GCP/RAF/271/FIN-TD/54(En) November 1996

THE PHYSICAL LIMNOLOGY OF LAKE TANGANYIKA
AUGUST-DECEMBER 1995

by

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FOOD AND AGRICULTURAL ORGANIZATION
OF THE UNITED NATIONS

Bujumbura, November 1996

PREFACE

The Research for the Management of the Fisheries on Lake Tanganyika project (LTR) became fully operational in January 1992. It is executed by the Food and Agriculture Organization of the United Nations (FAO) and funded by the Finnish International Development Agency (FINNIDA) and the Arab Gulf Program for the United Nations Development Organization (AGFUND).

LTR’s objective is the determination of the biological basis for fish production on Lake Tanganyika, in order to permit the formulation of a coherent lake–wide fisheries management policy for the four riparian States (Burundi, Tanzania, Zaïre and Zambia).

Particular attention is given to the reinforcement of the skills and physical facilities of the fisheries research units in all four beneficiary countries as well as to the build-up of effective coordination mechanisms to ensure full collaboration between the Governments concerned.

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For bibliographic purposes this document should be cited as follows:

Langenberg, V. TH. The physical limnology of Lake
1996 Tanganyika August - December 1995. FAO/FINNIDA Research for the Management of the Fisheries of Lake Tanganyika. **GCP/RAF/271/FIN-TD/54 (En): 52p.**

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ACKNOWLEDGEMENTS

I thank the LTR coordinator, Dr. G. Hanek, as well as other LTR staff at Bujumbura, Kigoma and Mpulungu for their support.

I specially want to thank in Kigoma: D. Chitamwembwa, P. Mannini, D. Lyoba, E. W. Lyoba, U. Kisisiwe, E. J. Kadula, S. Muhoza, M. Chatta, O. Kashushu, H. Kurki, A. Kalangali, P. Kamili, R. Wakafumbe, S. Kawawa, I. Shaban and B. Migembe, in Mpulungu: L. Mwape, C. Lukwesa, P-D, Plisnier, L. Makasa and R. Shapola, in Bujumbura and Uvira: K. Tshibangu, J.M. Tumba, E. Gahungu, E. Nikomeze, B. Ndimunzigo, S. Nyamushahu, C. Butoyi, P. Paffen and P. Kotilainen and all other occasional assistants for help with the sampling and data handling.

I wish to thank Dr. J. Kapetsky, Mr. M. Doeff and especially Mrs. D. Blessich for their assistance.

I thank Mr. G. Patterson for his fruitful discussions and advice.

This report was enhanced through the criticism of Dr. J. F. Craig who also supplied some missing data.

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SUMMARY

From August to December 1995, a weekly sampling programme was run at Bujumbura in Burundi, Kigoma in Tanzania and Mpulungu in Zambia, Lake Tanganyika. The vertical water column structure at all three stations was clearly seasonal. Most parameters measured were closely associated with the water temperature regime.

The seasonal south-east trade winds, locally strengthened by escarpment winds, caused upwelling at the Mpulungu station (August-September 1995) and established an internal seiche pattern on the lake. Also at the Bujumbura and Kigoma stations upwelling of cold water was observed (October-November 1995), probably associated with seiche activity.

In the north of the lake at the Bujumbura and Kigoma stations, the strength of the seiche affected the rates of internal nutrient loading. Peaks in nutrient loading were followed by peaks of concentrations of chlorophyll *a*. The results demonstrated that the pelagic zones of Lake Tanganyika can temporarily contain concentrations of chlorophyll *a* which are atypical for oligotrophic lakes (up to 17 µg l^{-1}) and that the photic zone in Lake Tanganyika is wider than previously published (mean depth of the compensation point at all stations was > 40 m). The productivity in Lake Tanganyika is determined to a large extent by the conditions of stratification and the amount of nutrient rich water that is brought up to the upper water layers.

1 INTRODUCTION

One of the main objectives of the Lake Tanganyika Research Project (LTR) is to investigate the trophic basis supporting the pelagic fish resource and the factors affecting fish abundance, distribution and variability as a contribution towards fisheries management.

The limnology component, as part of the Scientific Sampling Programme (SSP), was primarily concerned with describing the main physical processes in Lake Tanganyika and how these affect factors such as chlorophyll *a*, light and nutrient chemistry, which control primary producers in the pelagic zone of the lake.

This report presents the results of the weekly sampling conducted from August to December 1995 at three stations on the lake, Bujumbura, Kigoma and Mpulungu.

2 MATERIAL AND METHODS

2.1 Physical and chemical analysis

During this study, LTR has investigated pelagic zones located > 4 km from the nearest shore, with a minimum depth of 120 m (Fig. 1) and littoral zones located within 50 m from the shore, with a depth of ≥ 10 m). At Bujumbura, Kigoma and Mpulungu sampling was normally carried out on Tuesday mornings starting at 0900 h (GMT + 2h). Measurements of the vertical distribution of the following parameters were made (a) water transparency (secchi disk), water temperature, photosynthetically active radiation (PAR), dissolved oxygen, conductivity and pH (directly at the sampling site from the boat), and (b) NO_3-N, PO_4-P, NH_4-N, NO_2-N, chlorophyll *a*, SIO_2-SI and turbidity (on water samples taken to the laboratory after the sampling).

Every second week, primary production measurements were collected at the pelagic sampling sites from a 4 h *in situ* radiocarbon incubation (C^{14} as sodium carbonate). The sampling procedures followed were basically the same as described by Plisnier (1993), with the difference that during this study additional measurements were made on the vertical distribution of PAR and chlorophyll *a*. This report discusses the results of the pelagic sampling. The results of the littoral sampling are presented in another document (Langenberg, *in prep.*). Primary production measurements are still being analysed and are not yet available.

2.2 Biological analyses

Light intensity decreases exponentially with depth. This loss of light is expressed mathematically by the extinction coefficient ε_λ (Horne and Goldman, 1994). The higher the value of ε_λ, the lower the transmission of light or the less transparent the water. The intensity of light I at water depth z, is given by the formula:

$$I_z = I_o e^{-\varepsilon\lambda z} \qquad \text{(Equation 1.)}$$

where I_o = light intensity at the surface
z = path length (m)
ε_λ = extinction coefficient

For each sampling day, the slope of Photosynthetically Active Radiation (PAR) and depth between 0 and 50 m was calculated by a least square linear regression for all probe profiles to give the vertical light extension coefficient (ε_λ). The same formula was used to calculate the compensation depths for the sampling days. A compensation depth is defined as the lower limit of the photic zone where oxygen production by algae is in equilibrium with algal respiration and is often regarded as approximating to a depth at which radiation falls to a value of 1% of the incident incoming light (Horne and Goldman, 1994).

Chlorophyll *a* concentrations were estimated by filtering c. 3 l of lake water through Whatman GF/F filters and storing these filters for 24 h at 4° C until extraction of pigment in absolute ethanol. The extracted pigments were measured in 5 cm wide quarts cuvettes using a Milton Roy spectrophotometer, model 301. The chlorophyll *a* values ($\mu g\ m^{-3}$) were calculated after International standard ISO 10260 (1992), which is based on spectrophotometric absorbance at 665 nm. They were corrected for turbidity by subtracting the absorbance of the extracted pigment at 750 nm. To detect possible interference by phaeopigments, additional absorbance measurements of acidified pigment samples were made.

More details on the analytical methods and instruments used are given in Table 1. Details of the visits to the sampling sites are presented in Table 2 and on sampling rates and intervals for the different parameters in Appendix 3 (the original sampling form used by all three stations throughout this study).

The results of most of the parameters measured are presented as contour plots and in tables. To produce the contour plots, parameters with values below the detection limit were given nominal values of half the detection limit and where possible, values of the parameters were interpolated during periods not sampled assuming a linear weekly change. No interpolation was carried out during longer periods of missing data resulting in gaps in the graphs. The tables comprise some basic statistics calculated from the measurements made of the upper 100 m of depth.

3 RESULTS

3.1 Hydrodynamics

3.1.1 Temperature and stratification

The results of the temperature measurements are presented in Figure 2 and Table 3. Near Bujumbura the thermal or density structure of the lake was highly seasonal with a strongly developed thermocline at 70 - 90 m down in August and September followed by a weakening and tilting of the thermocline in October accompanied by a cooling of the epilimnion waters (a clear reduction in depth of the 25-25.5℃ isotherm) and a decrease in mean temperature of the whole water column sampled (Table 3). The thermocline re-established and increased in depth again in November, accompanied by a warming up of the epilimnion. In December the depth of the thermocline was reduced from about 85 to 45 m and was well defined, with a strong temperature gradient.

The seasonal vertical temperature structure near Kigoma was similar to that near Bujumbura, but during the study period, was weaker and, in October, the decrease in depth of the thermocline was less prominent near Kigoma than near Bujumbura.

Near Mpulungu strong south-eastern trade winds probably cooled the epilimnic waters by convection and wind mixing during August and September, resulting in a strong rise of the thermocline and cooling of the epilimnion. In August the thermocline disappeared. In September the thermocline reformed and deepened towards December as the hot, calm season continued. This deepening of the thermocline in December was accompanied by a strong warming of the epilimnion. In October-December 1995, the vertical temperature structure near Mpulungu was not characterised by a true epilimnetic water mass of uniform temperature but showed a nearly linear decrease in temperature from the surface to c. 75 m depth. The other stations maintained a marked thermocline during the same period.

3.1.2 Wedderburn numbers

Wind driven tilting of the thermocline in Lake Tanganyika has been described by Plisnier *et al.*, (1996). Thermocline tilting results in a density imbalance that acts as a store of potential energy. When wind stress decreases, water masses will move towards equilibrium and the thermocline will return to a horizontal plane which is generally accompanied by short term mixing and a decaying oscillation (seiche) of the thermocline.

The Wedderburn number (w) is often used to described this wind generated short term mixing (Coulter 1991, Patterson and Kachinjika, 1995). This dimensionless number is defined as:

$$W = g'h^2/u_*^2L \qquad \text{(Equation 2.)}$$

where h = the depth of the epilimnion (m)

u_* = the shear velocity of air (in m s^{-1})

L = the length of the lake (approx. 673 000 m)

The Wedderburn numbers for Mpulungu were calculated with the measurements made on limnological sampling dates. The daily average windspeeds used, to calculate the shear velocity of air, were obtained by DOF/FAO meteorological station which is about 8 km from the limnological sampling site on the main land at a height of about 3 m above lake level.

Close examination of the water density-depth curves obtained by a hydrographic probe (CTD-12 plus, Applied Microsystems Ltd.) during the first and third scientific cruises (respectively April-May 1995 and August-September 1995) showed that, throughout the lake g′ was rarely different from a value of 0.009825 m s^{-2}.

