

**Back to Office Report - Paul Tierney  
Lake Tanganyika Biodiversity Project  
Sedimentation Special Studies**

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**Consultant Ref. No: 1145  
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**Circulation :**

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LTBP PCU: Martin Pearce, Kelly West, Andy Menz, Henry Sichingabula  
MRAG: Vicki Cowan, Eddie Allison  
IFE: Tony Bailey-Watts

This report outlines the work carried out by Dr Paul Tierney while in Mpulungu, Zambia, under contract to Natural Resources Institute, from April 20th, 1998 until May 15th, 1998, in addition to briefing/debriefing sessions in London. This report may be amended by others thereby fulfilling the terms of reference of the above contract. A full contract diary is given in **Appendix I**.

**1. Objectives (Terms of Reference)**

1.1 “Follow up on the recommendations of Dr Irvine in the visit report dating from his field visit to Zambia in August 1997.”

1.2 “Meet with David Chuba at the University of Zambia and try and assess the possibilities of his registration at the University of Zambia for an M.Sc. Research. A local co-supervisor (along with Dr Irvine of Trinity College, Dublin) needs to be identified. Dr Mbata of the Dept of Biological Sciences should be approached in the first instance.”

1.3 “Meet with Dr Henry Sichingabula (Dept of Geography, UniZam) to discuss progress on his work on river monitoring in Zambia.”

1.4 “Travel to Mpulungu to establish the basic sampling programme under the supervision of Dr Irvine of Trinity College, Dublin and Dr Duck of University of Dundee. Principal active participants in Mpulungu will be Sinvinza and Svapila.

Other Zambian Government may be co-opted to this work as appropriate.”

## 2. Activities

2.1 *Liaison.* The Regional Co-ordinator for LTBP, Mr James Phiri, was contacted at the Environmental Council for Zambia, and briefed on the objectives of this visit.

Discussions with Drs Mbata, Mumba (Dept of Biological Sciences) and Sichingabula (Dept of Geography) at the School of Natural Sciences, University of Zambia(ToR.1.2). The involvement of David Chuba was discussed, as was a replacement for him, when it became known that he had changed his mind about participating. Also discussed was the nomination of a UniZam, co-supervisor (to act with Dr Irvine) and the difficulties this raised due to the inter-disciplinary nature of the research proposal.

Dr Sichingabula was briefed about the sampling programme formulated by Drs Irvine and Duck (ToR.1.1), and in turn a briefing was given by him on his progress to date in establishing gauging stations at lotic and lentic sites near the lake (ToR.1.3). His advice was sought on parameters on which he felt the two protocols should overlap, and areas covered by neither where additional sampling would be beneficial. A copy of the Cohen/Cruise 98’ report was given to Dr Sichingabula.

The above discussions took place on April 22nd.

### **Action:**

**1. Graeme/Ken/Rob:** A decision needs to be made as to whether a replacement is to be found for David Chuba, and if not, whether the experimental work to have been done by him is to be reassigned. Robert Sinyinza is a possible candidate to replace David Chuba, and would be agreeable.

## 2.2 Briefing Teams on Work Programme

2.2.1 *Protocol* On arrival, discussions were initiated with the special study teams for sedimentation and biodiversity with regard to commencing the sampling regime. My personal terms of reference were distributed to the teams for study, in addition to the full sedimentation special study protocol. It was found that Leonard Mwape and Robert Sinyinza were absent from Mpulungu and that Lawrence Makasa, being senior Fisheries Officer in their absence, would miss some sampling trips due to having to remain at base. Furthermore, due to his work with Fishing Practices and Pollution Charles Lukwesa would also miss all the BioSS field work. This meant that other personnel would have to be drafted in to help. In preparation for sample analysis, computers, microscopes and laboratory equipment were unpacked, assembled and checked. These were temporarily placed in an LTR office vacated by Petra Paffen, whereupon a serious deficit in voltage regulators for such equipment as the electronic scales was noted.

2.2.2 *Joint Exercises* Discussions were held between the PollSS, SedsSS and BioSS teams, in the presence of Kelly West, Nicki Wiltshire and Paul Tierney, with a view to joint quarterly field exercises being conducted at monitoring sites. These sites fell into three categories, those close to Mpulungu, which were being monitored by the Pollution Special Studies, and for which data on faunal communities and sediment structure was needed. For these sites grab/core sampling and gill-netting will be used, with diving possible at less polluted sites. Additional sites will be added as controls, when the effect of discharges from ships using the port is better understood.

The second category, are sites where the Sedimentation Special Study is monitoring river mouth sediment discharge, and where supporting information on substratum and community is needed. At these sites, the BioSS team will dive on the grabs to monitor grab efficiency, and conduct habitat profiles and fish censuses.

A third possible category, are sites of interest to the Biodiversity Special Study, but at which diving is not possible for safety reasons, e.g. parts of the coast of Nsumbu National Park. At these sites, grab sampling would be conducted to compliment data obtained by gill nets.

