

LAKE TANGANYIKA BIODIVERSITY PROJECT

Consultant Ref. No: 993

Project Number: C0765

Report of Visit to Zambia and Tanzania as part the Special Studies on sediment and its consequences.

This report covers the period 25 August-1 October 1997 and relates to a contract issued by NRI on 11 August 1997,

Stage 1. Travel to Mpulungu, Zambia

25 August, 18:00 Dublin to Stansted for onward flight to Dar es Salaam via Amsterdam, 26 August with 27-29 August spent at offices of Biodiversity Project in Dar es Salaam. This time was spent in discussions with Dr Menz (Project Coordinator) and Dr West (Scientific liaison officer), obtaining some chemicals for invertebrate preservation and arranging Zambian visa. The visa cost was TSh 15000 and can be applied for from the Zambian High Commission on Monday, Wednesday and Friday, requires 2 passport photos and takes 24 hours to arrange.

29 August, 17:00 Tazara train to Kasama in Zambia. Journey takes about 30 hours and is comfortable enough in first class. Meals are served for breakfast, lunch and dinner. Zambian kwacha can be obtained on the train from money sellers at more or less the same rate as the banks.

31 August arrived in Mpulungu. The journey from Kasama takes about two and a half hours. In Mpulungu I met the local project liaison officer, Dr. Martin Pearce, who arranged accommodation at Nkupi lodge. It is comfortable and adequate, but does not normally serve food. For a long stay it is possible to arrange some cooking. A little restaurant in town, 15 minute walk away, provides adequate meals. Discussions that day were had with Dr Pearce, Dr Henry Sichingabula, from the Geography Department of University of Zambia and with John Chama from Water Resources Dept., Kasama to arrange my programme and reach agreement over transport requirements. The Zambian scientists were there to check on existing river monitoring gauges of major inflows into the lake within Zambia and scope the feasibility of setting up or reviving a river monitoring programme as part of the Special Studies on Sediment.

Stage two: Mpulungu, Zambia (31 Aug-12 Sept.)

The objectives for my stay in Mpulungu were to

1. Identify suitable sampling sites near or within river mouths in order to obtain information on the effect of sediment texture and loadings on the distribution of invertebrates.
2. Locate a suitable site for a field study on the impact of sediment on biota.
3. Assess the capacity of the laboratory to carry out the research.

These goals were outlined to Mr Mwape, Director of the Fisheries lab at Mpulungu, on September 1. Field sampling was done from the RV SILVER SHOAL and from a small "banana boat". I was accompanied on all of my trips by Mr. Robert Sinyinza, a new Research Officer and Clement Sichamba, the skipper of the boat. For the sampling of the river mouths to the west of Mpulungu I was also accompanied by the hydrological team of Dr Henry Sichingabula.

Objective 1: River mouth sampling sites.

Between 1 and 9 September I collected grab samples from seven river mouths around the Zambian coast (Fig. 1). These were sorted subsequently in the lab. under a stereomicroscope and a collection made of the invertebrates found. Below is a brief description of each site sampled, the range of samples collected and a summary of the taxa found. Detailed description of species found was not attempted. All samples were preserved in 10% buffered formaldehyde. Comparisons of using sieves of different mesh size suggested that a 355 μm mesh size is adequate to collect the vast majority of the benthic invertebrates, but to err on the side of caution and account for collection of e.g. juvenile ostracods a mesh size of around 250 μm who be used.

(i) Kalambo River

The mouth of the river was estimated at 5-7m wide and is situated at the southern end of a wide track of reed swamp. There is a small village there. Three samples were taken at depths between 2.5 and 30 m with an Eckman grab in a transect perpendicular from the shore. Samples were collected on 350 μm and 180 μm mesh sieves. Substratum was a mixture of coarse sand and some organic material including bits of leaves and stems. The Kalambo marks the border between Tanzania and Zambia and drains a large catchment that lies in both countries. The Catchment, at least in the Zambian side contains the Lungu protected forest area and Lungu Reserve. From what could be seen from the boat the catchment is moderately well forested.

Invertebrates in the samples were mainly oligochaetes, ostracods and chironomids. Abundance of organisms in the first sample was greater than that from the other two, where it seemed abundance was low.