At Mpulungu, water temperature decreased more gradually with depth than at the other two stations (Figure 2). Thus the exact depth of the thermocline, which is normally considered to be at the point of maximum gradient in a temperature-depth curve, was difficult to determine. The depth-time plot of temperature at the other two pelagic sampling sites near Kigoma and Bujumbura showed that the 25 °C isotherm approximated the lower boundaries of the thermocline or the upper metalimnion. In order to calculate Wedderburn numbers for Mpulungu the depth of the 25°C isotherm was used as an alternative for the epilimnion depth.

The results of the Wedderburn numbers and the mean temperature values of the upper 100 m of depth are presented in Figure 3b. The windspeeds used to calculate the Wedderburn numbers are presented in Figure 3a. The low Wedderburn numbers found during the first two months of the study indicate that there were large velocity shears on the upper water layers resulting in a decrease in thermocline depth. During the rest of the study higher Wedderburn numbers were found and the water column structure was characterised by stability and relatively high temperatures (Fig. 2c).

3.2 Water chemistry and nutrient regime

3.2.1 Dissolved oxygen

The results of the dissolved oxygen measurements made during the sampling period are presented in Figure 4 and Table 4. At all three stations the surface waters were well oxygenated during this study. For Bujumbura and Kigoma the distribution of dissolved oxygen appeared to be closely related to the temperature regime (Fig 2a and 2b). At Mpulungu the relationship was not very clear since the oxycline was probably situated well below the 100 m sampled (Degens *et al.,* 1971, Hecky *et al.,* 1978, and Plisnier *et al.*, 1996). However, at the end of August, slightly lower concentrations of dissolved oxygen (3-4 mg l^{-1}) were found in the lower part of the water column between 90 to 100 m of depth, which could indicate deep upwelling of anoxic hypolimnion water. In October with the rising of the thermocline, a decrease in the dissolved oxygen gradient was found at Bujumbura and at Kigoma.

Besides the processes described above there were two single events where low dissolved oxygen concentrations were found high in the epilimnion and which could not be explained by temperature oscillations. One was measured at Kigoma in week 35 and the other at Mpulungu during weeks 47-49. These seemed not to be the result of intrusion of deep anoxic waters but could be the result of a temporary biological oxygen demand or a wrongly calibrated oxygen probe.

3.2.2 Turbidity

A correction factor was developed for the original turbidity readings. The values recorded from earlier turbidity readings (x) were recalculated (y) from y = 1.181 x + 0.0998 (r^2 = 0.98). The results of the turbidity measurements made during the sampling period are presented in Figure 5 and Table 5. At the Mpulungu and Bujumbura stations, turbidity fluctuations were larger than at the Kigoma station throughout the sampling period. Turbidity values from Kigoma were lower with less variation, monthly means values ranged from 0.4 to 0.5 NTU throughout the study. At Bujumbura and Mpulungu much higher values were found (monthly means up to 0.78 and 0.91 NTU respectively). Mean turbidity values were higher near Mpulungu than near Bujumbura and Kigoma and monthly means increased up to the end of 1995 coinciding with the warming up of the epilimnion waters. The highest fluctuations of turbidity were noticed near Bujumbura. At the other stations fluctuations of turbidity values were smaller in depth and time.

In general, the water layers below the thermocline were overall less turbid than above the thermocline.

3.2.3 Conductivity

Measured conductivity values are shown in Figure 6 and Table 6. These were higher at Bujumbura station (ranging from 640-705 µS cm^{-1}) than near Kigoma (618-689 µS cm^{-1})and Mpulungu (614-673 µS cm^{-1}). At both these stations, conductivity increased with increasing depth. Near Bujumbura the shallowing of the thermocline appeared to coincide with a strong increase in conductivity throughout the water column sampled.

3.2.4 pH

The pH values are presented in Figure 7 and Table 7. At

Kigoma and Bujumbura stations, pH decreased with depth having its largest gradient around the thermocline (Fig. 2). In October, when the thermocline and the oxycline moved upward near Kigoma and Bujumbura, pH increased as well.

In Mpulungu the vertical distribution of the pH was the most uniform found during this study, with somewhat lower pH values at the beginning and at the end of the sampling period. From September to November the whole upper 100 m was characterised by its homogeneity and high pH values (c. 9.1). The highest pH value measured at Kigoma station during October was 9.46.

3.2.5 Soluble reactive phosphate

The results of the soluble reactive phosphate (S.R.P.) measurements are presented in Figure 8 and Table 8. In general, phosphate concentrations increased with depth. The earlier observed deepening of the thermocline at Bujumbura and Kigoma (October-November) was followed by an increase of concentrations of S.R.P. During October and November, thermocline oscillations were accompanied by intrusions of hypolimnion waters with high concentrations of S.R.P. Near Mpulungu, elevated concentrations of S.R.P. were found during the upwelling period in August at 60-80 m of depth and throughout the water column in November.

3.2.6 Ammonia

The results of the ammonia measurements made during the sampling period are presented in Table 9. The construction of a depth-time plot of ammonia nitrogen concentrations (Figure 9.) was attempted, but since these concentrations were undetectable most of the time, this contour plot could easily lead to a wrong interpretation. In September and October at the Kigoma and Bujumbura stations higher concentrations of ammonia were found in the upper 100 m of water. At Kigoma, increased concentrations of ammonia were found throughout the whole water column, while at Bujumbura they were found only in water layers of around 80-100 m deep.

Near Mpulungu concentrations of ammonia remained undetectable over the whole period sampled, including the upwelling period at the beginning of the sampling period (August-September). Nevertheless, on 28 November (week 48) there were high concentrations of ammonia throughout the water column near Mpulungu. This single event was accompanied by low concentrations of dissolved oxygen which indicated biological activity.

3.2.6 Total oxidised nitrogen

Oxidised nitrogen (as NO_3-N) predominated in the meta- and epilimnion. Earlier work at Bujumbura and Kigoma (Plisnier *et al.,* 1996) showed that only slightly higher concentrations of NO2-N peaked close to the oxic-anoxic interface. No attempt was made to analyse further the vertical distribution of nitrite concentrations.

Concentrations of total oxidised nitrogen (NO_2-N and NO_3-N) are shown in Figure 10 and Table 10. In general, oxidised nitrogen concentrations increased with depth. Near Kigoma and Bujumbura, the oxidised nitrogen concentrations peaked along the thermocline depth. At all three stations these higher concentrations were restricted to water below 60 m, although the concentrations at the Mpulungu were lower when compared to the other two stations. A full interpretation of the vertical distribution of oxidised nitrogen throughout the sampling period was not possible since on many sampling days determinations were not carried out.

3.2.7 Silicate

The results of the silicate measurements made during the sampling period are presented in Figure 11 and Table 11. At Bujumbura concentrations of silicate increased with greater depth. This pattern was similar at Kigoma, although the concentrations were much lower there and did not seem to follow the thermocline oscillation as clearly as at Bujumbura. During thermocline shallowing, silicate concentrations peaked at Bujumbura (mean concentration of the upper 100 m in October was 1.96 mg l^{-1}), while mean concentrations near Kigoma reached a minimum for the study period (0.51 mg l^{-1}). Besides the occurrence of slightly increased concentrations of silicate in the deeper water layers during the upwelling period at Mpulungu station (80-100 m), the concentrations remained lower at Mpulungu than at Bujumbura, with little variation in depth up to the end of November.

3.3 Biological parameters

3.3.1 Irradiance

Light measurements from the photosynthetically active radiation meter were calculated as the vertical light extension coefficient ($\varepsilon\lambda$, Equation 1) and as the light compensation depth (C.P.). For all three sampling stations, values of $\varepsilon\lambda$ and C.P. are given in Table 12. A time plot of the secchi disk depth (S.D.) and the compensation depth (C.P.) is given in Figure 12. Data on the incoming solar radiation from the meteorological buoy c. 15 km away from the limnological sampling site at Mpulungu is given in Figure 3a. Values from the solar radiation sensor on the buoy (x) were recalculated after calibration with a quantum sensor (y) to give the PAR from $y = 2.034x$ ($r^2 = 0.99$).

The waters at Kigoma station were more transparent throughout the study (= 0.10 m^{-1}) than waters at Bujumbura (=0.12 m^{-1}), F-test: $p<0.05$. On average C.P. values were lower at Bujumbura (C.P.= 41 m) than at Kigoma (C.P = 49 m). Values for C.P. varied more in time at the Mpulungu and Bujumbura stations than at Kigoma.

At the Mpulungu station a significant correlation was found between S.D. and depth of the photic zone while the other stations showed a weak correlation. At Mpulungu station the S.D. was approximately one-fifth of the depth of the photic zone ($p<0.001$, $r^2 = 0.5$).

In the pelagic zone, incoming PAR increased from August to the beginning of November (from c. 500 to 600 µE s^{-1} m^{-2}). With the onset of the wet season weekly incoming PAR became highly variable, but in general, decreased up to the end of December.

3.3.2 Chlorophyll *a*

In this report only the chlorophyll *a* levels of unacidified pigment extracts were used, since the measurements of acidified extracts at Mpulungu station were not consistent. The results are shown in Figure 13, Table 13 and Figure 14. In general, concentrations of chlorophyll *a* decreased with depth. Although chlorophyll *a* peaked in the upper 50 m at all stations, significant amounts could still be found in deeper water layers. At Bujumbura the mean concentrations of chlorophyll *a* were low in August 1995 (0.91 µg l^{-1}) but increased towards December 1995 (1.51-1.55 µg l^{-1}). Also, a clear increase in chlorophyll *a* in the upper water layers was observed around the end of October. At Kigoma station concentrations were low (0.94 µg l^{-1}) and elevated chlorophyll *a* concentrations were found in December (1.76 µg l^{-1}), but data were incomplete. Except for the surface bloom at the end of October, which resulted in exceptionally high concentrations of chlorophyll *a* (c. 17.3 µg l^{-1}) and low water transparency ($\varepsilon\lambda$ = 0.35 m^{-1}), concentrations of chlorophyll *a* at the Mpulungu station decreased up to the end of the study period.

3.3.3 'Redfield ratio'

In 1934, Redfield suggested that cells which had a balanced nutrient supply would have a ratio (by atoms) of nitrogen:phosphorus of 16:1. Departure from this ratio indicates a nutrient limitation and thus biological activity (Carpenter *et al.*, 1992; Patterson and Kachinjika, 1995). In order to calculate Redfield ratios the concentrations of total oxidised nitrogen, ammonia and soluble reactive phosphate-phosphorus were used. The results of the calculated N:P ratios at 20, 40 and 60 m of depth are shown in Figure 15. N:P ratios where found to be very low at the Mpulungu station, never reaching Redfield ratios in the period sampled. At the Bujumbura station N:P ratios higher than 16:1 at the three depths sampled were found to occur in August and during the period when the thermocline decreased in depth (October-

November). At the Kigoma station several depths throughout the study had N:P ratios higher than 16:1.