2.2.3 *Tanganyika Lodge* Following 'Proposal 2 ; Annex 1 ; Special Study on Sediment and It's Consequences', the proposed site for field experimental work in front of Tanganyika Lodge was discussed with Dr Sigal Balshine-Earn of the Taborsky Research Project, based at the Lodge since January, 1998. It was described as having changed radically after the rains and a recent storm (pers comm: Dr Earn) with the elimination of the *Eretmodus cyanostictus* population, and the exposure of a sand substratum. Given that this naturally occurring phenomenon paralleled the experiments of Proposal 2, it was decided to initiate monitoring at this site (Kasakalawe Point), by the BIOSS team on April 30th in order to document any recolonisation succession. This programme was in anticipation of the SedsSS 'in-situ' field experiments.

**Action:**

- 1. Office, Mpulungu:** Martin Pearce or Robert Sinyinza need to establish a central calender of field trips, in particular joint exercises, with requirement for Silver Shoal, in order to avoid clashes with other trips, in terms of equipment and personnel.
- 2. NRI-GP:** The joint exercises will need to be prompted and occasionally monitored from London, until the facilitator is appointed in August/September. Otherwise the schedule is likely to derail.
- 3. KI/RD/GP/PT:** The BioSS teams survey of the Tanganyika Lodge (Kasakalawe Point) monitoring site needs to be reviewed, and progress assessed. It is unlikely that MRAG will be able to undertake this, as it is a SedsSS station. The divers need to get the feedback.

## 2.3 Equipment and Facility Review

2.3.1 A review of field equipment needed for the sedimentation team was conducted prior to sampling and several serious omissions were noted (ToR 11 & 12: 'Protocol for visit of Paul Tierney to Zambia. April 1998.'). A list of these is given in **Appendix II**. Robert Sinyinza was not in Mpulungu on my arrival and so the whereabouts of the Eckman Grab was unknown. The Windemere grab arrived safely from Kigoma on the 'Liemba', and the new winch and pulley system were successfully installed on the 'RV Silver Shoal'. Peter Llewellyn's report on the 'seaworthiness' and suggested refit of the Silver Shoal was read with interest, and some additional suggestions advanced in consultation with Gideon Banda and Clement Sichambo (mechanic and master), to Dr Andy Menz in Dar-es-Salaam. Some vital pieces of equipment are unfortunately not yet fitted (echo sounder, GPS and radio).

2.3.2 Similarly, the BioSS teams dive equipment was reviewed in light of the list of modifications suggested by Martin Pearce and Reuben Shapola. This list was compiled for consideration in the context of a future dive course in Mpulungu, to extend the capability of the dive equipment. The list was reviewed, interpreted and forwarded to MRAG. This list is contained in **Appendix III**.

2.2.4 In accordance with 'Proposal 3; Annex 1; Special Study on Sediment and it's Consequences', the aquarium was assessed, in terms of preparedness, for the commencement of laboratory experiments on the growth rates and fecundity of selected taxa subjected to a range of sediment loads. On arrival the aquarium in the GEF building was found to be full of unpacked stores. By the end of contract period these had largely been cleared out, and the aquarium could be checked out for the habitat experiments.

### **Action:**

- 1. PCU:** Refit of Silver Shoal needs to take place as soon as possible to facilitate the field programme of the SedsSS. Some of the equipment is vital e.g. echo sounder, GPS, and anchor warp/chain to be added.
- 2. NRI, KI/RD/GP:** Some additions to the SedsSS equipment would speed matters up, such as small 'pyrex' dishes for oven drying sediment subsamples, 250 micron sieve for invertebrates, surge protectors for microscopes and electronic balance, and voltage regulators for photocopier/computers (**Appendix II**).
- 3. MRAG,VC:** Vicki to review list of equipment suggestions by Pearce/Shapola, in light of PT's interpretation (**Appendix III**). Location for any future training course should be decided upon, as this will affect supplies to be sent. Otherwise, spares

only, need be sent.

4. **MP, Office, Mpulungu:** Electrician to check out wiring of room containing recently installed oven, to prevent large scale swings in voltage which are thought to have blown photocopier. b. Gideon Banda to oversee Eckman Grab having jaw-retaining pins braised, to prevent dislodgement on impact by the sender. c. Reuben Shapola to travel to the TAZARA Workshops at Mpika, to see if the broken part of the compressor can be turned there.

5. **Graeme/Ken/Rob:** To decide whether the aquarium is worth setting up for the lab experiments, in light of fact that David Chuba won't be participating in programme after all. If so, Mpulungu Office can contract to build glass cases, and refurbish pumps, drains etc.

6. **PT:** To contact Carl of Stoney Cove to order, if possible, the 'snorkel conduit' for the compressor.

### 3.1 Initiate SedsSS Field Programme.

The Sedimentation Special Study field programme was started after a long interval from the Kigoma 97' Training Workshop. The loss of momentum resulted in considerable delay in gathering the personnel and resources needed for the field work, as both were scattered amongst other projects based at Fisheries. This should solve itself once the sedimentation programme is well established.