(ii) Luचेche River

There was no obvious sign of water flowing into the lake. High reed growth along shore and some beach seining was happening. The lake bottom there was sandy with some large boulders. Sediment was collected from two sites. The first was 2 m deep about 50 m offshore; the second 9 m deep about 100 m offshore. Sediment was divided into fractions $>355\mu\text{m}$ and $>65<355\mu\text{m}$. The catchment is not as large as that of the Kalambo with evidence of patchy vegetation clearance. There is a village close to the river mouth an extensive plantation of mango trees. It did not appear that water was flowing into the lake.

Invertebrates were dominated by ostracods. Also present were oligochaetes, chironomids, nematodes, ephemeropterans, harpacticoids copepods and a number of stone cases, some of which were occupied, and probably constructed by insect larvae. One small mite was found. Overall invertebrate abundance was low from all the samples collected.

(iii) Lunzua River

The enters Chitata Bay. The sediment was fine and organic. At the first site, 2.4 m deep and about 30 m offshore sample was divided into >355 and $>65<355\mu\text{m}$ fractions. At the second site, 9 m deep and approximately 100 m offshore the sample was divided into three fractions by passing it though 355, 180 and 65 μm sieves. From the lake the catchment appears moderately well forested with extensive growth of mango trees behind a strip of reed that grows around the river mouth and along the margin of the lake. There was a small amount of water flowing into the lake.

The invertebrate community from the samples taken comprised mainly oligochaete and other worm-like creatures. Chironomids and ostracods were also quite prevalent. There were some tube dwelling insects and quite a lot of empty cases somewhat akin to the tubes of marine fan worms. Ostracods were not prevalent and comprised individuals of relatively large body size. The nature of the invertebrate community struck me as in keeping with the seemingly high organic content of the sediment in Chitata Bay. Overall abundance of benthic invertebrates also appeared higher than found in the samples from the Kalambo and Luheche. It is possible that the bay acts as a settling area for organic matter, such as phytoplankton, generated in the lake.

(iv) Mutifume River

Narrow river output (estimated at 3-5 m wide) amongst dense growth of reed. One sample collected from 3m depth about 25 m offshore. Substratum was hard sand and took a number of attempts with the Eckman grab to collect a reasonably sized sample. The Mutifume flows down a steep escarpment that is quite well forested. The catchment includes some land at the top of the escarpment, within the Lungu (Tafuna) Reserve. Sediment samples was fine sand and contained very few invertebrates.

(v) Lufubu River

The Lufubu is the largest of the Zambian rivers that drain into the lake. Its catchment drains large tracts of land that are protected within the Sumbu National Park. The river mouth did not contain any obvious delta and the SILVER SHOAL could approach quite close to the shore. There is, however, a network of channels among the reed swamp before the river enters the lake. The river was an estimated 20-30 m wide at the mouth and the channel remains wide for a considerable distance inland. There were clear signs that the river in spate is much wider and deeper. Samples were collected about 200 m offshore in 3.5 m depth of water. The sediment seemed mainly inorganic. Invertebrates in sample were not very abundant and contained chironomids, harpacticoids and nematodes. Notable that oligochaetes and ostracods were not found.

Chisala River

This was sampled after spending overnight of 8 September in the Wildlife Service resthouses-adequate but basic-in Sumbu village. Sample taken at a depth of 2 m about 80 m from the mouth of the river, a small channel emerging at northern edge of a fairly extensive bed of reeds. Lake bed comprised fine sand and some large boulders and some plants, identified to be charophytes. The sediment sampled contained relatively high amounts of organic material and plant debris and a diverse invertebrate community, probably reflecting an association with the plants. Chironomids, oligochaetes, ostracods, Ephemeroptera, shrimps, bivalves and gastropods were found. Nothing was obviously dominant.

Izzi River

The Izzi seems like it could be a large river during the rainy season, but no obvious water flowing during my visit. There was an extensive bed of reeds. Sample taken about 100 m offshore. Invertebrates were not abundant and comprised some ostracods, oligochaetes snails and chironomids.