4 DISCUSSION AND CONCLUSION

Vertical distribution of inorganic nutrients has been discussed by Beauchamp (1939; 1940), Kufferath (1952), Coulter (1988), Hecky and Bugenyi (1992) and Plisnier *et al.,* (1996). This study confirmed their findings and shows clearly that strong vertical gradients of nutrient concentrations and other related water column characteristics are caused by the meromictic condition of the lake. In general, concentrations of phosphate, nitrate, ammonia and silica were low in the epilimnion, probably due to uptake by autotrophic organisms, and high in the hypolimnion.

At Bujumbura there were three distinct phases (in the five month period of study) in the vertical distribution of nutrients and chlorophyll a. The first period, from August to mid-September, was characterised by a deep, strongly developed thermocline, nutrient impoverished epilimnetic waters, low chlorophyll *a* concentrations and a clear vertical distribution of most of the parameters measured that were related to the vertical water temperature structure. The second period, from mid-September to November, was characterised by marked vertical movements of the thermocline directing most of the parameters towards hypolimnetic values and increasing concentrations of chlorophyll *a*. The third period, from November to December, had a well-defined thermocline, fluctuating in depth and high concentrations of chlorophyll *a* in the epilimnion. This relation between occurrence of elevated concentrations of chlorophyll *a* and the seasonal changes in stratification was also observed in other large tropical lakes such as, Lake Victoria (Talling, 1966) and Lake Malawi (Patterson and Kachinjika*,* 1993).

At the Kigoma station the overall succession was similar, but the changes in the vertical distribution of most of the parameters and the cycle of stratification were less prominent than at Bujumbura. This was also found by van Well and Chapman (1976). The seasonal cycles in the vertical distribution of temperature, nutrients and other related limnological parameters in the northern part of the lake were described by Dubois (1958), Ferro (1975), Hecky *et al.* (1981), Coulter (1963) and Crul (1993). They observed a similar periodicity the one found in this study for Kigoma, which assumed that hydrographic changes affect concentrations of chlorophyll *a*.

The vertical temperature distribution in the southern part of the lake at Mpulungu could be divided into three seasonal phases although they were different from those at Bujumbura and Kigoma. The first period, from August to mid-September, was characterised by surface cooling and a minimum water temperature caused by upwelling, the near absence of a thermocline, nutrient impoverished water, and relatively high chlorophyll *a* concentrations throughout the upper 100 m of depth. The second period, from mid-September to November, was characterised by the strengthening of the thermocline, a strong warming up of the epilimnetic waters and, except for a surface bloom in October-November (1995), decreasing concentrations of chlorophyll a. The third period, from November to December, had a well-established thermocline which fluctuated in depth and low concentrations of chlorophyll *a* which were restricted to the surface layers.

These strong seasonal patterns were indicated by the distribution pattern of Wedderburn numbers for the Mpulungu station (Fig. 3). Wedderburn numbers were low in August and September, when surface waters moved to the north, in the direction of the prevailing winds, causing tilting of the thermocline and upwelling at the windward end of the lake and thermocline deepening at leeward end. This was confirmed by the depth-time plots of temperature at Mpulungu and Bujumbura stations. Upwelling at Mpulungu was identified by Plisnier *et al.* (1996), during July-September 1994 and has been associated with the strong offshore winds in the south of the lake during the dry season. This initiated a lake-wide internal seiche which persisted throughout the whole year.

The prevailing south-east winds are a combination of south-east trade winds and escarpment winds which are locally called ‘Kapata’ (Coulter, 1963). They cause upwelling in the south of the lake and imbalance the water layers across the north-south axis of the lake (Kotilainen *et al.*, 1995). Cessation of these winds probably caused the temporary, secondary upwelling witnessed in the north of the lake rather than the changing weather conditions with the onset of the wet season (Plisnier *et al.,* 1996 and Kotilainen *et al.,* 1995). Nevertheless, local weather conditions could strengthen this.

The upwelling at the Kigoma and Bujumbura stations (October-November) resulted in an increase of nutrients followed a month later by an increase of chlorophyll *a* in the upper water layers. There was no strong evidence of nutrient loading at Mpulungu station, although the vertical temperature structure suggested that the upwelling was stronger near Mpulungu than elsewhere. This was inferred from the different vertical stratification structures of temperature, dissolved oxygen and nutrients at both ends of the lake. In the northern part of the lake, the well defined thermocline, oxycline and chemocline were situated close together just above the bottom but below the photic zone. Any vertical movement of these boundaries in relation to each other could directly lead to a replenishment of nutrients into the epilimnion and photic zone, stimulating productivity. In the south of the lake the thermocline was less well defined and the oxycline and chemocline were much deeper (probably up to 200-300 m, Degens et al., 1971; Plisnier *et al.*, 1996) than at Kigoma and Bujumbura. In the south upwelling of water with elevated concentrations of reduced inorganic substances and dissolved organic carbon compounds first had to pass a much thicker oxygenated water layer before it could reach the photic zone.

Earlier work identified the importance of chemoautotrophic and heterotrophic activities, such as denitrification processes, in impoverishing the rising water layers by consuming these nutrients before they reach the upper water layers. (Edmond *et al*, 1993; Patterson and Kachinjika, 1995; Hecky and Kling, 1981).

In this study the mean depth of the photic zone differed slightly between the stations (41 m at Bujumbura, 49 m at Kigoma and 46 at Mpulungu). At the Bujumbura and Mpulungu stations the fluctuations were greater than at Kigoma station (SD. of 14.4, 15.1 and 7.5 respectively). These results are different from those of Coulter (1991) who found during two surveys (April-May and October-November 1975), a vertical light extinction coefficient of c. 0.16 and a photic zone of c. 28 m deep and assumed these to be constant in time and space.

The high N:P ratios measured in the northern part of the lake at Bujumbura during the beginning of the sampling period were caused by very low concentrations of phosphate while concentrations of the nitrogen compounds although low, were detectable. During the secondary upwelling and related nutrient loading in October 1995 at the Bujumbura station, higher N:P ratios were found at 20, 40 and 60 m deep. This was thought to be due to the selective uptake of phosphates, by phytoplankton. Phytoplankton is reportedly more efficient in the phosphate uptake than combined nitrogen uptake (Moss, 1988).
The low N:P ratios measured at Mpulungu were previously recorded by Hecky and Kling (1981) and Sarvala and Salonen (1995) and probably resulted from strong denitrification processes in deeper water layers leading to nitrogen deficiency in the upper water layers (Patterson *et al.,* 1995; Edmond *et al.,* 1993). At Bujumbura station the seasonal cycle of chlorophyll *a* correlated with the seasonal cycle of phytoplankton biomass and chlorophyll a concentrations reported by Hecky and Kling (1981 and 1987). They found low phytoplankton biomass dominated by small chlorophytes and cyanophytes in the period before the secondary upwelling. During the period of secondary upwelling, biomasses increased, favouring growth of chrysophytes and large diatoms, while cyanophytes were extremely sparse. During the third period, when the thermocline was re-established, the upper water layers were characterised by a dynamic succession of varying algae species with an *Anabeana* spp*.* showing the most dramatic increase, which often resulted in surface foam.

The measurement of dissolved nutrients in this study to explain potentially productive periods may be misleading since most of the nitrogen and phosphorus appeared to be in organic form and perhaps was not readily available to the algae (Hecky and Kling, 1981; Sarvala and Salonen, 1995). The nutrients which are most likely to limit primary production in African lakes are nitrogen and phosphorus (Talling and Talling, 1965; Moss 1969; Melack *et al.,* 1982). During the upwelling periods at the Bujumbura station, epilimnetic concentrations of silicate, nitrogen and phosphate increased, N:P ratios were relatively high and concentrations of chlorophyll *a* increased shortly after. This suggests that for most phytoplankton species or phytoplankton production both nitrogen and phosphorus concentrations were deficient.

Results from the nutrient enrichment studies carried out during the first lake-wide cruise in April-May 1995 (Järvinen *et al.,* 1996) showed that phytoplankton production was stimulated more by combined additions of nitrogen and phosphorus than by separate additions of these elements. However, measurements in the epilimnion at the three stations showed that only free phosphate was consistently close to the lower detection limits, except during upwelling. Combined with the assumption that in freshwater lakes phosphorus has fewer pathways to enter the epilimnion than nitrogen compounds (Carpenter *et al*, 1992; Downing and McCauley, 1992; Horne and Goldman, 1994), this could indicate a phosphorus limitation of phytoplankton in Lake Tanganyika as suggested earlier by Sarvala and Salonen (1995) and Järvinen *et al.* (1996). However, Edmond *et al.* (1993) found that inorganic nitrogen and phosphate are regenerated rapidly in nearly Redfield ratios, indicating an approximately balanced nutrient supply.

As reported by Hecky *et al.* (1981), offshore areas were found to contain high concentrations of chlorophyll *a* and to support high algal biomasses at certain times in the seasonal cycle (Figure 13 and 14). In the northern part of the lake, these are more likely to occur during the wet season after the intrusion of nutrient rich deep water. In the southern part of the lake at Mpulungu, excluding the surface bloom in October-November, high concentrations were found during and just after the upwelling event. In the north phytoplankton growth was probably stimulated by internal nutrient loading which could be increased by external sources such as precipitation and river water. Rains can contain considerable amounts of dissolved nutrients (Langenberg *et al*., 1995) and can induce mixing as can inflowing river water (Horne and Goldman, 1994). In addition, the lower solar radiation during the wet season (Fig. 3a) induces algae growth. Strong surface photo-inhibition of chlorophyll and primary production occurs with high solar radiation (Järvinen *et al*., 1996).

In tropical lakes chlorophyll *a* concentrations or phytoplankton biomass are poor predictors of phytoplankton production and consequently no relation between phytoplankton biomass and secondary production can normally be found (Hecky and Fee, 1981; Carpenter and Kitchell, 1984). However, in October 1981 (off Myako, Tanzania and off Uvira, Zaire), Narita *et al* (1986) found an increase in abundance of phytoplankton (dominated by an *Anabeana* spp.) which was directly followed by an increase in abundance and reproduction of zooplankton (an increase in shrimps and female *Diaptomus* with eggs was noticed).

This study showed a significant relation between secchi disk depth (S.D.), light extinction coefficient or compensation depth (C.P.) and concentrations of chlorophyll *a* at Mpulungu station. Light transmission is reduced by water molecules, dissolved material, particulate matter and algae. Near Mpulungu, gradients of temperature and oxygen, total dissolved solids (from conductivity) and turbidity were less variable in time and depth than at the other stations resulting in a better relation between the S.D., C.P. and concentrations of chlorophyll *a*. The relationship was weak near Bujumbura where the probably fluviatile turbidity was highly variable (Caljon 1992).