3.1.1 **First Sample Trip** Wednesday 29th April was chosen as the first sampling trip to the Kalambo and Lunzua Rivers. Field trials of the grab and lift system took place on 28th, and were successful. However, the old pulley was returned to the stern rail, as the new pulley did not reach over the stern, and so was not effective in lifting the grabs.

Grab sampling of the Kalambo was begun 60m to the south of the mouth in 6m of water, just outside the turbulence zone. The hand held sonar was used to ascertain depth. The second and third samples were 100m and 150m to the south of the river mouth respectively, each at 6.0-6.5 m in depth. This type of transect is called a 'side-on' approach, and tended to run parallel to the coastline. Several problems were encountered with the Windemere grab. Due to there being no 200 micron sieve present, 2mm and 63 micron sieves were used. Only one sample was taken from each site on this first day out.

The Silver Shoal then moved to the Lunzua River mouth where the procedure was repeated in 7.0 m of water. Again, no replicates were taken at the stations. The sediment was allowed settle in each sample bucket before as much water as possible was decanted.

**3.1.2 Second Sample Trip** The second sampling trip took place on May 5th. In addition to the samples taken 'side-on' to the rivermouth, parallel to the shore, samples were also taken on a transect directly on to the Kalambo river mouth, in an approach called 'face-on'. This approach from deeper water attempted to sample the 'slope'. The grab was dropped in 32m, 22m, 18.5 and 11.4m. The boat could not be anchored due to there being insufficient chain/warp. Sampling off the Lunzua was 'side-on' as before, and proved very slow due to the nature of the sediment. Replicates were taken from stations on the 'side-on' transects, but not from stations 'face-on' to the rivers. When surface water was decanted from the pooled samples, the remaining sediment was weighed and a 500g sub-sample taken for sediment analysis and invertebrate collection.

**3.1.3 Third Sample Trip** This took place on the May 8th, and involved sampling the Kalambo River only, in order to complete more detailed offshore sampling. The first sampling run was on 'a face-on' transect, and involved dropping the grab at 38, 34, 27, 20, 27, and 10m. Not all these attempts were successful. The second 'run' was 'side-on' at a constant 10m depth, travelling south, parallel to the shoreline. Most of these grabs were successful. As per usual Secchi Disc measurements and zooplankton samples were taken. Sub-samples were collected where applicable, although the deeper grabs yielded sparse samples, often of *Neothauma sp.* shells only.

**3.1.4 Fourth Sample Trip** Taking place on May 12th this trip made one stop off the Kalambo River where the Eckman grab was deployed with the Windemere, in 32m of water, and a dive team was sent down to assess the relative efficiency of each grab. A habitat profile of the site was also completed, as the first of a series of combined grab and dive sampling trips, to map the substratum of this and eventually other rivers using both SedsSS and BioSS teams. The Silver Shoal then moved to the Lunzua River where a 'face-on' sampling approach was tried. Distances of 50m, 100m and 150m from the river mouth corresponded to depths of 5.2m, 8.5m and 9.7m respectively. It is not known whether these depths will be suitably homogenous for sampling in future.

**Action:**

- 1. SedsSS, Sinyinza:** A preliminary report is due from the SedsSS team and Robert Sinyinza by the end of June at the latest. This brief report, part of the programme of work left with the team, will outline results to date, of sampling at different depths on both 'side-on' and 'face-on' approaches for each river individually, c.f. 3. below.
- 2. PT:** Regular correspondence by email has been established with Robert Sinyinza to keep the field work on track, as changes may be needed to the protocol in light of 1 & 3. This will necessitate supervision until the patterns become established.
- 3. Ken/Rob/Graeme:** Details such as the depth at which the grab is deployed on sampling transects and sediment found needs to be monitored by Drs Duck, Patterson and Irvine. Different depths have been tried (6m, 7m & 10m) by PT in order to see

how and if the sediment changes between 50, 100 and 150m stations, but a depth of 10m has now been established in consultation with Dr Irvine.

### **3.2 Work Programme for SedsSS.**

3.2.1 In order to continue the programme begun by PT on sampling the Kalambo and Lunzua Rivers, a work programme was left with Martin Pearce and the SedsSS field team (**Appendix IV**). This work programme incorporates specific instruction on continuing the field sampling programme, criteria for expanding the programme to sample other rivers in the event of further delays in appointing a field co-ordinator to Mpulungu. Also, the joint quarterly exercises between SedsSS, PollSS and BioSS are enumerated, as decided upon by the three teams. This programme gives the station administrator a template against which to measure claims of allowances, boat fuel and PRAs.

### **4.1 Review of Work Programme Completed by BioSS Team.**

4.1.1 The work programme left in place in November 1997 consisted of surveying two areas of religious significance, close to Mpulungu, both as a training exercise and to provide data, should gazetting these areas arise in future. These sites are Nkumbula Island and Cape Kapembwa, and were surveyed in December 1997 and January 1998. The survey reports were prepared by Charles Lukwesa, Maybin Mwenda and Reuben Shapola, and were of good quality. Some areas needing attention were identified, in particular in site descriptions and the use of habitat diagrams. In general the biodiversity team were encouraged to rely more on their powers of observation, and to set down their assessment of impacts on sites, and other incidental data. The habitat forms have been modified to reflect these needs.

