natural Sciences), Dr S M Mgwira (Head, Department of Physics), Professor J Cernak (Department of Physics), Professor P C R Jain (Manager, Environmental Resource Centre in the Physics Department), Dr F Kamona (Head, Department of Geology, School of Mines). Mr H. Sichingabula (Department of Geography)
28.8: Lusaka, University of Zambia: Dr Jere (Dean, School of Mines) and Dr S Simukanga (Head, Department of Metallurgy and Mineral Processing).
28.8: Lusaka, Embassy of Ireland: Bernadette Crawford (Senior Projects Office, Irish Aid Development Programme).
28.8: Kigoma, TAFIRI/LTR premises (Tanzania): Ms Els Bosma (Zooplankton, nekton and fish).
29.8: Lusaka, National Council for Scientific Research (Zambia): Dr M. Nomai (Head, Radio isotope Research Unit), Ms M. Sibbuki (Research and Development Co-ordinator), Ms C.M. Msomi (Acting Head, Water Section)
29.8: Lusaka, Food Drug and Control Laboratory, University Teaching Hospital (Ministry of Health), Zambia: Ms M. Sakala (Acting Head of Laboratory).
29.8: Lusak Geological Survey Department (Zambia): Mr. F. Njamu (Geologist, Prescribed Minerals and Materials Commission)
29.8: Dar es Salaam, TAFIRI: Prof. Bwathondi (Director of Fisheries)
29.8: Dar es Salaam: University, Department of Zoology (Dr Kasigwa)
30.8: Lusaka, National Council for Scientific Research (Zambia): Mr Kaposhe (Head, Livestock and Pest Centre at Chilanga).
30.8: Lusaka, Zambia Environmental Education Programme: Mr J Lupere (Materials Development Officer).
30.8: Lusaka, Geological Survey Department (Zambia): Mr F Njamu

1.9: Dar es Salaam, British High Commmission (Tanzania): Dr Jane Goodall (Director, Gombe National Park and Research Institute).
2.9 Dar es Salaam: University, Geology Department (Tanzania): Dr Kapilima (Stratigrapher and palaeologist) and Dr H H Nkotagu (Acting HOD).
2.9 Dar es Salaam: Ministry of Water - Subdivision of Water Resources' (Tanzania): Mr. Msuya (Meraji. O.Y.) Acting Director of Water Resources) and Mr. Mihayo (Hydrologist).
2.9 Dar es Salaam: University, Civil Engineering Department (Tanzania): Dr Mkhandi (Hydrologist - Co-ordinatorr for FRIEND)
3.9 Dar es Salaam: University, Faculty of Science (Tanzania): Professor M H N Nkunya (Associate Dean, Academic).
3.9 Dar es Salaam: University, Department of Chemistry (Tanzania): Professor Mulozoki (Acting Head of Department).
3.9 Dar es Salaam: University, Department of Zoology (Tanzania): Mr Botterweg (Biodiversity database inc. GIS).
3.9 Dar es Salaam: University, Department of Botany (Tanzania): Dr A K Kivaisi (Senior Lecturer in Applied Microbiology).
3.9 Dar es Salaam: Wildlife Conservation Society of Tanzania: Mrs Alice S Bhukali (WCST Co-ordinator).
3.9: Dar es Salaam: Lake Victoria Environmental Management Plan (Tanzania): Mr Mbwana (LVEMP Co-ordinator).
5.9 Arusha: Tropical Pesticide Research Institute (Tanzania): Mr C J Muangirwa (Chief Research Officer); Mr J Ak'habuhaya (Head, Physical and Chemical Division).

2. INSTITUTIONAL RESOURCE ASSESSMENTS AND REPORTS ON ASSOCIATED VISITS TO POTENTIAL STUDY SITES

A 'questionnaire'/'*aide memoire* (**Appendix II**) was prepared for the institutional visits, bearing in mind that the amount of time spent at each site, was often limited, and we had to gather as much information as possible on all issues relevant to the Special Studies. Indeed, the time spent at e.g. the Centre de la Recherche Hydrobiologique d'Uvira (Zaire) and the Mahale Mountains National Park (Tanzania) was generally less than that spent travelling to and from these places.

Preliminary discussions amongst the group suggested that a more or less standard lay-out could be adopted for reporting on the resources in each institution. However, it was soon realised that this was not appropriate because of the large disparity in the size and type of organisation (e.g. a regional fishery station compared with a research establishment or university department). As a reflection of this, the reports below vary considerable in character - and especially where resources of either people, buildings or equipment are presently virtually 'nil' in the context of achieving the aims of these studies. In general, however, for each country some preliminary comments are made on geography and topography, on the range and number of institutions and places visited, and on special/unique features with an important bearing on the studies. The institutional assessments are reported in the following order: (i) Ministry departments, (ii) Research institutes, (iii) University departments, (iv) NGOs and (v) 'others' including UNDP and the Lake Victoria Environmental Management Programme. Prior to our travels, we knew that some of the institutions were likely to be of more relevance in terms of their potential as field study sites than as bases for laboratories *per se*; as such, these organisations are reported on under a separate section headed 'Potential study sites visited'.

The remarks on each institution (within a country) outline first the reasons for our visit, the mandate/role of the organisation, and its approximate size (staffing). Second, we give in as much detail as possible, our findings on buildings, equipment, scientific expertise, and documentation. Other considerations of note are identified next, and the sections each conclude with our overall impressions of the institution and its potential involvement in the LTBP. As already indicated, the Section on Burundi (2.2 below) is comparatively short - summarising information gained from first, mobilisation visits by Keith Banister (KB), Ian Downey (ID), Tim Bostock (TB) and Andy Menz (AM), and second, the visit by TBW as part of his preparation of the Pollution Baseline Review. It is stressed therefore that the observations on staff, buildings and facilities as outlined below, may not represent the current situation.[1]

2.1 Burundi

Burundi borders much of the northern end of the lake. As one of the most densely populated and industrialised areas in the region, it is of major interest to the project by way of opportunities for assessing the levels of a wide range of pollutants and the patterns of biodiversity associated with different pollution sources. This country sector also encompasses much of the Rusizi River delta and thus, in-lake areas potentially affected by

sediment influx, as well as more traditional pollution from, e.g. cotton-growing, salt-mining and sugar refining areas.

Burundi owns the smallest area of land of the four main countries around the lake, i.e. 11,950 km^2 at 5.3% of the total catchment area of 266,890 km^2. This is, however, approximately three times the area of catchment lying within Rwanda. Burundi also ranks 4th on the basis of the area of Lake Tanganyika that it owns 1,838 km^2, although it is ranked 5th in terms of length of shoreline abutting the lake, i.e. 158 km. Contrastingly the country 'houses' the second largest feeder water of the lake - that of the 'petit' Rusizi and the 'grande' Rusizi which together drain a catchment of 15,430 km^2 (which is considerably larger than the 11,950 km^2 of Burundian land within the Lake Tanganyika catchment).

Burundi, and Bujumbura in particular, represents an especially important 'resource' for the LTBP, in three main respects. Firstly, it is the base for the FAO, FINNIDA's main research vessel (The 'Tanganyika Explorer'). Secondly, it has the LTR (FAO, FINNIDA) station which houses what is undoubtedly the most extensive collection of unpublished reports and scientific papers and books on work in the region, and has a small, but well-managed and equipped analytical laboratory. Thirdly, on the same 'campus' as LTR, are the offices and laboratories formerly governed by the CRRHA where the majority of the studies to date have been carried out on pollution and its effects on lake fauna (especially benthic invertebrates). Bujumbura is also 'special' in the context of the LTBP - and the main Scientific Special Studies in particular - in having a University that has many interests in ecological work.

Set against all of these potentially crucial resources/opportunities presented by this country, are major constraints occasioned primarily by inter-tribal wars. As a reflection of this, the present mission was unable to visit Burundi. TBW stayed in Bujumbura in November 1995 to write (at the LTR's Documentation Centre) the Baseline Review on 'Pollution in International Waters and its Effects on Biodiversity'. However, curfews and other situations prohibited visits to potential study areas out of Bujumbura, and there was no opportunity at that time to visit the university.

Numerous studies on the effects of various types of pollution on the biodiversity of the whole suite of organisms in LT could be conducted outside Burundi. Nevertheless, this would firstly go completely against the regional 'spirit' of the project. Such an alternative would also mean ignoring, and thus failing to advance knowledge on the effects of pollutants that may prove to be unique to this northern sector of the lake. Such a strategy would also marginalise the many Burundi-based resources crucial to the project as a whole; above all, it could miss the opportunity of capitalising on the corpus of intellectual, and thoroughly enthusiastic (and in many cases experienced) scientists, technicians and administrators in this country.

There are two centres (both in Bujumbura) that we consider very worthy of involvement in the LTBP project. One is the 'research compound' housing both the Lake Tanganyika Research FAO FINNIDA project (LTR), and the Belgium-funded Centre Regionale de Recherche Hydrobiologie Appliqué (CRRHA), while the other is the University. It is not known to what extent the present project can appoint staff that are presumably coming to, or

plain that a considerable body of well-qualified secretarial, technical and research workers is potentially available. Along with the existing buildings which are in good shape and reflect well the firm, but fair management and supervision maintained by the previous directors/project coordinators.

2.1.1 Ministry of Environment: Institute for the Environment and Conservation of Nature (INECN)

Dr Gaspard Bikwemu is the Director General of INECN which will be the lead organisation for the LTBP in Burundi. He was nominated for the position of National Coordinator by the Minister. He is a very amiable, apparently influential and enthusiastic individual, keen on building up his organisation. He clearly sees the LTBP as an important step in that direction. Quite early on, he drew up a list of delegates for the National Working Group and asked the Minister to agree his choice. Although this was a unilateral action with no reference having been made to the PCU, it demonstrates initiative and enthusiasm for the project.

The head office of INECN is in Gitega but the organisation also owns a building in Bujumbura near the University campus. This is quite spacious, but largely unoccupied, and is on two storeys. It has offices (with space available for the LTBP if required) and a small laboratory is under construction (Italian consultants) for 'pollution studies' - although Dr Bikwemu was unable to give details of the type of analyses that would be carried out, but they were related to industrial pollution. No technical staff are currently attached to INECN.

2.1.2 Ministry of Agriculture and Livestock: Department of Water, Fisheries and Aquaculture

Mr Roger Kanyaru is Director of this department. He is also keen to collaborate with the LTBP and provide office space if required. This could be very useful and would be the most conveniently located base for activities in Burundi. Nevertheless, in order not to offend INECN, it would be politic not to set up anything other than a temporary office here, unless there were overriding logistical reasons for doing so.

2.1.3 FAO/FINNIDA Lake Tanganyika Research Project

From the outset of the UK's LTBP Dr (now Professor) George Hanek (LTR's project Co-ordinator) has been extremely helpful generally, and in particular regarding logistics of visits made by the UK and American personnel. As examples, he has provided project visitors to Burundi with transport to most of our meetings and arranged e.g. for visa and transport to Uvira from Bujumbura. Promises of full co-operation have always been honoured. LTBP has held numerous discussions on a broad range of administrative and operational matters with Dr Hanek, such that he is well-versed in the aims and business of our projects. He has also provided information and advice over such potentially 'delicate' issues as salary, 'bonus' and *per diem* rates for nationals in the region. In addition, during TBW's visit to Bujumbura in November 1995, Professor Hanek allowed him free access to reports and publications in the LTR's Documentation Centre; without such an opportunity to use the library - in which a considerable body of the literature has been generated by the LTR studies - it would have been virtually impossible to produce the Baseline Review on 'Pollution and its effects on biodiversity'. Professor Hanek also invited TBW, KB and ID as representatives of the GEF project to attend the Fourth Joint Meeting of the LTR's coordination and international scientific committees (14-16 November): in addition to contributing to discussions on general

collaboration and vessel use between the LTR and the LTBP, TBW and KB presented short talks on respectively, the Pollution Special Study, and the LTBP as a whole.

A number of *curriculum vitae* of the staff at LTR were collected by TBW with the view to appointing the people to the project as soon as possible.

Telephone, Facsimile and E-mail are all available at the LTR station.

2.1.4 Centre Regionale de Recherche en Hydrobiologie et Appliqué.

Drs Alain Vandelannoote (Limnologist and Station Manager) and Luc de Vos (Senior Scientist with a special interest in fish taxonomy) headed this Belgium-funded research facility. Both have worked in Zaire, Rwanda and Burundi feeder streams as well as Lake Tanganyika itself. They had promised full co-operation with, and support for, the LTBP and this was amply borne out on numerous occasions during TBW's visit with loans of literature on pollution studies which also proved pertinent to the Baseline Review referred to above.

Staff are involved in both chemical and biological studies on the lake and some of its feeder waters; attention includes that paid to invertebrates and microscopic phytoplankton as well as the higher biota (especially fish). *Curriculum vitae* of the staff at CRRHA were also collected by TBW; again it is essential that these people be formally approached as soon as possible with the view to appointing them to the project.

2.1.5 The University of Burundi, Bujumbura

It is essential that a mission to the university is mounted as soon as the situation in Burundi improves. A number of the (very good) staff met at e.g. CRRHA are graduates of this university. With the additional experience of working under the direction of e.g. Dr Vandelannootte, these people constitute a valuable 'resource' which the LTBP cannot afford to overlook.

2.1.6 NGOs

None identified

2.1.7 Other organisations

None identified

2.1.8 Potential study sites visited

A number of industrial outfalls and polluted rivers and streams exist within, or very close to, Bujumbura itself. Security issues permitting, these could be sampled relatively easily - and often - from the LTR, CRRHA and university laboratories.

2.2 Tanzania

By far the greatest proportion (65% equivalent to 149,655 km^2) of the total catchment area of the lake lies in Tanzania. This country ranks second in terms of territory in the lake itself, i.e. 13,327 km^2, and on the basis of length of shoreline - 694 km. Tanzania also receives water *via* the largest influent river to the lake - the Malagarasi, which drains an area of 130,000 km^2 which is nearly 10 times that drained by the Rusizi(s). Other sizeable water courses include the Lugufu draining some 4,400 km^2, the Ifume (2,825 km^2) and the Kalembe (2,683 km^2). While much smaller than these rivers, the Luiche was of interest to this mission since it lies just a few kilometres from Kigoma (see below).

Not surprisingly this country encompasses a vast range of shoreline and offshore habitats. It also includes a rich mosaic of situations ranging from perhaps some of the least impacted by way of pollution (e.g. Mahale and Gombe areas) to the obviously perturbed zones such as Kigoma Port and the associated bay. The main 'scientific' centre of the LTBP is situated at Kigoma; being well-served by an airport and a lake port, Kigoma is probably the most accessible centre in the region for the delivery of freight from e.g. Europe, and for holding meetings of personnel from the other 3 countries. The area is also well-resourced in terms of communication facilities (telephone, facsimile and E-mail).

The present mission spent significant amounts of time in and around Dar es Salaam and Kigoma. It motored and voyaged to some 10 potential field study sites - including lakeshore, river and deltaic areas from Kigoma. One of us (EHA) also visited the Tropical Pesticide Research Organisation in Arusha, in connection with our possible need for particular exacting analyses, requiring instrumentation that is likely to be too expensive to be duplicated over the region. This does not obviate the possibility, however, of regional scientists being training in e.g. pesticide analysis.

2.2.1 Ministry of Water (Water Resources Technical Division), Dar es Salaam

We visited the Water Resources Division of the Ministry of Water in Dar es Salaam because we knew that it is largely responsible for collecting and collating data on river flows in Tanzania - including a number of sites in the Lake Tanganyika catchment. TBW has also collaborated with this station in relation to the setting up of hydrological and chemical analytical programmes for the Lake Victoria Environmental Management programme. The Ministry houses a major analytical laboratory for the region - although in the event due to circumstances out of anyone's control, it was not possible to assess this facility. This is not likely to prove a problem for LTBP, however, as chemical (and biological) analytical facilities already exist in the Kigoma area (see below) and these will be both strengthened and supplemented by the new project.

RWD, TBW, GP and CF met with Mr Meraji O Y Msuya (Acting Director of Water Resource and Mr Julius Mihayo on 2 September at the offices of the Ministry of Water (formerly the Ministry of Water, Energy and Minerals), Dar es Salaam. The principal aim was to determine their perception of the project following receipt of the Draft Inception Report. Mr Msuya stated that no major concerns arose from the report and that he and his

training must be a focus of the project, he is currently preparing written comments on the Pollution and Sediment Discharge Special Studies and these will be forwarded to the PCU in Dar es Salaam. [At the time of writing, however, no comments have been received in UK]. The Ministry of Water has three Technical Divisions: Water Resources; Rural Water Supplies; and Urban Water Supplies and Sewerage. The first of these is the most likely to become involved in the LTBP.

Mr Msuya stressed that all relevant archive data on water and sediment discharge held by the Ministry of Water will be made available. It is intended to publish hydrological data obtained since 1981, the year of the last 'Hydrological Yearbook of Tanzania' on a river basin basis rather than in the previous form of the country as a whole. All such data are now reported to be held on computer. It was confirmed that data from the Kigoma Regional Water Department (see below) are sent to Dar es Salaam for analysis. However, it was pointed out that few data on sediment transport are believed to exist. Mr Msuya undertook to provide the PCU with an inventory of rivers for which sediment discharge data are held and a summary of the nature of the data. Currently there are gauge readers at nearly all gauging stations in the charge of the Ministry. Virtually no automatic water level recorders are working. The possibility of establishing, within the project, a programme of sampling for determining suspended sediment concentrations was discussed. It was confirmed that it would be quite possible for gauge readers, subject to appropriate remuneration, to additionally collect water samples at the times of their water level readings, e.g. at gauging stations 4A9 and 4B9 (see below).

2.2.2 Ministry of Water (Water Resources Technical Division), Kigoma Regional Water Department

Not least considering the central role of Kigoma that is envisaged for the LTBP, the Kigoma Regional Water Department (KRWD) - a regional wing of the Ministry of Water based in Dar es Salaam - was considered from the outset, important as well as convenient. This department has a total of 50 staff of all grades and serves directly or indirectly, *ca* 40 % of the population of approximately 1.2 million people. However, we found that the water resources business of the Department is currently far more active than its other wing which is concerned with chemical analysis.

Staff and main activities of the KRWD - water resources and sediment discharges

On 13 August RWD, TBW and CF met firstly with the principal staff, Michael Baragwiha (Regional Water Engineer), C E L Rubabwa (Geologist) and Theodore Mpyalimi (Hydrologist In Charge).

Some 9,400 cubic metres of water is currently supplied per day, whereas the built capacity of the Kigoma Waterworks is 11,800 cubic metres/day. 90% of the water supplied is taken directly from the lake *via* an intake situated near the foreshore of the Railway Hotel, and located 60 metres from the shore at a depth of 5.8 metres. The quality of the raw water abstracted from the lake appears to be good, and treatment consists of chlorination only (but see below, remarks on 'pollution'). It should be noted that water supplies in parts of Kigoma

TAFIRI laboratory is thus essential. In addition to the main lake supply, there is one official deep water supply well serving the town, and many 'unofficial', dug wells. Routine measurements of rainfall and lake water level are made.

In addition to supplying water and maintaining the treatment works, some studies of river sediment transport have been carried out, though the data are far from comprehensive. Measurements of the sediment load of the River Malagarasi were made at one time, but these finished due to financial constraints. Data held at the KRWD date back to 1960. No data processing is carried out on site - copies of all hydrological data being forwarded to the offices of the Principal Secretary (Ministry of Water, PO Box 2000, Dar es Salaam), for analysis. The original, raw data are still held at the KRWD however, and are readily available for the LTBP, if required. At one time, hydrological data for the whole of Tanzania were collated by the Ministry of Water in volumes of the 'Hydrological Yearbook of Tanzania'. However, these have not been produced since 1981, although a map of the locations of the various gauging stations in the Kigoma Region (including stations on the Rivers Luiche and Malagarasi) is available in the 'Kigoma Water Master Plan'.

In terms of the LTBP Special Study on sediment discharge, it would appear necessary to visit at least the lowermost gauging stations on the Rivers Luiche and Malagarasi - and this was done (see below). The KRWD staff were unable to say what condition these stations are in, although data on water but not suspended sediment discharge, are allegedly still being acquired from these stations. The question remains as to whether or not these would be suitable sampling locations for river suspended sediment concentrations. Ease of access was established later in the mission.

Staff and main activities of the KRWD - water quality and pollution

The visiting group met secondly, with Paul Kiliho, a graduate, who has a staff of two in his chemical laboratory: Mr Mbarak Shemweta (water quality technician with Technical Certificate) who was present, and Ms Jane Rweyemamu (graduate technician) who was absent.

Partly due to the perceived good quality of most of the (lake) raw water supply, and partly as a result of very poor funding, pollution studies are not undertaken. Nevertheless, the plant of the Tanzanian Electricity Supply Company (TANESCO) in Kigoma, for example, is believed to be a significant point-source of oil pollution (TBW personal observation), and insecticides are used around the lake on cotton and coffee crops, especially towards the border with Burundi, and on tomatoes grown close to the lake between Kigoma and Ujiji. Pesticides are also applied to maize crops. Domestic sewage is allegedly collected in septic tanks; the contents of these are periodically transferred and dumped 10-15 km inland from Kigoma at Katosho. The KRWD does not monitor pesticide levels in the water supply because the concentrations present are not believed to pose a problem.

There were some inconsistencies in the various statements on what chemical analyses were being done. For example, one account suggested that since the NORAD programme ended in 1992, the laboratory has continued to carry out standard chemical, physico-chemical and bacteriological analyses on the stream and river waters used for supply. In this connection,

needed, for example when there is an outbreak of disease. Residual chlorine and bacteriological analyses are carried out on water supplies from Kigoma water works once weekly. Lake water samples are also allegedly analysed once per week. However, it was asserted that for many of the determinands no permanent water quality assessment programme has been established - at least for the lake itself, if not for rivers etc, too. Equally, while financial constraints presently appear to limit the frequency and range of analysis carried out, it was suggested that for river waters, sampling frequency is normally quarterly unless special circumstances demand otherwise, and that the range of determinands includes pH, conductivity, turbidity, temperature, colour, hardness and iron, The Department definitely does not undertake any microscope work. The following observations also suggest that rather little chemical analytical work is done - in large part for good reasons.

Main facilities

The present analytical laboratory is the only one of its kind in the Kigoma Region. Together with a sister laboratory at Sumbawanga in Rukwa region (to the south of Kigoma Region), it was built and equipped with the financial and technical assistance under the NORAD Water Master Plan Study in 1980-1981. The following account refers to the Kigoma base, as there was no opportunity during this mission to visit Sumbawanga. The Kigoma laboratory measures approximately 7m x 5m, with storage/preparatory rooms at each end. The detailed layout is given in **Figure 1**. The layout and condition of the laboratory benches are generally satisfactory, but cupboards, benches and shelves are in poor shape and in need of repair. The laboratory is not equipped with a fume cupboard, although Mr Kiliho assured us that the components to construct the this were supplied at the time the laboratory was built, and are still stored on site.

A few items of equipment have been purchased since the original installation but some of the equipment is now non-functional (**see next Table**) and the existing range and quantity of glassware is inadequate and will need supplementing. With the exception of the incubators, the laboratory is lacking dedicated field monitoring equipment for basic physico-chemical

Table: Instruments and ancillary equipment at the Kigoma Regional Water Department laboratory.

equipment	total No./No. functional
Incubator ('Termaks')	1/1
Water baths ('Heto')	4/3
Refrigerator ('Electrolux')	1/1
Heating plates ('Electrolux')	2/1
Autoclave ('Certoklav')	1/0
Water still (' Fison')	1/1
Balance - single pan ('Bosch')	1/1
Balance - top pan ('Bosch')	1/0

Comparator ('Hellige')	1/1
pH meter ('Metrohm Herrisau')	1/1
Conductivity meter ('Metrohm Herrisau')	1/1
Turbidity meter ('Hach' 2100A)	1/1
Field kit for chem/phys analysis ('Hach')	1/0
Membrane filtration equipment ('Sartorius')	2/2
Vacuum pump	1/0
Field kit - bacteriological analysis ('Millepore')	1/1
Water sampling equipment (sampler, bottles & sampling rods)	various
Field incubators ('Millipore')	1/1
Filtration, hand type	1/1
Spectrophotometer ('Hitachi, UV-Vis - Model 100-40')	1/1

parameters such as pH, dissolved oxygen, temperature and conductivity. At present, the laboratory instruments are transported to field sites in a large wooden crate, a procedure which is likely to cause damage to the equipment.

Analytical data

Analytical data exist, but most of these were generated during the period 1978-1992, whilst NORAD was supporting the activities of the Department. The Kigoma Water Master Plan (7 volumes) produced by Norconsult contains much useful information and copies need to acquired for LTBP. Data on both bacteriological and chemical aspects of water quality, are archived at Kigoma and copied to Dar-es-Salaam. Time did not allow the present mission to assess the extent of the archives, so the value of the information to the Project remains to be estimated. It is recommended that the SLO contracts a member of staff from the Water Department to do this.

Overall assessment and recommendations

The Regional Office of the Ministry of Water at Kigoma is responsible for the provision of water supplies for industrial and domestic use in the region, and in that capacity is also responsible for the water quality of the rivers. It is recommended that any possible role for the water laboratory should be restricted to the monitoring of river waters.

A fume cupboard is required and the laboratory furniture repaired. It will be necessary for the laboratory facilities, in particular instruments, glassware and chemicals, to be supplemented in order that basic monitoring of rivers flowing into the lake can be effectively and regularly carried out. As the activities of the TAFIRI laboratory focus on the lake itself, the monitoring programmes of the two laboratories in Kigoma will be complementary to each other. Furthermore, the analysis of common samples for a variety of determinands by the two laboratories will enable inter-laboratory quality control checks to be made and hence improve

If the KRWD is to participate in the project the provision of equipment and training are the priority needs. Hydrological activities must be improved and expanded to permit additional discharge gauging. For this, and other purposes, a vehicle is required. Laboratory activities should be expanded; more chemicals and equipment are needed. There is no telephone on site, such a facility is desirable. Training for laboratory staff was requested by Mr Baragwiha. As the KRWD offices are located far away from universities, the training of young hydrologists and water analysts is not usually undertaken, although local secondary school pupils periodically visit the KRWD as part of their studies in environmental education. The prospect that was raised by the mission, of training of more staff (by European scientists visiting the KRWD and KRWD personnel visiting European laboratories) was greeted with particular enthusiasm.

There is also a Paul Kiriho who is Chief Chemist in the Kigoma Region Development Programme (agricultural, planning and health aspects). The Dar es Salaam Ubunga Laboratory should also be explored with regard to training aspects.

2.2.3 Ministry of Environment and Tourism, Regional Fisheries Department

This Fisheries Department office is important in being responsible for the collection of official statistics on the status of the fisheries resources in Kigoma region. There is a programme of regular monitoring of landings, based on a statistical system implemented by FAO. Catches are monitored by landing location, boat, gear type, mesh size. The catch weight is estimated from the number of boxes, and partitioned into categories:

Lates, Dinopterus, Boulangerochromis, Auchenoglanis, Tilapia, Dagaa.

As such, the Department may well prove of use to the LTBP in being in a position to supply data on fish biodiversity from different grounds/habitats. Particularly valuable *quantitative and repeatable* measures of species diversity could be established if a *random* selection of a known number say, 100 fish in total (i.e. all species) were identified. Such material would also permit an assessment of the size frequency distributions of such 'catches' - for comparison with and display alongside the size frequency patterns of other organisms in the lake, e.g. planktonic and attached algae. The Fishery Department could also contribute materially to the Lake Tanganyika project in being in a position to supply (following appropriate 'awareness' training and instruction) fish tissue (e.g. muscle, liver) for a suite of pollutant and isotopic analyses.

Such aspirations are all the more achievable bearing in mind that the Fisheries Department is situated just yards from the Kigoma TAFIRI laboratory. In common with this institute and the FAO FINNIDA (LTR) premises, it is situated on the lake shore some 10 km from Kigoma Airport, and *ca* 1 km from a railway and Kigoma Port itself. Space is no problem, with the main building measuring approximately 25 m by 5 m; in addition there is a covered boat yard, workshop and small store. Moreover there are 5 reception/office rooms already reasonably well 'furnished'. The building presently lacks power, however - not for lack of wired sockets, but because these have not been connected to the mains. There is no emergency power generator - and (obviously) no surge-protection/current stabilisation facility.

The building does have a water supply, but only to latrines; there are no sinks. There are no fans, and certainly no air-conditioning. There is no safe (chemical) store, and the fuel store (concrete walls, tin roof and doors) is in need of repair. On the Health and Safety front, there is neither First-Aid nor fire-fighting equipment. There were also no life-jackets - although waterproof clothing and gum boots were listed as requirements for fisheries extension officers in the field. Interestingly, there is evidently no fishing gear, or even a ruler or scale/balance, or scale envelopes that might have been expected of a department with its particular remit. However, it transpires that the main focus of this institution is the 'landings' from a total of 7 stations in the Kigoma Region, i.e. 2 northern, 2 central and 3 southern areas - the data from which are sent to Dar es Salaam for processing. Incidentally, 5 of the 7 beach recorders speak English. The Department has no vehicles here, and only derelict open wooden boats and a fibre glass launch, There are also no engines.