Several scientists have estimated the primary production (note: only in the upper water layers of the lake) in Lake Tanganyika from 0.1 to 3.1 g C m^{-2} d^{-1} (Burgis, 1986; Hecky *et al*., 1978; Hecky *et al*., 1981; Hecky and Fee, 1981; Hecky and Kling, 1981; Melack, 1981) and suggested that this production was insufficient to maintain the annual fish yield of 125 kg ha^{-1} postulated by Coulter, 1981. Hecky *et al.* (1978) suggested that the primary production of Lake Tanganyika in 1975 was insufficient to meet the respiratory demand of the plankton community let alone to sustain populations at higher trophic levels. After analysing other sources of organic carbon, Hecky and Fee (1981) concluded that the only other possible source could be bacterial production.

Järvinen *et al*. (1996) and Hecky *et al.* (1979; 1981) postulated that the bacterial production probably contributes 25 to 50 % of the total primary production, which is similar to other aquatic environments (Weisse, 1991; Weisse and Stockner, 1992; Kuuppo, 1994). This is likely to be an underestimation because, as in Lake Malawi (Patterson and Kachinjika, 1995), Lake Tanganyika probably has year-round primary production extending into deeper water layers than previously expected, leading to higher values of production when integrating in depth and time. It has already been shown that bacterial activity through chemoautotrophy and heterotrophy (*e.g.*, denitrifying and methane-oxidising bacteria) up to the oxic-anoxic border (in the south sometimes deeper than 300 m of depth, Plisnier *et al.,* 1996) can contribute significantly to the total primary production (Hecky and Kling, 1981; Edmond et al, 1993). In addition, phototrophy can also be expected to take place much deeper than the compensation depth since some algae, especially the blue-greens, are known for their ability to adapt to low light intensities (Reynolds, 1984).

The south-east winds are likely to generate long-period internal waves or internal seiches, like Kelvin and Poincaré waves, which cause thermocline displacement, hypolimnion currents and related turbulence in large lakes such as Lake Tanganyika (Horne and Goldman, 1994). Kelvin waves are characterised by having their largest wave action at lake edges, while Poincaré waves, which are larger, influence the hypolimnion in open waters producing alternating water mounds and depressions. In Lake Tanganyika, the complexity of this south-east wind induced seiche pattern, which probably has a strong south-north component, is likely to be underestimated. This is because local meteorological events, bottom depth and morphometry and other wind generated short period waves could alter the occurrence of the thermocline displacement and thus nutrient loading into the epilimnion (Hecky and Kling, 1981; Coulter, 1968).

It is possible that the less variable vertical distribution of most of the parameters measured at the Kigoma station was the result of localised internal waves. The factors which were most likely to dampen the internal seiche at the Kigoma station are the basin morphometry (Fig. 1) and the wind regime, both of which were different from those at the Bujumbura and Mpulungu stations. The Kigoma station is characterised by a steeply shelving bottom and a wind regime with a strong east-west component (Kotilainen et al., 1995), while the other two stations are characterised by winds with a strong south-north component and a less steeply shelving bottom. The latter shelving could exaggerate the mixing events as suggested by Ferro and Coulter (1974) and Patterson and Kachinjika (1995). However, clear upwelling events inducing productivity are expected over the entire lake (Coulter, 1968). During LTR's fourth cruise (October 1995), blue-green algae blooms were found 200 km north of Mpulungu (personal observation). Patterson and Kachinjika (1995) also suggested that both ends of Lake Malawi were the most productive areas for the reasons above, but could not relate this to upwelling events which occurred in the pelagic areas.

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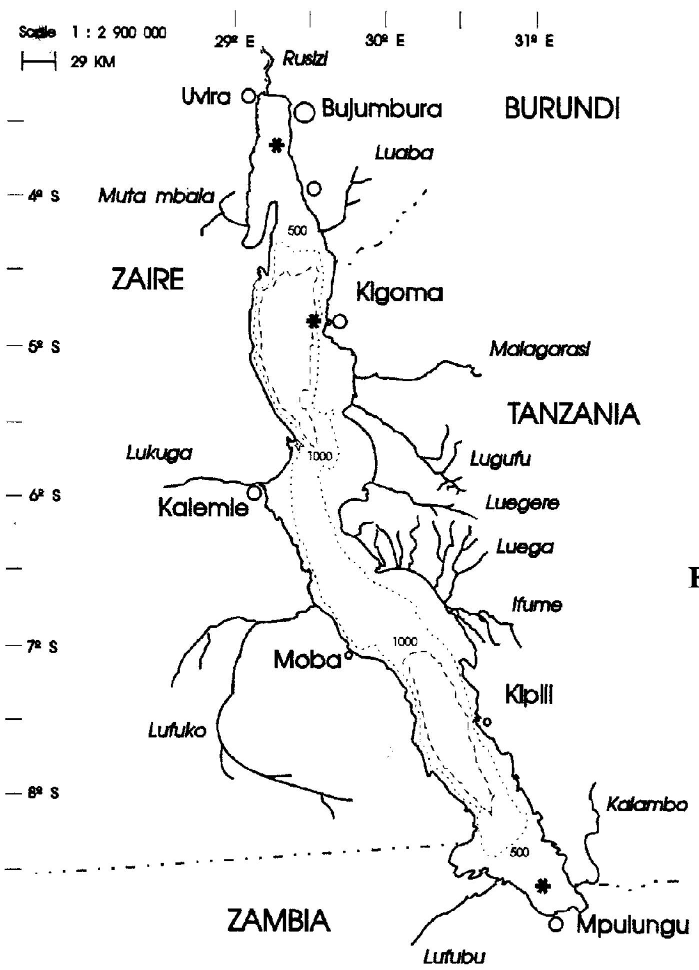


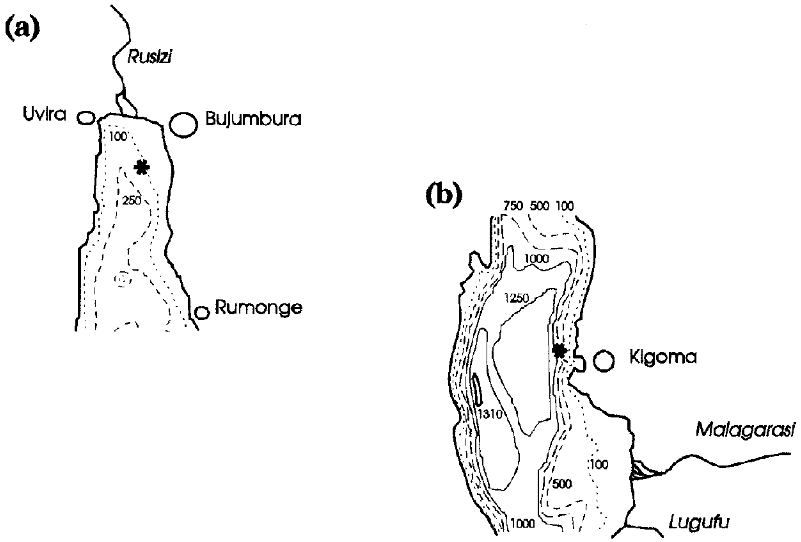
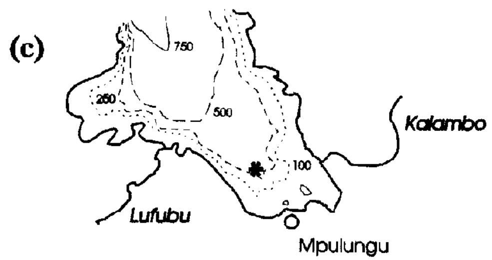


Fig. 1: Lake Tanganyika, showing the major towns and villages, rivers, the country borders, lake depth and sampling stations for limnological sampling (*) at (a) Bujumbura, (b) Kigoma and (c) Mpulungu.

(Redrawn from: 'Carte Bathymetrique de la Mission Hydrobiologique Belge, 1946-47'; Capart, 1949)



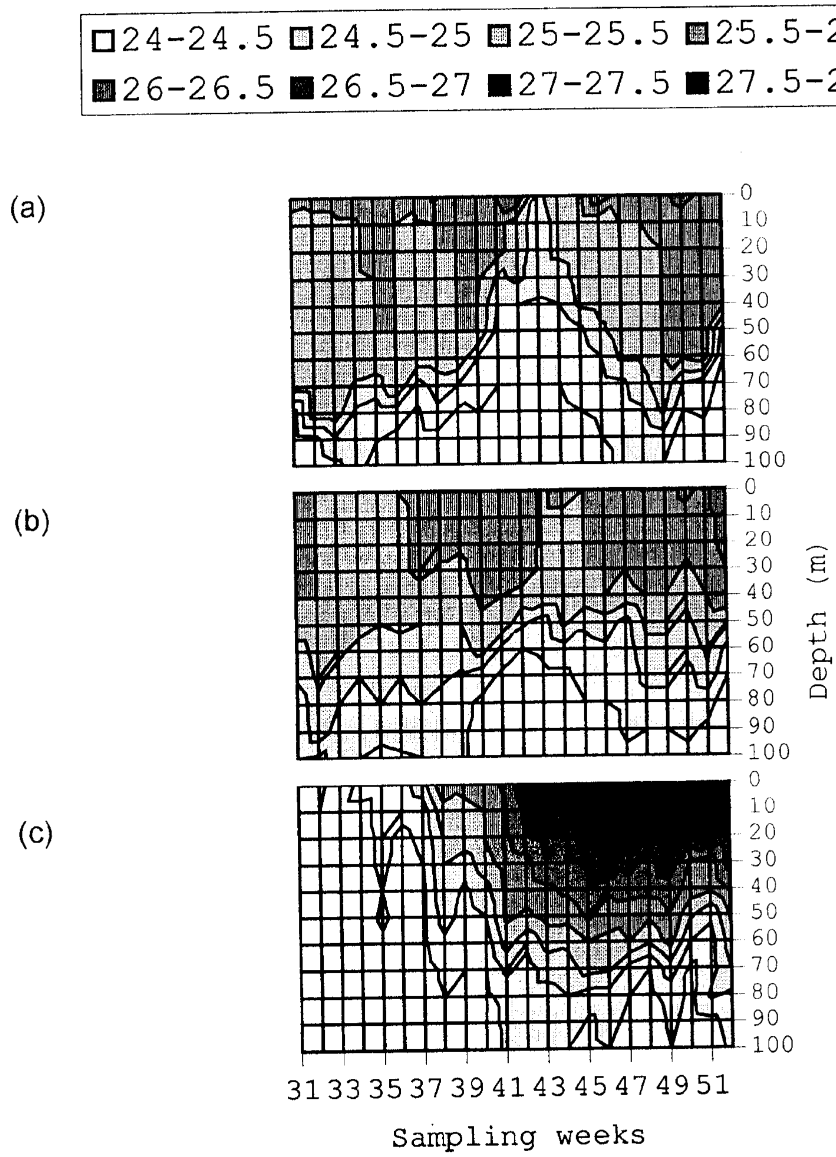


Figure 2. Depth-time plot for temperature (°C) (a) Bujumbura), (b) Kigoma and (c) Mpulungu from temperature measurements made during August 1995-December 1995.