Recommendations for study sites in Zambia

The greatest constraint to a study of sediment and invertebrate distribution is the time it takes to sort and identify the organisms. It is my opinion that this part of the study include the Kalambo and the Lufubu Rivers. These are the largest of the rivers in Zambia that flow into the lake, although the Lufubu is by far the largest river that drains the largest catchment. For that reason alone the Lufubu is suitable for an investigation of sediment loading to the lake. It also drains a largely pristine catchment and will provide important information on "natural" background sediment loads. It is also being considered for inclusion into a study of river flows, co-ordinated by Dr Sichingabula of the University of Zambia.

The Kalambo represents a river drainage basin that is probably more typical of the southern part of the lake. The catchment appears to comprise low density tree and scrub and probably represents a low to moderate anthropogenic disturbance of the

catchment. It flows throughout the year and is readily accessible from Mpulungu. This is also being considered for inclusion in the work of Dr. Sichingabula. Both river mouths could be samples from the SILVER SHOAL quite close to the shore. The protocol for sampling would involve samples collected with the WINDERMERE Grab deployed from a hand winch. The winch needs to be transported from Kigoma to Mpulungu. I recommend that samples be collected at stations that run along transect out from the river mouth and also parallel to the shore (at approximately the same depth) in order to account for changes caused by both sediment load and not by depth. The experimental design of this work would be to enable analysis by simple statistics such as ANOVA and therefore involve replicate sampling at each station. The design would be done in conjunction with Dr Duck (sedimentologist) from the University of Dundee, in order to optimise information on invertebrate distribution and patterns of sedimentation.

Objective 2: Site for a field study on the impact of sediment on biota.

On September 3 I searched for a rocky-shore location that would be suitable for a field experiment on the impact of sediment on the biota. A number of sites were assessed by snorkelling. Main problems were that the sites generally either contained large rocks that would require a considerable amount of sediment to be added or that sites were prone to disturbance through beach seining. The most suitable location found was near to the "Tanganyika Lodge" to the west of Mpulungu. It is readily accessed by boat and has an underwater habitat of small rocks in about 1-2 m depth along a strip of about 10m wide. There are plenty of small fish, probably eretmodines. Attempts to capture some fish with a small scoop net were unsuccessful. Only two species of snail, , identified as belonging to the genera *Spekia* and *Stormisia* were abundant and these had a clear zonation. *Spekia* appeared mainly on the least exposed parts of the rocks and on the very upper part of the shore, while *Stormisia* appeared more on exposed rocks. In total, four species of gastropod and one bivalve were collected from the area.

Overall impressions of the capacity of Zambian fisheries laboratory at Mpulungu in relation to proposed study.

The laboratory has suitable space and boats to carry out the work. It is important, however, that a number of additional items of equipment are purchased or installed. A recent consignment of equipment purchased for the GEF project has yet to be unpacked and/or checked. There appeared to be only one suitable stereomicroscope in the laboratory, purchased for the LTR project. Another microscope that was "dug out" of a cupboard was in a very poor state. The laboratory appears to have adequate computer facilities, purchased by the LTR project. The boat the SILVER SHOAL is suitable for the sediment work. It needs, however, to be ensured that the radio that was purchased for the boat is properly installed. Attempts to do this during my visit failed, possibly because of a shorting problem. A number of smaller boats and an outboard engine appear to be in reasonable condition. Aquaria facilities exist in the lab but is in very serious need of repair. This is not a large job but needs someone to

coordinate and ensure it happens. This could be useful for laboratory studies of the impact of sediment on the biota.

Paramount among the need for additional equipment for the sediment work is an additional compound and two additional binocular microscopes. At present there is a Wild M38 binocular and a Leitz inverted (FS) microscope. Microscope requirements require coordination among relevant special studies.

Other equipment needs or installations required before the sediment study can commence are:

-Oven -Top balance (mg-kg) and weighing boats -Portable turbidity metre - Formaldehyde; estimated 100 litres -Alcohol; estimated 50 litres -Fitting of winch to boat -Fitting of sonar to boat -Fitting of GPS to boat -Hand held depth probe x3

There is also a need for a much improved library facility. This should include general texts relevant to the range of activities of the GEF project as well as more specific literature pertinent to particular studies. A functioning library, however, requires the appointment of someone who will ensure good use and keep track of the books. The problem, nevertheless, is that without an adequate reference source an Institute such as that at Mpulungu can not achieve a sustainable store of knowledge.