As a result of the above surveys, two sites were suggested for monitoring by the BioSS team, and these two sites were dived by PT and the team in order to assess their suitability. The reports on these dives used the modified forms, complete with full site diagram and description, demonstrating the power of these additions. Cape Kapaembwa had soft conglomerate as its substratum, with soft sandstone opposite the seasonal rivermouth. The conglomerate formed shelves which harboured good numbers of fish, but these formations are in a state of flux with many disintegrating. They are interspersed with sand slopes with plant debris, occasional cobbles and some bivalve shells. Nkumbula Island was less unusual consisting of two boulder slopes, down to a shell sand plain, with good numbers of fish associated with the boulders, with lesser numbers being confined to the sediment.

### **4.2 Continue and expand Work Programme for BioSS Team**

4.2.1 The previous work programme stopped short in January 1998, due to the belief that consultant input would be re-established by then. Much momentum was lost in the interim, which must not be repeated. Therefore a new work programme was put in place which addresses not only the terms of reference of this contract but the general aims of the project (**Appendix V**).

The programme formalises the fortnightly dives to map and census Kasakalawe Point, in preparation for the commencement of the SedsSS 'in situ' field experiments on species extinction and recolonisation.

The monitoring site chosen at Cape Kapembwa is to be surveyed every second month, in order to assess changes to the substratum and resultant change in the communities, with time, especially between wet and dry seasons.

A programme to start mapping the coast of Zambia was established, in between other duties, so as to build up a database of habitats and census results. This serves as a vital training exercise, to build up experience in the BioSS and to allow areas of high diversity or disappearing habitats/communities to be identified.

To formalise for the BioSS team, the quarterly exercises decided upon between the three special studies teams, to monitor pollution and sedimentation close to Mpulungu town and harbour.

To formalise the involvement of the BioSS team in the SedsSS mapping of the Kalambo and Lunzua Rivers. The BioSS team will gradually build up a picture of the habitats and communities, by conducting one dive each trip.

**Action:**

- 1. BioSS Team :** One of the two sites suggested by the team is to become a monitoring site, due to the nature of the substratum and it's susceptability to erosion by rainy season river flow and wave surge.
- 2. EA :** Eddie to supply brief protocol of mollusc census techniques to PT and BioSS team in Mpulungu, to allow for census techniques to be rehearsed before SedSS Kasakalawe Point 'in situ' experiments begin. These involve mollusc and fish censuses.
- 3. MRAG, VC:** A replacement for Godfrey Milindi needs to be chosen to complete the BioSS team. With increased activity, Charles Lukwesa can be re-integrated into the team from other special studies.
- 4. PT:** To continue and communicate with the BioSS team to ensure that the work program is followed and changes in the forms are adhered to. It is a matter of concern that the immeadiate paperwork of each dive is not neglected. Existing protocol can be tweaked if necessary without major loss of time.

## **5. Outputs**

### **5.1 Areas of concern.**

5.1.1. *Policy planning.* There seems to be large differences in opinion on what are felt necessary LTBP activities, between London and Africa. This has been, and continues to be, detrimental to the project, and now time and budget are running out. Many of these issues have to be decided upon soon, before the thrust of the project is weakened. This seems to apply to some special studies more than others.

5.1.2 *Communication.* The system of email use is still highly inefficient and results in long delays in communication between consultants, and between London and Africa. This will bite where long range supervision is necessary. The multiplicity of consultants involved makes multipartite emailing difficult, but this is an area where we can all improve our operating practices.

5.1.3 *Logistics.* Future delays which halt the field work need to be minimised, e.g. echo-sounder, sieves, appointment of field co-ordinators etc... . The amount of data accrued to date in some special studies is minimal. Therefore uninterrupted, well-directed field work is needed for a period.

There is not enough equipment in any of the centres to contemplate it being divided. Equipment is in general holding up, but needs monitoring to anticipate crises. Field Co-ordinators could fulfill this role.

5.1.4 *Boat facilities.* Much of the SedsSS programme depends on the speedy refit of the Silver Shoal, any undue delay will result in loss of momentum. It is hoped that the refit will be complete by early August 1998.

5.1.5 *Archives.* The sorting and storage of the invertebrates found in the sediment samples, is of concern as the SedSS team needs to impliment this themselves. This applies to, not only the specimens, but also the SedsSS and BioSS written data. However, it will wait until the field co-ordinator is appointed to Mpulungu.

## **3.2 Future Training and Survey**

The work being carried out at present in Mpulungu needs to be continued, that the teams involved will gain enough experience to be able to draw conclusions about

Zambia's lakeside habitats and biodiversity. The best training possible is to continue sampling under field conditions, therefore the SedsSS need to sample as many rivers as possible, and the BioSS needs to visit as much of the Zambian coastline as possible.