By contrast to the generally poor resources indicated above, the site possesses the following:

'Bubble-Jet' portable printer and paper and writing materials. In common with many institutions visited however, 'basics' such as consumables and batteries, were lacking. Indeed, the PC referred to above could not be used, since (i) there was no power, and (ii) the batteries for this machine had discharged.

While the site has 2 security personnel, locks for both offices and outbuildings were lacking. Indeed, as the compound is not fenced, it is open to both road and lake.

The personnel were not investigated in detail. Field staff are seven Fishery extension officers, each responsible for a station. There are three senior staff, responsible for administration and fisheries statistics. One is Beatrice Mwara, currently employed as a Women's Development Officer on the LTR project, and already working with the GEF Socio-economic studies group. We recommend she also be employed on the Biodiversity and Fisheries Practices Special Study, which will have a site at Ujiji, an area where catches are already monitored to some extent. Senior staff names and qualifications are listed in the LTR directory.

The Department is also responsible for enforcement of fisheries legislation, and has the power to impose fines and confiscate gear. Arrests are normally made through the Military Police, as the Fisheries Department has no lake control or enforcement personnel.

2.2.4 Tanzania Fisheries Research Institute (TAFIRI) and LTR (FAO FINNIDA)

We visited this Institute because it is extremely well-known across East Africa. It already has an impressive record with its involvement in large lakes and river systems including both Lake Victoria and Lake Tanganyika. The Kigoma station also enjoys a high profile as a result of its close association with the LTR (FAO FINNIDA) Lake Tanganyika Fisheries and Hydrodynamics project (and **Appendix V** gives the names and scientific interests of the nationals involved in Lake Tanganyika monitoring in LTR stations at Mpulungu, Uvira, Bujumbura as well as Kigoma). Indeed, our visit was aimed primarily at exploring the possibilities and arrangements for LTBP to capitalise on these 'campus' facilities, and employ TAFIRI staff to varying degrees, as the Finnish funding comes to an end.

CF headed the assessment of the mainly chemical resources shared by the LTR (FAO FINNIDA), and the TAFIRI laboratories, while TBW attended to biological issues and activities. Over two days (12 and 13 August) they met with Mr Chitamwebwe (TAFIRI's Kigoma Station Director), Mr Kalangali and Mr Muhoza (respectively Researcher and Technician in mainly zooplankton and micro-nekton); CF also had detailed discussions on laboratory lay-out with Mr Kissaka in particular. The full names of the laboratory staff together with their qualifications, areas of expertise and their years of experience are listed in the **next Table**.

At numerous junctures during our stay in Kigoma TBW also discussed with Dr John Craig (LTR's statistician) issues stemming from the LTR's results. In brief, this 'science compound' includes a significant corpus of dedicated scientists; indeed, the ones cited above are very experienced by any standards, and their willingness to work LTR material with virtually no pay (as the main monitoring programme has finished), is testament to their

technicians that we consider necessary in each lake country (and assuming for the present, one centre in each country) to carry out the pollution and pollution-related biodiversity studies under the GEF project. It is plain that this collection of science buildings and personnel should be capitalised on and resourced. Indeed, bearing in mind the known capabilities of the scientists, technicians and field support staff, the main focus was on establishing what, if any, additional laboratory facilities were required.

At the FAO FINNIDA's Kigoma site, TBW also discussed at some length with Els Bosma (zoologist) , Piet Verburg (Fisheries biologist) and colleagues (including Mr Chitamwebwe, Mr Muhoza and Mr Lyoba) their current methods of zooplankton population density assessments and size analysis, and the handling, presentation and interpretation of size (e.g. length) frequency data. This was initiated by comments on the inordinate amount of time these sample analysers were taking -as testified by the hundreds of samples that remain to be analysed. TBW suggested that the present sample size was probably unnecessarily large and that in any event, a strategy could be developed where sampling/counting could be terminated, according to the specific values of each sample. Another suggestion introduced the use of 'rankits' or 'ranked normal deviates' whereby every value of an attribute (e.g. copepod length) that has been measured is plotted for examining the (length) frequency distribution - as distinct from grouping such measurements into (length) classes; this is important bearing in mind that where size classes are used, these should number at least 15 - this itself demanding a large number of measurements to be made, otherwise one runs the risk of 'influencing' the size frequency distribution.

It is accepted by the FAO FINNIDA personnel that all of their equipment - which has been carefully looked after - will be made available to the GEF project; this includes three very smart binocular microscopes (one stereo, and two compound inverted).

Discussions indicated the willingness of this station to act as the main centre for GEF studies in Tanzania. TBW also suggested that a workshop in limnological sampling and chemical and biological laboratory methods be organised as soon as possible; this would involve say, five scientists from each of the lake countries; it would use water, sediment and (lower) biota collected by the participants from the reasonable range of open water, and sandy, rocky, pebbly habitats existing near the station.

Table: Areas of expertise, qualifications and years of experience of TAFIRI laboratory staff.

name	expertise	qualifications (years experience)
Mr Deonatus Chitamwebwa	Limnology	Dip.Fish., Dip. Limnol., BSc (23)
Mr M B S Kissaka	Fish biology, Hydrodynamics	Dip. Fish., BSc. (Fish.), M.Tech. (Aquaculture) (21)
Mr Ibrahim Katonda	Fish biology	BSc, MSc. (Fish.) (22)
Mr Anthony Katangali	Zooplankton	BSc. (Dar es Salaam) (8)
Mr Elias Lyoba	Limnology	Cert. & Dip. (Fish.) (22)

Mr Ubald Kisisue	Fish biology, Marine engineering	Dip. Fish. (17)
Mr Edmund Kadula	Fish biology, Hydrodynamics	Technician Cert. (General) (8)
Mr Dmar Kashwshu	Fish biology, Hydrodynamics	Technician Cert. (General) (8)
Ms Dina Lyoba	Fish biology, Hydrodynamics	Technician (6)

Buildings - general

The basic laboratory buildings include 1 dry laboratory (for biological and limnological analyses) and 1 wet laboratory which houses an inflatable craft and is used for the handling and examination of wet (mainly fish) samples. Two other rooms are allocated for a library and computing. CF assessed the laboratory facilities, focusing first on the existing layout of the dry laboratory, and second on a new plan that he recommends in order to address drawbacks in the current arrangement. He then assessed the laboratory equipment and the analyses presently undertaken.

Dry laboratory - present design

The present laboratory (**Figure 2a**) is reasonably designed and equipped but suffers from a number of drawbacks which could be relatively easily remedied. The only bench space available comprises 4 tables situated in the centre of the laboratory. These tables are used both for the microscope and the various limnological analyses. There is only one cupboard - glass/solid fronted; this is used to store both chemicals and books. Meanwhile, glassware is stored on open shelves where it is easily contaminated by dust. There is presently no fume cupboard or air-conditioning unit, and the ceiling positioning of fans make zooplankton and other work at the microscopes immediately beneath them rather difficult.

Dry laboratory - proposed design

The proposed modifications (**Figure 2b**) intended to address the above drawbacks, amount basically to constructing wall and central benches; this will increase the available bench area *and* enable the biological and limnological work to be grouped into distinct areas of the laboratory. More power sockets will be provided by running a power line down the central bench and changing single to double sockets where possible. The cupboard and drawer space under the wall and central bench can then be used for the storage of equipment including glassware and consumable items used for the biological and chemical analyses respectively. The shelving down the middle of the central bench can also be used for reagents and samples etc. needed for the limnological analyses.

The positions of the (new) fume cupboard and air-conditioning unit are so located because of the availability of an outside wall. Air-conditioning would not only eliminate the need for central fans, but would enable the upper window area to be sealed, thus reducing dust levels.

Laboratory equipment

The laboratory is generally fairly well-equipped for basic limnological parameters. Presently, this is largely done using 'Hach' kits. However, the items identified in the **next Table** would increase the effectiveness of the laboratory substantially. The laboratory is particularly well-resourced as far as microscopes are concerned - this reflecting a main interest in zooplankton and micro-nekton. There are three especially fine instruments:

- a 'Leica' binocular Wild M3B Stereo

- a ‘Leitz’ ‘Labovert’ inverted

Analytical measurements

The range of measurements that the laboratory is capable of carrying out (albeit using 'Hach' kits - see below) is as follows:

pH, Secchi disc, conductivity, DO, TP, SRP, NO_3, NO_2, NH_3, I, alkalinity, Cl, Ca^{2+}, Si^{2+}, total hardness, SO_4^{2-}. Due to financial restraints, the frequency of measurements is now somewhat restricted. If, as recommended, more conventional methods of measurement of chemical analysis are adopted, more glassware will be required.

Table: Some equipment items recommended for the TAFIRI laboratory

equipment item	number recommended
chest freezer - storage of sample bottles etc.	1
water still - more recent model needed	1
magnetic stirrer hot plates	2
top-pan balance 0.01g sensitivity	2
double-beam UV/visible spectrophotometer & spares	1
fluorescence spectrophotometer	1
camera and attachments for microscopes	1
power stabiliser (present one only 1.5kVA)	1

Overall Assessment

The staff of the TAFIRI laboratory have many years of experience and given the opportunity are capable of making a substantial contribution to the LTBP. It is, therefore, recommended that the TAFIRI laboratory should be the base for the limnological and biological measurement in lake waters and that the laboratory of the Kigoma Regional Water Department (Ministry of Water), in Kigoma, should concentrate on the monitoring of river systems.

At present financial restrictions limit the monitoring activities of the TAFIRI laboratory. It is strongly recommended that the Project supports the TAFIRI laboratory and makes full use of the wealth of experience of the scientific staff for specific aspects of the research programmes.

One of the key objectives of the present project is, of course, to strengthen selected lakeside laboratories in the riparian countries. The changes in laboratory layout and facilities recommended for the TAFIRI site will result in much better use of the available space; hence, it should enhance the long-term sustainability of the laboratory research and monitoring programmes.

A further issue that has a bearing on the long-term monitoring of the lake relates to the nature of the analytical methods currently used to determine the limnological parameters. The 'Hach' kit methods that are currently used, whilst being ideal for measurements in the field,

packed chemicals. They also tend to nurture a 'cook-book' approach to chemical measurements which can result in an uncritical acceptance of data.

It is, therefore, recommended that the long-term and cost-effective acquisition of limnological data on the lake (in the other three countries as well as Tanzania) would be best achieved by the adoption of the more traditional methods of analysis. The 'Hach' kit approach could still be retained for field work and as an alternative method for cross-checking data acquired by traditional procedures. The adoption of the latter will require initial training programmes, but these could usefully be combined with the trial sampling and analytical measurements already planned and which are aimed at harmonising sampling and analytical procedures throughout the Project.

2.2.5 Tropical Pesticides Research Institute, Arusha

General information on TPRI

The mission was especially keen to visit TPRI in spite of the fact that Arusha is so far from Lake Tanganyika. Firstly, the institute is world-renowned, and secondly, the LVEMP project identification team of which TBW was a member in 1995, had been very well received at Arusha. EHA assessed the resources of TPRI on 5-9-96.

TPRI is situated on Nairobi Road, 8km from Arusha at Ngaramtoni. The institute dates back to 1945, and has been in Arusha since 1950. It was founded as the Colonial Insecticides Research Unit. Since independence, it was first an East African Common Services Organisation but, following the collapse of the East African Community, it was incorporated as an institute into the Tanzanian Ministry of Agriculture. The institute now employs over 300 people, and conducts both research and technical services in pesticide control and management. Activities and institutional structure, staff lists and ongoing research projects are outlined in the appended report.

The Chief Research Officer, Mr Charles J. Muangirwa, was most helpful in outlining the work of the institute. His own research is in Tsetse control. EHA explained the role of the LTBP and the likely requirements for pesticide residue analyses, and was taken to the Physical and Chemical Division, to meet Mr Jonathan Ak'habuhaya, the head of that department, who has been responsible for establishing the Environmental Chemistry programmes within TPRI. Mr Ak'habuhaya has worked on pesticide residues and heavy metals in fish, aquatic plants, fish etc, in various Tanzanian rivers and lakes, including Lake Victoria. He was very interested in potential collaboration with the project, and was of the opinion that their department has unrivalled experience and facilities within Tanzania for chemical analysis. He appears very enthusiastic and quite dynamic, but it is noted that his last published research was done with Finnish scientists in 1988.

Laboratory facilities and activities - with special reference to the Physical and Chemical Division

The laboratories are certainly extensive, generally in good order, and well-equipped. They

are also reliable. Many of the analytical apparatus were not functional however, and were described as having 'small problems' (e.g. missing lamps in Atomic Absorption Spectrophotometer). It was also striking that in laboratories where over 50 scientists are employed, only 3 were actually working. One was checking the composition of an industrial insecticide (Actelic) in the Pesticides Registration and Control Laboratory, using a new computer-linked HPLC purchased from South Africa. The second, in the Technical Services Department, was writing a report on modifications required to a new crop-sprayer from Japan. The third was a research officer in the Physical and Chemical Division fractionating plant material in the search for the active ingredient in a tick-repelling plant. The instrumentation room in the Physical and Chemical Division was locked at the time of the visit. There were many freezers containing samples of soil, plant material, human blood and urine, all awaiting analysis.

As indicated already, the main laboratories are very large - typical of many big teaching laboratories in a University Chemistry Department - and could accommodate training courses, or more intensive activity (including the simultaneous presence of all TPRI staff!). Several staff have come from ICIPE in Nairobi, and are therefore suitably qualified. The most senior technician has been working at the laboratory for 38 years!

Current pesticide residue research is being carried out on vegetation, water and soil and human body fluids. This research has been sponsored by FAO, FINNIDA and IDRC, Canada in the past, but the impression the gained is that this funding has come to an end.

The next Table indicates some of the equipment observed during the visit.

Library

The library is in a sorry state. The roof has leaked badly in the past, and has caused extensive damage. There are internal reports - probably unique - dating back to 1945 stored there. Staff at the institute do not appear to appreciate the archival value of old journals and reports. On the other hand, they are rightly concerned that new subscriptions are very limited. There is very little literature dating from more recently than 1978, apart from the usual plethora of leaflets, bulletins and free newsletters from various international and national research and aid organisations.

As there is no realistic possibility of filling gaps in journal subscriptions, the library is planning to go to on-line journals and CD-ROM abstracts as their main source of recent published information.

Other departments

There was no opportunity to visit the other departments, but it is understood that the Institute also houses the National Herbarium and The National Plant Gene Bank. It is also developing an entomological museum. These are all biodiversity-related activities, perhaps more relevant to the National Biodiversity Strategy project (FAO) than the Lake Tanganyika GEF.

It should be noted that the National Radiological Protection Laboratory, although not part of the institute, is located on the same site.

Table: Some large/sophisticated equipment in TPRI.* indicates not functional.

equipment item
Gas Chromatograph 'Hewlett Packard 5890A', Capilliary ECD detector, Paper output
'DANI 680' Gas Chromatograph, supplied by FAO; no detector, otherwise working
Two Gas Chromatographs supplied by Finnish Institute of Occupational Health *
'JASCO UVIDEC-100-V HPLC', supplied by International Atomic Energy Authority (a second one arrived at the airport the day of EHA's visit); associated equipment: 'Scalar ratemeter', liquid scintillation counter, Biological oxidiser
'Unicam SP90A Ser 2' Atomic Absorbtion Spectrophotometer * (lamps broken)
New 'GBC A.H. Korthof' AAS, not yet used, awaiting lamps.
UV/Visible Spectrophotometers (several)
Ovens, refrigerators and freezers - abundant
pH meters
Fraction collector - 'Pharmacia'
TLC coater
Abundant specialised glassware for distilling, fractionation columns etc., but some broken flasks still being used: this suggests basic consumables may be in short supply.
Portable refrigerator for field use
Speed vacuum concentrator with refrigerated condensation trap, several other sample concentrators
Centrifuge
Analytical evaporator
De-ionisers
Vortex machines
Gas supplies
Fully equipped darkroom and range of photographic equipment.
Capability for development of slides and colour film
'ACER 386' Computer with Dot-Matrix printer - considered inadequate
Various balances (sensitivity up to 4 dp)
Nitrogen generator *
Computerised HPLC - 'Varian 9012', 'Varian 9065' Polychrom (in Technical Services Dept., not Physical and Chemical Division of the Research Dept., ie used for full-strength samples, not residues)

Overall Impression

TPRI work on research, monitoring and extension services in pesticide use in agriculture and agricultural and human pest control. They provide a valuable service to the Tanzanian agricultural and health sectors. It is believed that this institute would function if it had more funds. It has a huge and apparently well trained staff, good facilities, extensive laboratories and grounds for field trials, and it is conducting some routine monitoring programmes within its very limited budget. It has a large assortment of analytical equipment, most of which it

project to get the institute working to its capacity, but perhaps if the Lake Tanganyika biodiversity project become involved, then other donors can be encouraged to involve TPRI in their programmes and provide some further institutional support. It was built to service the needs of East Africa, and is now working only in Tanzania. Involvement in regional projects (e.g. SADC) may expand their activities to fill those large empty labs.

Appended Material

Mr Ak'habuhaya gave EHA reprints including a Review of Pesticides in Tanzania (1988), the 1991 TPRI Annual Report, a Research and Technical Services Activities Booklet (1993-1996), a TPRI Information Leaflet, and some Business cards for Mr Ak'habuhaya and Mr Muangirwa (each including E-mail addresses).

2.2.6 Dar es Salaam University, Faculty of Science

The mission wanted to visit the University of Dar es Salaam, and its Science Faculty and component departments in particular (in spite of the remoteness from the lake) for a number of reasons. Firstly, it constitutes the most concentrated corpus of scientists including those in the natural sciences which could be of major relevance to the LTBP. Secondly, it was likely to have researchers and technicians skilled in areas that could be of considerable value to the project even if they had not been applied or related to the aquatic environment previously. Thirdly, the university was viewed as one of the major locations of large and/or sophisticated apparatus and instrumentation, that might be of value to the LTBP, but too expensive to warrant purchase by the project. Some of these pre-judgements on the potential relevance/use of the university were confirmed. Equally, however, some departments appeared to be very poorly motivated. Mainly as a consequence of the non-appearance of personnel, EHA and TBW were invited into the very impressive University Press.

2.2.7 Dar es Salaam University, Department of Botany

Met with Senior Lecturer in Applied Microbiology (Dr A Kivaisi), the Head of Botany, Professor A K Semesi was not present. LTBP was explained to Dr Kivaisi but she seemed quite uninterested - simply pointing out that ‘we do nothing like that here’.

2.2.8 Dar es Salaam University, Department of Chemistry

At meetings on 3 September between CF, Professor Nkunya, Associate Dean (Academic), Faculty of Science and Professor Mulokozi, Acting Head , Department of
Chemistry, the objectives and scope of the Lake Tanganyika Project were outlined and the possible involvement of the Department of Chemistry was discussed.
Professor Nkunya outlined the research and teaching activities of the Department and described future plans. As part of a Science Faculty review of undergraduate and post graduate courses, the current teaching programme is being restructured to focus more on the relevance of chemistry to society and to the environment in general. Undergraduate courses in Environmental Sciences are due to commence in the 1997 academic year and an MSc in Environmental Science has been approved by the University and will also commence in 1997.

Staff and Research Activities

At the time of the visit , most of the staff seemed to be away from the University and there was little evidence of an active research environment. Professor Mosha who is an experienced analytical chemist known to CF from his time at Kenyatta University was away in Kenya . Dr Mhinzi, also an experienced analytical chemist who is working on a study of salinity in Rift Valley lakes in conjunction with the Department of Chemistry , Oslo University, was also away at the time of the visit. It is not known whether these two members of staff , would be available or willing to participate in the project activities. This possibility is being followed up.

Laboratory Facilities

Mr Mapunda, the Laboratory Superintendent took CF on a tour of the research laboratories. Equipment in the Department potentially relevant to the project are as follows:

AAS- Perkin Elmer 2380 . Flame only facility . Adequate lamps . Instrument 5 years old but apparently working OK,

IR, GLC, HPLC, UV and NMR instruments. GLC and HPLC recently acquired through NORAD funds.

The department has no gas generators for GLC analysis and is thus reliant on compressed gas from Tanzania Oxygen Company or from overseas suppliers. Such compressed gas supplies are very costly.

There was little evidence of an active analysis programme using these instruments at the time of the visit.

Recommendation

On the basis of an admittedly brief and essentially unheralded visit, there would seem to be little potential for collaboration between the Department and the analytical aspects of the project. Considerable investment would need to be made to provide the capability necessary for the analysis of samples for pesticides and heavy metals and in view of the better facilities that exist at TPRI in Arusha, such an injection of funds is not recommended.

The commencement of undergraduate and postgraduate programmes in the Environmental Sciences is however an opportunity for collaboration between the Lake Tanganyika project and the Chemistry department. Several possibilities come to mind. Thus, for example, materials suitable for both the undergraduate and postgraduate course which focus on the nature, origins and current status of the Lake and also include the results of the Special Studies would help to raise the profile of the Lake at a University level. A further opportunity for links between the Department and the Project would be for some of the

2.2.9 Dar es Salaam University, Department of Civil Engineering

On 2-9-96 RWD, TBW and CF met with Mr Simon H Mkhandi, co-ordinator of the Flow Regimes from International and Experimental Data programme (FRIEND) for southern Africa; he is based in the Department of Civil Engineering. FRIEND involves 11 countries and its aim is to carry out, using computer software developed in the department, a flood frequency analysis for the whole of southern Africa. This is not a data gathering programme; all the relevant data are provided by various ministries, e.g. the Ministry of Water in Tanzania. For the purposes of the programme, ten regions are delineated for the country and, of possible relevance to the project, analyses have been undertaken for the River Malagarasi. Currently, the FRIEND programme is not concerned with sediment transport. However, the intention is to incorporate sediment transport data into the modelling as soon as possible. Possible links with the LTBP could be through the acquisition of data relevant to FRIEND. However, active involvement in LTBP, in terms of data acquisition, by FRIEND personnel would not be appropriate.

2.2.10 Dar es Salaam University, Department of Geology

Staff met, and main research activities

On 2-9-96 RWD, TBW and CF met with Dr Hudson Hamisi Nkotagu (hydrologist and Acting Head of the Department of Geology) and Dr S Kapilima (stratigrapher). Departmental personnel are involved in a major project on mining pollution in Tanzania, sponsored by the Swedish Agency for Research Co-operation with Developing Countries (SAREC). The project which has been going for two years - and is likely to continue for a further two years - is concerned with the impact of all kinds of open-cast and deep mining activities for both metallic and non-metallic materials.

The work began in the Lake Victoria area but has since expanded to the Uvinza (salt mines) area, i.e. to catchments draining into Lake Tanganyika. The Acting Co-ordinator of the project (not available at the time of the meeting) is Dr Mutakyahwa. In addition, six academic staff are involved part-time, together with occasional M.Sc. students and visiting Swedish scientists. The field programme involves the collection of water and sediment samples, but not vegetation or animal samples, from streams and rivers in areas of mining activity. Some samples are sent to Sweden for analysis but most are analysed in the department.

The staff with whom discussions were held appeared to be both well qualified and motivated. They were also recommended to the project by Dr A Cohen of the University of Arizona. For example, Dr Nkotagu has recently had two papers, on the isotopic characteristics of groundwater in Tanzania, published in the *Journal of African Earth Sciences* (Pergamon). He is also actively involved in research collaboration with BGS Wallingford in the UK and has had published a 158-page monograph : '*Hydrogeological and isotopic characterisation of a fractured basement groundwater flow system in the semi-arid area of Dodoma, Tanzania*'.

Potential links with the LTBP

Potential involvement of the Department in the LTBP was met with an enthusiastic response. It was suggested that analyses of pollutants, on a seasonal basis, might be extended to the lower reaches of several rivers draining into the lake in the Kigoma region and linked to the river gauging and suspended sediment sampling programmes. If the XRD can be repaired it would be possible to integrate a programme of semi-quantitative mineralogical analysis to the studies of sediment discharge and heavy metals. A major unknown concerns the extensive Malagarasi-Moyowosi swamps, in particular whether they are a sink for heavy metals. Analysis of samples collected above and below the swamps would be needed to ascertain this. It was suggested that sediment sampling and analysis could be undertaken as part of the programme of research of M.Sc. students. The M.Sc. degree is normally 24 months by thesis in the University of Dar es Salaam. Dr Nkotagu did not believe that it would be a problem for students to work so far away from the University, providing that funding support was made available. The collaboration could thus strengthen the Special Study on 'Pollution' *per se*, the one on 'Sediment Pollution' and the programmes concerned with these impacts of the pollutants on lake biodiversity.

Instrumentation

The main analytical tool is an Atomic Absorption Spectrometer (AAS), suitable for analysis of heavy metals (the principal pollutants are Cr, Ni and Hg). However, this equipment has problems with its graphite furnace and a lack of spare parts. Expert help is needed to effect the necessary maintenance and repairs. The department also has XRD equipment (not seen, as the key to the lab was lost), but this is not functioning. The problem is apparently due to a faulty cooling system, the cost of repairs being uncertain. It is believed that a complete overhaul of the instrument will be needed because it has been out of working order for several years.

2.2.11 Dar es Salaam University, Department of Zoology

GP visited on 1/11/96 and met with Dr Kasigwa (HOD Dr Urasa not present). Kasigwa not in a relevant field but expressed his Departments interest. The main contact that was made by EHA and TBW, was with Mr Botterweg from the Netherlands, on a contract that finishes on 1 December 1996, unless he can raise more funds. Moreover, Mr Botterweg is not an aquatic ecologist. Still, he proved immensely interesting and was interested in our project, particularly in connection with his main pre-occupation of establishing a tabular and Geographical Information System (GIS) database on animal (mainly vertebrate) biodiversity in Tanzania. In this context, he demonstrated the Microsoft 'Access' and 'MAPINFO' (not 'ARCHINIFO') - structured system. The system, which presently includes datasets on freshwater fish, partitions the country into 7 or 8 biogeographical zones. Maps based on such criteria as 'IUCN status' and 'endemism' can be produced, as well as traditional distributions/dispersions of animals. Maps are based on a _^{o} x _^{o} grid. Latitude-longitude reference points can be imported into the MAPINFO arrays. Throughout, a specimen is linked to the source record and name of recorder. Mr Botterweg's system is very impressive; we agreed to keep in touch as the LTBP evolves.

Staff at the Biology Department may be interested in participating in Biodiversity-related studies. Most of their fisheries/aquatic science interests are centred around marine systems. They have, through Dr Kim Howell, an interest in amphibians, and they may be enlisted for species inventory work in Mahale NP, for example, where total flora and fauna surveys could be conducted.

Interest in involvement in the Lake Tanganyika project was rather guarded. The fact that staff were heavily committed to existing projects, including other national and regional GEF biodiversity projects, was repeatedly mentioned, and requests were made for detailed work plans and specific requirements for staff time, estimates of funds available etc. It seems likely that this will have to be provided before we get any form of capability statement from them.

Note that Mr S.G.M. Ndaro, formerly of TAFIRI, Kigoma, is now employed as a lecturer in Dar es Salaam. This was not known at the time of the visit, so he was not contacted. He carried out the only study to date (published in 1992) on the catch-composition of beach-seines in Lake Tanganyika.

Action - send detailed work plans and formal invitation for involvement to Dr Kim Howell - including amount of funding available, time commitment required etc. In return, request CV and submission of any relevant research proposals. (MRAG)

Contact Mr Ndaro to guage interest of UDSM in involvement in fisheries related research

2.2.12 Institute of Resource Assessment

The Forest Resource Management Project (FRMP) at the University of Dar es Salaam's Institute of Resource Assessment (USDM-IRA) is currently preparing satellite images and maps for the (World Bank funded) National Reconnaissance Level Land Use/Cover and Natural Resources Mapping Project. Huntings Technical Services (HTS) are providing technical assistance. This is an "aerial" mapping project of all Tanzania at 1:250,000 scale, based on 1994/95 Landsat TM data, included as one component of the FRMP. The project is applying manual interpretation of TM image mosaics to provide 1:250,000 land cover mapping of Tanzania. 64 map sheets cover the country (5 cover the immediate L. Tanganyika shoreline on the Tanzania side). The Project co-ordinator is Mr. Jackson Musokwe at the Ministry of Natural Resources. This project is funded and controlled by World Bank Nairobi (task manager Paul Ryan) and commenced in 1992/93.