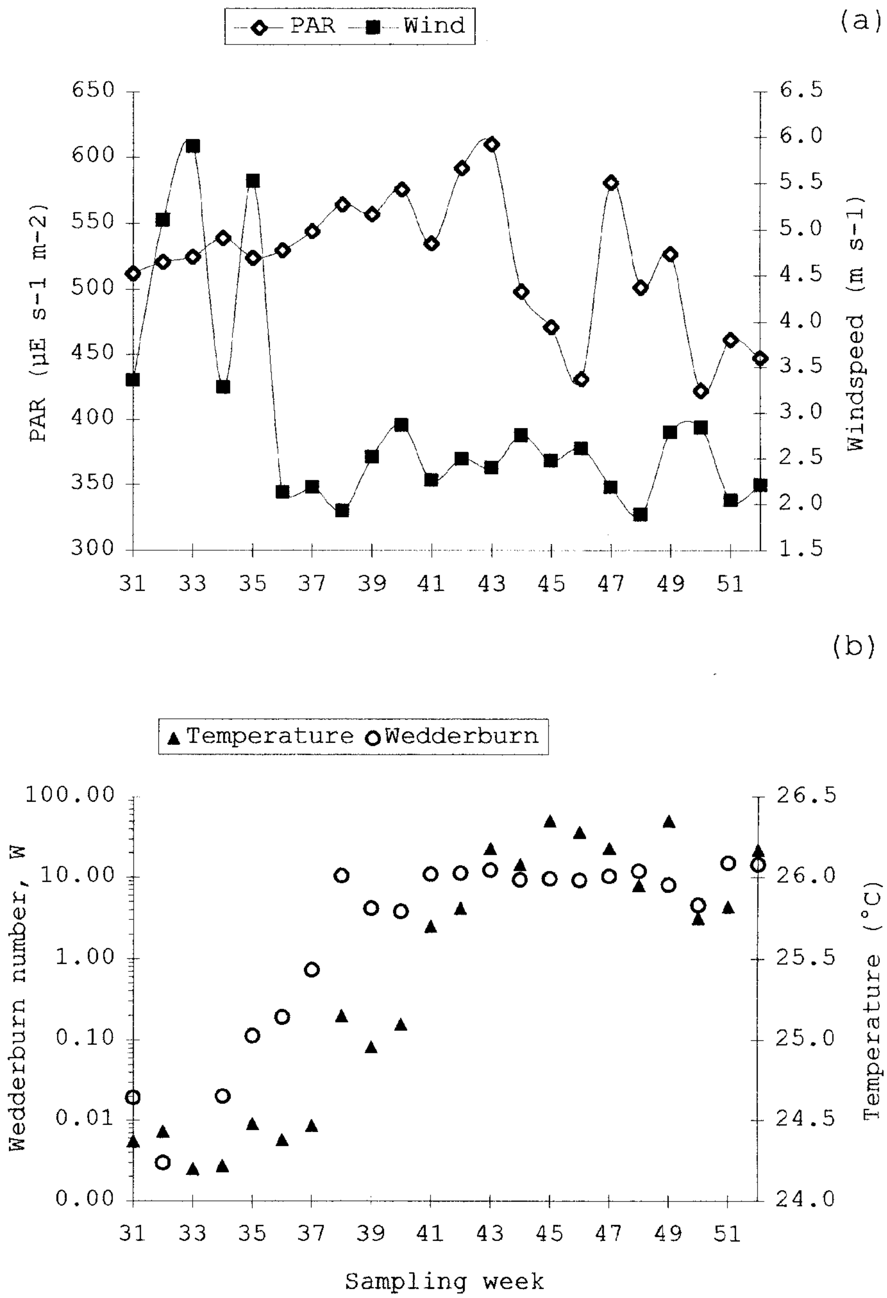


Figure 3. Time plots of (a) windspeed and incoming PAR and (b) Wedderburn numbers and mean temperature of upper 100 m from measurements made at Mpulungu station.

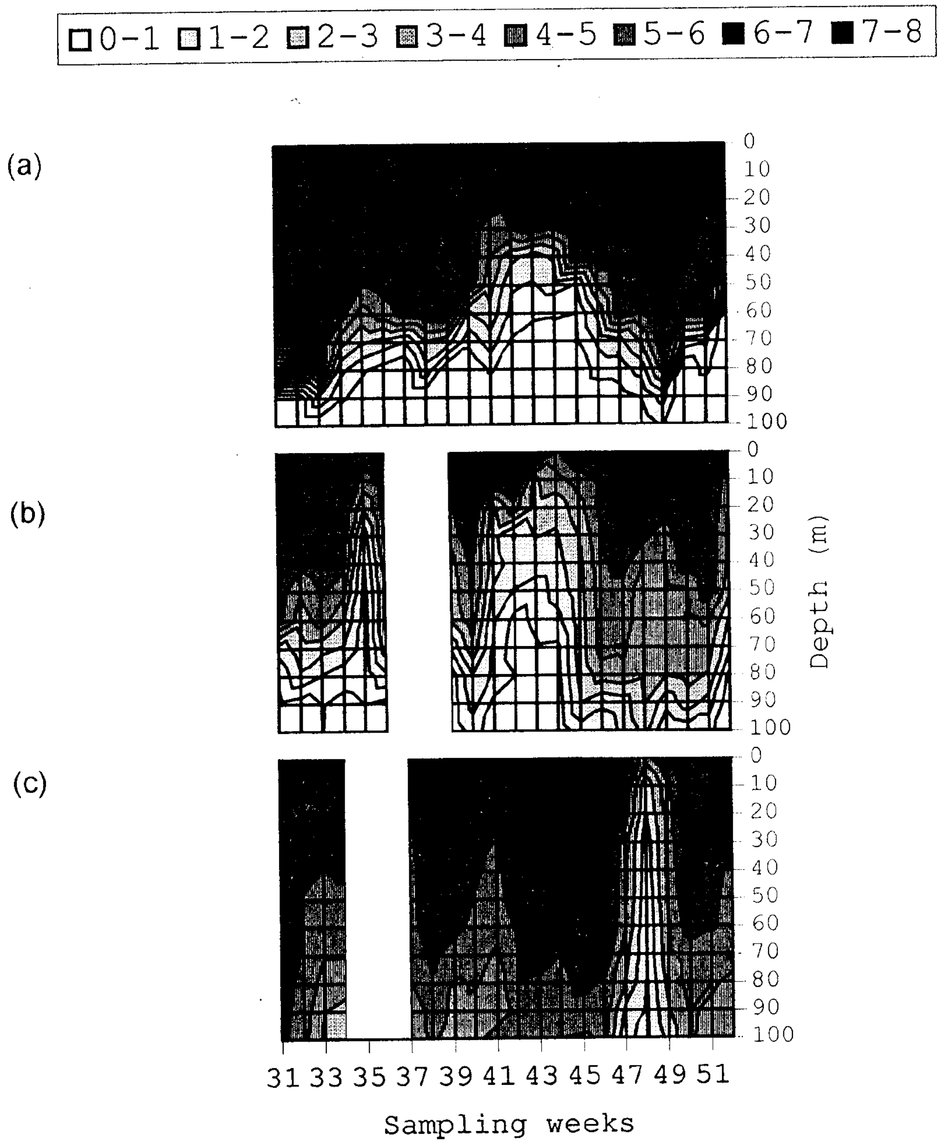


Figure 4. Depth-time plot for concentrations of dissolved oxygen (mg l^{-1})) (a) Bujumbura), (b) Kigoma and (c) Mpulungu from measurements made during August 1995-December 1995. (Patterns and colours which are situated within a black isopleth and not explained in the legend indicate dissolved oxygen concentrations > 8 mg l^{-1}).

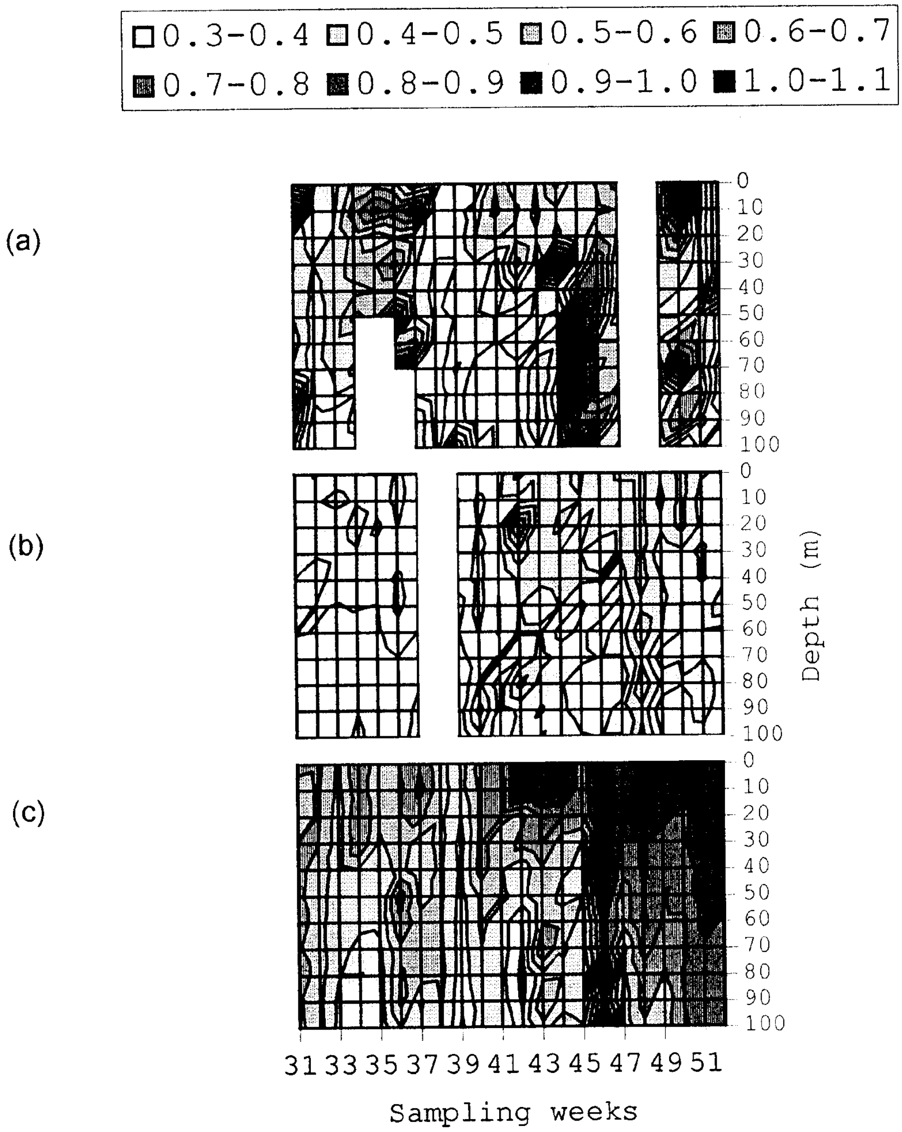


Figure 5. Depth-time plot for turbidity (NTU) (a) Bujumbura), (b) Kigoma and (c) Mpulungu from measurements made during August 1995-December 1995. Patterns and colours situated within a black isopleth and which are not explained in the legend indicate turbidity values > 1.10 NTU.