Although, budget constraints are looming ever larger, joint sampling will, if properly organised allow for economies to be made, in Silver Shoal usage, allowances and PRAs. Again, the field co-ordinators can do this.

#### 4. Conclusions

This visit was reasonably successful in that all the terms of reference were addressed, if not all were achieved e.g. David Chuba and the Aquarium. All the sedimentation sampling techniques were begun, **but need to be continued for long enough until the merits and demerits of the different alternatives become apparent.** A definitive protocol has been chosen, but not yet proven. This is the crucial stage of the programme, as until the field co-ordinator is in place, long range supervision is the only choice. It is at this stage that bad habits could be picked up, and poor data acquisition practices embarked upon.

Any uncertainty in policy choices does not help the field effort and should be handled firmly. This is becoming more imperative as the end of the project looms even with extensions.

### Appendix I

#### Contract Diary

20/04/98	Final briefing by Dr Graeme Patterson in London.
21/04/98	Arrive in Zambia.
22/04/98	Briefed Mr James Phiri on mission objectives. Discussions with Drs Mbata, Mumba and Sichingabula, at University of Zambia.
23/04/98	Arrival at Mpulungu. Unload, review shipment from Lusaka.
24/04/98	Meet SedsSS and BIOSS teams to discuss the plan for duration of trip. Disseminate copies of protocol on sedimentation special study to team members for perusal before Monday. Unpack and assemble computers and printers.
25-26/04/98	Unpack and assemble microscopes, prepare sedimentation field forms. Review BIOSS team reports from work set from previous visit.
27/04/98	Discussions with SedsSS team, about equipment needs for sampling trip on 29th. Review field forms to be used. Check stores for consumables. In nm. briefing of BIOSS team concerning survey reports of

Nkumbula Island and Cape Kapembwe. Discussed improvements in site descriptions, and starting making site diagrams.

Outlined plans for commencing monitoring at Tanganyika Lodge in accordance with SedsSS ToRs.

28/04/98 Pulley and winch fitted to Silver Shoal for use with Windemere grab. Fields trials of grab and system on Silver Shoal in Mpulungu.

29/04/98 Organising equipment for field trip to Kalambo and Lunzua Rivers. Field Trip to Kalambo and Lunzua Rivers, with SedsSS and BioSS teams.

30/04/98 Supervise sample treatment and preparation. Commence BioSS monitoring programme of site off Kasakalawe Point (Tanganyika Lodge).

1/05/98 Labour Day. Dr Kelly West (SLO), Jerrod Claybaugh (ITO) and Nikki Officer arrive in Mpulungu. Review of progress to date. Extension suggested.

2/05/98 Discussions with SLO and ITO. Commenced preparation of workplan for SedsSS to be left in place on departure.

3/05/98 Visited Kalambo Falls.

4/05/98 New pulley system on Silver Shoal found to be inadequate. Old pulley replaced, to be used with new winch. Preparation of equipment for next days sampling. Extension applied for.

5/05/98 Full day's sampling to Kalambo and Lunzua Rivers.

6/05/98 Special Studies Meeting. Individual discussions between SLO and each of the special study groups. Progress to date, future programs. Extension granted.

7/05/98 Sites Meeting with all special study groups. Sites for joint sampling on a quarterly basis suggested and reviewed. BioSS dive suggested monitoring site, off Nkumbula Island suggested for gazetting as religious shrine.

8/05/98 Full day's sampling off Kalambo River only. SLO/ITO leave Mpulungu.

9/05/98 BioSS and SedsSS field logs completed. BioSS forms modified.

10/05/98 Work programmes for SedsSS and BioSS completed.

11/05/98 Discussion of work plans with BioSS and SedsSS teams. Preparation for last two days field work.

12/05/98 BioSS dive at suggested monitoring site, Cape Kapembwa. Proposed for gazetting due to religious significance.

13/05/9 Full day's sampling Kalambo and Lunzua Rivers. Joint SedsSS and BioSS operation.

14/05/98 Paul Tierney leaves for Lusaka.

15/05/98 Paul Tierney leaves Zambia. BioSS team dive Kasakalawe Point. Joint SedsSS/BioSS exercise

## Appendix II

### **Equipment Needs for Sedimentation Special Study**

1. Sieve for sediment sampling (255 micron)
2. Working depth sounder. Profiler with screen would have been more useful, although more expensive, but given that a digital is bought already, there seems no point in arguing. Besides Rob Duck's side-scan will give better data. Some hand-held depth sounders would be very useful, especially if anyone is visiting Mpulungu before the Silver Shoal is refitted.
3. Small (14 X 14 cm) 'pyrex' dishes for use in the oven are needed as only two large size are present. There will probably always be the need to oven dry some samples (6-12).
4. More ordinary 'wash bottles', very useful in washing out sieves with minimum of water (2-4).
5. Simple block type surge protectors, 5 x outlets for electronic balance, microscopes etc. These could be plugged into a voltage regulator if necessary.
6. Voltage regulators for computers, and perhaps the photocopier also as it may have blown due to surge. These were omitted from Lusaka shipment.
7. Small airtight jars for invertebrate specimens. Kilner jars are miles too big. A size of 250ml would be ideal for archiving.