Personnel

At the time of my visit there was little activity at the laboratory. A number of staff were in Kigoma on a training course so it may be that I came at an atypical time. I, nevertheless, feel that if the sediment study proceeds without a person at a post-doctoral level who is dedicated to its success then it will not work well. The GEF liaison officer at Mpulungu, Dr Pearce works only part time on GEF and it would be unreasonable to expect Dr Pearce to take on a close supervisory role of work associated with this, or indeed any other, Special Study.

While in the Mpulungu lab I identified Robert Sinyinza as a suitable Research Officer to be associated with the Special Studies. He would, however, require close supervision. Technical staff that have previously sorted zooplankton samples, such as Lawrence Makasa and Mr. Zulu would be suitable for initial sorting of sediment to remove invertebrates for later identification by more qualified staff. Mr Zulu, however, also shows a capacity and interest to be involved beyond a basic level and I would encourage his greater involvement in invertebrate taxonomy.

Relationship between GEF and LTR.

At present there appears to be a neutral disassociation between the two projects. It would help if relationships were to be more positive. It is important, however, to emphasise that I did not witness anything that could be considered as obstructive

between the two projects and I experienced no problems with the LTR APO, Victor Langenberg.

I left Zambia on September 12 and took the LIEMBA to Kigoma, where I arrived at 17:00 on Sunday September 14.

Stage three: Kigoma, Tanzania (14 Sept-29 Sept)

Objectives for visit to Kigoma were

1. Assess suitability of a "paired catchment study" to investigate impact of sediment on biota.
2. Assess possibilities of integrating study sites with C. O Reilly of the University of Arizona.
3. Explore possibilities of the feasibility of additional river for inclusion in the overall study
4. Discuss the programme of the Special studies and its linkage with other aspects of the overall Biodiversity Project with other project staff consultants who were in Kigoma for a Regional Training programme.

Objective 1. Suitability of a "paired catchment study" to investigate impact of sediment on biota.

Catherine O Reilly and Simone Alin, postgraduate students from the University of Arizona, are currently working on a number of sites that include productivity measurements and ostracod collections from rock and sand substrata from near the mouth of two streams that drain forested and deforested catchments. These study sites are near the mouth of the Mtanga and the northern stream in Gombe National Park, close to the Wildlife HQ. I was keen to see whether or not these would provide suitable study sites for invertebrate collections and arranged a trip on the RV ECHO to investigate that.

September 16 I went with C. O Reilly, S. Alin, K. Martens and I. Schoen to the mouth of the Mtanga River, with plans for further sampling off Gombe National Park. At Mtanga one sediment samples were collected close to site used by the University of Arizona which was at least 500 m north of the river mouth. Sample collected from offshore from the river mouth in about a battery failure on the on the RV ECHO caused the cruise to be abandoned. It was lucky that Mtanga village had facilities for recharge of battery. This was not a new problem on the boat and illustrated that there is some communication problems between the crew of the boat and the scientific staff. The absence of a radio also illustrated that safety precautions were not as there should be.

The trip to Gombe was rescheduled for the 19 September. The University Arizona site was about 100 m to the north of the river input and close to the shore. This site was chosen because it had both rock and sand habitat. I am not convinced that the two sites chosen for this work are good representatives of rivers that drain an "impacted" and "unimpacted" catchment. I think that the need or desire to compare rocky and sandy substrata may have compromised the need for an "impacted" and "unimpacted" comparison. Sediment samples were collected with the Eckman near the Arizona station (04° 38' 07" S 29° 37' 53" E) in 3 m of water and also nearer the mouth of the river in about 4 m depth. An additional sample was taken about 250 m offshore in about 18 m depth.