GP met with David Smith of Huntings. The project getting close to production of full map cover for Tanzania. There is a pipeline proposal for using archive satellite imagery to look at changes of forest cover in the last ten years comparing the currently produced maps to some derived form old Landsat data. They are considering in particular 7 LANDSAT areas close to the Lake shore and including a most of the Malagarasi catchment and approximately 50 % of the lake shoreline. The project should look into this as a possible additional data set and perhaps we can direct the study and look at catchment changes in forest cover and the extent of wetland shrinkage over the period. The contact would be Rob Behr at World Bank, Nairobi - the potential sponsors.

2.2.13 Institute of Marine Sciences, Zanzibar.

Since the visit GP has received a fax from Dr Nyandwi of the Institute of Marine Sciences (part of UniDar) expressing his interest in the project. Dr Nyandwi has a good background as a sedimentologist and should be considered for involvement in the project.

2.2.14 Tanzania National Parks Authority (TANAPA)

Good contacts were established with TANAPA, both at their headquarters in Arusha and in Mahale Mts and Gombe Stream National Parks. We have received a specific request for biodiversity inventories in Mahale that we should respond to. Mr Mwasaga, Chief Ecologist, and the senior staff at Mahale have supported the principle of establishing research facilities, environmental education centres and increasing tourism, both on land and in the water in Mahale.

2.2.15 Wildlife Division, Department of Environment and Tourism

While Wildlife Division staff are unlikely to be directly involved in field research, contact should be established, through the Director Mr Bakari Mbano, to obtain further details of the new game reserve in the catchment area (see section 4.3.6). Mr. Mbano is also responsible for the administration of the Mafia Island Aquatic Reserve, and it may be useful to learn from this project in setting up aquatic reserves that allow local community involvement in limited exploitative activities.

a. Wildlife Conservation Society of Tanzania

CF and TBW visited (3-9-96) the WCST partly because it's headquarters are situated within a few hundred metres of the British Council and the (then) LTBP office, but also because a number of people that we had met on our travels, had recommended such a visit. This proved to be good advice. In addition to welcoming us very graciously, the WCST's co-ordinator (Ms Alice Bhukali) and her staff demonstrated a very well-organised set-up, and impressive displays. This led to discussions on possibly links with the LTBP - and especially in the context of Environmental Education (see 4.2.2).

b. Frontier Tanzania

GP visited the headquarters of Frontier Tanzania. This is a linkage programme between the University of Dar es Salaam and the Society for Experimental Exploration and they have been conducting a number of projects in Tanzania including a large programme to survey the littoral zone of Mafia Island. They have long experience of training African counterparts in diving and underwater survey techniques. The HQ of the Society of Experimental Exploration is in UK.

c. Others

TACARE. Tanzania Catchment Reforestation organisation: community work, sustainable agriculture. Successful NGO - EU funded. Contact: Mr Mtiti.
COIPIBO - sutainable agriculture practices
CADIC - environmental organisation
CRDB - Co-operative Rural Development Bank
KRFCU - Kigoma Region Fisheries Co-operative Union - upcoming local initiative.

2.2.17 Other organisations

a. The Lake Victoria Environmental Management Plan (LVEMP)

TBW had met Mr Mbwana, the Co-ordinator of LVEMP on a number of previous occasions during his project identification mission to the Lake Victoria counties in 1995. Mr Mbwana had also contributed to the LTBP Inception Workshop (which TBW and GP attended) in March 1996. The reason for visiting him again (3-9-96) was to introduce EHA and CF to him, catch up on progress with the Lake Victoria studies, but more importantly to get him to outline his experiences in setting up and co-ordinating a 'large African lake' research programme. He made the following points which might be borne in mind for the LTBP:

> experts (especially in land use) exist in-country provided one can obtain maps, images etc. not surprisingly, very good staff also exist in fisheries and biodiversity
>
> for advice and information on pollution - utilise water departments, universities etc, for the initial identification of pollution at point-sources; then bring in local international experts for non-point sources

it is very important to select personnel carefully, as one needs people who are especially committed, i.e. willing to take time and care over their duties; in addition one needs personnel who can assist from the outset with report writing

Mr Mbwana can assist on staff selection if asked.

b. Department of Wildlife, Chilanga

Department of Wildlife are responsible for activities within Nsumbu National Park, which includes part of the lake. I did not meet any staff from Wildlife Department on my visit (EHA), but I was able to speak to Dr H. Mwima, Chief ecologist, by telephone later the same evening. Involvement of Wildlife Research Staff in biodiversity survey activities is a possibility that needs to be investigated. Dr Mwima expressed strong interest. According to Dr Mwima (Chief Ecologist, Dept. of Wildlife) there is currently no active research work in Nsumbu NP. There is no biologist on the park staff. GEF activities could provide a catalyst for other wildlife-related research activities.

Action: Biodiversity research plans to be sent to Dr Henry Mwima, Chief Ecologist, Department of Wildlife.

c. World Wide Fund for Nature

There is a WWF programme of Wetlands research, based in the Wildlife Dept, Chilanga. Details of the GEF project were left with the programme. Possible collaboration in Lufubu river area, Nsumbu park.

Action: Contacted by EHA, awaiting reply

2.2.18 Potential study sites in Tanzania

The mission was mounted primarily for the purpose of assessing institutions (buildings, equipment and people). However, it had always been hoped that the team would also have the opportunity to visit areas of the lakeshore, to gain (in some cases first-hand) impressions of the types of field sites and 'habitats' that we would be assessing and sampling in order to establish to what extent pollution/sediment pollution affects biodiversity. In the event, we not only saw vast stretches of shore-line and experience boat journeys over long distances while travelling between Kigoma, Mahale, Uvira and Mpulungu: we were also able to visit (by road or boat), a variety of areas for long enough spells to take this project's first samples of e.g. sediment, rock, water, plankton and attached organisms. Although some of these excursions were made in conjunction with visits to institutions, the majority of the total of approximately 15 areas described in this section were visited primarily to see the environmental/ecological features; examples are inland, and deltaic zones of running waters, and numerous bays and shoreline stretches of the lake itself. The areas are reported below in order of location from North to South i.e. from Gombe to Mahale.

i. Gombe Stream National Park

A full day trip to Gombe Stream National Park was made on 29-8-96 by RWD, KB and Bertha, primarily to facilitate the visit of the British High Commissioner to Tanzania, Alan Montgomery, and his daughter Justine. The journey to Gombe (*ca* two hours from Kigoma)

on the lake. The guided walks within the confines of the park and reception were hosted by Mr Dattomax G M Sellanyika who is the Acting Warden of the Gombe National Park, with 34 staff; the associated Jane Goodall Foundation has 26 staff. A useful, illustrated publication on the park and its wildlife is that by Bygott (Bygott, D., 1992 *Gombe Stream National Park*. Tanzanian National Parks/African Wildlife Foundation, 67 pp.)

Along its coastal length of 7 km, 13 streams enter Lake Tanganyika perennially *via* Gombe Park. Two of these - draining small, unimpacted, forested catchments - were examined in detail. A further five flow only during the rainy season. None of the rivers is gauged. Since there are no roads in the park, access to the lower reaches of any potential river sites must be *via* boat and/or on foot along the lake shore. Gombe occupies a naturally forested site, completely unimpacted in terms of disturbance of the land by cultivation. As such, and in common with Mahale, it could provide an important comparison - for sediment discharge studies - with areas that are cultivated and/or deforested. Especially as so few studies of sediment yields from land covered by virgin forest have been conducted, the two continually flowing streams referred to above, would be valuable. These same sites are equally attractive as far as the studies on pollution and its effects on biodiversity are concerned. Any data from Gombe could also be of value in a wider context than even that of the LTBP. Indeed, from the probable main project base at Kigoma it would be more practical to carry out sampling in Gombe (50 km away) than in Mahale (150 km).

Mr Sellanyika indicated that he would be very enthusiastic about the possibility of some of the streams in the Gombe Park being used for sediment discharge or other studies. Indeed, he would be prepared to make a very positive recommendation to that effect to his superiors. However, as is the case for Mahale, there is absolutely no equipment available at Gombe for such studies. Thus, all necessary items would have to be brought in (see section on Mahale for more details). In addition, river discharge gauging would be needed. It would be both costly and impractical to establish permanent or semi-permanent gauging stations on the streams and it is suggested that the method of dilution gauging would be the most suitable if some of the Gombe rivers were to be studied. In contrast, the 'lending' of simple water quality probes, sampling gear, filtration apparatus and batches of sample tubes and e.g. a freezer-refrigerator, would make feasible a useful suite of pollution and biodiversity investigations; capacity-building would also be achieved through the programmes of training that would be mounted in order to execute these studies.

ii. Rivers Luiche and Malagarasi

The lowermost gauging stations on the Rivers Luiche and Malagarasi are designated as 4B9 and 4A9, respectively (DANIDA) and are located *ca* 15 km and 30 km up-river from Lake Tanganyika. RWD and KB, in the company of Theodore Mpyalimi (Hydrologist in Charge at KRWD) and a second member of KRWD staff, visited these sites on 28-8-96. The KRWD personnel, owing to the lack of a vehicle, had last inspected these stations in June 1993! The journey by Land Rover from Kigoma (*ca* 25 km) to 4B9 took about 40 minutes with road access directly to the station. The distance to 4A9 (*ca* 107 km) was completed in about two hours and 15 minutes by vehicle and a further 10 minutes on foot (but see below). At each gauging station the water level is read manually from post gauges by local personnel

are recorded three times per day, at 07.00, 12.00 and 18.00 hours (N.B. this information was ascertained in the field; it had not been provided previously by the KRWD) and the data forwarded to the Ministry of Water.

iii. Sites between Kigoma and Gombe

Between Kigoma and Gombe the shore of Lake Tanganyika is characterised by steep, often wooded cliffs delimiting the eastern margin of the rift valley. These are broken by many river valleys, often deeply incised, at the foot of which are developed alluvial fans. The latter provide sites for numerous small settlements and villages. In places, active burning of vegetation was observed on high slopes. Elsewhere, large areas of recently burned slopes were visible extending down to the lake beaches. Gully erosion is widespread and it is likely that the loss of vegetation cover has contributed to gully development.

On 27-8-96, a detailed study (incorporating photographs - available from RWD) was made of one well-developed gully at the foot of which was a small, but archetypal alluvial fan. This feature was drawn to the attention of the SLO by Dr Tony Collins, a primate researcher at Gombe Stream National Park. According to his observations the fan at the foot of the gully formed as a consequence of a single episode of high intensity rainfall during the last (i.e. 1995-96) rainy season. The sediment released during this event, ranging in size from fine particles to cobbles, was largely composed of heavily weathered and lateritised sedimentary (sandstone) bedrock. This had accumulated on top of modern, relatively well-rounded, beach gravels and was readily distinguishable in terms of its overall red colour, angularity and poor sorting of particles. The distal edge of the fan showed evidence of wave erosion - indicating that a higher lake level than that prevailing on the day of observation had existed at some time after fan development. Measurements were made of the lengths of the three sides of the fan, its vertical height at positions along the toe, its lateral margins and at its apex. From these dimensions, the volume of eroded debris forming the fan was estimated to be *ca* 80 m^3. This is, however, a minimum estimate since some debris will have been removed to the lake by wave redistribution. On the basis of an average density of 1.6 t m^{-3}, the minimum mass of material eroded in this one event was some 130 t.

This one-off study is of limited value. However, sequential, systematic observations of the marginal slopes of the lake in the area between Gombe and Kigoma could easily be achieved. The impact of vegetation burning, which is carried out for no apparent reason, could be evaluated on a seasonal basis. Selected gullies could be monitored and the impact of onshore practices on sediment movement assessed. The existence of such a wide variety of beach and shoreline substrates could be of considerable relevance to the Special Studies, in their efforts to distinguish between species diversity and distribution patterns controlled by pollution and the patterns determined by availability/non-availability of substrate.

iv. Lake Shore Sites to the South of Kigoma

During the period 23 to 25-8-96, RWD and KB visited several lake shore sites within a few kilometres to the south of Kigoma, each readily accessible by road. They included:

boulder and cobble beaches to the north and south of the promontory at Kitwe (visited and photographed by TBW in November 1995)
the extensive, flat, sandy beach at Ujiji (also visited and photographed by TBW in November 1995)
two small pocket beaches of sand ('Jacobsen's Beaches', also visited by TBW on this occasion).

These sites afford, in a small area, a wide variety of substrate types, ranging from bedrock, boulders and cobbles to fine sand. The beaches close to Kitwe are thought to be the least impacted of the group of sites in terms of human activity; they are characterised by well-rounded particles of quartzite derived from local cliffs of conglomerate. Above water level the cobbles are encrusted with films of diatoms and other algae. The long, wide stretch of sandy beach at Ujiji is heavily impacted by human activity, including fishing and boat-building located close to many dwellings. Several small streams enter the lake in this area, flowing over the beach *en route.* The pocket (i.e. rock-bounded) 'Jacobsen's Beaches' essentially represent closed systems in terms of sediment, little material being either lost or gained. These are being developed for tourist use and are beginning to become popular with visitors. At the time of observation, a shell and auger drilling rig was in position on the southern beach, evidently for the purpose of drilling a bore hole for groundwater. Still, these beach sites are likely to be of potential importance to the biodiversity and pollution studies, particularly with reference to lower organisms. Their ease of access is of especial significance. The beaches may, however, be of lesser relevance to the sediment study.

v. River Luiche - Gauging Station 4B9

This station is located adjacent to the road bridge at Simbo where, on the day of observation, the breadth of the river was *ca* 20 m. An automatic water level recorder was at one time installed at the site but it was subsequently washed away during a flood. Two post gauges are therefore used to record water levels manually. The lower post, for dry season flow conditions, is displaced from the vertical so that an accurate reading is not possible. However, the upper post, for rainy season flow conditions, is vertical. The bridge provides a good platform for current meter readings in the river and could be used for water/suspended sediment sampling.

vi. River Luiche near Ujiji

A visit to the lower reaches of the Luiche delta, i.e. downstream from the Gauging Station 4B9, was made by road (RWD and KB) from Kigoma on 23-8-96. Whereas at the gauging station the river occupies a single channel, in the onshore part of the delta, near Ujiji, the channel splits into numerous, smaller distributaries. These are easily accessed from Kigoma i.e. within about 20 minutes' drive. Visiting such a site during the dry season gives an impression of channel widths and stabilities. The channels in this reach are largely developed within thick lateritic soils which provide sediment to the channels through bank collapse. The principal channels at the time of observation were 2-4 m broad. The waters flow at velocities of the order of 1 m s^{-1}, are very turbid due to suspended sediment, and are navigable by canoe. In the wet season, the water escapes from the channels to inundate the delta plain. In

Although the sites examined would be suitable in terms of their proximity and ease of access to Kigoma for sampling, gauging would be required since the 4B9 data would not be appropriate for the very different channel geometries of this reach of the river. The site is in an area used by many people for fishing and agriculture, so the possibility of semi-permanently installed sampling equipment being damaged or stolen should not be overlooked.

vii. River Malagarasi - onshore at Gauging Station 4A9

This station, erected in 1976, is located within a wooded gorge section of the river, close to the road which heads south to Uvinza from the Kigoma to Dar es Salaam road. An automatic water level recorder at the site has not worked for several years. A cascade of six post gauges is used to record water levels manually at progressively increasing stages. These are all in good condition. A cableway for current metering spans the *ca* 120-m wide river at this point. It appears to be in a reasonable state of repair but does not look to have had recent use. Water/suspended sediment sampling in the centre of the river channel would require the use of a boat. Two dug-out canoes were observed close to the lowest post gauge. It should be noted that it is highly unlikely that this gauging station would be accessible by road from Kigoma during the wet season.

viii. Luiche and Malagarasi deltas - offshore

The distance from Kigoma to the Luiche (visited by EHA, TBW, RWD and PP on 20-8-96 on route to Mahale *via* the Malagarasi delta) is 9 km and the journey time by boat is *ca* one hour. The mouth of the Luiche is characterised by low, relatively featureless topography when observed from the lake. The entrance channel(s) is/are not obvious from offshore although the location of what is believed to be the main channel was pointed out by M Chatta, Captain of the R.V. *'Echo'*.

The visit (made on the way to Mahale) to the area off the mouth of the Malagarasi, was relevant to all of the Special Studies. It marks firstly, an area of considerable deposition of sediment - as amply demonstrated when the *'Echo'* grounded - not something one would generally expect in the world's second deepest lake! [Section 5 comments on the somewhat cavalier, and potentially dangerous, strategy (reverse thrust) adopted by Mr Chatta to extricate ourselves.] However, the experience is likely to prove of value in alerting us to the need for very shallow-draft craft for limnological work in this area. The trip also allowed sampling of rooted vegetation and sediment, some seine-netting with local fishermen, and a view of fringing reed-bed environments (all photographed).

The much larger delta of the Malagarasi, is 37 km from Kigoma and takes about two-and-a-half hours by boat. It is interesting to note that the staff of the Mahale Mountains National Park reported that the Malagarasi delta has prograded considerably over the past few years causing the shallows to extend further offshore. Certainly the nearshore waters are accessible only with a very shallow-draft boat such as the inflatable craft that we had at this time.

ix. Mahale Mountains National Park

General features

The visit (20 to 22-8-96) to the Mahale Mountains National Park was also of relevance to each of the main Special Study co-ordinators, perhaps not least as the area is likely to encompass some relatively unimpacted sites. The long boat journey (albeit not all done in daylight) also gave us an opportunity to see a much greater section of the lake edge than hitherto. While the enormous size of the lake was further impressed on us, it was encouraging to identify areas quite close to Kigoma (and south of the port) that from a distance at least, appeared to cover the full gamut of shoreline habitats (rock, sand, cobble, etc.).

The park is situated on the shore of Lake Tanganyika, some 150 km to the south of Kigoma. It is allegedly the least visited National Park in the world attracting, on average, 350 visitors per year. The journey from Kigoma was by means of the TAFIRI boat *RV Echo* for which the travelling time would have been *ca* 8.5 hours had stops at the Luiche and Malagarasi deltas not been made *en route*. Most tourists arrive by light aircraft which can land at the airstrip located 10 minutes journey time from Mahale by boat. Up to 12-seater aircraft can land during the May to early October period but aircraft landing is not possible during the wet season. Tourist accommodation is available, principally in fixed tents. No electricity is available for tourists but a generator provides power for the administration buildings. There is no piped water supply, Lake Tanganyika providing for all needs. There is a permanent Medical Assistant on site. The nearest Rural Health Centre is at Mgambo, one hour away by boat. Persons who develop serious medical problems whilst visiting or working at Mahale have to be air-lifted to Kigoma.

Mahale became a National Park in 1985 and has an area of 1, 613 km^2. The confines of the 60- km long park extend 1.6 km into the lake. Thus an area of 96 km^2 is 'aquatic' and the remainder terrestrial. The principal purpose of the visit by RWD was to assess potential sites and facilities for sediment sampling and discharge monitoring, while the other members of the mission were interested in the potentially unimpacted nature of the area from the viewpoints of pollution and associated biodiversity. The onshore terrain is largely forested and rises steeply from the narrow beach and coastal plain up the slopes of the Mahale Mountains. Indeed, there is no agricultural activity within the park, so the draining rivers are unimpacted and representative of undisturbed, naturally forested terrain. The dry season extends from May to September. The wettest months of the wet season (October to April) are November, December, March and April.

People met, major interests and facilities

A meeting was held on 21-8-96 between EHA, TBW, RWD and PP with the principal officers of the Park i.e. Arui Hamidu Seki (Senior Park Warden In Charge), James Wakibara (B.Sc., Park Ecologist), William Daniel (Park Warden In Charge of Law Enforcement) and Frederick Malisa (Park Warden In Charge of Tourism and Community Conservation Service). Visits were also made to various environments (river, lake beach, rocky cliff etc.) within the park. Much of the meeting highlighted what is lacking here. There is no road to Mahale, therefore there are no vehicles in the park. Five open boats are located on site, three of which are in very poor condition. There are few ropes and no chains or safety rails. Thus, a few

11 outboard motors, ranging in size from 8 to 75 h.p. but only five of these are currently in working condition. No maps, either old or contemporary, are available on site. Indeed, the provision of up-to-date maps of the park is seen by the staff as a priority and could possibly be achieved most efficiently using remote sensing methods. GPS equipment is not available. Not surprisingly, the bathymetry of the offshore zone of the park is uncharted. The park lacks any form of water or sediment sampling equipment and laboratory, and the library holds little more than '*Mahale: Study for the proposed Mahale Mountains National Park*' (1980) and reports on Chimpanzee behavioural studies carried out by Japanese researchers. The few books on site belong to individual staff of the park. There is no telephone, and the accommodation block which is 40 minutes to one hour away by boat, has no radio.

However, on the 'plus' side, two radio sets are in working order, but these are located at the park headquarters. The park office is equipped with a typewriter and paper, a photocopier, one Macintosh computer (including Word 5.1 and Excel) and a laser printer. Even then, however, the computer and printer belong to Dr Fukuda, a resident Japanese researcher studying Chimpanzee behaviour. Allegedly, all of these items will be donated to the park when his work is completed. All four senior Mahale staff have some computer knowledge.

According to the senior staff, no-one has worked on the sediments of the rivers which drain into Lake Tanganyika through the park, nor has any geological or soil mapping and research been carried out within its confines. Few rivers flow during the dry season but many do so during the wet season - the principal water courses being from west to east: the Bilenge, Myako, Mpika, Kasina, Sinsiba, Ntale, Kambele, Mubulungu, Lubugwe, Katimba and Lumbye. The Lubugwe is the largest and, together with the Mubulungu and Katimba, flows year-round. The catchment areas of the individual rivers are known with limited accuracy from Figure 52 of the report quoted above. None of the rivers is gauged, but since there are no roads in the park, access to the lower reaches of any potential river sites must be *via* boat and/or on foot along the lake shore. It was not possible in the time available to assess the practicalities of this, but it is stressed again that the along-shore length of the park is 60 km.

Prospects of links with the LTBP

If Mahale were to form a project base, a strategy parallel to that outlined above for Gombe would be needed, i.e. as regards the 'importing' of equipment, and the occasional deployment of staff for short intensive study periods. *Inter alia* water sampling bottles, filtration equipment (funnels, filter papers etc.) and a balance, would be needed as a minimum. It would be both costly and impractical to establish permanent or semi-permanent gauging stations on the streams and it is suggested that the method of dilution gauging would be the most suitable. This would necessitate the provision of chemicals (NaCl) and a conductivity meter. In order to understand the patterns of dispersal of sediment into the lake it would be necessary to collect samples offshore. Equipment for both bottom and suspended sediment sampling would therefore be needed, together with a reliable, seaworthy vessel. A high frequency echo-sounder (200 kHz transmission frequency, for example) and GPS would facilitate the bathymetric mapping of the offshore zone; in providing the first information on the distribution of bottom substrates, this would underpin and complement the studies of offshore biota.

All four staff, in particular Mr Wakibara, appeared very interested in the Lake Tanganyika project, even though they see their main priority as the creation of an inventory of the aquatic creatures in the offshore zone - that is, rather than pollution and sediment pollution research. Hitherto, all of their work has been directed towards the terrestrial animals. Indeed, all the tourists visit the park because of these. As a possible adjunct to extending their knowledge of the offshore zone, the possibility of the staff being trained as diving instructors (and, ultimately under water tour guides) was greeted with particular enthusiasm. Such training could lead to the development of 'aquatic tourism' in Mahale. The second priority of the Mahale staff is the production of literature/guides for visitors.

2.2.19 Overview of institutions in Tanzania

Tanzanian Government Institutions are feeling the effects of the IMF Structural Adjustment programmes. There are no funds for taking on new personnel, and compulsory redundancies seem likely. Institutional reform seems necessary in the long run, given that every sector is controlled by more than one government department; for example, the Fisheries Department of the Ministry of Environment and Tourism, is responsible for fisheries development and statistics, while the Tanzania Fisheries Research Institute (TAFIRI) also carries out fisheries research. For wildlife, the Wildlife Department are responsible for game reserves and game conservation areas, while the Tanzania National Parks Authority (TANAPA) are responsible for National Parks.

Mr Lazarus Nhwani of TAFIRI informed us of the transfer of TAFIRI to COSTEC, but assured us that there would be no large-scale disruption of the activities and capability of TAFIRI.

2.3 Zaire

Zaire features prominently on maps of the Lake Tanganyika catchment, not least since much of the western shoreline abuts this country. Indeed, the Zairean land-water interface extends over 814 km. However, owing to (potentially very interesting) steep terrain, much of this is inaccessible from other than the lake itself. Civil unrest in certain northern areas, adds to problems even where road or rail travel are possible. The largest river entering the lake from this 'coast' is the Lukuga, draining 27,216 km^2, while the second largest inflow - the Lufuko - is considerably smaller in draining some 4,400 km^2. The following rivers drain land areas of between 1,200 km^2 and 1,600 km^2: Lunangwa, Mulabosi, Lubaya, Lugumba and Mutambala. A smaller 'water course' - the Lubilaye has a catchment of 925 km^2. Zaire owns most of the lake area albeit only 15% more than that around Tanzania (i.e. 15,506 km^2 *cf* 13,327 km^2).

This stage of the mission (EHA, TBW, RWD and PP) focused on only one institution - the Centre Recherche de la Hydrobiologique d'Uvira (CRH) - due to a somewhat unanticipated long crossing of the lake from Kigoma to Uvira by commercial boat (the m.v.*'Mwongozo'*). This 'voyage' took from 19.30 h (the recommended boarding time although the vessel did not leave the port until *ca* midnight on 14-8-96) to 9.00 h local i.e. Zaire time on 15-8-96. We then used up a further 4_ hours negotiating immigration into Zaire, mainly because we had not

4 of us) must do so initially *via* Kinshasa. The group was well-compensated, however, by the staff's keenness to be involved in the LTBP. The CRH Director had organised a question-and-answer session between us and his staff as a whole, and separate, more focused sessions, which continued well into 2 evenings (15 and 16-8-96). We also had time to visit two albeit relatively small local river systems, and also overlook from some distance, the Rusizi delta.

2.3.1 Centre Recherche de la Hydrobiologique d'Uvira

Background, general facilities

CRH was prominent on our itinerary from the outset in that it constitutes the main (only?) freshwater research institute in the Lake Tanganyika region of Zaïre. It is well-known, in having been set up some 40 years ago and funded until the early 1960's by the Belgian Government. Since that time much less has been done due to lack of anything more than subsistence funding. However, some (impressive) fish and fishery projects, managed and paid for by the Japanese, have been published, and even now, some valiant efforts are being made on the hydrological, chemical and biological fronts. All types of resources of the station (buildings, equipment and people) deserve to be strengthened by the LTBP.

Accommodation was made available for us at the CRH 'Guest House' which is comfortable, provides good food and is two minutes walk from the laboratories. However, the cost per person for the two night stay was US $165, which is much higher than we had been led to believe. The nearest airport is 124 km north of Uvira at Bukavu; it has connecting flights to Kinshasa and Nairobi.

After booking in and lunching at the 'Guest House' on 15-8-96, we walked the approximately 150 m to tour CRH. This institute occupies a spacious and imposing building, originally built by Greek settlers as a hotel, and converted for its present use in 1946/47 under the Belgians. It offers much scope for development and additionally, would be ideally suited as an environmental education centre. A list of the CRH library holdings has been lodged with the LTBP Scientific Liaison Officer in Kigoma. The scientific operations of CRH are divided amongst three departments: ecology, fisheries and hydrology. However, the main staff research interests are, in order of priority, fish biology, fish statistics, fish taxonomy, ecology, economics, sociology and hydrology. There are two workers with some practical expertise in sedimentology.

Table: Principal scientific staff in the Biology Department C.R.H., Uvira.

I. Researchers	**Main interests and whether a diver**
Mboko Simakeita	Fish taxonomy and ecology. Diver.
Dr Nshombo	A @ A @
Mulimbwa Nsibula	Biology of pelagic fish.
Bajhonga Bishobibiri	Macroinvertebrates. Diver.
Kukiye Buda	A @
Amundala Shekaivi	Fish taxonomy and ecology. Diver.
Muzunaivi Dijasi	Fish taxonomy and curatorial work. Diver.
Kamalebo Mukungilwa	Epilithic algae and phytoplankton. Diver
II. Technicians	

Bwebwa Diamani	Composition and abundance of zooplankton.
III. Laboratory Assistants	
Matata Kitete	Curatorial work. Fish collector
Mbilize Ndalozibwa	Boat handler. Fish collector.
Barasta Napala	Fish collector.
Mangaiko Kisaro	Fish collector.
Kiza Kabale	Fish collector and biometric measurements.
Watuna Igundji	A @ A @
Bahane Byeragi	Aquaria management and fish collector.
Bulimwengu Kilindja	In charge of maps drawer.