## Appendix III

### **Dive Equipment List for Mpulungu Station**

(Compiled by Martin Pearce & Reuben Shapola ; interpreted by PT)

Inflatable	Too small for four divers travelling any distance, and too slow. Fibreglass on order will solve this.
Outboard	No complaints, but spare prop needed as a matter of urgency before present one gets trashed.
Compressor	More spare filters needed.
Regulators	In good shape, holding up well. No diaphragms with spares however. Probably worth taking chance with this though.
Mouth-pieces	Lots more needed (30), in particular for beginners as they bite through in nervousness.
Intermediate Hoses	Not really needed as they don't blow any more, or rarely.
Cylinders	Major problems with these as the valve seats are configured for high

	oxygen mixtures, and not for durability. Need major supplies of valve seats, plus Silicone Grease for maintainence. If they were better at maintaining the pillar valves they wouldn't need so many spares. Otherwise these are good bottles, and will last a long time. Shapola wants some spare pillar valve assemblies (the full shebang on top of the cylinder) to be able to cannibalise, which sounds reasonable.
'O'-rings	<b>Two pillar valve assemblies should do.</b> If another course occurs in Mpulungu then it probably isn't worth changing the bottle brand. Preobably enough as they are not being blown, and many/most of the Kigoma supply travelled down to Zambia.
BCs	Need more big sizes for any future course, more medium and large sizes. Shapola wants two spare direct feed assemblies, which seems reasonable, again to cannabalise should the necessity arise.
Wet Suits	These are getting very frayed with holes, but are still servicable and the holes are unlikely to effect the thermal characteristics.
Torches	OK, except puny if areas of low vis are going to be encountered. What Shapola means here is that if another course is going to take place, then two larger torches amongst the new lot would give the team greater capability. <b>This is sound reasoning (if the budget stretches)</b> as low viz has already been encountered.
Masks	One seems to have walked! Everyone happy with these. A couple of spare straps would be wise(3).
Snorkels	One or two more would be wise as it would ennabe any further training to continue while not interfering with diving. Need spare snorkel mouth pieces, how I can't imagine.
Weights	If another course was going to take place, it would be wiser to send the moulds and let the crew here make wieghts, 1kg moulds.
Compasses	Very stiff, but they always are, so little can be done in lake's highly alkaline water.
Knives	Again small, although I think this is a personal thing. Same story as for bigger torches, although I would imagine that knife size would be irrelevant where crocodiles are concerned..
Knife straps	Needs spares (4)
Weight belts	No complaints
Fin Straps	More needed (12 + attached buckles), steady attrition. This should have eased off as they become more competent.
Fins	Crap quality, large rips in soft boot part, but with luck will last the project. Any future fins should be Typhoon Hurricane fins. They will last forever.
Booties	For any further courses a serious effort should be made to get zipless boots, in larger sizes. The zips go inevitably. I got so fed up I brought my own pair over in April. Agail Typhoon make good quality kit.
Tie wraps	No shortage.

This list is of suggestions, but is influenced by the fact that further training courses will be limited, and that the project does not have forever to run, or money to burn and will likely stop the day the money runs out. There is little to panic about, just to send the spares for compressor etc.

## Appendix IV

### **Sedimentation Special Study Work Plan**

1. **Objectives:** To continue the sampling program of the mouths of the Kalambo and Lunzua Rivers. To perfect the use of the Windemere and Eckman grabs in sampling the substratum, opting for whichever is the more effective in terms of deployment and results.

Once the technique is mastered for these rivers, it will be tried on the Lucheche and Mutifume Rivers and the results compared with those of the Kalambo and Lunzua.

To initiate joint sampling exercises with the pollution and biodiversity special studies, at sites of key interest, on a quarterly basis, to gain a more comprehensive appreciation of the interaction between parameters of the water/sediment and the communities they affect.

2. **Time Scale:** The sampling of the Kalambo and Lunzua Rivers will occur once a week for four weeks, thereafter sampling occurring once a month, until directed otherwise. This protocol will be supervised by Mr Robert Sinyinza.

3. **Protocol Part 1; 'side-on' approach.**  
'Side-on' sites chosen 50m, 100m and 150m from the mouths of the above rivers. This will be to the south of the Kalambo mouth and to the east of the Lunzua mouth. Sampling will be at 10m. Maintaining a constant depth is more important than achieving an exact distance from the river mouths, on the 'side-on' approach. With time the approximate positions of the sampling sites will become familiar, and easier to revisit.

**The Windemere Grab will be used three times at each site.**

At each site, the Secchi disc readings and zooplankton samples will be taken using the phytoplankton net first, before the water is disturbed by the grab. These will be used only once at each site.

The zooplankton collected will be placed in a 250ml container with added formaldehyde. **This will be buffered with a**

### **teaspoonful of Sodium Bicarbonate per litre.**

Each time the grab is raised, it will be washed into a bucket.