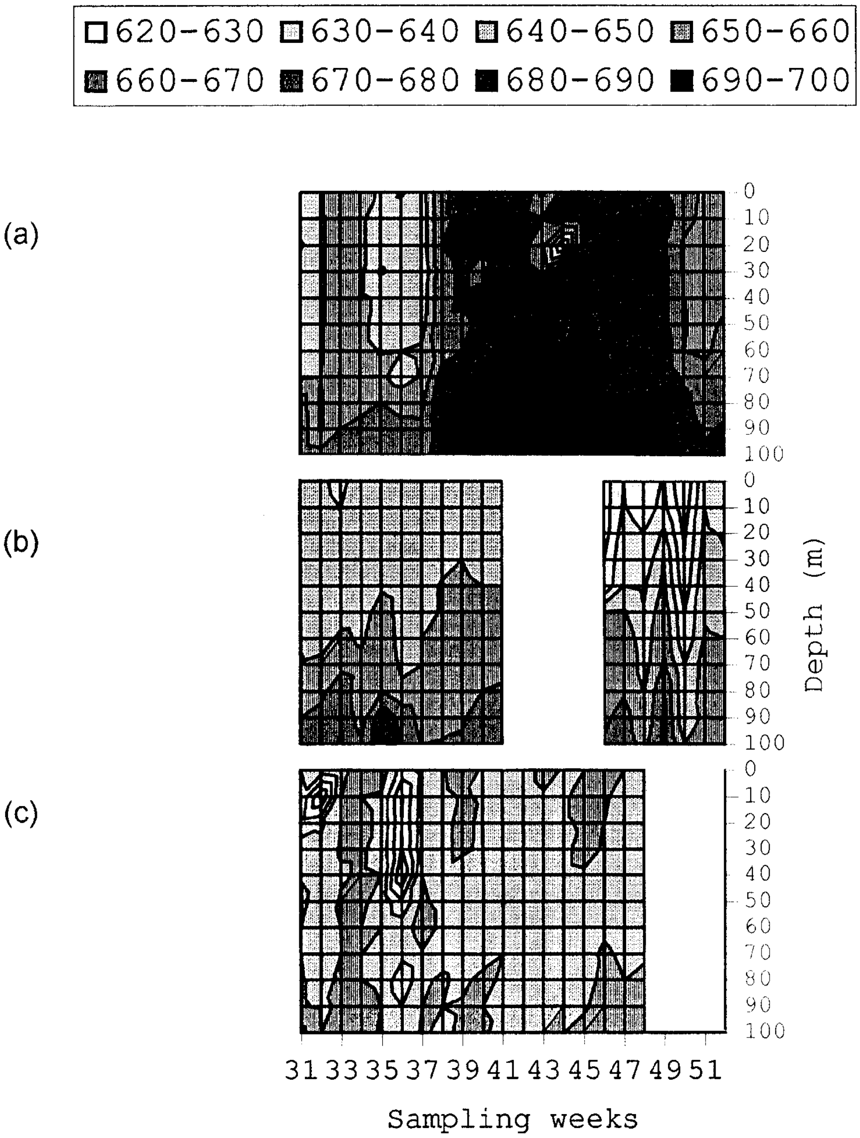


Figure 6. Depth-time plot for conductivity (μS cm^{-1} at 25 °C) (a) Bujumbura, (b) Kigoma and (c) Mpulungu from measurements made during August 1995-December 1995.

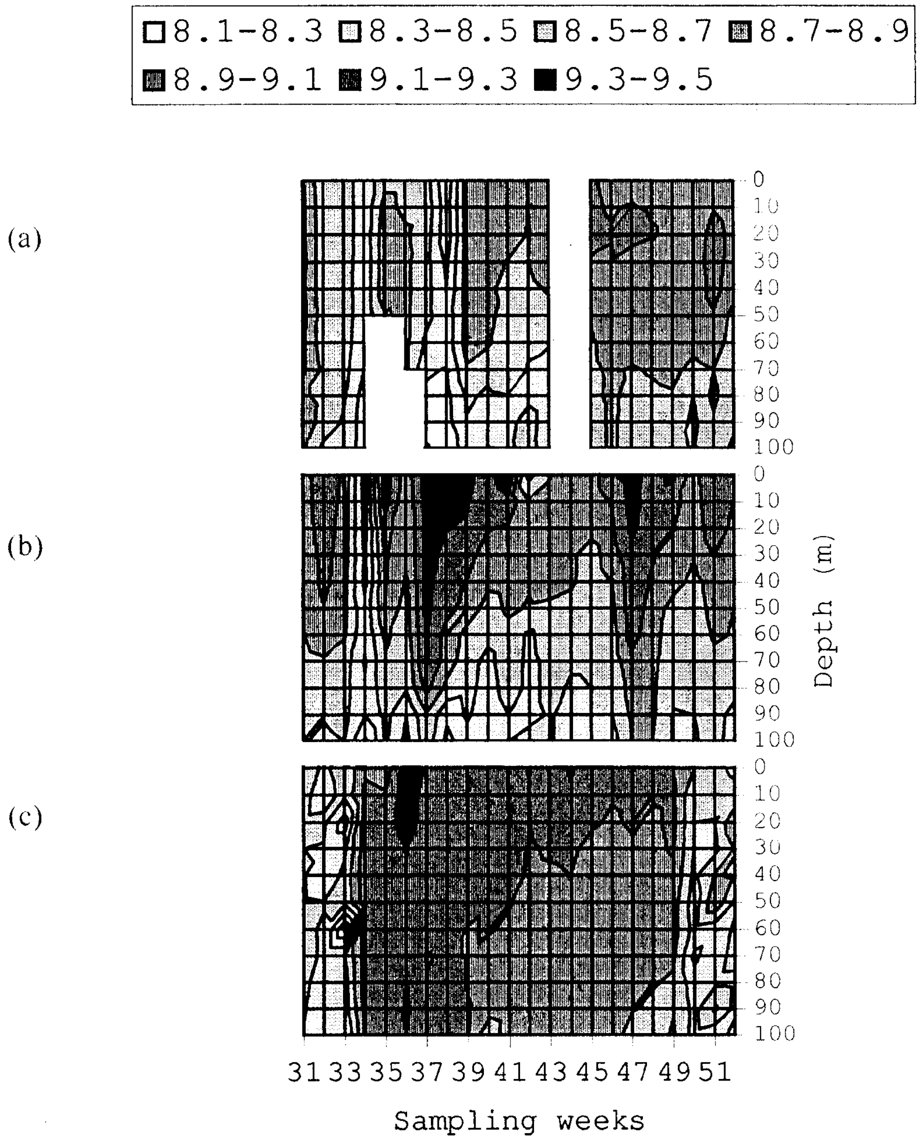


Figure 7. Depth-time plot for pH (a) Bujumbura, (b) Kigoma and (c) Mpulungu from measurements made during August 1995-December 1995.

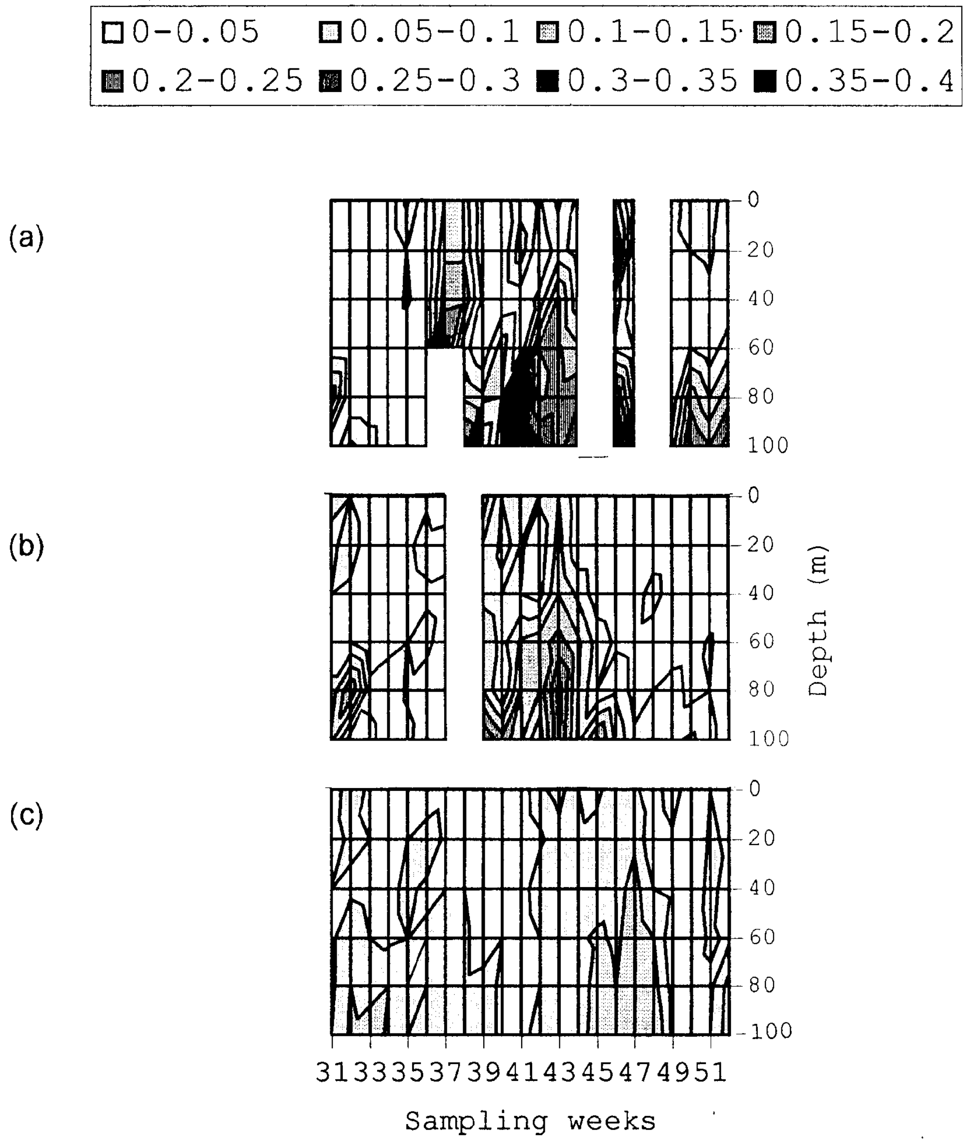


Figure 8. Depth-time plot for concentrations of soluble reactive phosphate (mg l^{-1}) (a) Bujumbura, (b) Kigoma and (c) Mpulungu from measurements made during August 1995-December 1995.