According to Dr A Kwetuenda Menga (Dr. of Physical Limnology, Scientific director in Charge and Administrative and Financial Director of CRH), *curricula vitae* of all the CRH staff have been forwarded to the LTBP Scientific Liaison Officer in Kigoma and to NRI in Chatham. All of the total of 101 staff (including all ranks) at CRH would be available for the project and the **Table above** gives some details on the principal scientists and technicians in CRH's Biology Department. A further four staff work in Kinshasa. The Director expressed in the most positive of terms, a willingness for CRH to become a major LTBP site in Zaire. An enthusiasm to have European scientists based for periods at CRH and for CRH staff to go to Europe for training was also expressed. Following the tour, the mission held discussions in an open 'forum' organised by the Director.

The Uvira station have three derelict boats (not reviewed further here, but EHA has notes), an inflatable dinghy, and a large ex purse-seiner, currently not operational, but possibly worth repairing.

General forum: discussions with whole staff

The open forum (starting at 1300h) re-iterated firstly, what Special Studies within the LTBP each of the mission members are co-ordinating; the co-ordinators had previously handed out copies of the ToR of this visit (**Appendix I**), and copies of the summary (in French and English) of the Baseline Review on the Special Studies i.e. 'Pollution and it effects on biodiversity' and 'Sediment pollution and its impacts on biodiversity' (**Appendix III**). Secondly, this open session identified above all, an enthusiasm not found in so many Tropical institutes. Here, for example a keenness was expressed for analysing one's own data; some previous aid programmes had not allowed this. This session ended at *ca* 1730 h - well beyond normal 'closing time' for the institute - this demonstrating the keenness of the staff to be involved in the LTBP. Indeed, a number of scientists joined us at the 'Guest House' long into the evening.

For the more detailed assessment of e.g. the laboratories, and discussions with CRH staff (16-8-96), we divided into three groups: passing from the physical, through the chemical, to the biological issues, RWD met the staff interested in sediments, sediment transport and hydrology, while TBW discussed those with interests in analytical chemistry relating to pollution, and studies on the lower aquatic organisms, while EHA and PP met with fish biologists and fishery experts.

Discussions on hydrology, sedimentology and related resource issues

These discussions involved Kakogozo Bombi (Scientific Secretary of the Hydrology Department), Mwenyemali Banamwezi Diedonné (Research Assistant in the Department of Hydrology) together with Dr A Kwetuenda Menga. From the outset it was made clear that very little work is, or has been done at CRH on sediments since most of the centre's work is biological. When asked what the priority of the CRH staff would be if they could contribute to the sediments programme of the project, the reply was a focus, in particular, on the quantification of seasonal variations in river sediment discharge to Lake Tanganyika. All relevant data held at CRH would be freely available for the project. The following is a summary of the current level of knowledge of CRH staff on fluvial sediments:

(i) Mr Bombi measured suspended sediment concentrations in four small rivers to the south of Uvira and has 2-3 months data (unpublished) from 1994.
(ii) Mr S Kimbadi (a chemist, who joined the meeting briefly) has worked on the physico-chemical characteristics of 13 streams in the Uvira region [Kimbadi, S., Vandelannoote, A. and Mbemba, M. (1995). *The physico-chemical water characteristics of 13 tributaries of the north-western part of Lake Tanganyika*. In: Mölsä (Ed.), Abstracts, *Symposium on Lake* Tanganyika Research, September 11-15, 1995, Kuopio, Finland, p. 109. Department of Applied Zoology and Veterinary Science, University of Kuopio, Finland.]. The rivers involved are the Kabimba, Maasa, Kijaga, Ruzozi, Kashekezi, Kavimvira, Katuta, Mulongwe, Kakumba, Kambekulu, Kalimabenge, Sangeza and Kalongwe (all to the north of Burton Bay). These were sampled monthly over a period of one year. Parameters measured included dissolved oxygen, pH, water temperature, and the concentrations of N, P, major cations and major anions. No data have been published on suspended sediment concentrations or water discharge but, according to Peter Coveliers of Tauw Milieu, Antwerp (pers. comm.), the sediment loads of these rivers have also been evaluated over the one-year study period. Three groups of rivers were distinguished by the study: rivers rich in (bi)carbonate and chloride, rivers rich in sulphate and rivers of intermediate water chemistry. According to Kimbadi *et al,* the differences may be a reflection of the soil type, bedrock geology and of various kinds of human activity, such as land use and pollution
(iii) Mr Banamwezi has an interest in the granulometry of fluvial bedload deposits, principally sands, but has acquired little data to date.
(iv) There are no post-1960 data on the discharges of any of the Zairean rivers draining into Lake Tanganyika.

If contemporary sediment loads are to be measured it is important to be able to compare these with archive data. Moreover, the existence of archive data for a particular river, or rivers, may help to determine the locations of study sites in Zaire. Prior to 1960 many of the rivers of the former Belgian Congo were studied by Belgian researchers. Data on water discharge, sediment concentrations and the variation of the level of Lake Tanganyika with time are known to be held in the Royal Belgian Museum of Central Africa, Tervuren, Brussels. For example, the Institut Royal Colonial Belge, Section des Science Techniques Mémoires (1952) contains the Annuaire Hydrologique du Congo Belge et du Ruanda-Urundi for 1951 by E J Devoy. A cursory glance at this volume (which was found lying on the floor of the CRH

Albertville (Kalemie) from 1846-1918. It is considered important for the LTBP that an attempt is made to systematically analyse and collate the archive data which are held in Tervuren. This task needs a scientist (possibly a member of the CRH staff) who is fluent in French but who also has some knowledge of Flemish. It would probably need 3-4 months to undertake this exercise.

An analysis of data on the outflow of Lake Tanganyika (the River Lukuga, at Kalemie), has been undertaken by Laurent Bergonzini from the Laboratoire d'Hydrologie et de Géochimie Isotopique, Université de Paris-sud, Bât 504, 91405 Orsay, Cedex, France, '*Les écoulements de la Lukuga à l'exutoire du lac Tanganyika*'). This study has been prepared for publication. Bergonzini should be contacted, as he may know of additional data from Zaire rivers relevant to the sediment discharge studies.

Sedimentological equipment

There is no sedimentological laboratory at CRH. For sediment analysis the facilities of the chemistry laboratory are shared. No sedimentological text books or books on sedimentological techniques are available in the library. **The following Table** lists the few equipment items held by CRH and used for sedimentological and related hydrological studies.

Electric pump for vacuum filtration of suspended sediments (Japanese manufacture). N.B. no filter funnels or papers were in evidence.
Set of six stainless steel sieves (Japanese manufacture, mesh sizes: 4, 2, 1, 0.25, 0.125 and 0.063 mm plus pan) but no sieve shaker; sieving is carried out by hand.
'Furuno' (Japanese) echo-sounder plus transducer and chart paper, allegedly in working order.
Current meter for river flow measuring is allegedly held at CRH. However, when the box was opened surprise was expressed that it was missing.
STD (salinity-temperature-depth) probe (Japanese manufacture), allegedly in working order, but has no battery because spares can be obtained only from Japan.

Items such as suspended and bottom sediment samplers are not available.

Discussions on water chemistry, micro-algae and related resource issues

At CRH, Uvira, TBW had in-depth discussions over chemical analytical work with firstly, Sona Kimbadi (Chemist, with interests also in river and lake benthic invertebrates), Mavula Mbemba (Nutritionist) and Kalala Tshibangu (Chemist). As in the 'open forum' it was heartening to learn about the wide variety of habitats that exist within approximately 15 km either side of the institute, and could be investigated under the 'Pollution', 'Sediment Pollution' and 'Biodiversity' Special Studies. In addition to shore-line, inshore, offshore and pelagic zones with their myriad types of bottom substrates, Uvira has a number of running waters.

In the past, although the mission doubts to any significant extent for many years now, the

the lake; and nutrients. Organic matter and chlorophyll levels have not been measured. The CRH scientists - in common with ourselves - recognised the need for particularly sensitive instrumentation (e.g. probes) for assessing water quality characteristics in the very dilute Lake Tanganyika. Though still in need of more basic standard equipment items such as burettes, pipettes, flasks and beakers, the laboratories appear to be reasonably well-supplied with these. However, without a reliable supply of reasonable 'raw' water *and* power to run the water distillation machine, the chances of keeping such glassware in the especially 'pristine' condition (bearing in mind the generally very low ion and nutrient status of the lake) are slim indeed.

These discussions were notable for their frankness and thoroughly good-nature in response to questions from TBW, the scientists raised certain fears - borne out of experience with previous 'aid programmes'. For example, some studies had 'promised' involvement of the Africans in all aspects of the work - not just the menial, unsophisticated and routines. Equally stated prospects of reciprocal visits of e.g. European *and* African workers to each other's country rarely materialised. Some programmes had even intimated the availability of 'sickness benefit' - but this too, never surfaced.

Although TBW was unable to comment on the last-mentioned issue, he asserted that it was his intention that the LTBP Special Study on 'Pollution and its effects on biodiversity' (of which he is co-ordinator) would involve Africans in all aspects of the work; indeed, how could one otherwise hope to develop a sustainable programme of monitoring/research? At the same time, TBW stressed that his observations suggested very much that visits by e.g. Zairoise to UK, should be for a few well-spaced short periods (*ca* 3-6 months), not for a single period of say 2 or 3 years.

TBW talked secondly with Mukungilwa Kamalebo, because Mr Kamalebo was one of the few Africans met during the mission who had interests in micro-algae. His situation is somewhat depressing, however - although probably not an uncommon one. Far from 'complaining', he demonstrated how poorly-equipped he is for carrying out his main 'duties' - the investigation of epilithic algae, including the taxonomy. It transpires that he has a knife, metal brush, bucket and small hand-net for his field-work. On the surface, this would appear to be not so different from those studying the epilithon in UK. However, Mr Kamalebo has no sampling bottles, nor does his project run to a boat and fuel. Thus, he is primarily 'confined' to working on sand and stones in the Uvira area. Even more serious is the very poor microscope he is meant to use on these organisms: it dates from the 'Belgian period'.

General equipment needed at CRH

During the relatively short tour of the laboratories (as against lengthy discussions with the scientists round the table), few major equipment items were evident. What is more, most of these were defunct, although for want of a reliable power supply, or small replacement parts such as bulbs, fuses, batteries. Examples are tabulated below.

'Indesit' freezer-refrigerator'

'Van der Heyden' drying oven
'Aquarius' G5-18 water still

Equally, probes for measuring salinity, temperature and depth - used in Japanese-funded (J.I.C.A.) projects, were not working - largely as a result of a lack of knowledge in electronics.

Many other, even more basic, resources are lacking. For example, owing to the present situation in Burundi, and the fact that Uvira normally receives its electricity supplies from there, the CRH is currently without mains electricity and will be for the foreseeable future; the present generator is unreliable, inadequate and a new, heavy-duty one is an urgent top priority. However, for the moment, fuel supplies are said to be adequate in Uvira. The centre's present vehicle, a Toyota 4WD Land Cruiser is old, in poor condition and unreliable, thus a replacement is seen as a priority to visit field sites. Since many of the potential field sites close to Uvira are accessible only by narrow tracks, a motor-cycle is seen as necessary to provide transport.

There is no Fax at CRH, yet this is essential for good communication with other laboratories working on the project. The present photocopier is beyond repair; a replacement is required. The two working ADDONICS PCs have inadequate memories for the needs of the project, so new PCs - a minimum of one for each of the Special Studies: - and new software are required. The laser printer does not work; this should either be repaired or replaced.
The centre does not have a good climatological measuring station, within air temperature and rainfall only, being measured on a daily basis; ideally the CRH staff would like a recording weather station capable of continuously monitoring wind velocity, sunshine and air pressure, in addition to temperature and rainfall. The nearest meteorological stations to Uvira are at Kalemie Airport and Bukavu. N. B. Mr Bombi has worked for three years on the statistical analysis (using the software package STATISTICA) of meteorological data (FAO) from Bujumbura, so has experience in this field.

2.3.2 NGOs

NOPTA - Nouvelles Orientations de la Peche sur le lac Tanganyika

This NGO was formed by fishing communities in the Uvira region in 1990, with the intention of forming a professional association to represent their interests, and to develop initiatives to protect the lake environment and fish populations.

The main concerns of NOPTA are that overfishing on *Lates* has led to their dissappearance from the the north of the lake, and that the capture of juvenile clupeids is affecting that fishery also. They propose a a suite of regulations, including a closed season on Lates fishing, banning of mosquito beach seines, and use of a minimum mesh size of 14 mm.

NOPTA intends to support community-led initiatives to institute volunatary closed seasons, to support fishers to substitute fishing activities in over-exploited localities for small-scale livestock rearing.

Since their work started in 1993, they have concentrated on two sites MBOKO, and BARAKA, both south of Uvira, and close to reserve/study areas proposed by CRH staff.

None identified

2.3.4 Potential study sites in Zaïre

In the time available to us in Uvira it was not possible to travel to many potential field sites. However, the team was taken to visit the Kalimabenge River, within the town of Uvira, and the Mulongwe River, 1 km to the north. Both of these rivers were included in the study of Kimbadri referred to above. Eight years ago, during a short but high intensity rain storm, these rivers experienced extreme erosion events resulting in the transport of vast quantities of boulders; thus caused great destruction to houses, the severance of electricity lines and resulted in at least 40 deaths. The Kalimabenge, as a consequence, has developed impressive boulder levees at the margins of its channel.

The CRH staff also drew our attention to the Mutambala River as a possible field site (although this site was not visited), which enters the lake in Burton Bay,. Allegedly, some sediment discharge data are available for this river, the catchment of which is severely deforestated. This could provide a contrast with a river draining a relatively unimpacted catchment. Note that no pesticides or agrochemicals are used along the whole of the Zaire shore nor are there chemical industries discharging into the lake.

In addition, a brief visit was made to see the wide expanses of the Ruzizi delta plain, some 5 km to the north of Uvira. Currently this is not a practicable field site owing to the situation in Burundi. In this connection much of this area of Zaire is dominated by a large but allegedly a well-managed, refugee camp. We also had a few minutes at a hot-spring with differentially pigmented cyanobacteria in evidence.

It is not possible solely on the basis of this visit to recommend possible river sites for sediment discharge monitoring. Guidance will be provided by the CRH staff but it seems likely that some or all of the 13 sites studied previously (Kimbadi *et al.*, 1995) are potentially amongst the most suitable, together with the possibility of the River Mutambala. The assessment and evaluation of the archive data at Tervuren (and potential data of Bergonzini) should also facilitate the choice of sites.

2.3.5 Overview of institutions in Zaire

Observations in the laboratories suggested that many of the shortcomings of previous programmes could be avoided in the new studies by ensuring the provision of 'consumables' such as fixatives/preservatives, filter papers, reagents, batteries, spares and replacement parts for various equipment items; other examples are basics including power generator and water still. Personal computers and peripheral hard- and software are also sorely needed, and a special request was made for literature of all types - papers, books, manuals, keys etc. We also lent support to the view expressed during many of the discussion groups, that the region should be resourced with sophisticated as well as simple apparatus - with the probable exception of very expensive ‘one-off’ instrumentation. Finally, we summarised the morning's deliberations over training, by mentioning custom-designed workshops, short reciprocal visits

One of the few (only?) drawbacks of selecting CRH as a main centre for the LTBP (apart from concerns over recent fighting in the north of the country), relates to the need to re-furbish the roof of this building. Otherwise, there is an almost over-abundance of space. Nevertheless, the Centre needs a substantial strengthening in resources by way of all manner of equipment; for land-boat travel to study areas; for sampling: for sample fixation/preservation; for physical, chemical and biological analyses, and for data handling analysis; interpretation and reporting. All this as compared with some of the LTR sites, for example.

2.4 Zambia

Zambia ranks third on the basis of lake catchment area (13,906 km^2), lake surface area (2,082 km^2) and on length of Lake Tanganyika shoreline (210 km) - these values equating to percentages of 5.2, 1.3 and 11. However, the country is very important to the LTBP as a whole in having a comparative plethora of organisations concerned with the lake. It is certainly the best-endowed of the 4 main lake countries in terms of institutions (and the number visited by this mission). Examples are national parks encompassing riverine and lacustrine environments, fisheries departments, the Environmental Council, National Council for Scientific Research, the Environmental Education Programme and numerous university departments. Indeed, this mission talked with 50 people representing over 15 institutions. Moreover, Mpulungu houses one of the stations of LTR (FAO FINNIDA) with whom the LTBP is closely involved also in e.g. Kigoma and Bujumbura. Discussions during this mission and in the Inception Workshop suggest that the Zambian sector is less concerned than the other countries with industrial pollution and heavy metals (but what of e.g. copper?). This country is somewhat special too, in not having to contend with problems of ethnic unrest and civil war.

Mr James Phiri, (Environmental Council of Zambia). National Co-ordinator for Zambia, is unlikely to be involved at field- level in the Biodiversity Special Studies. He has deputised Ms Musonda Mumba, currently studying in Sweden, to take responsibility for the administration of the Zambian input into the Biodiversity Special Studies (a second person is deputised for the Pollution/Sedimentation aspects). Ms Musonda is returning to Zambia via London, and could be briefed on progress so far during her stopover.

2.4.1 Ministry of Energy and Water Development , Department of Water affairs

GP visited the district office in Mpulungu. The northern Regional Office in Kasama and the National HQ in Lusaka.

District Office

District officer for Mpulungu is Mr Kasonde. His department is mainly involved in supply, disposal and water rights. Previous lake level gauging station now responsibility of Fisheries. Gave us literature referring to WASHE programme (Water, Sanitation and Health Education), HQ on 8th Floor, INDECO House, Lusaka.

Between District and Regional levels of administration there is a provincial office in Mbala. It was not possible to make an appointment here. The resident water engineer is Mr O.C. Mwansa. Tel: Mbala 221310, 221690 (residence)

Regional Office

Met with Mr NGA'MBI. Water engineer. (Box 41025, Kasama) Office had some broken data sets and some gauging results (see later at Lusaka HQ). Very little happening though, in 1990 all gauge readers laid off though we were assured that Lufubu still gauged and that experienced officers were still available in the region. Mr Chama is the regional hydrological officer in Kasama but he has been absent for a long period due to illness. Principal records maintained in Lusaka but evidence that a visit to this office may uncover some interesting data.

National HQ

Principal office in Mulungushi House, Box 50288, Lusaka. Tel: 252011. Meeting with Mr Cheleshe - Senior Hydrologist. Mr Cheleshe was very helpful and was able to demonstrate the records and for the Tanganyika catchment, these were limited and data since the early 90s were very few. He gave the project a copy of the map showing all gauging stations of Zambia (past and present). Those in the Tanganyika catchment are:

Station No.	**Location**	**Records**
7-005	Lunzua R.	1960s-1992
7-006	Lunzua R. (On weir)	1950s-present
7-750	Lufubu River (road crossing c.20 km from outflow)	1976 - 1990
7-800	Lake level. Sumbu	Uncertain
7-010	Lake level. @fisheries Mpulungu	Continuos
7-020	Station near Mbala (uncertain)	??
7-021	(ditto)	??

GP suggests a strong role for Mr Cheleshe, possibly in collaboration of Mr Sichingabula at the Dept. of Geography UNZA (see below).

All data and the laboratory facilities of the Department are held in their Water Quality Unit in Sheki Sheki Road, Lusaka. Mrs Murelwa is head of operations in the Sheki Sheki Road office but was unavailable nor was Mr Mutale (2nd in command but role not certain). GP was seen by Mrs Florence Simbu. The data repository where (in theory) all flow records were being computerised. Tanganyika catchment takes very low priority as it is both small and distant. Looked at paper records for station 7-006 which looked like a good data set (due to presence of hydroelectric company). Also the hard data needed to get rating curves existed and will

probably still apply. There is an amount of sediment data held on paper records (no intention to computerise these) which could probably be traced.

Visited laboratory. Pretty basic but clearly the ability to do simple silt, dissolved solids and suspended matter exists to give total transfers (though less sure about how bed loads can be (or indeed are) measured). Visit was brief as staff were anxious to get home but lab seems to have basics only.

2.4.2 Department of Fisheries

Headquarters, Chilanga

Only the director, Mr. H.G. Mudenda was contacted (BSc Biology & Chemistry, UNZA. MSc Maths for Biologists Univ. Buckingham, U.K. Postgrad Cert. Limnol., Univ. Constanz, Switzerland Postgrad Cert. Fisheries, Univ. Bergen, Norway). In a very useful meeting, Mr Mudenda gave a comprehensive overview of the role and organisation of the Fisheries Department, and some specific information on food, sport and ornamental fisheries, as well as fisheries training programmes.

Organisation: Fisheries Dept. is divided into three sections: Fisheries (subdivided into research and management units), Aquaculture (subdivided into research and extension & development units) and Training.

It is evident that Zambian fisheries are very diverse and fragmented - there are a large number of important lake, reservoir, river and wetland fisheries, often in remote areas far from logistic support and good transport networks. FD attempts to monitor and manage the major fisheries through its network of fishery centres. There are seven FD centres: Mpulungu (with a sub-station at Nsumbu), Upper Zambezi (new), Lake Mweru, Lake Mweru wa Ntipa, Itezi tezi, Kafue and Sinazongwe, on L. Kariba.

There is great difficulty in enforcing fisheries legislation with very limited resources. For this reason, there is currently a move to support community-based fisheries management initiatives, so that use of destructive fishing practices - the main concern - would be eliminated through self-enforcement by stakeholders.

The most important of Zambia's fisheries are those on Lake Tanganyika, with recorded landings of 12-15 000 t per year. Bangweulu swamps, with 10-11 000, provide the next most important fishery, with the Zambian waters of Kariba also being important. Markets are along 'lines of rail', where the Zambian population is concentrated.

As well as a food-fish industry, Fisheries Department also deal with the management of sport and ornamental fishing trades.

Ornamental fish trade: There are two companies involved in the ornamental fishing trade on L. Tanganyika, and FD are keen to encourage more, particularly in areas where collecting has not yet taken place - some of the other lakes, rivers and swamps in Zambia. Legislation to control introduction of exotic species exists, and this also covers internal movements of species between lake/river catchments within Zambia. This has been drafted mainly with the aquaculture industry in mind.

Mr Mudenda was not aware of any illegal aquarium export trade in Zambian waters of Lake Tanganyika, although Dr Banister had mentioned that it may be extensive. Licences have not been granted to short-term operators recently, as far as he is aware. It is standard practice to look at companies' proposals and shareholders before granting an ornamental fish export licence. A fee of K50 per fish exported is levied. It may be worth investigating a differential

payment scale by species, but this would require a thorough review of the industry - a task which is being undertaken by Dr Banister.

Sport fishing: Sport fishing is a potentially important source of tourist revenue to Zambia. Sport fishing is particularly popular on Lake Kariba (although most tour operators favour Zimbabwe), and has potential in Nsumbu on Lake Tanganyika. Flights from Ndola to Kasaba and Nkamba used to be fully booked by sport fishers, but this flight service is no longer regular, and safari companies operating in the region have been experiencing difficulties. This may change in now that Kasaba lodge is under new ownership.

Fisheries Department collect revenue from angling permits, while Wildlife Department gain revenue from national park entry fees. There are no restrictions on sport-fishing permits at present.

Training & Institutional requirements for L. Tanganyika: With respect to activities on Lake Tanganyika, Mr Mudenda indicated that FD intended to maintain a staff of 2 or 3 research officers at Mpulungu, despite financial pressures.Two or three fishery officers are expected to retire in the next year, but it is hoped to replace them with graduates from the Fisheries Training School.

Fishery research officers are normally recruited as graduates in biology from UNZA, while technical and managerial staff are normally graduates of the Natural Resources Development College, which offers a 3 year diploma in Fisheries. Course participants gain practical experience with Fisheries Dept. and work on collection of fishery statistics and in fish culture research stations.

Finance is not currently available to run the training programme for next year, however. There has been a change in policy with regard to training, away from 'training for Fisheries Dept.' to 'training for the fisheries industry'. In the past, a qualification in fisheries meant automatic employment by Fisheries Dept. This is no longer guaranteed.

In the meantime, fisheries training at UNZA seems likely to continue, now that a lecturer in fisheries has been appointed (see UNZA section). Since 1989-90, there has been a decline in the availability of overseas training, and there are no recent MSc graduates. A request for GEF support for post-graduate level training in UK institutes was made.

The status of fishery department activities in Sumbu seems not to be clear. A number of conflicting reports were received regarding the conservation status of the lake area adjacent to the park, and the FD facilities within the park. A FD station at Kasaba Bay was constructed to monitor the trade in ornamental fish, at a time when regular flights from Kasaba to Lusaka were used by fish traders. This station was reported by Mr Mudenda to be in need of refurbishment, and by P. Petit who was visiting the park at the time, to have been demolished! There is a fisheries office at Nsumbu town, which could be used as a base to work in the area and Mr Mudenda made a specific request that the project should consider refurbishment of this site.

Department of Fisheries, Mpulungu

The Fisheries Station at Mpulungu is small but well equipped. Equipment, computers and library facilities seem well-maintained. As LTR winds down, there are a number of unoccupied personel in evidence. The primary contraint to the effectiveness of the institution is the lack of senior staff: there are only two Research Officers, trained to degree level. One is Director, and has administrative duties, and the station has the dual function of a fisheries management and statistics centre and a research laboratory. There appears to be a willingness and initiative to undertake their own research with Zambian finance, as evidenced by a proposed gillnet sampling programme, to take place early in 1997. This initiative should be supported.

Scientific personnel

2 research officers: Mr. Mwape, Director - limnology, Zooplankton taxonomy & biomass estimation, fisheries statistics, Mr Godfrey Mlindi (who was on a fisheries management workshop in Namibia at the time of our visit)

A third research officer, Mr Harris Phiri, is currently training in Japan but is due back in 1997.

Both research officers currently present are educated to degree level, but do not have research or post-graduate qualifications.

13 research assistants - Chikoti (involved in Wildlife Conservation NGO), Chapola - only trained diver.

The Mpulungu station have been collecting industrial fishing records since 1962. Most of these data have been recently published by Martin Pearce, and all are available on the LTR database.

Records of artisanal and subsistence fishing activity is less comprehensive. An FAO- designed catch assessment survey has been carried out since the early 1980s. Most fishing is by beach seine and Chirimila net.

Additionally, scientific gillnet surveys have been carried out at approximately 10 year intervals in the Sumbu region (Nkhamba Bay). The next survey is due to be carried out next year, when fish community structure in this lightly fished area will be compared with that in the more regularly fished Chituta Bay (SE arm). All past data is available on paper at Mpulungu, where efforts are currently underway to computerize it. Apparently this was done by Martin Pearce in 'Parabase' but is not accessible, so is being repeated.

NB - No-one from Mpulungu was at the inception meeting, and none of the staff have met the national coordinator.

Additional - While in Mpulungu, we had a very useful meeting with Dr T. Sato who is leading the Japanese research group in studies of cichlid ecology and behaviour. Dr Sato suggested a number of potential sites, both in Zambia and in Burundi and Zaire, where he had previously worked. He also suggested a number of people to contact with reference to sampling techniques and field identification of particular groups. The details will be reported in the Biodiversity Special study work plan.

Laboratory facilities and equipment.

Fishing gear. Boat R/V Silver Shoal 2 small fibreglass/plank boats for catch-assessment surveys + outboard motors. Two fleets of 13 multi-mesh gillnets, each 90x1.5m, mesh sizes from 25-178 mm, recently purchased. Fished both at bottom and in mid-water. The nets are hauled by hand from depths >100 m as there is no net-hauler on the R/V 'Silver Shoal'. 90 m long liftnet for catamaran - used for catching shrimp for experimental fish feed. Balances10 kg spring 5 kg spring 0.1g electronic top-pan 0.0001g electronic - hard to zero

Laboratory facilities

This site is situated 30 metres from the lake shore overlooking the bay, has a laboratory for zooplankton work, one for limnological (chemical) analysis and one devoted to fish biology. The roof of the building housing the 2 laboratories is of corrugated iron construction, but each of the rooms have internal ceilings. The present layout and fittings of the limnology laboratory are illustrated in **Figure 3a** below. It is reasonably well-equipped and maintained, but with some reorganisation much better use could be made of the available space. As examples, the only bench space available at present consists of a bench down the left-hand wall and another forming a central island. Storage space for chemicals and glassware is

ventilation, result in the room being quite dusty. There is no fume cupboard or air-conditioning unit, and nor (apparently) any First Aid or fire-fighting equipment.

The proposed modifications depicted in **Figure 3b** are designed to address the above drawbacks. The construction of extra wall/peninsula benches will increase the available bench area substantially and enable the 'wet chemistry' operations to be separated from the instrumental work. Thus, for example, the latter could be carried out on benches A and B with the wet chemistry activities taking place on benches E and F. More electrical sockets could be provided by running a power line down the centre of the peninsula bench (F) and by putting double sockets along the wall benches. The shelving down the middle of bench F could then be used for the reagents and samples etc., required for the limnological analyses. The position of the fume cupboard and air-conditioning units are positioned as indicated because of the availability of an outside wall. Air-conditioning would enable the louver windows above the sink (C) to be replaced by sheet glass, thus reducing dust levels in the laboratory significantly.