I walked part of the catchment and also further south near the main National Park buildings and visitor accommodation. The river there was larger than the one near the Arizona site and drained what seemed unequivocal pristine habitat. For an example of a pristine site it appeared more suitable than the one chosen. An alternative impacted site just to the north of the park was to be explored by G. Patterson following my own departure from Kigoma. This could be a better comparison than the Mtanga stream as it is close by, the topography is likely to be similar to that within the Gombe Park and has the advantage that competent personnel from the park, such as the warden Sellanyika Dattomax, are on hand to take routine hydrological measurements. One sample was collected from offshore of the larger Gombe stream

The benthic samples from near the Mtanga River comprised sand with a good deal of organic material. Invertebrates were scarce; ostracods, gastropods, oligochaetes and chironomids were present. One insect larvae was found. Invertebrates found in the first of the northern Gombe samples, that close to the Arizona site, comprised mainly oligochaetes, but with low abundance. Sediment comprised fine sand and little organic debris. Greater diversity of invertebrates was found in the two other samples taken near the northern stream. Samples included some organic debris and the following invertebrates: harpacticoids, ostracods, chironomids and other dipteran larvae, oligochaetes, gastropods and shrimp. The fourth sample taken near to the mouth of the larger stream contained very few invertebrates; harpacticoids, ostracods and chironomids.

Recommendations for paired catchment study

I suggest the following suggestions for future work to study the distribution of invertebrates in the lake in relation to sediment loads from a forested and deforested catchment. These recommendations are also designed to integrate with catchment and river hydrological work. The study sites have been assessed on the basis of river flow, catchment characteristics that are similar except that one is of deforested and the other pristine, availability of local staff for river monitoring and accessibility of research vessel to enable samples to be collected.

(i) Pristine catchments should be the one that contains the majority of the National Park buildings (e.g. guest accommodation and pharmacy) which lies to the south of

the site currently investigated by the University of Arizona. Impacted catchment should be just to the north of the Gombe Park boundary, where catchment topography is fairly similar and which is accessible by Park staff.

(ii) Sampling for sediment and associated invertebrates should be done on a grid basis to be agreed between myself and R. Duck. Sampling design should include replication in order to allow statistical analysis such as ANOVA. samples should be taken at twice in the year: March-April to represent end of the rainy season and August-October to represent the before-rain period.

(iii) Samples should be collected with the Windermere Grab and will require a winch.

(iv) Sediment samples will be analysed for invertebrate community structure and sediment texture. At each sampling station concurrent samples will be taken for zooplankton with a vertical net haul and vertical profiles taken for light, temperature, conductivity and turbidity

(v) Seasonal studies need to be done within the rivers to measure river flow and estimate sediment load and information collated on catchment topography and vegetation cover.

(vi) Routine measurements within rivers to be collected by National Park staff. Samples from the lake to be collected by ex-patriot consultants in conjunction with African Research staff.

Objective 2. Assess possibilities of integration of study sites with C O Reilly of the University of Arizona.

I am not sure that the current sampling programme of the University Arizona will produce results that adequately assess the impact of sediment loads on benthic productivity. The programme seems to me to be well designed to compare benthic primary productivity on a rock and a sand substrata and that there may be some confusion between the two goals. This has probably arisen out of the difficulty of locating suitably position rocky substrata close to the river mouths. Consequently, for paired catchment work it may not be suitable to use the same sites as those of the University of Arizona. This applies particularly to the Mtanga study. which I recommend is not included in the Sediment Special Study sampling programme if the catchment just to the north of Gombe is suitable as a study site. I am not here criticising the judgement of sites selected by C O Reilly, who needs to be mindful of what is achievable for her PhD study. It does illustrate, however, that the goals of a postgraduate study may not always be compatible with those of the project. Discussion with C O Reilly on this and other issues were positive and there is a willingness to combine study sites both in Tanzanian and Zambian waters in order to maximise the information on catchments that are included in the study. I would hope that some comparisons of benthic primary production are possible within all of the

river mouths that are selected for study by the Sediment Group. The technique that is used for those measurements is elegant in that it is simple and appears reliable.

Objective 3: Explore possibilities of the feasibility of inclusion of additional river catchments in the overall study

During my visit there were a number of discussions of whether or not the Malagarasi and Luiche Rivers should be included in the sampling programme of the Sediment Special Studies. These occurred mainly with Drs R. Duck, G. Patterson, E. Allison and K. West.