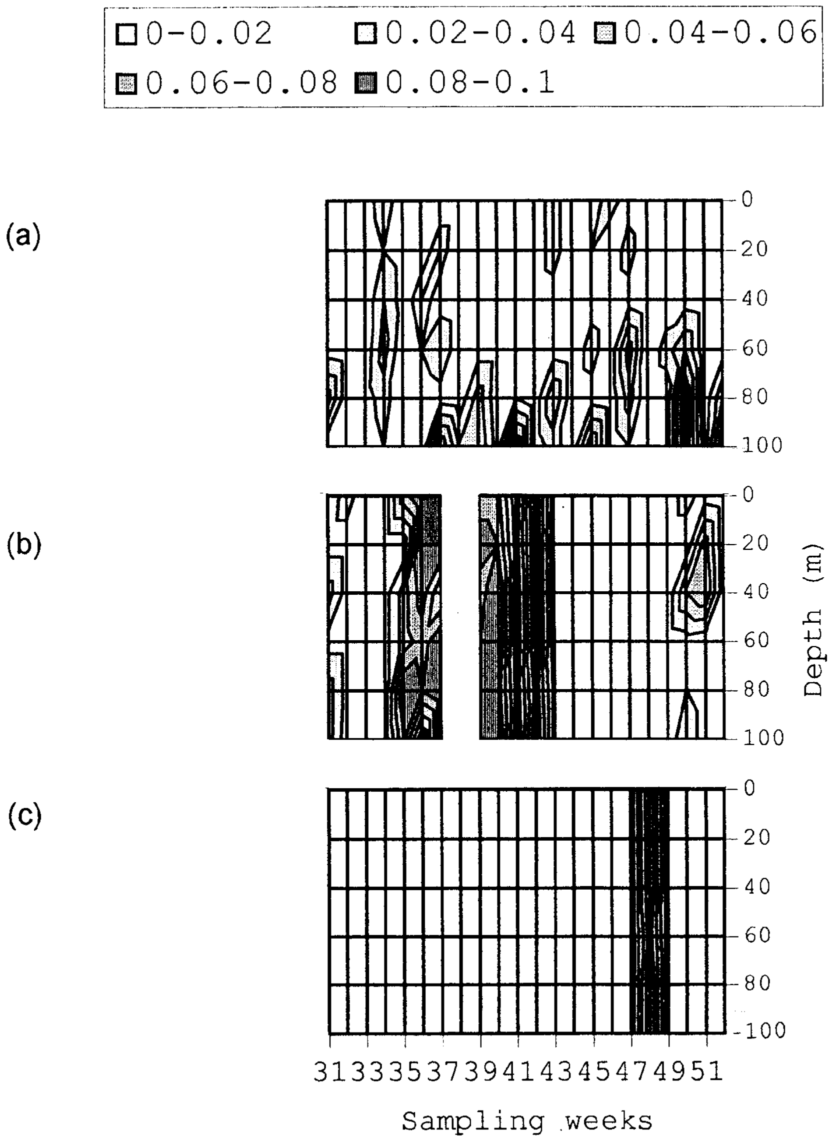


Figure 9. Depth-time plot for concentrations of ammonia (mg l^{-1}) (a) Bujumbura, (b) Kigoma and (c) Mpulungu from measurements made during August 1995-December 1995.

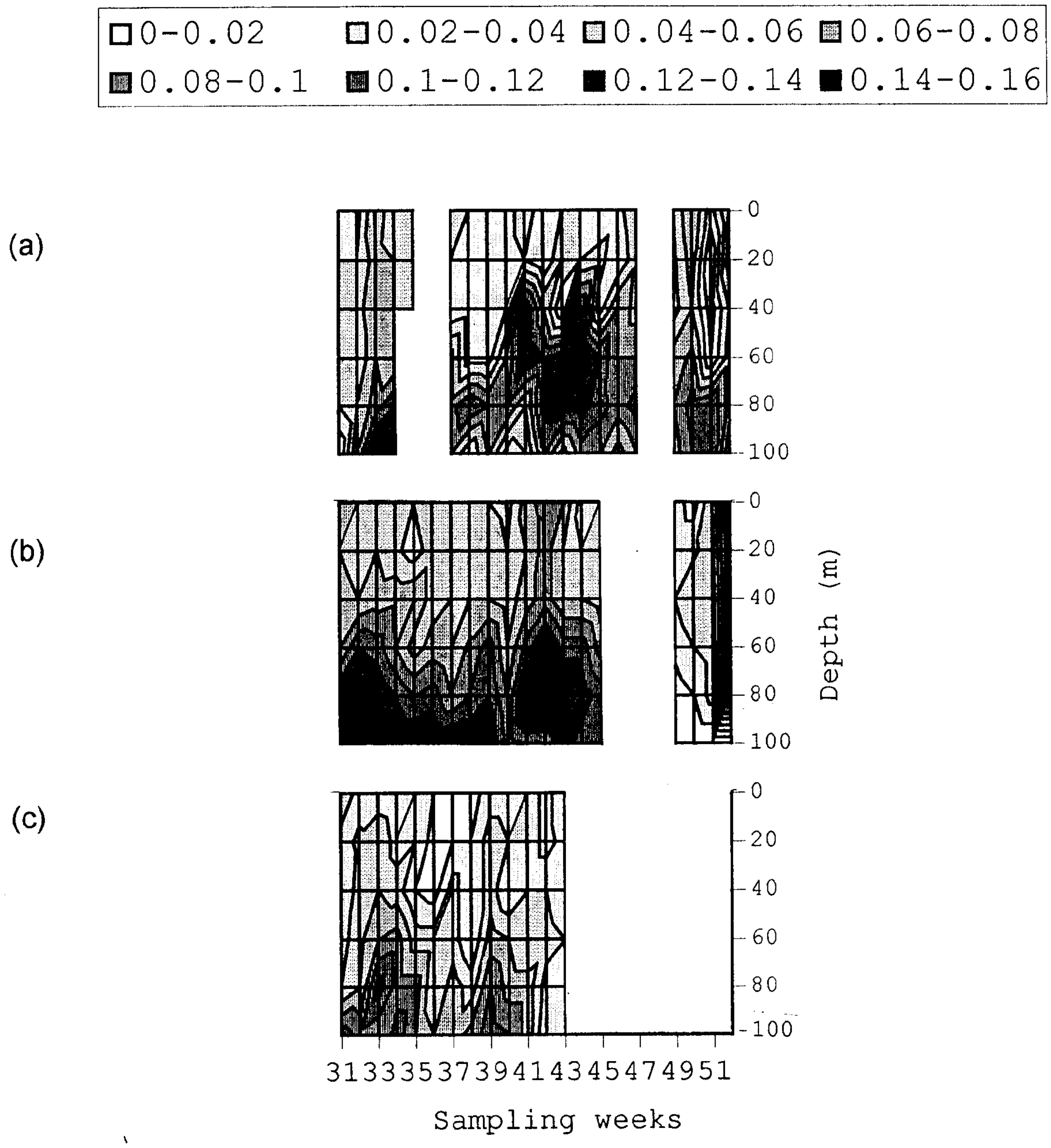


Figure 10. Depth-time plot for concentrations of nitrate and nitrite (mg l^{-1}) (a) Bujumbura, (b) Kigoma and (c) Mpulungu from measurements made during August 1995-December 1995.

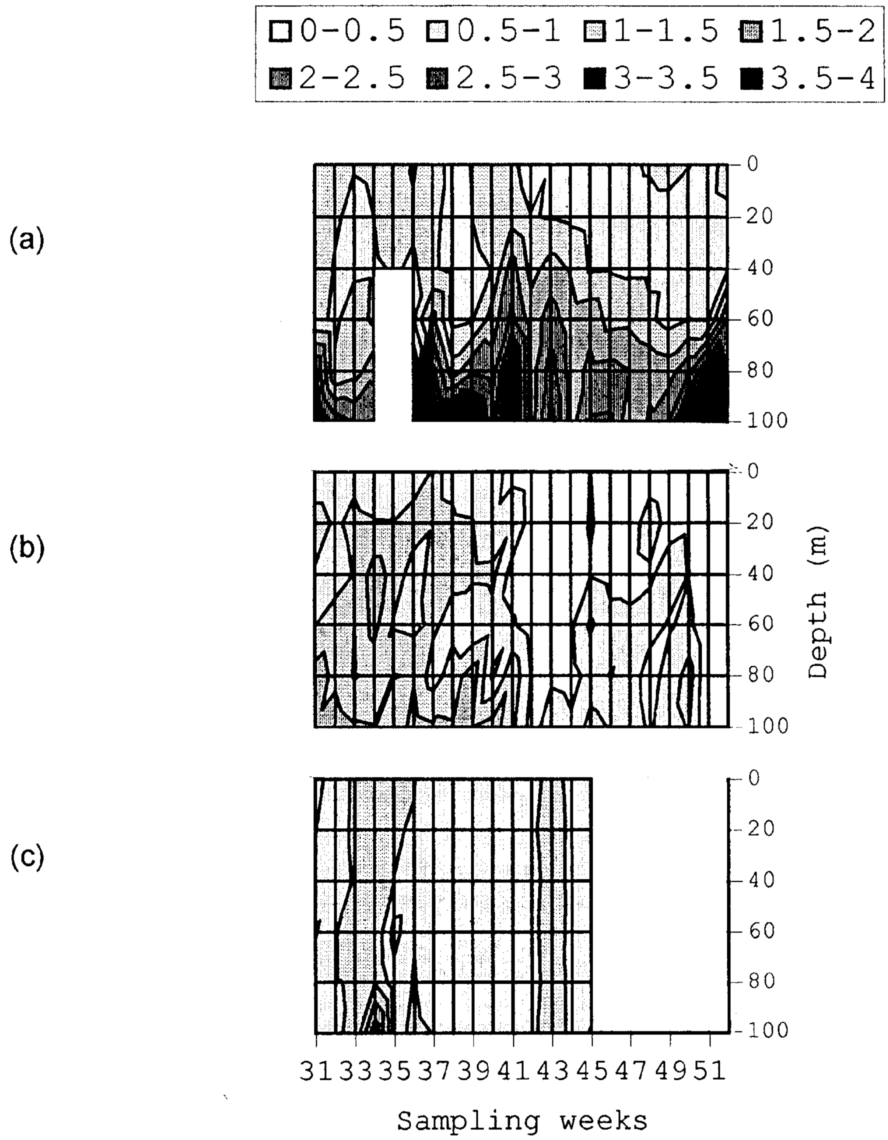


Figure 11. Depth-time plot for concentrations of silicate (mg l^{-1}) (a) Bujumbura, (b) Kigoma and (c) Mpulungu from measurements made during August 1995-December 1995.