Owing to the on-going restructuring exercise in the Department of Fisheries and the consequent financial constraints, the core activities of the Department, including routine limnological analyses have had to be severely contained. The measurements presently being made largely reflect the needs of the associated LTR programme. At present, limnological analyses are conducted using 'Hach' kits and the laboratory is reasonably well-equipped for this type of analysis. However, as emphasised earlier in this report, such kits are best-suited to field use, and it is recommended that the more traditional and *sustainable* methods should be adopted for analyses carried out in the laboratory. This requires additional equipment, such as glassware and chemicals for titrations, for example, and a list for the proposed LTBP laboratories is currently being prepared. It is also recommended that the equipment items in **the following Table** be purchased for the Mpulungu laboratories.

equipment	**no.**
chest freezer-storage of sample bottles	1
water still more recent model needed	1
magnetic stirrer/ hot plates	2
top-pan balances - 0.01g sensitivity	2
double-beam UV/Visible spectrophotometer and spares	1
fluorescence spectrophotometer	1
camera and attachments for microscopes	As appropriate
power stabiliser (present one only 1.5kVA)	1
a range of truly portable pH, DO, conductivity and temperature probes	2

Library/Computer Room

The existing room, which acts as a library and computer work-space, would be greatly improved by fitting sheet glass to the windows above the computers and installing air-conditioning. Mpulungu is hot and dusty for much of the year, and at present the windows are covered with blackout in an attempt to cut down dust levels. This results in an uncomfortable working environment.

The room presently houses 4 computers, which are principally used for database and spreadsheet work. An AST adv 6050 is for general use, while a DMA model is assigned to each of the 3 laboratory groups. Although the staff appear to be satisfied with the capacity and performance of these computers to date, it is recommended that a more powerful machine (e.g. a Viglen 'genie 486' or equivalent) be installed at Mpulungu (and at Kigoma); this would allow a wider range of software to be operated and it would also give access to CD ROM-based literature searches.

The library has a fairly comprehensive range of FAO and related documents but urgently needs a broader range of reference and other books on e.g. algae, zooplankton, fisheries, limnology and environmental pollutants.

Boats

The Fisheries Department boat - the RV '*Silver Shoal*' - was overhauled extensively by LTR fairly recently, and so is now in basically good condition. Repairs included complete replacement of the bottom plates and the fitting of new (and very powerful) engines. Lifejackets are also available. However, the vessel still lacks a functional radio, cooking facilities and a lavatory. For example, the room designed for the latter is currently full of nets and other fishing gear. Also, the motorised winch does not work and the anchor has to be lifted by hand. The sampling winch support is inadequate. These deficiencies need to be remedied for the boat to be suitable for survey work.

The Department also has 3 usable 'banana boats' (but these are old and in constant need of repair), and 2 functional 15 hp outboard engines which we were assured are reasonably reliable. It is recommended that an inflatable craft, with outboard motor be purchased; this could be towed behind the '*Silver Shoal'* and be used for shallow inshore waters and river estuaries.

Sumbu office

Dept. of Fisheries maintain an office in Sumbu village. These were very run down and would need major refurbishment. The village does offer a good work opportunity as it is adjacent to the national park and has most other requirements including decent jetty. Also a regular flight service from Kasaba Bay to Lusaka (via Kasama) exists. A generator would be required.

Overall Assessment

The laboratory staff at Mpulungu have substantial analytical experience and have benefited in both laboratory facilities and training from the LTR project. It is recommended that the Fisheries laboratory be the principal focus for the limnological and biological measurements of the Zambian waters of the Lake. The activities of the station as a whole are severely curtailed by the present financial restrictions and it is proposed that the LTBP strengthens the Department and draws as fully as possible on the experience of the present staff.

The proposed changes in laboratory layout and the additional facilities suggested will result in a substantial increase in and a more effective use of bench space. It will also facilitate the adoption of the more traditional methods of analysis that are recommended. As suggested by this mission for other laboratories being strengthened for the LTBP, the re-introduction of the more conventional chemical analytical methods will require training programmes. These could be located at Mpulungu and/or Kigoma. However, the 'Hach' kits should be retained for field work and for cross-checking the results with the traditional laboratory-based methods.

2.4.3 Food and Drug Control Laboratory, Ministry of Health, Lusaka

Staff met, and laboratory infrastructure and activities

CF met Ms Margaret Sakala (Acting Head of the Laboratory) on 29-8-96 to explain the nature of the LTBP and to discuss potential participation in the LTBP research and monitoring programme. The laboratory is located at the University teaching Hospital in Lusaka and comes under the Ministry of Health. An extensive review of health sector priorities has recently been carried out by the Government, which is understood to have confirmed the central role performed by this laboratory; as a result, no retrenchment of activities is expected. The laboratory functions as the Public Analytical Laboratory and in this capacity analyses a very wide range of samples for both the public and private sectors. In addition to its routine monitoring work, the laboratory is involved in a number of major national and international research programmes as indicated below:

i) Food Security Sub-Saharan Africa

This programme is essentially concerned with determining pesticide residue levels in staple food crops such as maize, sorghum and cassava, and includes the supply of GC and HPLC analytical equipment and, at the IAEA laboratories in Vienna, the training of staff and technicians. It is supported by IAEA and FAO and involves Ethiopia, Niger, Senegal, Kenya, Tanzania, and Zambia.

ii) Food Safety Programme

The FS programme is also supported by FAO and has been running since 1991. It is mainly concerned with ensuring the safety of borehole water supplies, and involves both chemical and bacteriological measurements. In-house training courses have been conducted at the laboratory and FAO are currently considering setting up satellite laboratories in other areas of the country.

The objective of the WA programme - which has been funded by NORAD since 1993 - is to ensure that there are personnel trained in the chemical and bacteriological analysis of water samples in hospital laboratories throughout the country. To this end, a number of in-house training programmes have already taken place.

Laboratory facilities and equipment

The Food and Drug Laboratory complex consists of a number of individual laboratories specialising in pesticides, drug enforcement, chemical and bacteriological analyses, microbiology and forensic work. They are generally fairly well equipped and maintained, and the equipment in the laboratories of relevance to the LTBP includes that itemised in **the following Table**.

Pye 204 GC equipped with FID detector
Varian 3300 GC (1990 model) - currently used for drug enforcement work
Nitrogen and Hydrogen generators; so the laboratory is independent of bottled gas supplies.
Spectrophotometers: Pye SP3-200 IR; Pye SP8-400 UV/VIS; and Corning Flame Photometer - for Sodium and Potassium Analysis.

The delivery of a new GC (capillary column) instrument and an HPLC, as part of the IAEA/FAO Food Security programme, is expected in early September 1996.

Staff and technical training

Ms Sakala took over as Acting-Head of the Food and Drug Laboratory earlier this year when the previous Head, Mr Sinyianga retired. She is an experienced Chemist and enthusiastic about her work. The level of training and experience of the other scientists and of the Technical Staff appears to be good. Many of the staff have benefited from the various training courses that they have attended both in the laboratory itself or overseas. Further training needs, particularly for the analysis of pesticides using capillary columns, were discussed in the light of possible collaboration with the LTBP.

Overall assessment

A generally well-equipped and very active laboratory staffed by experienced and enthusiastic personnel. The laboratory is in a position to carry out pesticide analyses in fish tissues and other biological materials collected as part of the LTBP. It is recommended that, in Zambia, this is carried out in conjunction with the Livestock and Pest Research Centre, NCSR, Chilanga. As these institutions have limited experience of the determination of pesticides in matrices such as fish, some additional training in such analytical procedures will be needed.

2.4.4 Geological Survey Department

On 29-8-96 CF met Mr Fred Njamu (a Senior Geologist in the Prescribed Minerals and Materials Commission) in the Geological Survey department with the view to ascertaining what, if any, geological surveys had been done in the Zambian sector of the lake catchment. The opportunity was also taken to explain the nature of the LTBP. Mr Njamu is familiar with albeit few (see below) areas of Northern Province and expressed an interest in participating in the project. His field experience would be invaluable in this respect.

Geological surveys, Northern Province

Relatively little attention appears to have been paid to the geology of this Province although a few detailed reports on the area bordering the lake have been published. However, a copy of the text of an, as yet, unpublished Geological Survey report by Mr Malik (*'The Geology of the Mbala area: an explanation of Degree sheets 0831C 1-'3. Report No 104)* was obtained from Mr Njamu. In addition and in conjunction with this report, Mr Njamu kindly provided copies of the maps in question; these detail the geological characteristics of the lake catchment. The shoreline covered by the maps extends from the Kalambo river on the Zambia/Tanzania border through Mpulungu to Katoto on the western side of Mbete Bay. A soil map for Zambia (Atlas Sheet No. 12) was also obtained. This is now out of print and no copies were available at the Map Office in Lusaka. CF also obtained a copy of a paper entitled *'Geodynamic Evolution of the Bangweulu Block, Northern Zambia'* presented at the International Conference on the Proterozoic, in Lusaka (1983) by Lars Andersen and Rafael Unrug. Finally, a geochemical study of northern Zambia is apparently about to be published by Gencor, South Africa. Mr Njamu undertook to provide more details of this report.

2.4.5 National Council for Scientific Research (NCSR), Lusaka

An initial meeting was held on 26-8-96 at the NCSR Headquarters, on the role and activities of the Council and on its potential collaboration with the 'Pollution' and 'Sedimentation' Special Study components of the LTBP. Those present were CF, Mr Charles Mwamba (Acting Secretary General) and Mrs Masinah Sibbuki (Research and Development Co-ordinator). Terms of reference and the summaries of the Baseline Reviews on 'Pollution' and 'Sediment Pollution' were circulated.

Institutional background and infrastructure

The NCSR was formed in 1970 as a mandatory Government department, but its effectiveness appears to have declined significantly in recent years. For a variety of reasons it has failed to raise the substantial funds needed for contract research and is consequently very dependant upon annual Government grants, the size of which continue to decline. As a result, facilities and equipment have generally not been well maintained and the retrenchment necessary as a result of the financial restrictions has severely depleted the staff and reduced analytical activities. Indeed, according to an article published in the Zambian Times during our visit, NCSR faces the prospect of losing its annual Government grant altogether - and soon. Were this to happen, the Council would be wholly dependent on external contracts. However the sections of NCSR such as the Livestock and Pest Research Centre at Chilanga, and the Radioisotopes Research Unit that have received external support through collaborative

NCSR comprises (i) the National Centre (i.e. HQ), situated some 10 km out of Lusaka on the road to the International Airport, and (ii) two subsidiary centres located at Chilanga and Kitwe respectively. The units associated with these centres are indicated in **the following Table**.

Units in the National Centre
Food Technology Research Unit
Water Resource and Environmental Research Unit*
Radioisotope Research Unit*
Buildings and Industrial Research Unit
Information Services Unit
Technical Services Unit
Research and Development Unit
Subsidiary Centres
Livestock and Pest Research Centre*
Tree Improvement Research Centre

Units marked with * are those - according to Mr Mwamba and Ms Sibbuki - with a particular interest in the LTBP.

As a result of these discussions, meetings were arranged with the heads of each of these 3 Units/Centres, and the outcomes of these discussions are detailed below.

I. Water Resources and Environmental Research Unit (WRERU)

A meeting was held on pollution and hydrological issues at the WRERU offices on 29-8-96. Those present were CF, Ms C M Nsomi (Acting Head of Unit) and Ms M Sibbuki (Research and Development Co-ordinator). During this discussion it became clear that in addition to the restrictions placed on the Unit's research and monitoring activities by financial constraints, the Unit has suffered badly as a result of the recent death of its Head.

The laboratory carries out bacteriological and chemical analyses of water samples for Government Departments, the Environmental Council of Zambia (ECZ) and private industries. The Unit is also currently participating in an environmental monitoring programme concerned with heavy metal contamination in the Kafue River. The Unit houses two reasonably sized laboratories, although much of the equipment appears dated and little used. The Water Section has an instrument room containing an old, but functioning atomic absorption (AA) instrument (Varian Techtron, Australia) with a wide range of lamps including those for the determination of chromium, manganese, zinc, lead, iron, nickel, copper, cobalt, cadmium, calcium and magnesium. The technician in charge, Mr Mutale, has over ten

If this unit were to carry out the measurements of heavy metal residues in fish and other aquatic organisms as planned for the LTBP, its instrument would need to be ungraded, to include a graphite furnace in order to achieve the necessary sensitivity. In view of the age of the present AA instrument, this option, even if technically feasible, is not recommended.

II. Radioisotope Research Unit (RIRU)

Staff

An initial meeting between CF and Dr Matongo Nomai, Head of the Radioisotope Research Unit was held in the office of Dr Nomai on 26-8-96 at which the background of the LTBP was discussed. Copies of the Mission ToR and summaries of the Baseline Reviews on 'Pollution' and 'Sediment Pollution' were given to Dr Nomai. A visit to the actual Radioisotope Laboratory was not possible that afternoon, but it was toured on 29-8-96. Those present in addition to CF and Dr Nomai were Dr M B Zaman, Mr Patrick Hayumbu and Ms Sibbuki. The three principal scientists at RIRU have extensive analytical chemistry experience and are very keen to contribute to the LTBP. Dr Nomai, the present Head of the Unit, has been at NCSR since 1977. Patrick Hayumbu and Mohammad Zaman have 17 and 16 years' experience respectively of XRF and related analytical techniques. *Curriculum vitae* were collected from each of these three scientists. Five technicians also work at the laboratory, and these too, have considerable analytical experience.

The laboratories

The laboratory was constructed and set up in 1981 by the International Atomic Energy Authority (IAEA) as part of a Technical Cooperation Project (TCP) which also involved provision of equipment and extensive training of scientists and technicians. The TCP finished in 1990, but the laboratory equipment is now supported by an IAEA Africa Region Nuclear Instrument Maintenance Project

The staff have looked after the laboratory and the equipment very well. The principal instrumentation consists of an X-Ray Fluorescence (XRF) spectrometer with both source and tube (Mo and Cr) excitation modes - although one of the amplifier channels needs repair - and Fast Neutron Activation Analysis equipped with Cd, Am and F sources. The equipment has been used extensively for geochemical, mineral and environmental analysis. At present the staff have no experience of heavy metal determinations in fish and other biological tissues, but provided with the necessary simple sample preparation facilities such as freeze-drying equipment and sample homogenisers, they are well capable of carrying out such analyses. It is, of course, possible that the heavy metal concentrations in fish tissues may be at or below the limits of detection for their current equipment. The staff expressed the desire to upgrade their present equipment by purchasing the total reflectance XRF accessory which would substantially increase the range and sensitivity of their analyses. However this would cost in the region of $10,000.

The existing XRF equipment would be especially useful for the analysis of LTBP sediment

results to 'fingerprint' sediments - and potentially identify the source and movements of sediments.

Library

Owing to the present financial difficulties at NCSR, subscriptions to analytical chemistry journals have effectively ceased, and the Unit staff are finding it difficult to keep abreast of developments in their field. This situation could be addressed at least in part, by providing the Unit with some modern instrumental texts and facilities for computer literature searches.

Overall Assessment

The RIRU is well-equipped, well-run and the staff have a wealth of analytical experience. It is strongly recommended that the Unit is given the opportunity of working with the LTBP, particularly on the elemental analysis of sediments and possibly also on the determination of heavy metals in e.g. fish tissues.

III. Livestock and Pest Research Centre, Chilanga (LPRC)

Staff and overall activities
A meeting was held with Mr Kaposhe (Head of LPRC) at the Pamodzi Hotel, Lusaka on 30-8-96 to explain the nature and scope of the LTBP and to explore the potential for pesticide analyses being carried out at LPRC.

The following Table indicates the principal staff and their research interests.

Scientific Staff
Mr C K M Kaposhi, Head of Centre Dr P M Mwangala, Head, Pesticide Toxicology Section Mr Mundia, Pesticide Analysis Mr Mondo, Entomology Mr Kabalo, Entomology
Technical (pesticide analysis)
Mr Reuben Banda (soon retiring) Mr Cephas Mangoye

A *cv* was obtained from Mr Kaposhi, and he promised to provide CF with the corresponding documents for the other scientific staff.

The Centre is comprised of the following sections: Veterinary diseases, Nutrition, Reproductive Physiology, Mycotoxicology, Pesticide Toxicology and Vector Biology. There is also a Centre farm. Although the Centre has also suffered from the financial restrictions affecting NCSR as a whole, it was also supported by an IAEA Technical Cooperation Project from 1987-1990. The Centre currently has IAEA research contracts on (i) stability of acaricides (1991-1996), and (ii) the persistence of pesticides (e.g. Endosulphan and Lindane -

Centre is also investigating natural sources of pesticides from plants, and it provides a pesticide analytical service under contract to the Livestock Service Co-operative Society

Laboratory Equipment

Support for equipment maintenance is provided *via* the IAEA research contracts. Lack of time prevented a visit to the laboratory, but Dr Kaposhi indicated that the instruments listed in **the following Table** were available.

Pye-Unicam PU 4500 Packed and Capillary Column Gas-Chromatograph (GC) equipped with FID and ECD detectors
Pye-Unicam PU 4811 Computing Integrator (print lead needs replacing)
Pye 204 Packed Column (GC) with FID/ECD detectors
Liquid Scintillation Counter
Biological Oxidiser
Perkin-Elmer HPLC Series 100 (tubing between pump and detector needs replacing)
Hydrogen and Nitrogen Generators

Mr Kaposhi undertook to indicate what additional equipment and accessories would be required were they to be involved in the analysis of fish and sediment samples from the LTBP.

Overall Assessment

The LPRC pesticide laboratories would appear to reasonably well equipped and the staff clearly have substantial experience of pesticide analysis as part of IAEA and other research contracts. The Centre would appear to be worth supporting and it is recommended that the laboratory should be involved in the LTBP's determination of pesticide levels in biological samples and in sediments. Some ancillary equipment, accessories and consumables (together with some training) for these analyses will be needed to ensure that results are in harmony with those from other laboratories.

2.4.6 University of Zambia (UNZA), Lusaka

A number of visits to various departments in the School of Natural Sciences and in the School of Mines at the University of Zambia were made by EHA, CF and GP on 27 and 28-8-96. CF met with Professor D Theo, (Dean, Natural Sciences) and Dr E H Jere, (Dean, Mines) - explaining the background and scope of the LTBP, and exploring the potential for these Schools involvement in the LTBP. At each of the departmental meetings also, the nature and objectives of the LTBP were explained, and copies of the ToR and the appropriate summaries of the Baseline Reviews were circulated. A visit to assess the UNZA library resources was

Faculty of Natural Sciences

Meeting with the faculty Dean (Prof. Theo) and informed him about the project. He offered full co-operation.

Department of Biology

There are four research staff in UNZA Biology Dept. with interests in population ecology, biodiversity and fisheries. There are the head of department Professor Chitumayo (Forests and biodiversity) , Dr Chabwera (ex Deputy-Director of Fisheries & Wildlife Dept, population ecologist and wetlands biodiversity specialist), Dr Mbata (attended Inception Workshop: insect population dynamics and systematics), Dr. Joseph Munyandarero (fisheries and fish ecology, with experience of L. Tanganyika - CV collected).

Their major role is likely to be in the supervision of student research projects, whose fieldwork could be carried out in areas of interest to the project. The department runs undergraduate and master's degrees in ecology, with specialisation in conservation ,wildlife management and biodiversity. The university appears to be adequately resourced for this type of activity, but lacks money to send students into the field for their projects. The GEF could assist with this type of activity.

Dr Joseph Munyandarero has been appointed to a lectureship in the Fisheries Department. He is a highly qualified scientist, with a PhD from ENSA, Toulouse. He intends to develop a research programme in fisheries that could include L. Tanganyika, and will be teaching a fisheries course within the ecology degree. At present there is no fisheries degree in Zambia, only a diploma course run by the Zambian Natural Resources Development College, aimed at technical staff. Senior fisheries staff are mostly ecologists who have taken a short fisheries course, or have gone on to do fisheries training overseas. One of the wider objectives of the GEF project could be to provide UNZA with some support to establish a fisheries BSc - this is one of their objectives.

Postgraduate training is also available in UNZA. An MSc in Biosystematics and Ecology is run, with options in fisheries, forest ecology and rangeland management. This takes the form of one-year taught courses and one year's research project.

The NRDC is run jointly by the university and by the Ministry of Agriculture, and recieves SADC funding.

Action: Consider support for curriculum development in Fisheries for new fisheries degree, to take the form of advising on, and assisting with field-based training, perhaps on Lake Tanganyika. (EA/MRAG to develop proposal in consultation with Dr Munyandarero). UNZA to be kept informed of work-plans, and asked to participate as required.

Department of Chemistry

Staff and teaching/research

The staff of this Department are indicated in **the following Table**.

Analytical Chemistry: Professor Cernak; Dr Mainga and Mr Sinyianga (ex-Head of Food and Drug Laboratory, Ministry of Health)
Organic Chemistry: Dr Phiri, Dr Prakash and Dr Singh

Biochemistry: Mr Mbewe

Professor Kiremeri, the Head of Department, was away from the University at the time of the visit, so Professor James Cernak, an analytical chemist, introduced the Department and its teaching and research activities. The department runs a conventional 4-year BSc programme with entry to the course being appropriate grades at School Certificate level. A two-year MSc programme involves course work and lectures during the first year and a research project in the second year. There are currently 4 Ph.D students studying overseas - including Derek Chewe, who worked with CF at UEA in the early stages of Dr Chewe's Ph.D and is soon due to return to the Department.

Laboratory facilities and equipment

A tour of the teaching and research laboratories suggested that the financial restrictions affecting the University was severely curtailing laboratory activities. Much of the equipment is clearly quite dated, and there were few signs of activity at the time of our visit. It appears that the department has been unable to attract any significant outside funding in the form of research contracts, and is thus largely relying on central University funds. The major items of equipment noticed on a tour of the laboratories are as indicated in **the following Table**.

Equipment Item
Atomic Absorption Spectrometer Varian 1000 (reasonable range of lamps)
Pye 204 GC (FID, ECD, Conductivity detectors)
Polarograph (Dropping mercury Electrode)
Pye-Unicam SP8-400 UV/VIS spectrophotometer
Pye-Unicam SP400 UV/VIS spectrophotometer
Perkin-Elmer 297 Infra-Red spectrophotometer
Shimadzu UV 120-02 Spectrophotometer
HPLC-not functioning
MSE high speed centrifuge

Overall Assessment

Professor Cernak was very keen to participate in the LTBP and offered to produce proposals for MSc programmes that would address issues of importance to this project. However, he appears to be the only member of staff who has a primary interest in analytical chemistry and as he has already reached retirement age, the sustainability of the research programmes must be carefully assessed. Also, in view of the age and general condition of the laboratories and equipment, and the apparent dearth of substantial and ongoing research programmes, it seems likely that a considerable financial investment would need to be made by the LTBP to raise the analytical capacity of the Department to an appropriate level; we suggest therefore, that

Zambia (ECZ) is expecting a number of new pieces of equipment, which will probably be installed at the University, but the timescale of this programme is not yet clear.

Department of Geography

A sedimentolgist (Henry Sichingabula) has published on sediment loads in the Zambesi. He knows, and has worked with Mr Chileshe in the Department of Water affairs. There seems to be a good chance of a linkup here with University and easy access to records in the Dept. of Water affairs.

The Geography department has natural resource management programmes, covering environment and development and natural resource economics. Dr Mashalete was suggested as a contact, but it was not possible to follow up on this.

Departments of Geology and Metallurgy/Mineral Processing

Staff and teaching/research

The Departments of Geology and that of Metallurgy and Mineral Processing together with the Department of Mining Engineering, constitute the School of Mines. This is housed in a distinctive and well-kept complex on the university campus. Meetings were held with Dr Jere, Dr Fred Kamona (Head, Department of Geology), and Dr Simukanga (Head, Department of Metallurgy and Mineral Processing) at which the nature of the LTBP was explained and the opportunities for the Departments to be involved in it were discussed. The School is very keen to be involved - especially in the analytical programme.

The senior technical staff (all very experienced technicians) are responsible for the AAS, XRD and XRF equipment and for carrying out the analyses. These staff are indicated in **the following Table**.

staff	grade
Mrs Sichilima	Analyst
Mr Kasengele	Senior technician
Mr Mkandawire	Senior technician
Mr Musonde	Senior technician (XRF and XRD)

This School is clearly a very active part of the University and is vigorously involved in research and consultancy work. There appears to be a considerable demand for students from the School at both undergraduate and postgraduate level. All students entering the School do so at Second Year level, having spent their first year in the School of Natural Sciences. The distribution of students between the three Departments of the School is done on a quota system, which reflects the national demand for students in the various sectors. The quota for geology students has recently been increased in response to the increased exploration activity in the country.

The School, of course, has very strong links with the mining industry and many of its research activities are focused on mineral analysis and exploration. The identification of sources of groundwater and the determination of the water quality of such reservoirs on behalf of industrial and agricultural users is a significant part of the contract research activities of the School. A Unit is currently being established which will focus mainly on environmental and general pollution issues relating to mining activities. The school is also currently participating in a wide-ranging interdisciplinary project supported by Swedish Aid (SIDA); this is concerned with the impacts of the rapidly spreading water hyacinth (*Eichhornia crassipes*) on the Kafue River.

Laboratory facilities and equipment

The analytical laboratories in the School were generally reasonably well-equipped and were being fully used at the time of the visit. The wet chemical laboratory houses two Atomic Absorption Spectrophotometers, one of which is equipped with a graphite furnace. The latter, owing to its lower limits of detection, would be particularly suitable for the analysis of heavy metals in fish and other biological samples - as envisaged by the LTBP. The laboratory is also equipped with a good range of lamps for the instruments and both instruments are presently functioning well. Other instruments include those itemised in **the following Table**.

Carbon and Sulphur monitor
Muffle furnace
UV/Visible Spectrophotometer Lambda 1A
Philips 1410 X-Ray Fluorescence (XRF) Spectrophotometer
Philips X-Ray Diffraction (XRD)

Apart from a minor problem with one of the XRD scintillation tubes, the equipment is working well and was in use at the time of the visit. This equipment would also be an asset to the Lake Tanganyika project.

Overall Assessment

The School is relatively well-equipped to carry out heavy metal analyses on biological and sediment samples using AAS techniques. Its XRF and XRD equipment could also play a very useful role in the analysis and characterisation of sediment samples. It is recommended that the sediment samples are analysed in conjunction with the Radioisotope Research Unit at NCSR as part of an international inter-laboratory quality control programme.

Department of Physics (Environmental Resource Centre)

Staff and teaching/research and facilities

A meeting was held in the Environmental Resource Centre (ERC), Department of Physics, on

present were CF, Dr S M Ngwira (Head, Department of Physics) and Professor P C R Jain (Manager, ERC).

The Centre was inaugurated earlier this year and is supported by Swedish Aid (SIDA). The principal interests of the Centre are climatic studies, renewable energy and environmental physics. Although the Centre has only recently opened, it already has a reasonable selection of journals and has already established links with similar Centres in other countries, (including the Climatic Research Centre at UEA). The Centre also has a computer room/laboratory which is used by staff and students for the analysis of meteorological, climatic and other data. In this connection, it has received support from the World Meteorological Organisation (WMO) and a senior WMO expert has recently been assisting the ERC staff to transfer their climatic and other information onto databases.

Professor Jain is very keen for the Centre to be involved in the LTBP. He has a particular interest in rainfall and temperature patterns in Zambia and nearby countries, and is currently monitoring these factors at 32 locations in Zambia, some of which are apparently in the catchment area of Lake Tanganyika. He offered to extract the information that his database holds on the latter locations. The importance of rainfall as a source of nutrients/pollutants into Lake Tanganyika was discussed at length, and the Centre staff are keen to be involved in a joint research programme of this nature. Indeed, such a project might usefully form the basis of MSc or Ph.D studies for students or members of staff of the Centre - possibly in conjunction with the Climatic Research Unit at UEA.

Overall Assessment

The centre is small but well-equipped and has experienced and enthusiastic staff. Their inputs, particularly regarding recent and ongoing rainfall and temperature patterns in the lake area, would be of considerable benefit to the 'Pollution' and 'Sediment Pollution' aspects of the LTBP. Such data are very hard to come by. Professor Jain agreed to indicate what equipment, additional facilities and further training would be required to move this forward.

2.4.7 Potential study sites in Zambia

The Japanese team are constructing a laboratory with dormitory accomodation in Mpulungu, and will have a presence from September to March. They have indicated that they would welcome use of their facilities by the GEF project outside this period.

One of the major logistic contraints for biodiversity survey activities in Zambian waters is the number of crocodiles. Japanese divers believe that the numbers of crocodiles have been increasing, and sites must be carefully assessed before dives are made.