This will be emptied into another through a 2 mm sieve.

What is retained in the sieve is to be placed in water and kept as cool as possible, in a cooler with ice. This measure will prevent the invertebrates dying. The three samples from each station will be pooled for invertebrates and sediment.

The pooled sediment will be allowed settle.

When settled, the excess water will be poured off and the remaining sediment weighed, using the 10kg spring balance. If necessary a larger 20kg+ spring balance exists at DoF. A 500g subsample will be taken from this known weight of sediment and kept for mineralogy and sediment description.

**N.B.** When the *ca* 250 $\mu$ m sieve arrives, excess water will be disposed of by passage through it rather than the 2mm sieve, and the retained material washed back into the sediment, before weighing and taking the subsample for sediment description. The remainder will have a 200g subsample taken to be sorted for invertebrates. If there are very few of these invertebrates, the whole sample can be sorted. These samples for invertebrate analysis must be processed as soon as possible, to prevent the specimens dying and decomposing.

Once dried the sediment subsample can be dealt with more leisurely. However, all samples need to be cleared before the next sampling trip.

### **Part 2; 'face-on' approach.**

A direct 'face-on' sampling approach will be used on both rivers also, in addition to the 'side-on' approach. Sampling will be at 30, 20 and 10m, and will try to approach the river along its estimated subsurface course **e.g. in the Kalambo, Southwset from the mouth, rather than West.** The aim is to sample the slope associated with each river, and the differing sediments found at different depths. The grab will be used three times at each station and the samples pooled as before. This will probably mean that only one river can be visited on one day.

### **Using the Windemere Grab.**

Given difficulties with the grab some changes are necessary. The grab will be lowered slowly on the pulley to the bottom **without** using the freewheel. This will stop it turning on its side. Once down all slack cable will be taken in to avoid it fouling the grab. Then the trip rope will be pulled to free the restraining bar, and allow the jaws to close, on lifting.

It is to be expected that once the monthly sampling proper begins, **two divers will accompany the SedsSS team and dive, in order to become familiar with the slope off the Kalambo and Lunzua River mouths**, and how the habitat changes on the slopes. On the 13/05/98 the first of these dives, to 32 metres, was completed, but missed the channel.

Depths of 35, 30, 25, 20 and 15m should be attempted, trying to locate the river channel underwater, and the substratum changing with depth. The Kalambo mouth itself is not to be approached at less than 15m for diving, due to the risk of encountering crocs. The Lunzua shelves much more gradually, therefore the above depths will be some way off shore.

4. **Storage**

All invertebrates collected in this way should be separated by taxon within each sample, and stored in individual (250ml) jars of 4% formaldehyde, for each taxon within each sample. Kilner jars of the correct size have been requested. An archival numbering system needs to be developed at Mpulungu, to facilitate the retrieval of specimens at a future date.

5. **Reporting.**

Quarterly reports will be prepared, of the previous quarter's findings including, sections on fauna collected and sediment variation throughout the sites. At the end of June 1998, a brief report (10 pages ) will be prepared for forwarding to Drs Duck, Irvine, Patterson and Tierney, of the findings to date, and suggested modifications, if any, to the protocol.

6. **Broadening the protocol.**

Once the sampling programme for the Lunzua and Kalambo is in place, other sites may be sampled using the same procedure and the results compared. Such rivers might include, the Luचेche, the Izi, the Mutifume. The Lufubu and the Chisala will be sampled later under the guidance of Drs Irvine and Duck.

7. **Payment**

Payment of PRA's will be dependent on the samples from each trip being sorted for invertebrates within the specified three days. **If this does not occur, thereby wasting the samples, the Station Officer will be authorised to withhold payment, due to non-completion of work set.**

It is suggested that a roster be established, whereby sample

sorting is shared equally. This will be supervised by Robert Sinyinza. Lunch allowances will be applied for two days in advance of each trip, on the requisite form. Otherwise they will not be paid until after each trip.

## 8. Boats

It is anticipated that the Silver Shoal will be needed for all the grab sampling work, due to the requirement for a stable work platform. However a flexible approach between the different special studies teams is necessary to maximise use of the Silver Shoal.

### **Quarterly joint Sampling Trips:**

SedsSS & BioSS. Kalambo and Lunzua Rivers; sampling Trip to - Overnight stay, Windemere Grab, Gill nets set, try night and day. If predation is significant confine to separate night and day gill nets.

PollSS, SedsSS & BioSS  
Ngwenya Market, off beach in front of –  
Eckman Grab, Gill nets, Water samples

PollSS, SedsSS & BioSS  
Samaki Fisheries, harbour off of –  
Dredges (chain?), Gill Nets (day/night), Water samples.

PollSS, SedsSS & BioSS  
Mpulungu Harbour, sandy bottom off of –  
Eckman Grab, Gill Nets, ?Fish Census, Water Samples

SedsSS & BioSS  
Tanganyika Lodge, rocky substratum off of –  
Bi-weekly BioSS visits to document extent of habitat.  
Eventually SedsSS will set up experiments on this site.