The Malagarasi is the major river flowing into the lake within Tanzania. and therefore, a significant transporter of sediment. It passes through an extensive wetland before reaching the lake and the delta of the river within the lake is very large. Accessibility by the ECHO is likely to be very restricted. General opinions were that the ECHO could not approach within 1 km of the river mouth and sampling nearer than could only be done from an inflatable. That would exclude sampling with the Windermere Grab. There is also a, probably small, risk from hippopotami and crocodiles that are common within the delta. Other difficulties arise from obtaining hydrological and sedimentological data from the river itself and its network of channels. Access to the river during period of high flow could be problematic. It would seem, therefore, that although the river is very important in assessing patterns of sediment load to the lake the practical difficulties of access and sampling may, nevertheless, make it unsuitable for inclusion, at least in the main programme of work. An alternative, and arguably smaller model of the Malagarasi is the Luiche River, the river mouth of which is only a few km south of Kigoma.

On 16 September I visited the mouth of the Luiche River with E. Allison. The Luiche passes through an extensive wetland before it enters the lake. Three samples were collected from, respectively, within the river in about 1.5 m water depth, just off the mouth in about 32m water and about 50 m offshore in about 3 m of water. The sample within the river had a large organic content. Access to the Luiche was via Ujiji and hire of a small boat. I suspect that the ECHO could approach within a hundred metres or so of the river mouth to enable grab samples to be collected. The sediment texture collected in the samples from the lake was considerably more diverse and angular than that found at any of the other sites that I had visited. Invertebrates comprised some large ostracods, chironomids and a dipteran larva identified as a ceratopogonid. Overall diversity was quite low. The sample collected within the river contained a few oligochaetes and chironomids, some ostracods (?Tanganyicae cypris) and some molluscs.

Archive data from the Malagarasi and Luiche exists, but appears more complete from the Luiche, collected by a NORAD water development programme. The consensus from discussions with Drs Duck and Patterson was that while it would be desirable to include the Malagarasi the difficulties associated with that would probably prevent an intensive study. The Luiche could act as a smaller model for the processes operating

within the Malagarasi and has the advantage of been accessible, close to Kigoma and an existing and seemingly extensive hydrological data set collected by NORAIID.

The recommendation, therefore, is that we consider further the possibilities of an intensive survey of the Luiche, in similar manner to that suggested for the Kalambo and the Lufubu and that some river gauging data is collected from the Malagarasi in two ways. The first is that river gauges are measured twice a day by somebody who lives in the area and the second is that approximately monthly visits are made by scientific staff, possibly from Dept. Water Resources, based in Kigoma. This would provide some validation of data collected locally.

Focus on inclusion of sites in the study has been on those within Zambia and Tanzania. This is because at the moment the security situation in the Congo Republic and Burundi prohibit work there. If the security situation improves then it is important that the Sediment Special Study considers sites within the Francophone countries. In particular, it is important that the Rusizi is considered for inclusion into any study that investigates anthropogenic induced sediment load to the lake. The inclusion of the Rusizi and rivers entering the lake in Congo will be reviewed as and when the political situation allows.

Objective 4: Discuss the programme of the Special studies and its linkage with other aspects of the overall Biodiversity Project with other project staff consultants who were in Kigoma for a Regional Training programme.

During the course of my visit to Kigoma I was involved in activities and discussions relating to the Project with most people who were involved in the training workshop but in particular with E. Allison, A. Bailey-Watts, R. Bills, R. Duck, K. Martens, Patterson, P. Tierney, K. West. These were concerned primarily with the Sediment Special Studies but also with the integration of other Special studies, the value of Biodiversity Indicator taxa, the applicability of GIS, the capability of the riparian countries to develop a sustainable capacity of monitoring and research, the development & testing of sampling gear and observation and limited involvement in the Training course.

Summary of conclusions or personal opinions of these discussions follow:

Proposed programme for Sediment Special Studies

I had very positive discussions with R. Duck on how to integrate our respective components of the Sediment Special Studies. The main conclusion is that investigations of the invertebrate communities will have concurrent analysis of sediment texture. This will involve subsamples of about 0.5 kg from each grab to be set aside for sediment work. This would be stored in a plastic bag for subsequent drying. Sediment sub-sample will put in a plastic bag. Rest of sample will put through a 200 μm sieve and preserved in 4% buffered formaldehyde in 1 litre plastic containers. It is important that the final concentration of preservative is $>$ or $=34\%$.

therefore the formaldehyde added to the sediment should be made up to 10% and a volume approximately equal to that of the sediment added. and the cap screwed on tightly.