Sumbu National Park

Sumbu National Park is a mainly low-lying, heavily wooded park land with significant numbers of large mammals including lion, elephant and buffalo. The park extends around 60 km inland and much of the southern boundary of the park is the Lufubu River. More significantly for the Project the park includes 80 km of the lake shore and extends 1.6 km into

Nkamba Bay as national park contributing an approximate additional 15 km2. The park appears to be well policed and our tip along the shoreline showed no sign of any human activity (apart from at the lodges). It could be therefore defined as a pristine site. We were also approached by a park ranger (in one of the lodge speedboats) to explain our presence.

Fisheries department maintains offices in Sumbu village on the northern boundary of the park. Fisheries Department of Zambia have expressed a wish to refurbish these offices and make this a base for activities. GP & CF visited these and found them to be in poor state of repair but not beyond hope. The proximity of the airstrip at Kasaba Lodge makes this place reasonably accessible though access to Kasaba would still involve a 25 km boat trip. Ideally a base near the lodge would be preferable. Sumbu is a 7-8 hour trip from Mpulungu on the *RV Silver Shoal.*

GP and CF met with the Deputy warden of Sumbu Game Reserve, Thomas Mito. Clearly administration of National Parks has strong cross-over with security and military activities. When dealing with Parks it is vital to have necessary clearances. Once bona fides established then highly co-operative.

Lufubu River

As one of the main rivers entiering the Lake the Lufubu is worth of attention. There are hstorical records for guaging station 7-750 approx 15 km inland from the outflow of the river and it may prove worthwhile to re-establish gauging activities at this point. There is also an established park rangers encampment on the north side of the river very close to the outfow which would make short periods of intensive work possible.

Due to the fact that good bathymetic charts exist for the Zambia part of the lake it may be sensible to develop models of riverine inflow in this region wher it is more straightforward to compare modelled and *in situ* data.

There is great interest in working in this area by other research teams (Japanese, SIAL). The southern part of the lake is thought to have particularly diverse fish communities, and this area is relatively unimpacted by human activities. A potential base for activities is Kasanga.

Tanzania/Zambia border area

Kasanga is a small picturesque village 3-4 hours by road (dry season only) from Sumbawanga. The descent to Kasanga from the high, grassland plateau around Sumbawanga is steep, through Miombo woodland. Farming and charcoal-burning activities are not intensive.

Kasanga is the last port of call for the Liemba before reaching Zambian waters. It is around 1.5 hrs journey, but there are also many local craft plying this route. A passage costs less than $5, but the hire on an entire boat with 8.5 hp engine costs $100 for a 3.5 hour trip. Customs officials and the village head were very friendly and welcome visitors. They are used to dealing with tourists, as quite large numbers come there to see the Kalambo Falls. There are the usual small shops, restaurants and guesthouses. There appears to be little fishing activity and 'border-related activities' can be assumed to constitute an important source of livelihood for many inhabitants.

The only visible potential impacts to biodiversity are: i) Localized effects of inshore fishing ii) Localized deforestation iii) Exploitation of aquarium fishes (Mr Toby Weir has an operational base just south of Kasanga iv) There is a harbour development project funded by NORAD that aims to increase the use of Kasanga as a port for goods moving in and out of Southern Tanzania. The road to Sumbawanga may be upgraded as part of this infrastructure development project. At present, it is only passable in the dry season.

Lunzua River

The Lunzua River enters the lake close to Mpulungu and was flowing strongly during the visit (in the dry season). A hydroelectric scheme exists further up the river and it was not clear whether this high flow is due to water impoundment or perhaps due to a well protected catchment. Further investigation of the gauging station at the hydroelectric station recommended.

2.4.8 Overview of institutions in Zambia

The Zambia Government Institutions are aslo feeling a very tight squeeze on finances There are no funds for taking on new personnel, and compulsory redundancies are occuring or have recently occured. Restructuring of Government reponsibilites is occuring and roles and responsibilites seem confusing for the outsider.

The Environmental Council of Zambia (ECZ) is clearly assuming a pivotal role in Environmental matters in Zambia - the project is well placed in this respect with the Zambian Narional Co-ordinator (James Phiri) being the director of ECZ.

3. SPECIAL STUDIES: GENERAL STRATEGIES, LOGISTICS, STUDY SITES AND WORK PLANS

This section deals with important and far-reaching consequences for the execution of the Special Studies, of a number of the issues and developments discussed throughout this report. At this stage the Section must be viewed as a preliminary account of the subjects suggested in the title.

The Special Study Co-ordinators intend to concentrate in the first 12 months or so of the practical phase of the Special Studies (sampling, sample and data analysis) on a comprehensive training programme for scientists, technicians, field operatives - and associated administrators. In this connection, it is recommended that just 4 centres (one in each country) around the lake be established in the first instance. 'Established' means resourcing by way of providing new, or re-furbishing existing, buildings; installing equipment; and carrying out the training programmes indicated above. Section 2 details what is needed, and Section 6 summarises the resources recommended by this mission.

Whether, for example, the 'first' centre in Zaire is Uvira or Kalemie, is relatively immaterial; the main point is that the project has a much greater chance of achieving its objectives (on time) if each country concentrates on developing ('getting up and running') one laboratory site, before attempting other areas. It is envisaged that during this period a considerable number of regional field and laboratory training workshops, and associated discussion groups and meetings will be held. Kigoma is almost certainly the best centre for these purposes and particularly as the lakeside TAFIRI complex (also well-serviced with regard to communications, and well-resourced as far as office and laboratory space are concerned) is just 5 minutes' walk from the SLO's residence, and in similarly easy reach of small hotels. Naturally, regardless of distance travelled, visitors to such meetings would need to be fully re-munerated. More importantly, all of the members of the present mission are familiar with the countryside and lake shore areas around Kigoma, and have noted the training opportunities presented by habitats ranging from mud, through silt, sand, pebble, cobble, boulder and cliff environments within a few kilometres of this centre. Such considerations do not, however, rule out the occasional holding of meetings/workshops in Mpulungu, Uvira/Kalemie and (hopefully) Bujumbura. Indeed, such forays will constitute an essential component of this *regional* project, bearing in mind that we are recommending that all scientists, regardless of nationality, use comparable methods, and are made aware of each others situations regarding laboratory and field resources and lacustrine habitats.

The mission has observed at virtually all of the institutions visited, an enthusiasm not found in many Tropical institutes. A keenness was expressed in analysing one's own data; some previous aid programmes had not allowed this. There were other issues too, that touched on the concern that the nationals' interests should always be borne in mind. Many of the shortcomings of previous programmes could be avoided in the new studies by ensuring the provision of 'consumables' such as fixatives/preservatives, filter papers, reagents, batteries, spares and replacement parts for various equipment items; other examples are basics including power generators and water stills. P/c and peripheral hard- and software are also sorely needed, and numerous people enquired about literature of all types, e.g. papers, books,

workshops, short reciprocal visits between UK and African scientists, and supervision of studies to at least MSc level will feature prominently in the LTBP.

In spite of these very encouraging prospects, the mission is very aware of the incredible challenge that this project presents: for example, getting things going and evolving a *sustainable* programme of scientific study - even with adequate resources - on a system that is characterised by organism abundances and ion concentrations near the current limits of detectability! The programme must also achieve as wide a scope of activities as possible from the outset in order to establish which aspects/determinands are the most appropriate to maintain in the long-term i.e. post-GEF. The fact that with very few exceptions so many previous programmes (e.g. NORAD, Belgian initiatives, FAO FINNIDA) have foundered very soon after 'official' funding has ceased, is a sobering thought: we should examine why we think that this project can reverse this trend.

3.1 Special Study on 'Pollution and its effects on biodiversity'

Difficulties encountered during this mission alone, suggest that the current plans for the Special Study on 'Pollution and its effects on biodiversity', be revised by assuming that essentially, no large vessel (that is, neither the *'Explorer'* nor the *'Echo'*) will be available; in the case of the former the political situation in Burundi is dominating events, while the issues discussed in Section 5 explain why the *'Echo'* cannot be relied upon. For this Special Study, therefore, inflatable craft will be the main means of reaching sampling sites - including reasonably deep water locations representative of 'pelagic' conditions. Preliminary discussions between the members of the mission and regional scientists, suggest that such a strategy would not seriously affect the programme, although some of the gear that is likely to be needed even for inshore and littoral work could be heavy and/or bulky. Even the most casual observations also suggest that a considerable corpus of diving expertise will be required to assess and sample many habitats. This has consequences for training programmes and safety management.

It would be unfair, and probably inappropriate to burden the Scientific Liaison Officer with all responsibilities of the extremely diverse day-to-day activities envisaged for the pollution and pollution-related biodiversity programmes; these should be the ultimate responsibility of the Special Study co-ordinators, their consultants and other scientists that they wish to place in the field. The SLO should nevertheless, be charged with facilitating the scientists' requirements. In order to enhance the successful completion of the scientific work, an absolutely essential feature of this strategy is the more or less ‘permanent’ establishment of two graduates from IFE/UEA in the region.

The co-ordinator of the ‘Pollution’ Special Study at least, is approaching the work with a very open mind regarding the relationship between pollution and biodiversity. Far from consistently effecting a decrease in biodiversity, pockets of pollution may well provide new, or extend existing, spectra of physical and chemical situations and thus opportunities for invasion by 'new' species; if so, this could be interpreted as pollution extending the variety of organisms in the lake. Alternatively, the unlikely universal perturbation of the lake's habitats might well result in an overall decline in species numbers. In this connection we need to consider carefully what constitutes a 'desirable' species as against an 'undesirable organism. Regardless of the actual relationship between pollution and species richness etc., our main pre-occupation must be the generating of relevant and robust data that will identify the nature (e.g. positive or negative correlation) and strength of the relationship.

On a more practical front, ‘field operatives’ will need to be trained in the collection and initial processing (e.g. filtration and fixation/preservation), of samples for all three main studies i.e.

arrays on the other; these are crucial to establishing whether, and in what manner, the one is affecting the other. Also, the potentially enormous distances between sampling stations/study sites will generally rule out the 'luxury' of the pollution scientists, for example, being able to concentrate solely on their 'own' work.

Particularly in the early stages (including training) of the field and laboratory phases of the project, this study will concentrate very specifically on pollution and its effects on biodiversity. Thus, while it would generate data of general limnological interest (on e.g. temperature, conductivity, pH and dissolved oxygen content, and substrate type, water depth and beach slope), it would 'resist' the temptation to explore the broader freshwater ecological issues/phenomena. In this connection, the other Special Studies should heed the advice of scientists involved in the LTR 'Programme of Basic Monitoring by Nationals' at Kigoma, Bujumbura, Kalemie, Moba, Uvira, Karonda and Mpulungu. This programme was charged with, and achieved, truly lake-wide sampling; however, on nutrients in particular, there are concerns over lack of care with the identity of units (e.g. P or PO_4P), and recording whether one or duplicate samples taken.

Training will feature prominently in the Studies. Following discussions with scientists in all 4 lake countries, we propose to mount a first training workshop on pollution and pollution-related biodiversity issues as soon as possible (i.e. subject to the release of funds for travel, T and S, and daily remuneration, and the procurement of some outstanding equipment items). Details have yet to be completed but it will involve say, 3 scientists/technicians from each country, and run for probably no more than 3 or 4 days. It would consider the practicalities of sampling such a large and ecologically diverse, planning the sampling trips, preserving the materials for chemical and biological analysis, data recording and analysis, and even some aspects of data interpretation and considerations about their presentation (reporting and publication).

The co-ordinators of the 'Pollution impacts...' study, recommend very strongly that at the outset of the practical phases of the work (which for at least 12 months would also form the basis of the training programmes), just two multi-habitat sites near (1-h journey) each of just 4 main centres are established. By avoiding too many worries associated with long distance travel, the aim would be to see these stations/institutions running smoothly (and in a *sustainable* manner), before 'graduating' to more remote areas, and trying to cope with the added pressures of travel. Additional stations/laboratories would be established ultimately, but not at the risk of hampering progress at the initial centres.

Doubts over the above strategy have been expressed in some quarters within the PCU - the view being that 'we must achieve lake-wide sampling i.e. stations right round and on the lake'. The logistics of the latter are outlined below. Meanwhile, it should be emphasised that the somewhat 'conservative' programme suggested above has a good chance of furthering knowledge considerably on, and identifying the following

> spatial and temporal variation in the pollution status of a wide range of sediments and biota in shoreline, inshore, offshore and open water habitats; the suite of pollution parameters includes nutrients such as nitrogen and phosphorus species; metal ions oil and pesticide residues.
>
> the diversity of (primarily) the lower organisms including planktonic and attached micro-Algae, Protozoa, Rotifera, Mollusca and Arthropoda.
>
> the nature of the association/relationships between biodiversity ('total', species-, other taxon- or size-specific) and particular pollutants or combinations of pollutants.
>
> all of the above, as a function of the gradients exhibited by a particular pollutant e.g. mud phosphorus content, Mollusc tissue mercury status.
>
> the sources of the pollutants.

Above all, the project would establish comparatively 'well-found' laboratories, and cadres of freshwater scientists capable of maintaining future studies, establishing new centres and influencing policy over matters of water quality and lake management.

Truly 'lake-wide' coverage could never be resourced, while the proposed 4-station coverage that will still encompass habitats dispersed widely over the lake can be supported. Of course, such a strategy would produce at the most, only 8 (i.e. 4 x 2) sets of data (excluding information based on horizontal or vertical transects) for a given pollutant (e.g. P) in a particular habitat (e.g. rocky shore); however, even this would represent a major increase in data generation for this aspect of Lake Tanganyika.

3.2 Special Study on 'Sediment discharge and its effects on biodiversity'

This section is currently being developed for discussion at the Project Preliminary Strategic Plan meeting. It will be inserted into this report at that stage.

3.3 Special Study on 'Biodiversity'

This section is currently being developed for discussion at the Project Preliminary Strategic Plan meeting. It will be inserted into this report at that stage.

4. LINKS TO ENVIRONMENTAL EDUCATION ISSUES

General introduction

As emphasised in the LTBP Inception Report (e.g. section 6.5.3), environmental education (EE) is vital to the success of the project - particularly in relation to achieving the goal of protecting the biodiversity of the lake.

EE is stressed as being important because:

1. it empowers people with the knowledge, skills, attitudes and values that enables their participation in present and future environmental management of the lake.

2. it is the major precursor to environmental action and the main way of ensuring that the project's goal is sustainable in the long term.

3. it is one of the primary mechanisms to achieve unification of project strands and integration of these to present the project as a holistic one.

As stressed in the executive summary of the Environmental Education Baseline Review, environmental education is not seen as a separate area of project activity. It is rather an integral component of the sustainable management of the lake. Although responsibility for the EE programme at regional level falls within the Socio-Economic Special Studies, *it is vital for the success of the LTBP that the Special Study teams are also actively involved in EE activities, particularly at a local level and in the presentation of their findings to local communities.*

With this in mind, although the principal purpose of the present mission is largely scientific in nature, the opportunity was also taken during the visit to identify individuals, institutions and organisations keen to participate in the environmental education aspects of the various Special Studies programmes. The contacts made, discussions held and opportunities identified in the countries visited are described in the following sections.

4.1 Burundi

It is hoped that a separate institutional resource assessment visit to this country can be achieved soon, although the present news regarding Burundi and its neighbouring countries suggests that there is little likelihood of this.

4.2 Tanzania

4.2.1 Kigoma High School

Kigoma High School was visited on 14-8-96. Present at the meeting were CF, Mrs Fatima Mashaka (Deputy Head), Mr Lunga (Head, Department of Biology). The School Head, Mr

participate in, and benefit from this were explored. Mrs Mashaka, speaking (she felt sure) on behalf of all the staff and students, expressed their enthusiasm to be involved with the large lake study.

School infrastructure

Kigoma Secondary is the major Government secondary school in Kigoma. It has 722 pupils and 34 staff. At present it has five streams in Forms 1 and 2, and 4 streams in Forms 3 and 4. A Form 5 is expected to commence in the next academic year. Subject combinations offered being Physics/Chemistry/Biology and Mathematics.

Potential collaborative activities

From the discussions, it is clear that little information is currently available for teachers and students on Lake Tanganyika. The provision of such information in the form of newsletters, booklets, posters, science project materials etc., would not only be a valuable resource for the school but would raise the awareness of the lake amongst the students and staff alike.

As part of the Form 4 curriculum, science students are required to carry out a mini-project. A few students have already visited TAFIRI in this connection. There is an excellent opportunity here to encourage students studying Chemistry, Physics, Biology etc to make fuller use of Lake Tanganyika for their project work. This of course applies to other such schools in the vicinity of the lake.

Requests were made for LTBP staff (consultants and locally engaged personnel) to give talks on the lake to both staff and students. It is strongly recommended that this activity be initiated as soon as possible at this and other schools. The frequency of such visits will of necessity be restricted by time factors, but a regular, even if relatively infrequent, series of events would do much to disseminate information on the lake and provide a much needed link to local communities.

At present, TAFIRI appears to be seen by teachers and students as a Government institution with little obvious immediate relevance to their studies or their everyday lives. Under the auspices of the present project, there is an opportunity for TAFIRI , in addition to its scientific role, to provide a focus for the wider scientific and environmental education issues of relevance and interest to the local communities bordering the lake. A detailed proposal suggesting how this might be achieved at very little cost both at TAFIRI and the Department of Fisheries, Mpulungu (Zambia), is presently being prepared by CF and TBW.

4.2.2 Mahale Mountains National Park

A meeting was held between GP, CF and Mr James Wakibara, Ecologist, Mahale Mountains National Park on the RV *'Liemba'* on 14-8-96. The nature of the LTBP was explained and the opportunities for collaboration discussed. In addition to scientific issues, potential environmental education programmes relevant to the various Special Studies were also

Environmental education activities.

Some of the issues covered in this section are raised in earlier sections of this mission report, although not specifically in relation to EE.

In view of the focus in the Mahale Mountains National Park thus far being on chimpanzee research, Mr Wakibara expressed the need to diversify the research activities of the park. In that context, a priority is the production for visitors to the park, of educational materials illustrating the rich floral and faunal diversity in the terrestrial and aquatic zones. Such materials could usefully include general information on the geology and history of the lake, common birds and fish, and simple identification keys for trees and insects etc.

There is a strong focus on community conservation in and around the park, as evidenced by the construction of schools and health units financed by the park in the 7 villages within its boundaries. The production of environmental materials relating to Lake Tanganyika in general, and to Mahale Mountains area in particular, for schools would be a very worthwhile.

4.2.3 Gombe National Park

During a reception held by the British Ambassador in Dar es Salaam to celebrate the opening of an 'Environmental Awareness Week', CF and TBW had the opportunity to discuss the LTBP with Jane Goodall of Gombe National Park and the Jane Goodall Foundation/Institute in particular. This park is, of course, much better known than Mahale and material describing Gombe is apparently already available. Nevertheless, Dr Goodall expressed considerable interest in the project and especially the proposals to disseminate the findings of the Special Studies to the local communities. The production of appropriate environmental education materials on Lake Tanganyika and its flora and fauna was also strongly supported. If the Gombe area is eventually selected as a 'reserve' by the LTBP, it could act as a 'buffer zone' which might minimise the attentions of Chimpanzee trophy hunters who often shoot from the lake.

4.2.4 Wildlife Conservation Society of Tanzania (WCST)

A visit was made to this Society by TBW and CF to discuss the potential for collaboration between the Project and WCST. Ms Alice Bhukali, the Co-ordinator, outlined the scope of the Society's activities and expressed a strong interest in the LTBP.

WCST activities

WCST was established in 1988 with a mission to "preserve the natural flora and fauna of Tanzania for the sake of mankind". The Society publishes MIOMBO - a regular newsletter with up to date information on its activities and articles on wildlife and conservation. Copies of the newsletter and other WCST publications were obtained. WCST launched a Coastal

Tanzania. This is clearly an active programme and much seems to have been achieved during the six years of the project.

The Society has an active Education Section which organises Wildlife Clubs in schools, publishes leaflets and booklets and arranges seminars for teachers and students. It also organises regular monthly meetings about wildlife and conservation issues, and it has a library for use by its members and members of the public. Copies of the Special Study Baseline Reviews were requested for the library.

The Society is currently very short of funds and its activities are severely curtailed by having only one vehicle. (The other vehicle was stolen last year and the driver killed during the robbery)

Potential areas of collaboration

Possible joint LTBP/WCST activities in the field of EE are listed below:

regular presentations on the various aspects of Lake Tanganyika by Special Study Project staff at the WCST public meetings in Dar es Salaam

preparation of articles on Lake Tanganyika in general, and on the Special Studies concerned with biodiversity in particular, for the WCST newsletter (MIOMBO)

joint programmes with WCST Education Section including presentations on the results and activities of the Special Studies to Wildlife Clubs in schools

production of educational materials for schools use and for the teachers' seminars run by WCST: indeed, a series of such seminars focusing specifically on the lake would do much to raise the profile of Lake Tanganyika in Tanzanian schools.

The opening of a WCST office and the development of their activities in the Lake Tanganyika region would foster local interest in the lake and would underpin the sustainability of the LTBP activities. It is recommended that consideration be given to supporting the opening of such an office, perhaps in Kigoma, which would play a major role in many of the activities suggested above.

Joint LTBP/WCST desk-top publishing facilities could be centred in the office. Vehicular support would also be needed. At present much of the WCST activities are, of necessity, centred on Dar es Salaam and the coastal strip. The opening of an office in Western Tanzania would redress this imbalance and raise the profile of Lake Tanganyika in the country as a whole.

4.2.5 TANAPA

TANAPA own some land in Kigoma, at Kibirizi, just north of the Port. This is accessible by road and by boat in around 10 minutes from Kigoma town. This was granted to them 2-3

TANAPA have the intention of establishing an education/tourism centre there to promote both Mahale and Gombe. They expressed an interest in using the proposed centre for a wider environmental education/centre for promotion of lake tourism. This could fall within the remit of the GEF project.

Action: i) A letter informing TANAPA of the GEF project objectives, areas of possible participation and an invitation to participate are required from the PCU to:

Mr Lota Melamari, Director General, TANAPA, P.O. Box 3134, Arusha (cc to Mr Mwasaga, Chief Ecologist)

ii) TANAPA would also like a copy of the Inception Report, and would like to be made aware of any important developments in the project, perhaps though the invitation of a TANAPA representative to Steering Committee meetings. Note that Mr Mwasaga has been involved in the early stages of this project, and was at Andy Cohen's meeting in Bujumbura in 1991. Until a recent visit to Kigoma, where he talked with Keith Banister, he had not heard of any progress with the project.

iii) The Scientific Liaison Officer should enquire further on the status of current plans for the proposed Kigoma centre.

4.3 Zaire

none identified

4.4 Zambia

4.4.1 "Zapoto"-Lungu Theatre Group

This Theatre Group travels around the shoreline of the lake presenting plays in the local Lungu language on lake-related environmental issues such as oil pollution in harbours, over-fishing, and sewage contamination. The group is apparently quite popular and would make an ideal vehicle for disseminating background information on the lake, and for informing the local people about the nature and results of the LTBP. No contact with the Group was possible during the mission and so no information is presently available on the make-up of the Group or on their source of funding. This information is currently being sought.

Such local theatre groups could play a major role in raising public awareness regarding the threats to the lake and it's catchment area, and have the potential to contribute significantly to the long term efforts to ensure the sustainability of the lake.

Recommendation

It is recommended that the Special Study Groups make as full use as possible of Zapoto and similar theatre groups to raise awareness of Lake Tanganyika amongst the local communities and to disseminate the activities and findings of the various special studies. This would, of

course require, working closely with group members to provide the necessary information and materials. Financial assistance for their activities should perhaps also be considered.

4.4.2 Chongololo and Conservation Club, Chitinta School, Mpulungu

Chongololo Clubs such as the one at Chitinta School are to be found in primary schools throughout Zambia and are run by interested teachers after school. They focus primarily on environmental and conservation issues and often act as one of the focal points for such matters in the local community. As such, members of the local communities often play an active role in such clubs by giving talks, organising activities, and raising funds in various ways. Thus, for example, CF and GP were approached whilst at Mpulungu for a contribution to the Chongololo Club at Chitinta School by one of the staff of the Department of Fisheries who was acting on behalf of the Secretary, Mr M R Mumba. Local residents of Mpulungu including the owners of the local petrol station actively support the club.

Nationally, support for the Chongololo Clubs comes not only from the Ministry of Education, the University of Zambia (a lecturer in the School of Education has a specific responsibility for such clubs) but also from various NGOs including ZEEP.

Recommendation

Chongololo Clubs represent an excellent vehicle for disseminating information about the lake in general and for publicising, even in a necessarily simple form, the results of the special studies to primary school pupils, their teachers and to the wider community. As with the theatre groups mentioned above, this would necessitate working closely with the respective club organisers either directly or through an NGO such as ZEEP to prepare suitable presentations and educational materials. Some financial assistance, even if relatively modest would be required.

In towns such as Mpulungu, which are anticipated to be centres of project scientific activity, it may be worth considering appointing a (part-time?) local environmental education officer, possibly a local primary school teacher, who would be responsible for linking project outputs with theatre groups, Chongololo clubs, and the wider local community.

4.4.3 Motomoto Museum, Mbala

A meeting between CF and Mr E Nkole Sosala, Keeper of Prehistory at the Museum took place on 17 August in Mbala. The LTBP was explained and possible links with the Museum explored. Discussions centred principally on the environmental education aspects of the special studies programme and ways in which the Museum could participate in disseminating the results of the project to the local communities in the vicinity.

The museum is unusually substantial for a small town and is in fact the second largest in Zambia. Discussions are under way at present, however, which may result in some of the exhibits being transferred to other museums. The large number of artefacts and exhibits housed at the Motomoto Museum were almost all collected over a period of many years by a

local missionary, who was never seen in public without a pipe - hence the name of the museum!

The museum is well known in the area and is particularly popular with local school children. The museum was closed on the day the visit to Mbala was made, but it is understood that the collections are housed in a number of separate buildings and include a display devoted to fishing activities on Lake Tanganyika.

Potential collaborative activities

Mr Sosala is very keen for the Museum to play an active part in the LTBP. The Museum located as it is a comparatively short distance from the Lake is ideally situated as a Centre for raising the profile of the lake amongst the local communities and for disseminating the results and conclusions from the project to audiences in the vicinity of the lake.

It is therefore suggested that, in conjunction with the Museum, displays be set up at the Museum which focus on the various aspects of the Project activities. These could include information on the Lake itself, on the flora and fauna of the lake, on fishing activities, on threats from pollution etc.

It is also recommended that the Provincial Fisheries Department and also the Water Department be encouraged to mount complementary displays illustrating the way in which their activities help to support the viability and long term sustainability of the lake. This collaborative effort between the local departments and the Project personnel would serve to underline the capacity building nature of the project whilst at the same time informing the local residents about the lake itself. In addition to the displays, the Museum would be a suitable location for Project staff to give talks on the Lake Tanganyika Programme from time to time.

The activities outlined above would, of course, involve financial support for materials, preparation of the display room and the displays themselves and would require the appointment, probably on a part-time basis, of a local environmental education co-ordinator to ensure the success of the project. This could be one of the Museum staff.

In summary, collaboration with the Museum in the ways suggested above, would provide an excellent opportunity for raising interest in and concern for Lake Tanganyika amongst the local communities for a relatively modest outlay.

4.4.4 Mbala Secondary School, Mbala

During a visit to Mbala on 17-8-96, CF met Mr E Sosala and discussed the possibilities for staff, parents and students of Mbala Secondary School to be involved in the LTBP, were discussed. Mr Sosala, in addition to his responsibilities as Keeper of Prehistory at Motomoto Museum is also Vice-Chairman of the Parent-Teachers Association of the school. Mr Sosala was of the opinion that parents, staff and students would be very interested in learning more about the lake and the activities that it supports and was very keen for the Parent-Teachers

Lack of time prevented a visit to the school, but Mr Sosala indicated that it was an old established school with a student role of over 1000 pupils. As is the case for other secondary schools in Zambia, Chemistry, Physics, Biology, Maths etc. are not taught as separate subjects until Grade 10 i.e. from the third year onwards. For the first two years of secondary school (Grades 8 and 9) science is taught as an interdisciplinary subject (Environmental Science).

Potential collaborative activities

From the discussions, it is clear that little information on Lake Tanganyika is currently available for teachers or students. The preparation of such information in the form of newsletters, booklets. science project materials etc. would be of substantial benefit to the school but would also raise awareness of the lake amongst students, staff and indeed parents. It is further suggested that any such programmes be carried in conjunction with the Advancement of English, Maths and Science (AIEMS) Project Resource and Training Centre in Mbala. Such centres which are equipped by the British Council are part of AIEMS Project which is aimed at improving secondary schools and in-service training in Zambia. If materials that focus particularly on Lake Tanganyika were to be incorporated as an integral part of the AIEMS Project this could raise the awareness of the Lake not only in the areas close to the Lake itself but amongst school children throughout Zambia.