## **Appendix V**

### **Biodiversity Special Studies Work Plan**

#### **Objectives :**

To continue the monitoring programmes initiated during the visit of Dr Paul Tierney to Mpulungu in may 1998. Namely that of Kasakalawe Point, also called Tanganyika Lodge, a proposed area for ‘in situ’

experiments by the sedimentation special study.

To commence the underwater mapping of the Zambian coastline by divers, thereby building an archive of data on individual sites, contributing to a greater understanding of the biodiversity off the Zambian coast.

To initiate joint sampling exercises with the other special studies, at monitoring sites which have been identified as requiring the skills of another special study, to achieve a full understanding of the living and non-living conditions prevailing at those sites.

## Exercises :

### **Kasakalawe Point**

To continue, on a **two weekly basis**, the monitoring of Kasakalawe Point begun on 30/04/98. Each dive will consist of both fish census and habitat profile, with a view to building an thorough knowledge of the substratum around the point and it's different zones, e.g. boulders, sand patches, shell gravel beds and cobble fields, and a familiarity with the fish community associated with different substrata. Both these will allow short term change in habitat and fauna to be noted, allowing the optimisation in siting of the SedsSS experiments.

The full protocol of site descriptions and site diagrams is expected to be followed for these dives, and a simple map of substrata around the point attempted.

### **Zambian Coastline**

Beginning on the eastern coastline, a series of dives should be initiated, at rocky points (with occasional sandy bays known to be safe), starting from near the Kalambo and working south. These can probably be reached by **banana boat** from Mpulungu, and **should not interfere** with monitoring work. Full census and profiles should be carried out for each site, with site descriptions and diagrams. It is not envisaged that Manta Boarding will be carried out at these sites, as they will be half-day or full-day excursions. Results should be written up soon after completing the dive, with requisite diagrams etc. The results of these dives should be properly archived for reference, and at intervals depending on time or section covered, small reports should be prepared synopsising the findings and comparing sites within the area. This will improve the teams ability to recognise sites of outstanding diversity. Eventually, this series of non-intensive diving will focus to the west of Mpulungu, where the coastline from Mbete Bay to Cape Chaitika is of special interest. Weeklong trips, using the RV Silver Shoal, may be

necessary to survey the coastline north of Nsumbu National Park. This will probably not take place before the end of 1998. The Manta Board may be used on this extended survey. Nikki will be purchasing folders from Kasama, in which the original dive forms may be stored, marked by month and year for referencing.

#### **West of Kapembwa Village.**

This interesting site will be visited once every two months, as it is a dynamic site with the shoreline being constantly eroded by wave and river action. This will entail using the Silver Shoal as the journey is too long for the banana boats. The erosion of the conglomerate making up the hard substratum is of particular interest, in addition to the river channel, which is carving out soft sandstone each wet season.

#### **Kalambo & Lunzua Rivers.**

Each monthly trip by the SedsSS team will be accompanied by two divers from the BioSS team. The purpose is to gradually become familiar with the slope of the delta lying 5-600m off the Kalambo River mouth. Each month, a different depth will be dived at, in the range 35, 30, 25, 20 and 15m, staying clear of the river mouth. These dives were begun at 35m with Paul Tierney, and will map the river channel and associated habitats offshore. The Windemere grab will be dropped and the divers will travel down the steel cable, spend ten minutes on the bottom describing, before ascending up the cable. **In this time the cable will not be lifted.** While down, the divers will assess the positioning of the grab, and the surrounding terrain. Once the divers are safely recovered the grab may be lifted. These dives will be square profile dives and decompression will be calculated using the Tables. Full habitat profiles and fish censuses will be carried out on these dives, gradually building a map of the subsurface channels of the Kalambo and Lunzua.

### **Quarterly Joint Sampling Trips**

SedsSS & BioSS.

**Kalambo and Lunzua Rivers;** sampling Trip to -  
Overnight stay, Windemere Grab, Gill nets. Try night and day netting combined. If predation is significant confine to separate night and day gill nets. A thorough knowledge should be gained of the slope off the Kalambo River, by diving. This is 5-600m off the delta and so should be safe from crocs.

PollSS, SedsSS & BioSS

**Ngwenya Market,** off beach in front of –  
Eckman Grab, Gill nets, Water samples

No diving due to filth of water.

PollSS, SedsSS & BioSS

**Samaki Fisheries**, harbour off of –  
Dredges (chain?), Gill Nets (day/night), Water samples.  
No diving due to pollution.

PollSS, SedsSS & BioSS

**Mpulungu Harbour**, sandy bottom off of –  
Eckman Grab, Gill Nets, ?Fish Census, Water Samples  
Diving may be possible here!  
Other sites will be selected as controls, for the various special studies,  
and joint exercises, can be organised.

### **Maintainnce**

Reuben Shapola will be travelling to Mpika, to see if the snorkel conduit from the Kigoma compressor can be manufactured, in the machine shop there. A spare part from the UK has simultaneously been ordered, but local capability to produce is being tested.