Dr Duck would advise on associated hydrological and sediment measurements within the rivers, and I would recommend that he is asked to comment on the proposals that are to be submitted for riverine studies by Dr. Sichingabula. We are both of the opinion that the research component of the Sediment Special Studies is unlikely to be effective without the continuity of a trained scientist who will be able to maintain the momentum and who supervise the work. We felt that this appointment needs to be for a two year period and be at the post-doctoral level. My recommendation is that he/she is based in Mpulungu which could act as the base of the sediment study. This would not preclude sediment work elsewhere, which is an essential component of the project, or the use of the Sediment Studies base by personnel from the other riparian countries. I would hope that the appointment could be established before the end of the year with a prospective start date around March 1998. In discussions with G. Patterson it was agreed that any such person would be employed by the University of Greenwich but interact closely with myself and Dr. Duck at our respective universities. It is important that the post doc can be in the Region in time to be involved in post-rains sampling of the intensive study sites and to help implement the field and laboratory experiments before mid 1998.

The value of Biodiversity Indicator Taxa

Recommendation for this aspect of the Biodiversity SS will be brought forward by E. Allison and he has clearly thought a lot about the subject and is well versed in current literature. My experience with developing a rapid assessment for Irish lakes has been that indicator taxa are probably not of universal use to assess anthropogenic impact, other than in some particular situations such as increase in profundal enrichment indicated by profundal invertebrates and body size of plankton as an indicator of fish predation. Even in those situations there are probably sufficient "exceptions to the rule" to render their universal applicability doubtful. It may be that within a single system such as Lake Tanganyika indicator species will be of relevance. It is, however, important that a concerted effort is made into testing the response of likely taxa to specific anthropogenic disturbance in order to evaluate their potential as indicator species. Taxonomic familiarity or ease of identification, while essential, is not in itself enough. I suggest it should be the role of the Sediment and Pollution Special Studies to make those assessments, and any subsequent recommendations and in conjunction with the Biodiversity Special Study.

The applicability of GIS

While my experience with GIS is limited it is my strong opinion that the development of GIS system should be centralised and then "exported " to the Region for continued use. If that does not happen it will not work. It was also apparent from the discussions that the understanding of what GIS could and could not do in relation to

the Tanganyika Project was limited, with uncertainty to the goals of using it within the project. I would suggest that there is a need for someone to act as an interface between the scientific measurement within the project and any GIS development that occurs. The fact that there appears to be a considerable flux of GIS personnel associated with the project is not helpful and may indicate a difficulty of NRI 's capability to do that aspect of the work.

Capability of the riparian countries to develop a sustainable capacity of monitoring and research

From my observations I am of the opinion that the Zambian Fisheries laboratory in Mpulungu has the capacity to be active in ongoing monitoring and research programmes, given an improvement of the infrastructure and appropriate supervision. I did not witness any strong inclination to initiate such work but I did detect a strong willingness to be involved. The progression to independently directed research is feasible. The situation in Kigoma, in comparison, is not optimistic. There appears two major, and certainly not unrelated, problems. The first is that there is a great lack experienced and motivated staff. I understand that some such scientists have recently left. The Director, while keen on limnology appears fully occupied with administrative duties and his own business endeavours. The second, and perhaps even more serious problem, is that there is an ethos prevails that requires remuneration for every task and a tradition of, for example, providing project transport to and from work for many of the staff. While one may sympathise with low paid Government employees the fact is that the prevailing situation in TAFIRI in Kigoma is not conducive to any research, monitoring or educational initiative in the Biodiversity of Lake Tanganyika. Without a major change in ethos in the laboratory I see no hope that TAFIRI Kigoma can play an important role in and, especially, beyond the project.

Capacity of the Francophone countries for active involvement research And monitoring is apparently very good, with praise heard frequently for scientists from both Burundi and the Congo Republic. Others have a much better understanding of that situation than me.