The Junior Engineers and Technologists Society (JETS) club at the school is very active and would be a further useful avenue for raising interest in the lake. The JETS clubs are in all schools and are funded by the Ministries of Education and of Technology and are co-ordinated by Dr Simboli of the School of Education, UNZA. Activities include competitions, quizzes and projects on a variety of environmental and agricultural topics. Visits by club members to Mpulungu to see Project activities at first hand, talks by Project personnel and similar events would be an effective way of increasing interest in the long term future of the lake.

In view of the relative proximity of the school to the lake, there is also an excellent opportunity here for the Project to facilitate visits by students to the lake to carry out their project work and for Project staff (consultants and locally engaged personnel) to give talks about the lake and project activities and results to the students, staff and parents. Such programmes could also be usefully linked into the activities at the Motomoto museum suggested in the previous section.

4.4.5 Northern Province Development Programme (NPDP), Irish Aid

Meetings were held between CF and Mr Cosmos Chizongo (Deputy Co-ordinator, NPDP) in Kasama, Northern Province on 22-8-96 and with Ms Bernadette Crawford (Senior Programme Officer, Irish Aid) at the Embassy of Ireland on 26-8-96. The purpose of the meetings were to assess the extent to which the projected activities of the LTBP and the existing programmes of the NPDP are complementary to each other.

The Irish Aid Programme which began in 1982 has increased substantially in scope and budget in recent years and reached £3.1 million pounds in 1994. Approximately 40% of the Zambian expenditure is targeted at Northern Province and indeed Irish Aid is probably the principal donor agency in Northern Province. The programme in that area draws together a number of related components including water supply, sanitation, health care, primary education. An urban upgrading programme was added in 1995.

During the discussions, Ms Crawford and Mr Chizongo both expressed considerable interest in the LTBP and were keen to develop collaborative activities wherever possible. Ms Crawford also requested copies of the various Baseline Reviews.

On the basis of the visits made to the NPDP Headquarters in Kasama and from discussions with Irish Aid personnel it was evident that the NPDP programme is very wide ranging in its scope, effectively run and takes the potential environmental implications of its activities very seriously. A number of the NPDP activities are of relevance to the technical and environmental education aspects of the Project Special studies.

The Rural Water Supply Project, begun in Kasama in 1983, which supports the digging/rehabilitation of large numbers of village wells with a view to providing clean drinking water to rural communities, was extended to Mbalain 1992, and to Kaputa District in 1995. In the latter case, prior to wells being dug, the local people were dependant upon Lake Kaputa (near to Nsumbu National Park) for water. A number had been killed by crocodiles in the process.

As part of the Water supply Project, support is currently being provided for Water Analysis Laboratories in Kasama and Mbala.

The Health Project, based in Mbala, is designed to upgrade the District's poor health facilities and to provide health sector training. The project also supported the rehabilitation of a health centre in Mpulungu, where cholera was a particular problem.

Urban Upgrading Projects in which the major emphasis is placed on capacity building, empowerment of local residents and community participation in upgrading their environment and living conditions, are a major feature of the NPDP programme. Such programmes were first initiated at Kamanga, a shanty town on the outskirts of Lusaka and in the light of the success of the programme a similar project was initiated in Ndeke, Mazabuka, some 90 miles north of Lusaka in 1993. Two further programmes were commenced in Kasama and Mbala in 1995.

A central feature of all the Irish Aid supported programmes outlined above is the commitment to education programmes at all levels from primary schools to informal adult education. The NPDP staff run a series of in-service training courses as part of their programme activities and expressed their interest in any LTBP related materials that they could make use of in their various education programmes. In Mbala, they already work in conjunction with the British Council AIEMS Centre.

The LTBP has an excellent opportunity here to disseminate information on the importance of Lake Tanganyika as a vital local resource by participating in and supporting such educational initiatives. This could be achieved, for example, by preparing suitable educational materials for use by the Irish Aid programmes and if time and resources allowed, taking part in their training programmes. Ms Crawford expressed her enthusiasm for such collaborative activities.

A further aspect of the Irish Aid programme that is potentially relevant to the project is concerned with tourism. In 1994, a major new programme of support for the Hotel and Training Institute (HTTI) began. At present, Zambia's significant tourist potential, which could greatly enhance the country's foreign earnings, is severely under-exploited-nowhere more so than in the Northern Province. The potential of Sumbu National Park as a tourist destination is enormous, and yet it is relatively little known even within Zambia itself.

There is an excellent opportunity here for the Project to have an input to the HTTI programme, possibly by preparing descriptive materials on the Lake itself, ,the wildlife, current environmental concerns and Project activities etc., These would serve to emphasise the existing and potential opportunities for fishing, game viewing, bird watching, photography etc. provided by the Lake and in so doing, the importance of attempts to ensure the sustainability of Lake would be communicated to those actively involved in the tourism industry.

The recent refurbishment of the hotel at Kasaba Bay and the recently introduced scheduled air service linking Kasaba Bay with Kasama, Ndola and Lusaka suggests that the importance of the Lake to Zambia's tourism industry is increasingly being recognised.

4.4.6 Zambia Environmental Education Project (ZEEP)

A meeting was held at the ZEEP offices on 30-8-96 between CF and Mr Justin Lupere, Materials Development Officer during which potential links between ZEEP and the LTBP were discussed. The importance of disseminating the results of the Special Studies to the wider community was emphasised and Mr Lupere outlined the diverse activities of ZEEP in general and the work of the Materials Development Section in particular.

ZEEP is currently funded by WWF and run by Juliana Chileshe. ZEEP's activities include building EE centres, teacher training, and the preparation of EE materials for primary and secondary schools. Mr Lupere generously provided CF with a comprehensive selection of some of these materials. More specifically ZEEP has initiated the following EE activities:

4. production of a training manual for teacher trainers working in pre-school teacher training colleges.
5. Training of District Inspectors of Schools from each of the Provinces of Zambia. The training is carried out by means of workshops of one week duration aimed at emphasising environmental education issues. The workshops are run in conjunction with the relevant Provincial Education Office.
6. Preparation of EE materials for Primary schools, including books, pamphlets, posters etc. The materials produced are evaluated by the Curriculum Development Centre, revised as

7. Preparation of EE materials for Secondary schools. These are based on the Environmental Science Syllabus in Grades 8 and 9 and on the separate subject curricula for the later grades.
8. Production of a teacher training manual for tertiary level students training to be teachers is in preparation.
9. ZEEP actively encourages project work and investigative activities in schools and supports the JETS club programme. It also organises local science fairs at district level.
10. ZEEP has recently appointed a Community Environmental Education Officer, Mr Jonathan Chisaka, who will be responsible for the extension activities of the Project.

Potential collaborative activities.

ZEEP has an excellent reputation in Zambia and is clearly very active in promoting environmental education issues and activities. It has built up considerable expertise in EE and materials development and Mr Lupere was very keen to develop joint EE activities with the LTBP.

An excellent opportunity exists here to work with ZEEP to disseminate the results of the Special Studies to District Officials, colleges, schools, JETS clubs, and to the wider community. Suitable materials based on Lake Tanganyika and on the results of the Special studies could be prepared and used by ZEEP as an integral part of their training manuals, materials and in-service courses.

5. CONSIDERATIONS OF GENERAL RELEVANCE TO THE LAKE TANGANYIKA BIODIVERSITY SPECIAL STUDIES

This section addresses issues that became particularly apparent during the present mission, and which impinge on more or less all aspects of the Special Studies - including the environmental education issues addressed in the previous chapter. Prominent here are comments that have a considerable bearing on the 'image' of the project as it stands at present, such as the state of one of the main the research vessels,

5.1 The *RV* '*Echo*'

Introduction

The '*RV Echo'* (hereafter the *Echo*) is the approximately 10-m research vessel owned by TAFIRI, with cabin, wheel-house, fore- and aft- deck accommodation. She is equipped with a helmsman's compass and a Raytheon GPS, both in working condition. The following observations on her general condition, facilities and seaworthiness are based on the voyage to Mahale from Kigoma (20 August) and back to Kigoma (21-22 August).

Apparently, considerable resources (US$ 11,000) have been spent on upgrading the *Echo* by the Lake Tanganyika project (N.B. a report, detailing the overhauling and refitting of the engine of the this vessel by Mr N A Chaile is held by the PCU). However, she is still a dirty (the port side of the glass fibre hull of the vessel is blackened by diesel exhaust fumes) and noisy vessel, with significant engine problems, and a lack of basic facilities. Even more serious are her potentially dangerous features. Thus, the wisdom of this expenditure is questionable in the light of the experiences of the voyage. The following extracts from RWD's diary refer to some of the problems encountered on the journey to and from Mahale.

Tuesday 20 August

RWD, TBW, EHA and PP boarded the *Echo* at Kigoma Port at 07.00 hours together with the two man crew. Headed south along the western shores of Lake Tanganyika via the delta of the River Luiche, 9 km (c. 1 hour) from Kigoma. Continued southwards to the waters of the Malagarasi Delta, 37 km (c. 2.5 hours from Kigoma). Here the *Echo* ran aground in the shallow waters. The vessel was refloated by towing it with an outboard motor-propelled inflatable craft which the *Echo* was carrying. This task was succeeded after 30 minutes. The *Echo* was then anchored and we were able to explore the nearshore distributaries of the Malagarasi by means of the inflatable. Some bottom sediment samples were collected. At 11.15 hours we returned to the *Echo* and resumed the passage southwards. At 11.55 hours the *Echo* experienced exhaust problems causing extensive and severe emission of fumes. The crew managed to carry out a makeshift repair within 20 minutes. However, the vessel continued to be very dirty and noisy for the rest of the journey. Journey to Mahale resumed, the *Echo* arriving at 19.30 hours.

Wednesday 21 August

It was intended to spend the afternoon viewing various parts of the park from the lake aboard the *Echo.* However, on reboarding this boat we were informed by the crew that it had developed major engine problems such that no forward transmission could be engaged. Consequently, whilst attempts were being made to repair the engine by the vessel's crew, the afternoon was spent visiting some of the terrestrial environments of the park; beach, nearshore, fluvial channels etc. Departed from Mahale by means of the inflatable at 17.10 hours by which time the engine problems had apparently been fixed.

Observations and some recommendations

(i) Safety on board

In places the guard rails are broken and the fixtures are loose and potentially very dangerous. New guard rails along the entire length of the vessel are required.

There is no echo-sounder on board. Given that we ran aground in the shallow waters of the Malagarasi an echo-sounder is essential.

The radio does not function and requires to be repaired or replaced.

The canopy uprights are insecurely fixed to the deck and would not bear the weight of a person in rough water conditions. These require attention.

The deck is, in places, very slippery, and requires painting with non-slip deck-track.

The stern platform is in a poor state of repair and requires attention.

There are no life jackets on board (although these had been requested prior to the trip), only buoyancy aids are available.

The few ropes on board are new but of inferior quality and should be upgraded.

There is no fire extinguisher on board. This must be rectified.

The wiring is in a generally very poor state of repair and needs replacing. The canopy light hangs loose on its wires and requires fixing.

No maps/charts of the lake are available on board.

(ii) Engine

The engine requires a **complete** overhaul. Problems with both the exhaust and transmission system were encountered. Exhaust emissions are consistently high. It is noisy and dirty. Sound deadening should be fitted below the engine cover to improve the working environment.

There is no toilet, although the cabin accommodation exists for one. Given that long periods of time may potentially be spent on board by individuals involved in the sampling programmes, toilet facilities are essential.

There are no fixed cooking facilities or refrigerator on board although spaces exist for these. Such facilities are not essential but desirable on long journeys.

(iv) On board practices

The one bucket on board the boat is used for baling the engine room, washing purposes and preparing food.

All wastes, solid and liquid, are thrown over the side into the lake.

On entering shallow waters, for example close to a beach, the vessel is first run aground, prior to running astern into slightly deeper waters, then the anchor is dropped.

Conclusions

The *Echo* presents a very poor advertisement for the Lake Tanganyika project. Her overall facilities and appearance are certainly not those of a scientific research vessel!

The crew require training in hygienic practices on board and, whilst it may be the norm on the lake, it is not appropriate for this project to dispose of wastes over the side of a research vessel being deployed to monitor levels of pollution. In general terms, the crew should be trained to take greater care of the vessel and to avoid unnecessary damage to the hull.

Before any more money is spent on the *Echo* it is recommended that she be given a thorough examination, whilst out of the water, by a qualified boat/marine engineer. Only then can the true costs of upgrading her to an acceptable and safe standard be realistically assessed. Such a survey should determine if indeed it is worth spending any more money on the *Echo* or if the resources of the project would be better and more economically directed towards another vessel.

5.2 Project Liaison

This section deals with observations made during the mission and concerning liaison between British persons on the project, and between these and outside bodies/persons. In this connection it should be noted that although the SLO took/accompanied us to relatively nearby 'habitats', he did not join us on the really long and often very arduous journeys to e.g. Mpulungu, Mahale and Uvira. Indeed he accompanied us on a very minor fraction of our 'institutional resource assessments'. Surprisingly too, we were never accompanied by any African counterpart to the institutions - and certainly not by any National Co-ordinators!

The flow of information within the project

The passage of information between UK- and Africa-based British personnel has proceeded reasonably well; as far as we can gather, Baseline Reviews, Progress Reports, Inception Workshop reports prepared in UK reached their African destinations in reasonable time. However, the following 'hiccups' are listed in the hope that they can be avoided in the future:

provision by NRI of 'single-entry' visas for Tanzania, whereas we requested, and paid the appropriate monies for, 'multiple-entry' versions; this resulted in each of us paying an unforeseen 50$ US.

the PCU had not prepared us at all for the following extra expenditures (pooled between 4 persons - and not without some considerable anxiety for some): 400,000 Tz shillings for fuel for the *RV 'Echo'* and 86$ US for outboard engine oil (Kigoma-Malagarasi-Mahale-Kigoma); 120$ US for accommodation and travel costs for Bertha (SLO's secretary) who accompanied us on the trip to Uvira and environs.

having assumed that 'B and B' at the Kigoma house of the Project Liaison Officer meant just that, we were surprised at being forced to eat at the 'Railway' Hotel a kilometre away; while this cost only some £1.50 daily for the approximately 12 days involved, it took up a total of some 1.5 person-hours out of each day.

an unnecessary worry was placed on consultants by the UK administrators, by failing to provide the former with ample financial 'advances' before they leave their respective countries; no workers should have to pay what can amount to substantial sums out of their own pockets/accounts.

We are also report that the PCU failed to attend to many of the concerns that the mission raised while preparing for this mission. Even though requests regarding the following issues were communicated to the PCU only weeks in advance of the mission leaving UK, we cannot believe that such fundamentals could be other than uppermost in the PCU's mind in any event.

The flow of information between the PCU and African personnel and institutions

We are very concerned that while some people (mainly in Kigoma) are aware of the Lake Tanganyika Biodiversity Protection Project, many are of the view that little has been, or is being, done under this umbrella. Moreover, many groups in Kigoma and elsewhere have also only a vague idea of the project, its aims and aspirations and the way in which it proposes to achieve these aims - especially where their involvement is a possibility. This is disturbing on a number of counts:

barring final ratification, UNDP accepted our Technical Proposal nearly a year ago, the Scientific Liaison Officer arrived in Kigoma some 8 months prior to this visit.

the TAFIRI-FAO FINNIDA compound, and a number of other organisations/institutions (e.g. TACARE, KRWD) are virtually within walking

even though this project was unable to establish reasonable telephone, facsimile or other e.g. radio, links (and it has yet to achieve all of these even now), some such facilities existed in the nearby institutions

back in UK, co-ordinators of the Special Studies at least, have produced an immense volume of literature in the form of the Baseline Reviews in particular, but also 'Back-to-Office' and Progress reports, and these have been communicated to Tanzania.

at least one of the co-ordinating institutes has repeatedly offered, human and, albeit moderate, monetary resources to place a graduate in the region to hasten the project 'start-up' and thus, the publicising process.

between the time of the Inception Workshop (March 1996) to the time of writing, TBW has received only one communication (a short fax) from the PCU in Africa.

Particularly bearing in mind the close proximity of the major institutions in Kigoma to the Scientific Liaison Officer's residence, we feel that the potential for strengthening links between the Project co-ordinators and regional administrators on the one hand and regional scientists on the other, has been very little explored. It is accepted, however, that while documents such as the Baseline Reviews were sent out to the National Co-ordinators, these persons did not forward them to those personnel such as the scientists who needed the information most.

5.3 Public Perception/'Image'

The mission has been generally dismayed at the image that seems now to be widely associated with this project. Shortcomings include the lack of progress with the work - and this relates in part to the comments under 'Liaison'. Setting aside issues such as those consequent on the developments in Burundi and Zaire, and very real delays due to telecommunication failures, for example, we identify the following as in need of attention:

no immediately obvious and easily identifiable project Centre; the Scientific Liaison Officer's residence was selected as Project HQ at the Lake. A greater presence in the Dept. of Fisheries should be encouraged

the accommodation of visiting scientists and others associated with the project; visits to the region are extremely exacting; and very long journeys in quite small and spartan vessels exhausting. As a potential 'haven' for visitors it is suggested, that the SLO residence is not adequate.

similar remarks apply to the *Echo;* conditions on this vessel are not only primitive, but also dangerous; but for good fortune, trips by the present mission could have proved disastrous at a number of junctures

at least two 'high profile' exercises highlighted the slack planning, poor preparedness, and

having with some trepidation invited Mahale Mountains National Park staff onto the 'Research' (!) vessel for a trip along the shore of the Reserve, the engine failed and these personnel had to be transferred to land in our inflatable craft (which - along with life-jackets) would not even have been taken on the journey from Kigoma had it not been at the insistence of the UK consultants); the second instance concerned a 'Ujiji'-type boat journey to an erosion site to the north of Kigoma (and south of Gombe) with, including others, the daughter of the British High Commissioner to Tanzania; this programme started off badly with prolonged delays (boat and engine at different localities) and later, considerable and potentially very serious leaks, necessitating 4 stops ashore to effect very makeshift repairs and bale out the boat out.

In all, many of these shortcomings and failings seem to stem from an unqualified acceptance that ‘this is Africa’. Although living, working, and travelling and communicating over long distances in Africa, can be, and often is, very difficult, we suggest that project personnel residing permanently in the region see as an important aspect of 'resourcing', the elevation of operating standards - towards those characteristic of ecological projects in UK; the impression gained at present suggests that our standards are being compromised.

In conclusion, our 'corporate image' must be turned round completely and swiftly; this is a highly prestigious venture - and one in which most of us feel highly privileged to be involved. However, some of the UK institutes who contributed to the original (and successful) Technical Proposal are likely to terminate their contracts, if they do not see a very noticeable, and widely publicised shift in 'attitude' and action.

5.4 Health and Safety

This section is itemised to emphasise the importance we attach to the safety and well-being of all involved in the project. However, because of the project's obvious and singularly poor attention to health and safety - at both personal and project levels - the issues have already been raised in the foregoing sections. In addition, we would welcome protocols and 'advice' sheets on aspects that need to be considered before leaving UK (e.g. the provision of the 'best' insurance in the case of a really serious emergency in a remote area - even in mid-lake).

6. OVERALL RECOMMENDATIONS

The mission has made a number recommendations on aspects that need attention in order to progress the whole LTBP effectively, and the 'limnological' Special Studies and associated environmental education activities (EE) in particular. The present section paraphrases most of the main recommendations. Exceptions are aspects relating to the links with EE (Section 4) and particularly crucial issues affecting all studies, including the state of the RV '*Echo*' and the situation regarding the project 'image' (Section 5).

6.1 Burundi

6.1.1 Ministry departments and non-university research institutions

It is essential that all efforts be made to keep Burundi involved in the LTBP. Failure to do this will not only tarnish the *regional* character of the project; without this country's involvement, we would lose the opportunity of assessing pollution impacts on biodiversity, in an area of the lake and its catchment probably most severely affected by industrial outfalls and population pressures. Above all, we would lose the chance of capitalising on the infra-structure and a proven body of scientific expertise and equipment resources that have been built up at LTR (FAO FINNIDA) and CRRHA. We would also lose out on office and other facilitation offered by e.g. the Ministries of Environment (INECN) and of Agriculture and Livestock.

6.1.2 The University of Burundi, Bujumbura

It is important to mount a mission to the university as soon as the situation in Burundi improves. A number of the (very good) staff met at e.g. LTR (FAO FINNIDA) and CRHHA are graduates of this university. With the additional experience of working under the direction of e.g. Dr Vandelannootte, these people constitute a valuable 'resource' which the LTBP cannot afford to overlook.

6.1.3 NGOs

These must be explored once the security situation improves.

6.1.4 Other organisations

These must be explored once the security situation improves.

6.1.5 Potential study sites visited

These must be explored once the security situation improves.

6.2 Tanzania

From the viewpoint of its location as near to the centre of the region as any of the other main lakeside areas (i.e. Bujumbura, Uvira and Mpulungu), Kigoma must continue to be established as a very 'visible' and strong base for the LTBP. It is relatively easily reached by rail, water (lake) and air from Europe and beyond. Moreover, it can build on the already established laboratory campus of TAFIRI and LTR, and the Ministry of Environment and Tourism's Regional Fishery Department. Other organisations such as the KRWD, and NGOs e.g. TACARE, are nearby. Along with local hotels, these facilities provide some of the best opportunities for regional meetings, workshops and seminars. Of paramount importance in this connection, and in view of the important training element encompassed by LTBP, is the close proximity of Kigoma to a wide range of unimpacted and polluted areas, comprising a broad suite of shore-line habitats (e.g. boulders through to fine muds) as well as influent rivers and the open lake. Phone, facsimile and a number of E-mail links also point to the sense of developing this centre.

6.2.1 Ministry of Water (Water Resources Technical Division), Dar es Salaam

The project must maintain contact with this Ministry Division over all aspects of water resource assessment; any river flow data (generated by the Ministry's Kigoma Regional Water Department) are crucial to obtaining estimates of the loadings of nutrients and pollutants to the lake: 'loading' = water discharge x (e.g.) nutrient concentration). Archived data must also be reviewed.

6.2.2 Ministry of Water (Water Resources Technical Division), Kigoma Regional Water Department

Preliminary plans regarding river flow and sediment discharge recording, must be finalised. An appropriately harmonised programme of water quality monitoring must be designed in conjunction with the KRWD. The SLO must remain in regular and frequent contact with the KRWD and obtain copies of incoming data for analysis.

Further checks than were possible during this mission, need to be made on the actual working order, and mode of storage and maintenance, of the instruments and ancillary laboratory equipment currently lodged at KRWD.

It is recommended that the KRWD's involvement in LTBP water quality work, be focused on the river environments.

Paul Kiliho (Chief Chemist with Kigoma Region Redevelopment Programme) should be contacted in relation to agricultural planning, while the Dar es Salaam (Ubungo) laboratory of the Ministry of Water should be approached over possible training of analytical chemists.

6.2.3 Ministry of Environment and Tourism, Regional Fisheries Department

Links with this department ought to be maintained and strengthened with a view to it contributing to the LTBP by way of not just the provision of catch statistics, but the making available of samples for biodiversity and size frequency analysis, and e.g. liver and other

Moderate funding from the LTBP should be released in order to upgrade/refurbish this site in the following areas: security gates and fences; wooden boats and fibre glass 'launch'; power generator; basic fish measuring devices (scales, rulers, notebooks); boat engine(s); life-jackets; and waterproofs and gumboots.

6.2.4 Tanzania Fisheries Research Institute (TAFIRI) and LTR (FAO FINNIDA)

It is vital that the LTBP strengthens this station - partly because of its location in Kigoma, but also because of its historical association with the LTR (FAO FINNIDA) project; that link has produced a number of dedicated scientists who must be assigned QUICKLY to the project - otherwise they will leave the area (as has happened in one or two cases already). Moreover, the existing laboratory is reasonably well-equipped, and there is an inflatable craft (and possibly the RV '*Echo*' - but see below) The PCU must establish whether all of the facilities previously used by the LTR will - as intimated during this mission - be 'left' to the LTBP.

In spite of the acknowledged experience of many of the researchers and technicians based here, training is still needed; it is thus, very important that the training workshop mooted by this mission (to involve say, 5 scientists/technicians from each of the 4 lake countries), be facilitated as expeditiously as possible.

The alterations proposed by the mission for the TAFIRI laboratory and associated work space should also be made as quickly as possible.

It is recommended that the Kigoma TAFIRI laboratory be the main centre for Tanzania's involvement in the LTBP's lake-based work. In this connection - and in the interests of establishing a sustainable programme of limnological investigations - the mission advises an approach to chemical analysis involving the older, traditional techniques (gravimetry, titrations etc.) rather than the kit-based (e.g. 'Hach' instrument) procedures.

Equipment items recommended for the TAFIRI laboratory are: 1 chest freezer for storage samples etc.; 1 water still - more recent model needed; 2 magnetic stirrer/hot plates; 2 top-pan balance (0.01g sensitivity); 1 double-beam UV/visible spectrophotometer & spares; 1 fluorescence spectrophotometer; camera and attachments for the 3 existing microscopes; a power stabiliser (more powerful than the present one which is only 1.5kVA).

It is again recommended that the long-term and cost-effective acquisition of limnological data on the lake (in the other three countries as well as Tanzania) would be best achieved by the adoption of the more traditional methods of analysis. The 'Hach' kit approach could still be retained for field work and as an alternative method for cross-checking data acquired by traditional procedures.

6.2.5 Tropical Pesticides Research Institute, Arusha

Some decisions have to be made as regards capitalising on the undoubted expertise that exists

tissue and sediment analysis, for example. It is important to establish whether the non-functioning of certain sophisticated analytical equipment e.g. AAS is simply due to lack of spare bulbs asserted by the staff.

6.2.6 Dar es Salaam University, Faculty of Science, and selected departments

We suggest that - of the 6 Departments in the University of Dar es Salaam that the mission visited - few are likely to be of major interest to the LTBP. Exceptions are the potential links identified with the Departments of Chemistry; Civil Engineering (flood frequency analysis and flood forecasting); Geology (XRD analysis of suspended sediments and possibly, of associated heavy metal(s)), and Zoology (Mr Botterweg's computerised database and mapping of species distributions). However, the university as a whole must be viewed as a source of graduates with the potential to contribute to the LTBP through the execution of MSc and/or PhD studies. Such people would almost certainly be required to register with the likes of Dar es Salaam University, even if all/the majority of the work towards these degrees was done at the LTBP lake-side laboratories.

6.2.7 Wildlife Conservation Society of Tanzania

The LTBP should endeavour to establish, at each of its 4 (?) main centres, at least, displays and collections of leaflets, 'fliers', reports and other literature that it produces/publishes. In so doing, it should not only draw on the experience and achievements of the WCST, but accept the offer made by this Society to display such publicity material at its headquarters in Dar es Salaam. (See also recommendations relating to 'Links with Environmental Education').

6.2.8 Other organisations

a. The Lake Victoria Environmental Management Plan (LVEMP)

A representative of the LVEMP (Mr Mbwana) was invited to speak at the LTBP Inception Workshop in Dar es Salaam (March 1996). Such a move should be repeated by inviting Mr Mburane or 'A.N. Other' to as many of our (i.e. LTBP) planning/strategy meetings - and even seminars/workshops. Invitees to meetings devoted primarily to field and laboratory practice should, however, be more or less strictly reserved for practising researchers and technicians - not administrators, institute directors and national co-ordinators. This does not obviate the occasional presence of such officers, however; indeed, the LTBP Special Studies must foster good scientist-administrator collaboration.

6.2.9 Potential study sites in Tanzania

i. Gombe Stream National Park

Particularly during the approximately 12-month period envisaged primarily for training national appointees to the LTBP, the Gombe area should be used as a field site. Firstly, it appears to represent one of the least impacted areas visited by this mission; it could provide, for example, a rare opportunity to study the chemistry (pollutant status) and sediment loads

within two hours from Kigoma. Thirdly, the Gombe Park is associated with the Institute directed by Dr Jane Goodall, with whom we briefly discussed possible collaboration; such a link can only prove beneficial to the GEF project, and may even lay the foundation for one of the Aquatic (Reserve) Parks that the LTBP is committed to establishing.

It is suggested that (i) the feasibility of 'manning' such a site in the longer-term be explored, and (ii) the costs are estimated for resourcing the park headquarters - capacity-building at the same time - with water quality probes, sampling gear and e.g. a freezer-refrigerator for storing batches of samples until they can be dispatched to e.g. Kigoma.

ii. Rivers Luiche and Malagarasi

It is important for the LTBP to help the KRWD to maintain (or re-establish) their recording of river levels - and thus water discharges - and sediment loads from these rivers; this may mean the project lending the KRWD a vehicle plus driver at regular intervals, and providing sampling gear and storage bottles; however, without this, the chance of obtaining valuable information on these relatively impacted waters and their deltas, will be lost.

iii. Sites between Kigoma and Gombe

A number of sites comprising a rich variety of beach and shoreline habitats within this stretch of the lake, needs to be selected for investigating e.g. the impact of vegetation burning on water quality and biodiversity. It is also important for another reason, that this area of apparent, substantial, ecological diversity is surveyed: it may help to distinguish between species diversity and distribution patterns that are controlled by pollution, from those determined largely by availability/non-availability of substrate.

iv. Lake Shore Sites to the South of Kigoma

There is probably little difference between the overall ecological diversity at these sites, and those found in many places elsewhere. However, it is recommended that in the early stages of training scientists and technicians in field sampling techniques, these areas be used. Firstly, the sites lie just a few minutes' drive from Kigoma; secondly, these small bays contrast with Kigoma Bay in terms of size and pollution pressure.

v. River Luiche - Gauging Station 4B9

This station should be included in programmes aimed at quantifying riverine pollution and/or sediment pollution loadings to the lake. As such, it could generate some of the first estimates of the rates of loss - and thus, 'export coefficients' - of materials such as nutrients, from the land areas drained.

vi. River Luiche near Ujiji

For reasons relating to the risk of people damaging or stealing recording instrumentation left in this area, it is suggested that the site is not used by the LTBP.

vii. River Malagarasi - onshore at Gauging Station 4A9

It is unfortunate that this station is likely to be inaccessible by road from Kigoma in the wet season. Otherwise, it is recommended that the existing cableway for current metering be used for that purpose, and for the collection (by rope and bucket?) of samples for water and suspended sediment analysis and quantification across what is a reasonably wide river stretch (120 m plus).

viii. Luiche and Malagarasi deltas - offshore

It is suggested that however difficult it is likely to be, that some work is done towards quantifying particulate and solute inputs to Lake Tanganyika from the much larger of these two rivers - the Malagarasi. The observations made in August 1996 at least, suggest too, that the deltaic area harbours diverse assemblages of fish, zoobenthos and both emergent and submerged hydrophytes; it is likely that a rich microflora and fauna is associated with these plants, but the LTBP should investigate this to establish the actual situation.

ix. Mahale Mountains National Park

Even ignoring scientific reasons for investigating situations of relevance to the 'Pollution' 'Sediment Pollution' and 'Biodiversity' Special Studies, it is suggested that this very special 'pristine' area be included. The area is one of the remotest from any of the 4 main project centres presently envisaged. However, the keenness of the Park staff to be involved, combined with a resourcing strategy recommended for Gombe (see above), could easily accommodate valuable echo-sounding, river gauging and associated chemical and biodiversity work here.

6.3 Zaire

This mission visited only one institution in Zaire (CRH, Uvira) but plainly, if and when the current security situation in Zaire improves, every effort should be made to explore the potential for collaborating with other institutions too. This should include NGOs as well as GOs that exist in the enormous area of Lake Tanganyika that lies within this country and especially over the astounding length of land-water interface.

6.3.1 Centre Recherche de la Hydrobiologique d'Uvira

In spite of the ongoing debate on whether Uvira or Kalemie is to be the main base for LTBP, activities in Zaire, there are numerous reasons for resourcing the latter station: e.g. a very accommodating and effective Director; ample space for both scientific work and an environmental education centre; a significant amount of field and laboratory equipment on which to build, although much of this must be repaired, and e.g. batteries and spare bulbs and other parts must be purchased. The possibility of providing a meteorological station at Uvira should be considered.

On quite a different front, the PCU/NRI must arrange for LTBP staff to pass into and out of the lake countries with considerably greater ease than that experienced by the present mission

During the relatively short tour of the laboratories (as against lengthy discussions with the scientists round the table), few major equipment items were evident. What is more, most of these were defunct, although for want of a reliable power supply, or small replacement parts such as bulbs, fuses, batteries. Examples are an 'Indesit' freezer-refrigerator'; a 'Yamato DN-42' constant temperature oven; a 'Van der Heyden' drying oven; and an 'Aquarius' G5-18 water still.

6.4 Zambia

6.4.1 Department of Fisheries, Mpulungu

Department of Fisheries, Mpulungu

The laboratory staff at Mpulungu have substantial analytical experience and have benefited in both laboratory facilities and training from their association with the LTR project. It is recommended that the Fisheries Laboratory be the principal site for the limnological and biological measurements of the Zambian waters of the lake. The activities of the station as a whole are severely curtailed by the present financial restrictions and it is proposed that the LTBP strengthens the Department and draws as fully as possible on the experience of the present staff.

The proposed changes in laboratory layout and the additional facilities suggested will result in a substantial increase in, and a more effective use of, bench space. It will also facilitate the adoption of the more traditional methods of analysis that are recommended. As suggested by this mission for other laboratories which are to be being strengthened by the LTBP, the re-introduction of the more conventional *and sustainable* chemical analytical methods (involving gravimetry, titrations etc.) will require training programmes. These could be located at Mpulungu and/or Kigoma. However, the 'Hach' kits should be retained for field work and for cross-checking the results with the traditional laboratory-based methods.

The modifications proposed for the laboratory complex (primarily extra benches and shelving; more electronic points; and the installation of a fume cupboard and air-conditioning) should be put in train a.s.a.p. The resources needed to resume routine measurements of relevance to the LTBP must be provided. This must also incorporate a shift in analytical practice from one relying almost entirely on 'Hach' type apparatus methodology. The 9 sets of equipment items identified as being of particular importance to the strengthening of the laboratory, should be purchased and air-conditioning should be seriously considered for the library/computing room; this is especially important in view of the fact that we are also recommending that a more powerful desk-top computer than those already present is provided -in order to mount a wider range of database software and access to CD ROM-based literature searcher.

A functional radio is a first priority for the RV *'Silver Shoal'* along with provision of cooking and toilet facilities. The motorised (anchor) which must be repaired, and the present sampling winch should be replaced with a more substantial one. We recommend that an inflatable craft

engines are 'seaworthy'. We still have to ascertain whether it is worthwhile mending the present (3) 'banana boats'.

6.4.2 Food and Drug Control Laboratory, Ministry of Health, Lusaka

The co-ordinators of the Special Studies on 'Pollution' and on 'Sediment Pollution' must decide soon. to what extent this laboratory might be better than TPRI (Arusha) and more convenient, for analysing pesticides in samples collected in the Zambia (i.e. 'deep southern') sector of the lake. The general consensus prevailing at present, is that while Zambian institution may have little first-hand experience of analysing limnological materials such as fish tissue and e.g. plankton concentrates, they are well-qualified in terms of overall laboratory practice. What is more, their experience with soils must be of relevance to techniques for analysing sediments. The FDCL staff are also very keen to become involved in the LTBP.

6.4.3 Geological Survey Department

It is suggested that this Department be kept abreast of LTBP developments, with the view to identifying collaborative practical programmes that are strictly germane to the interests of (especially) the 'Sediment Pollution' Special Study.

6.4.4 National Council for Scientific Research (NCSR), Lusaka

Collaboration between the LTBP and this Council - especially its Water Resource and Environmental, and the Radio-isotope Research Units - could prove of considerable mutual value. Its Livestock and Pest Research Centre also expressed an interest in the Lake Tanganyika project. However, much of the (largely substantial and sophisticated) instrumentation, in which we would be interested, would need a considerable injection of funds for repairs, up-grading etc. LTBP personnel will have to make a decision on this, after we have assessed better the resource needs in the lake region as a whole.

As an example, for the WRERU to measure heavy metal residues in fish and other aquatic organisms, a significant proportion of its instrumentation would need to be upgraded to include a graphite furnace; without this, this we cannot achieve the necessary sensitivity required by the LTBP. In view of the age of the present AA instrument, this option, even if technically feasible, is not recommended.

6.4.5 University of Zambia (UNZA), Lusaka

As with many of the NCSR units, a number of the UNZA departments are keen to be involved in the LTBP. Again, for this to transpire, the programme would need also to invest in the University considerably, primarily by way of equipment maintenance and/or upgrading. Taking account of this as well as the more or less imminent retirement of key staff such as Professor Cernek in the Chemistry Department, it is recommended that this Department is not approached at this stage about involvement in the LTBP.

Contrastingly, it is suggested that the well-equipped (AAS, XRF and XRD) laboratories of the Departments of Geology and Metallurgy/Mineral Processing are used for LTBP heavy metal and sediment analysis; moreover, it is recommended that a number of these analyses be done in conjunction with the Radio-isotope Research Unit of NCSR as part of an international inter-laboratory AQC programme. Whether the latter materialises, however, depends on the decisions made in relation to the involvement of the NCSR unit in the LTBP.

It is suggested that Dr Sichingabula of the Department of Geography and Mr Chileshe of the Dept of Water Affairs be encouraged to put together a programme of compiling river data and developing a monitoring programme for the Zambian Lake Tanganyika Basin.

We recommend very strongly that LTBP funds are provided to establish what would almost certainly prove to be a valuable link, with the Physics Department's Environmental Research Centre. Indeed, without such collaboration it is difficult to see how the LTBP could gain any reasonable estimates of the inputs of solutes and particulates onto the lake surface. What is more, the extra instrumentation envisaged - including more computing power -for strengthening such a venture, is likely to be comparatively minor.

Regardless of specific weaknesses in various university departments, the LTBP must also consider capitalising on the enormous potential that the universities possess by way of students - at under-graduate, post-graduate and post-doctoral levels.

6.5 Existing data

6.5.1 LTR data

The major existing datasets on the fisheries and pelagic-zone ecology of Lake Tanganyika are those assembled by LTR and preceding FAO fisheries projects. These datasets are the property of the national governments, who participated fully in creating them, and on whose behalf they were collected. It is recognised that LTR scientists have prior claim to the data for the purposes of analysis, but it is important that these datasets be made available as soon as possible to the institutions in the riparian countries that are collaborating with the GEF project and its special studies. It is normal practice that such data are made available on completion of project final reports.

It has been established that industrial catch records from the Zambian sector are available as an unbroken series since 1962 - a valuable dataset.

Action: Formal request from National Co-ordinators to LTR Project Manager for release of all LTR datasets on completion of the final report. Request to be drafted by PCU/NRI management team.

6.5.2 Data from Japanese work on the lake.

Japanese scientists and their riparian-country counterparts have assembled a variety of survey and ecological data and observations. The raw data, in electronic form, seems unlikely to be available. The Japanese research team, notably Dr Tetsu Sato, have been extremely co-operative and supportive in the field, and have made available what they have. A full set of publications, including a forthcoming book on Lake Tanganyika, should be available from Kyoto University Press, or perhaps through Dr Sato.

Action: SLO and Biodiversity Special Studies Co-ordinators to assemble one copy of this

6.5.3 Data from Speciation in Ancient Lakes teams (SIAL).

The co-operation and assistance of the SIAL group is required to set the Biodiversity field programme into operation. Their co-operation may also ensure the availability of their data on distribution and abundance of fishes, molluscs, ostracods etc. This would form an important input into a GIS system of species distributions around the lake.

The Sediments Special Study Group have already enlisted the assistance of Dr Andy Cohen's team for research of mutual interest. Similar arrangements should be explored for the Belgian-based SIAL members (see section on Fieldwork Strategies).

Action: Meeting to be arranged between Biodiversity groups and SIAL members to discuss acceptable terms and strategies. EHA to initiate contact if required.

6.5.4 Data from Zambian Gillnet survey programme

Fisheries Department in Mpulungu maintain an important series of scientific surveys of benthic fish communities using gillnets. These have been undertaken in the Nsumbu area at ten year intervals for 40 years. Summary tables were transferred to computer and analysed by Martin Pearce, but raw data are still in paper files. The Mpulungu staff hope to transfer this data to computers in the near future. They also have funds and equipment from the Zambian Fisheries Dept. to carry out a further survey, comparing benthic fish communities in Chituta Bay with Nsumbu. This will be carried out early next year. It would be useful to incorporate this initiative into a wider biodiversity survey.

Action: Biodiversity Special Study to offer assistance with database design and financial incentive to complete the work rapidly. Assistance with analysis if appropriate.

6.5.5 Ecological/biodiversity, management work done on Gombe Stream NP

An extensive bibliography of work done in Gombe Stream NP is available. Dr Martin Walsh, NRI, obtained copies of relevant papers on his visit to the park.

Action: SLO to obtain copies to retain in Kigoma, and make a bibliography available to the Special Studies groups. The Biodiversity Special Studies Group should obtain copies.

6.5.6 Aquarium fish trade

Dr. Bannister's interaction with the aquarium export traders indicate that the responsible operators with long-term interests in the area are willing to share their data on fish exports, catches and the results of their monitoring programmes with the project. In addition to their potential active participatory role, this willingness to make available their data is particularly encouraging in developing initiatives for sustainable monitoring programmes beyond the duration of the project.

6.6.7 Data from National Biodiversity Surveys

There are GEF-funded national biodiversity inventory projects operating in both Tanzania and Zambia and possibly Zaire. The Tanzania country database is being set up by Mr Ron Botterweg, FAO.

6.6.8 Hydrological and Meteorological data

Clearly a large amount of data exists in government archives of variable quality and intensity.

APPENDICES

APPENDIX I: TERMS OF REFERENCE OF VISIT

Pollution Control and other measures to Protect Biodiversity in Lake Tanganyika (RAF/92/G32). Special Studies: 'Pollution of International Waters', 'Sediment Discharge and Its Consequences' and Related biodiversity studies

Terms of Reference for country visits by project technical advisors -Natural Resources Institute (NRI), Institute of Freshwater Ecology (IFE) University of East Anglia (UEA) and University of Dundee (UoD)

1. Introduction

The task of this mission will be to make a practical assessment to follow up the baseline review and draw up plans for detailed studies to be initiated in Stage II. The studies are to be conducted by suitable local institutions, with technical support, supervision and co-ordination by the NRI/IFE/UEA/UoD Consortium project team. The mission will determine which institutions can most suitably undertake the studies in each country, enlisting their support in setting specific objectives, development of terms of reference and implementation of different elements of the special studies, also considering contractual arrangements.

This visit follows for the Inception Workshop of the project where the principal objectives of each special study were agreed and a number of Institutions were identified which may play a role in the study. This material has been compiled in an Inception Report and this will be available by the period of the visit and will summarise the priorities of the special studies which form the basis of this mission ('Pollution of International Waters' and 'Sediment Discharge and Its Consequences')

The Inception Workshop endorsed proposals for assessment at selected sites in each country, to be undertaken. The workshop also identified the need to incorporate 'pristine' unimpacted/unpolluted sites in the surveys, and take account of the situations prevailing in open and in-shore waters, including the water column, near-bottom waters and sediments and other substrates.

The mission will comprise Graeme Patterson (NRI), Tony Bailey-Watts (IFE), Robert Duck (UoD) and Chris Foxall (UEA). The mission is likely to span 3-4 weeks in August 1996.

Table 1: The organisations proposed by the national delegates for involvement in the work.

BURUNDI	TANZANIA	ZAIRE	ZAMBIA
m ainly Bujum bura: ********** The University of Burundi - Chem istry Departm ent The University of Burundi - Biology Departm ent University of Burundi, Department de Earth Sciences FAO FINNIDA LTR station (plus links with Uvira) INECN Institut Département des Eaux, Pêche et Pisciculture CRRHA IGEBU	m ainly Kigom a and Dar es Salaam : ********** Ministry of Water, Environm ent and Minerals TAFIRI NEMC University of Dar-es-Salaam TANAPA Department of Wildlife Department of Fisheries Frontier Tanzania (NGO)	Uvira or Kalem ie? ********** Centre de Recherche en Science Naturelle The University of Kinshasa: Institut Superiere Pedagogie, Bukavu. Centre Recherche d'Hydrobiologique	m ainly Mpulungu and Lusaka ********** UNZA National Council of Scientific Research, Lusaka (especially for Analytical Quality Control) ECZ Food and Drug Laboratory Departm ent of Water Affairs Fisheries Department National Parks and Wildlife Department Ministry of Water Soil conservation unit of Dept. of Irrigation and Land Husbandry

2. Terms of Reference

All members will visit the 4 countries, i.e. Burundi, Tanzania, Zaire and Zambia, although not necessarily the same institutions and locations (See Table 1). Also, because TBW has visited Bujumbura (Burundi) and Kigoma (Tanzania), perhaps extra special efforts be made to assess first the situation in Zaire and Zambia. In so doing, the mission will:

i) visit the institutions identified above, and investigate their capacity - with respect to human resources, infra-structure and equipment - and identify those institutions that will collaborate with the project and the specific individuals that will be assigned in the lake basin area.

ii) where possible in the time available, identify the nature and scale of logistic problems in each country's lake sector that have a bearing on the sampling schedules envisaged, and how these 'aspirations' relate to 'practicability'. Appendix I which outlines the results of, and priorities identified by the Inception Workshop, includes details of sampling areas proposed.

iii) propose arrangements for execution of all stages of the work, i.e.:

- planning of field and laboratory work
- assembling equipment for travel to sampling sites; sample collection, preservation and storage
- field recording
- laboratory analysis
- data analysis
- interpretation and reporting of the results.

iv) hold discussions with National Co-ordinators to consider their ToR in relation to the above, and assist in planning, education and training needs relating to the work within the studies.

v) develop country strategies for all aspects of the studies.

vii) review the interim findings with the PCU at a team meeting to be held provisionally in Kigoma (Tanzania).

viii) provide National Co-ordinators (*via* the PCU in Dar) and NRI with full reports detailing the findings of the mission and recommendations for the conduct of the Pollution and Sediment Discharge Special Studies.

Departure dates from UK as near as possible to 1 August 1996 should be arranged forthwith. Full reporting to NRI should be complete by the end of September 1996. Precise travel schedules and meetings will be worked out as contacts with the respective national institutions are established.

3. Notes - for the PCU

A number of tasks need to be attended to, by the PCU in preparation for this mission. It should:

i) identify specific individuals and gather the contact numbers for the relevant national institutions

ii) notify the National Co-ordinators/local institutions contact persons, of the objectives and timing of the proposed visits

iii) translate the ToR into French

iv) investigate the possibility that Sarah Oume-Bottelberge could join the mission?

v) clarify the logistics for the journey, local transport schedules, the possible need for local travel permits, and arrangements for provision of transport or funds to secure it.

vi) consider the financial mechanisms for disbursal of funds for Special Study sub-contracts with national institutions, and clarification of procedures to be followed for the negotiation of contracts with local institutions

4. Transportation

It is essential that this mission includes visits to all four riparian countries including visits to Kigoma, Bujumbura, Mpulungu and Uvira (or Kalemie) on the lakeshore. Further visits to Dar-es-Salaam, Kinshasa and Lusaka may also be necessary in order to contact key personnel at various government institutions. It is suggested that the PCU investigate hiring the 'Tanganyika Explorer' for at least two weeks during the period of the visit (latter part of August 1996) to allow visits to the lakeshore stations. If this period of hire can be included with visits made by the PCU and the Biodiversity special study then this could be very cost effective. It is suggested that if this is possible that the four national co-ordinators (or their nominated representatives) also be included in this part of the visit. A period onboard the 'Tanganyika Explorer' will also allow key the key members of the Special Studies to become familiar with the capabilities of the ship and would also allow the viewing of the key areas of the lake.

APPENDIX II: PROFORMA/ **'AIDE-MEMOIRE'** *USED FOR RECORDING INFORMATION GAINED DURING VISITS TO INSTITUTIONS AND THE ASSESSMENT OF RESOURCES.*

General comments: We are about to embark on our tours of the LT region with the main view to assessing what is already available (and as importantly, what is not) as regards resources needed to execute the Special Studies on Biodiversity, Fishing Practices and Biodiversity, Sediment Pollution and its Impacts on Biodiversity, and Pollution in International Waters and its Effects on Biodiversity. This document is an *aide memoire* aimed at reducing the chances of our forgetting/overlooking issues on which we need to focus during these tours, and our visits to institutions and discussions with personnel. While not a *major* concern of these trips, the 'nature' (aspect, accessibility, sampling gear needed, etc.) of potential sampling sites should be assessed and noted (photograph/s?) - where time allows.

The situations/items that we need to assess/count are grouped below into 6 categories. Note that this extensive list represents something like the 'ideal' situation we hope to achieve; it is likely that rather few of the items listed will be found in the majority of the institutions we visit. Also, some information may be lacking altogether. We will thus be commenting on relatively few of the items - and even then, we need only brief, though reasonably accurate, notes (for example, the 'condition' of a room, the numbers of people, the model and make of a piece of equipment).

INSTITUTION:
1. MAJOR INFRASTRUCTURE - BUILDINGS

Proximity to lake/sampling sites:
Proximity to airport:
Proximity to railway:
Dimensions:
Roof type/condition:
No. rooms: reception/office: lab.,wet: lab. dry: meeting:
library/writing:
Benches:
Chairs:
Shelving:
Racks:
Cupboards:
Fume cupboard:
No. windows:
Power supply:
No. sockets:
Emergency power supply - compressor:
Surge-protection/current stabilisation:

Water supply:

Workshops:
Garage/boat compound/store:
Fuel store:
'Safe' chemical store:
First-Aid facilities:
Protective clothing/life-jackets:

Security - general:

2. PERSONNEL

(Cleaners/ Drivers/ Security/ Boat handlers/ Field operatives/ Technicians/ Researchers/ Administrative/ Office typists/ telephonists)
Total number of staff:
Information on individual staff:

Name:
Grade: Tel: Fax: E-mail:
Availability and on what appointment basis: casual, temporary/term, 'permanent'. Experience:
Qualifications:
c.v. collected?:
Name:
Grade: Tel: Fax: E-mail:
Availability and on what appointment basis: casual, temporary/term, 'permanent'. Experience:

Qualifications:
c.v. collected?:

Name:
Grade: Tel: Fax: E-mail:
Availability and on what appointment basis: casual, temporary/term, 'permanent'. Experience:

Qualifications:
c.v. collected?:

Name:
Grade: Tel: Fax: E-mail:
Availability and on what appointment basis: casual, temporary/term, 'permanent'. Experience:

Qualifications:
cv collected?:

3. FIELD EQUIPMENT

Vehicles: age, condition and availability:

Maps:
GPS:
Anchors and ropes:
Waterproof note-pads and pens/pencils/field tape recorder (personal 'memo'):
Cameras:

Fishing gear:
Spring/electronic balance/field scales:
Ruler:
Dissection kits:
Fish scale envelopes:

Discrete depth/profiling sampling gear (winches, cables, ropes) and sample containers (inc. polybags), fixers/preservatives for:

- water and associated organisms inc. fish/tissue:
- fine sediment ..... ditto
- coarse sediment.....ditto
- stones.....ditto
- pebbles.....ditto
- rocks.....ditto
- cliffs.....ditto
- macrophytic vegetation.....ditto
- animals (inc. crocs and hippos with astoundingly diverse epizoic assemblages)

Dark/cool boxes - dri-ice:
Discrete depth/profiling field probes:

- temperature, dissolved O_2, conductivity, **p**er**H**aps, sampling depth:

Echo-sounding gear:
Sun-protection awning/canopy:
Field filtration kits:

4. LABORATORY EQUIPMENT - mainly furniture, as glass- and polythene-ware and many equipment items including microscopes are listed in the Baseline Review on 'Pollution and its effects on biodiversity'.

Still - distilled water:
Freezers:
Refrigerators:
Ovens:
Hot-plates:
Balances ?sensitivity:
Fluorometer (for field and lab use:
Spectrophotometer:
Aquaria:
Photomicrographic apparatus/image-capture facility:
Glass- and polythene-ware - see separate lists:
Laboratory tissues:

5. DOCUMENTATION

Books:
Reports:
Journals:
Re-prints:
Manuals for chemical analyses;
ditto for organism identification:
Archived data:

6. OFFICE:

Communications:
Phone - Fax - E-mail - Radio.
Hardware:
p/cs:
typewriters:
printers:
paper:
pens, pencils etc:
Software:
For leaflets, special issues: Desk-top publishing facility
For routine reporting: e.g. WordPerfect/Word for Windows: Excel/Lotus/HYDATA: Sigma-Plot or equivalent:

APPENDIX III : ENGLISH-FRENCH SUMMARY OF BASELINE REVIEW ON POLLUTION IN INTERNATIONAL WATERS AND ITS EFFECTS ON BIODIVERSITY IN LAKE TANGANYIKA

To reduce the bulk of this draft document this summary is not included in the draft version. This material is available in the respective baseline review.

APPENDIX IV : ENGLISH-FRENCH SUMMARY OF BASELINE REVIEW ON SEDIMENT POLLUTION AND ITS IMPACTS ON BIODIVERSITY IN LAKE TANGANYIKA

To reduce the bulk of this draft document this summary is not included in the this version. This material is available in the respective baseline review.

APPENDIX V: LTR STAFF

The national staff contributing to the different aspects of the 'Programme for basic monitoring' at LTR Stations. (Names in italics denotes those persons responsible for the activity at a station).

BUJUMBURA	
Hydrodynamics	*Mr Kakogozo* and Mr Nikomeze
Limnology	*Mr Tumba*, Mr Nyamushahu, Mr Tshibangu, Mr Butoyi, Mr Ndimunzigo, Mr Nikomeze and Mr Gahungu
Zooplankton	*Mr Bwebwa* and Mr Nyamushahu
Fish biology	*Mr Nikomeze*, Mr Butoyi, Mr Ndimunzigo, Mr Tumba, Mr Nyamushahu and Mr Gahungu
Fish statistics	*Mr Nikomeze*, Mr Ndimunzigo, Mr Gahungu and Mr Tumba
KARONDA	
Fish biology	*Mr Nibigira*
KALEMIE	
Hydrodynamics	*Mr Detsimas*
Fish biology	*Mr Mundula*, Mr Chalula and Mr Kavula
MOBA	
Fish biology	*Mr Mpweto*
UVIRA	
Fish biology	*Mr Bahane* and *Mr Mbemba*
Fish statistics	*Mr Mambona* and Mr Kwetuenda
Zooplankton	*Mr Bwembwa*
Chemistry	*Mr Tshibangu* and *Mr Kimbadi*
Sedimentation	*Mr Kahindo* and *Mr Mwenyemali*
KIGOMA	
Hydrodynamics	*Mr Kihakwi*
Limnology	*Mr Chitamwebwa (Director)*, Mr Lyoba and Mrs Lyoba
Zooplankton	*Mr Kalangali (Deputy Director)*, Mr Muhoza and Mr Kadula
Fish biology	*Mr Katonda*, Mr Kissaka and Mr Kashushu
Fish statistics	*Mr Kissaka*, Mr Katonda and Mr Kashushu
MPULUNGU	
Hydrodynamics	*Mr Makassa*, Mr Kaoma and Mr Sichivu
Limnology	*Mr Mwape*, Mr Lukwessa, Mr Ngandu and Mr Shapola
Zooplankton	*Mr Zulu*, Mr Sichivu and Mr Kaoma
Fish Biology	*Mr Milindi*, Mr Mwape, Mr Kabakwe, Mr Mwenda, Mr Chomba, Mr Syapila, Mr Skaona and Mr Banda
Fish statistics	*Mr Mwape*, Mr Milindi, Mr Kabakwe, Mr Mwenda, Mr Chomba, Mr Syapila, Mr Skaona and Mr Banda

APPENDIX VI: REPORTS OBTAINED

Anon. (1996). Reconstruction and development programme (RDP) for refugees affected areas in Kigoma (sic) - Short term action plan and project profiles. Office of the Prime Minister/Office of the Regional Commissioner, P.O. Box 125 Kigoma. January, 1996

> [Section 4.3.2. Artisanal Fishery, pp 56-58 - proposed 3 year fishery project implemented by FAO to buy fishing gear and distribute it on credit & other support for artisanal fishery - to be channelled though Fisheries Dept., Kigoma]

Chipungu, P.M. & Kunda, D.M. (eds) (1994). State of Environment in Zambia. Environmental Council of Zambia, Lusaka. 116 pp.

Dodman, T. & Taylor, V. (1995). African Waterfowl Census 1995. IWRB, Slimbridge, U.K., 192 pp.

Kigoma Regional Socio-economic development Profile/Brief. Joint Publ. of The Planning Commission, Regional Rural Development Division, Dar es Salaam and The Regional Commissioner's Office, Planning Dept., Kigoma

(a similar document exists for Rukwa Region)

NORAD (1993). NORAD-funded Integrated Rural Development Programmes in Tanzania. KIDEP - Kigoma region & RUDEP - Rukwa region. Royal Norwegian Embassy, Dar es Salaam.

Suontausta, T. (1992). Fisheries of Lake Tanganyika in a socio-economic context: management or adaptation? MSc thesis, Norwegian College of Fisheries Science, Univ. of Tromso.

UNDP (1993). Institutional support for the protection of East African Biodiversity UNO/RAF/1006/GEF Project Inception Report, 1993.