Development & testing of sampling gear

While in Kigoma I tested the Windermere Grab deployed from the winch of the ECHO. The grab itself appears well suited to the collection of quantitative samples of sediment and penetrates sandy substrata well. I am concerned, however, that the winch on the ECHO and particularly the wire is not sufficiently robust to reliably haul the sampler. I would be very hesitant to use it at depths of greater than 20 m. This opinion is based merely on observing how the winch operated during a number of samples taken down to about 20 m. The winch on the ECHO was fitted by LTR for deployment of water bottles. That is a much lighter load than the Windermere and it would be useful if we had information relating to the load capability of the winch.

Other greater tested included the bottom sled and some samplers designed to catch shrimps by bait and light attractant. The sled is useful to be pulled over sediment in shallow water but probably not suitable for deployment in deeper water or towed except very slowly (<1 m sec⁻¹). Light attractant traps seem to work well. These were placed on the bed of the lake at night in about 15 m water and after about 2 hours contained a good number of shrimp.

Training Course Activity

This was limited and included observation at some of the lectures and demonstration of some equipment. I suggest in such a course that it is important to pitch the training at the correct level. I saw some talks that, in my opinion, were at too high a level to be understood by most of the participants. I would also advise that in these demanding training sessions then the trainers should have either some experience of teaching (or lecturing) or, if not, have clear instructions beforehand from those who do. The assumption that because someone knows his/her subject they can therefore teach it is, unfortunately, not true. Most of the training sessions that I was party too, however, were very well done.

Stage 4. Kigoma-Dublin (Sept 29-Oct 1)

Flew Kigoma-Dar es Salaam on 29 September. Had further discussions with Dr Menz and arranged for plastic 1-litre containers for sediment work to be purchased. Departed for Ireland 2345 hrs on 30 September KLM. Arrived back in Dublin at 14:00 hrs. The superfluous requirement to travel via Stansted, after an overnight flight to Amsterdam, was a definite drag.

Summary of Recommendations and Action Points and

1. The Sediment Special studies is based in Mpulungu in Zambia, while maintaining the capacity to work on intensive sampling over short time periods elsewhere in the lake.
2. Robert Sinyinza (Research Officer) from Mpulungu and Mr Zulu (technical support) are encouraged to be actively involved in the work.
3. Use of Zambian divers trained in Kigoma are associated with the in situ experimental work.
4. An MSc student from the University of Lusaka is attached to the Special Studies and based in Mpulungu
5. A post doctoral scientist capable of supervising the study is employed. This person will have close links with Drs Duck and Irvine at, respectively, the Universities of Dundee and Dublin.

6. The Windermere Grab, and appropriate winch, is transported to Mpulungu and fitted to the RV SILVER SHOAL

7. The aquaria facility in Mpulungu is upgraded.

8. Remaining equipment required for the study (see above) is acquired.

9. Close liaison is maintained between personnel on the project concerned with the Special studies and the project management in order to coordinate activities and protocols.

10. Catchments that are included for intensive work in the Special Study are the Kalambo, Lufubu, Luiche and the two Gombe streams for impacted/unimpacted comparison.

11. Close coordination for the monitoring strategy of these catchments is maintained among G. Patterson, R. Duck and K. Irvine.

12. Close coordination between the Biodiversity SS and the other Special Studies is maintained for the testing of the appropriateness of indicator taxa.

13. The provisional work plan set out below is commented on and ratified by the end of 1998.

Provisional Workplan for the Sediment Special Studies.

October/November 1997. Advert placed for a Biologist/Sedimentologist to supervise the biota/sediment study.

December 1997. Interviews for post doc

Jan-March. Post doc commences with time in London/Dublin/Dundee to collate information and to become familiar with work programme and protocols. Maybe KI to visit London/Dundee.

Jan/Feb. KI to go to Lusaka/Mpulungu to establish contact with University of Lusaka and prospective MSc student and, if require, to Mpulungu to make preparations for start of project.

March/April. Post doc to go to Zambia. Sampling inverts in mouth of Lufubu in April. Samples also needed about this time from the Luiche and the Gombe streams.

May, Set up sediment in situ experiment with assistance of Erik Verheyen from KNIB

June-July R. Duck (?plus KI) goes to Mpulungu to maintain momentum and check on progress of sediment and laboratory work.

September/October 1998. Sampling of Lufubu, Luiche and Gombe streams.

Sediment processing and experimental studies continue until about June 1999. Report due September 1999 and monitoring protocol initiated.

(KI, 22 October 1997).