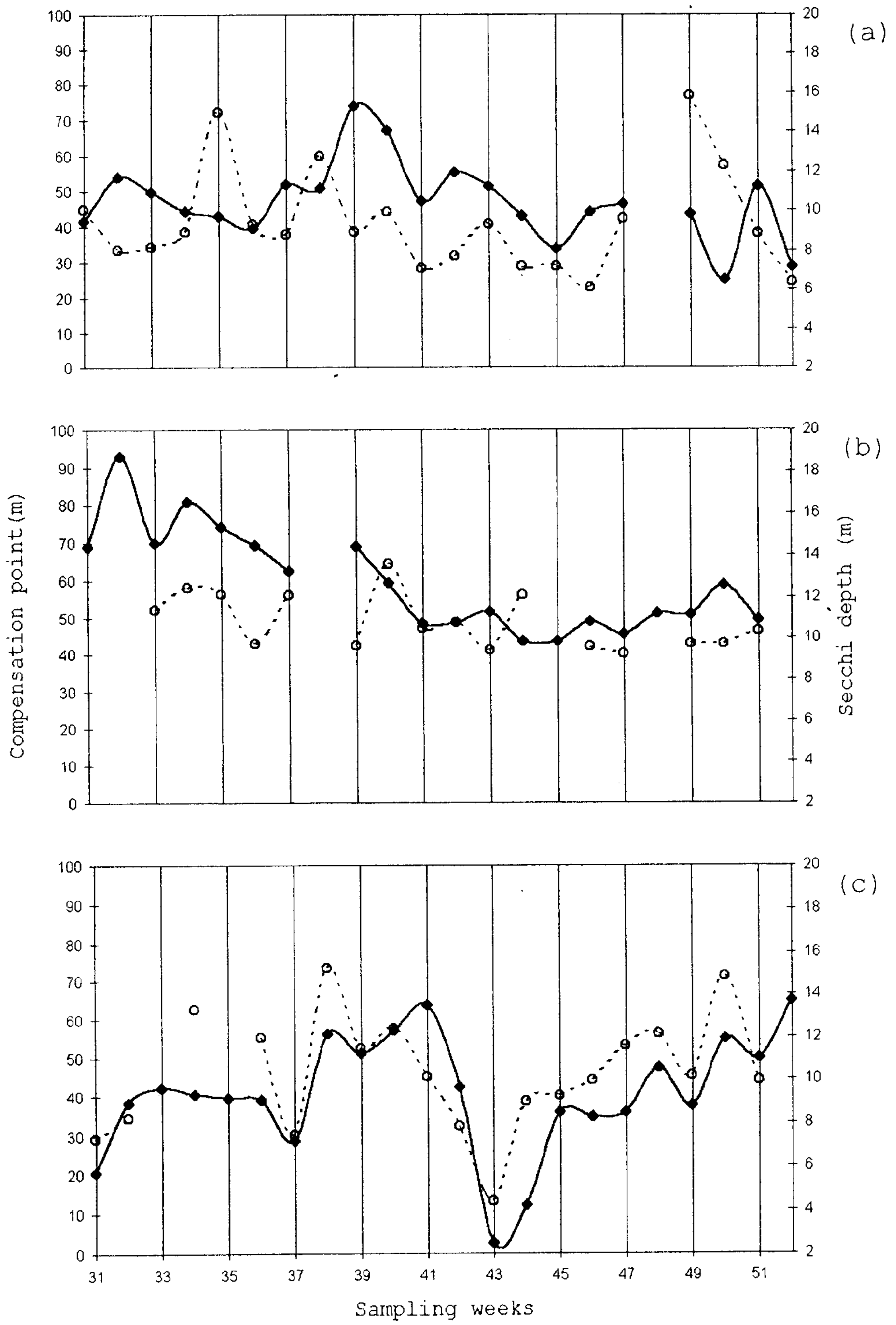


Figure 12. Time plot of mean secchi depth (S.D., m) and compensation point (C.P., m) (a) Bujumbura , (b) Kigoma and (c) Mpulungu from secchi disk and light measurements made during August 1995-December 1995 .

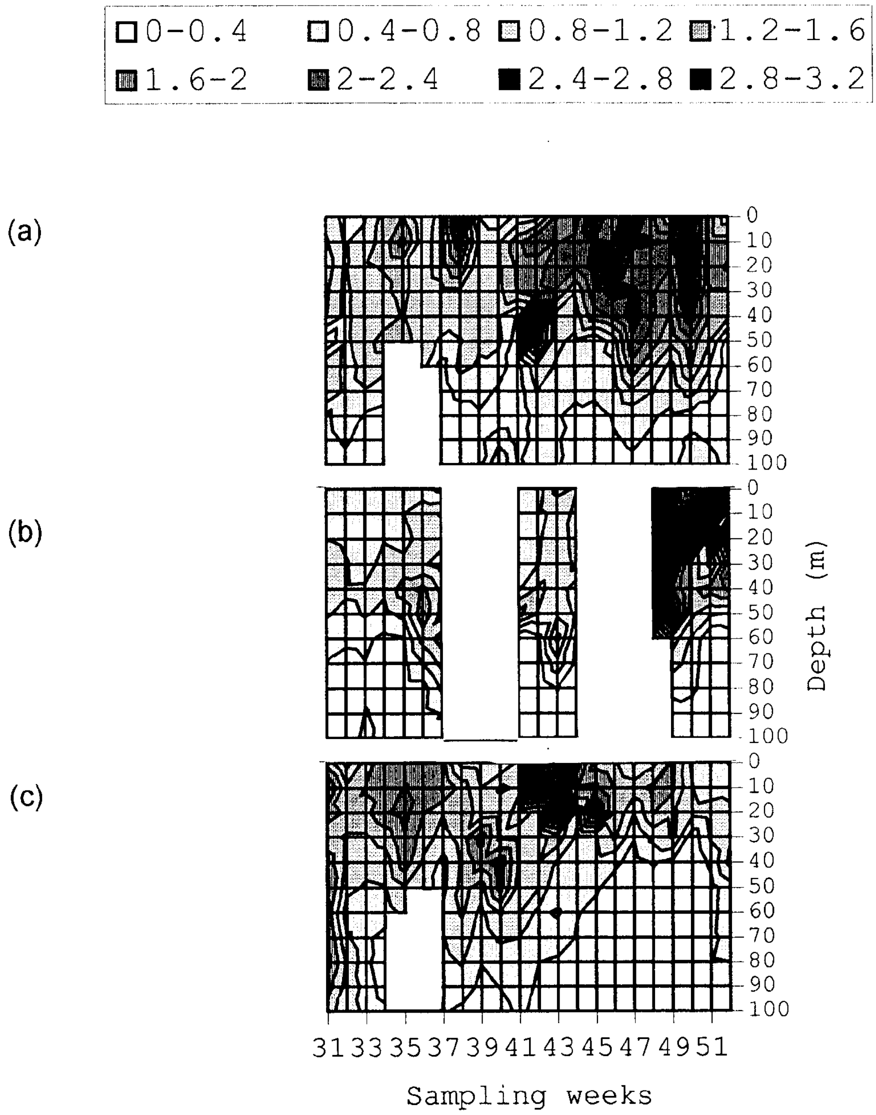


Figure 13. Depth-time plot for concentrations of chlorophyll a (µg l^{-1}) (a) Bujumbura, (b) Kigoma and (c) Mpulungu from measurements made during August 1995 December 1995. Patterns and colours situated within a black isopleth and which are not explained in the legend indicate concentrations > 3.2 µg l^{-1} .

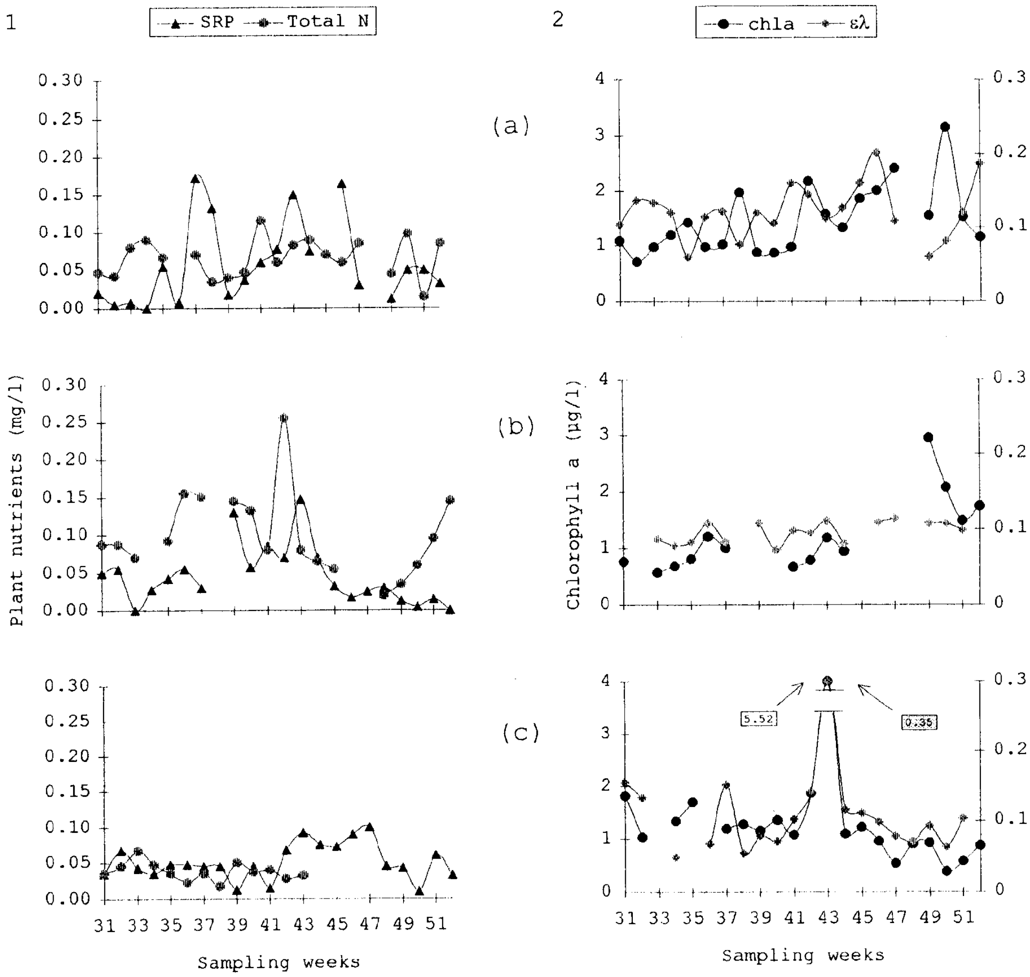


Figure 14. Time plot of (1) Soluble Reactive Phosphate (PO_4-P) and Total Nitrogen (NH_4-N and NO_x-N) and (2) Chlorophyll a and the extinction coefficient ($\varepsilon\lambda$) (a) Bujumbura , (b) Kigoma and (c) Mpulungu from measurements made during August 1995-December 1995. The concentrations of Soluble Reactive Phosphate, Total Nitrogen and Chlorophyll *a* represent mean values calculated from the upper 60 m of water.

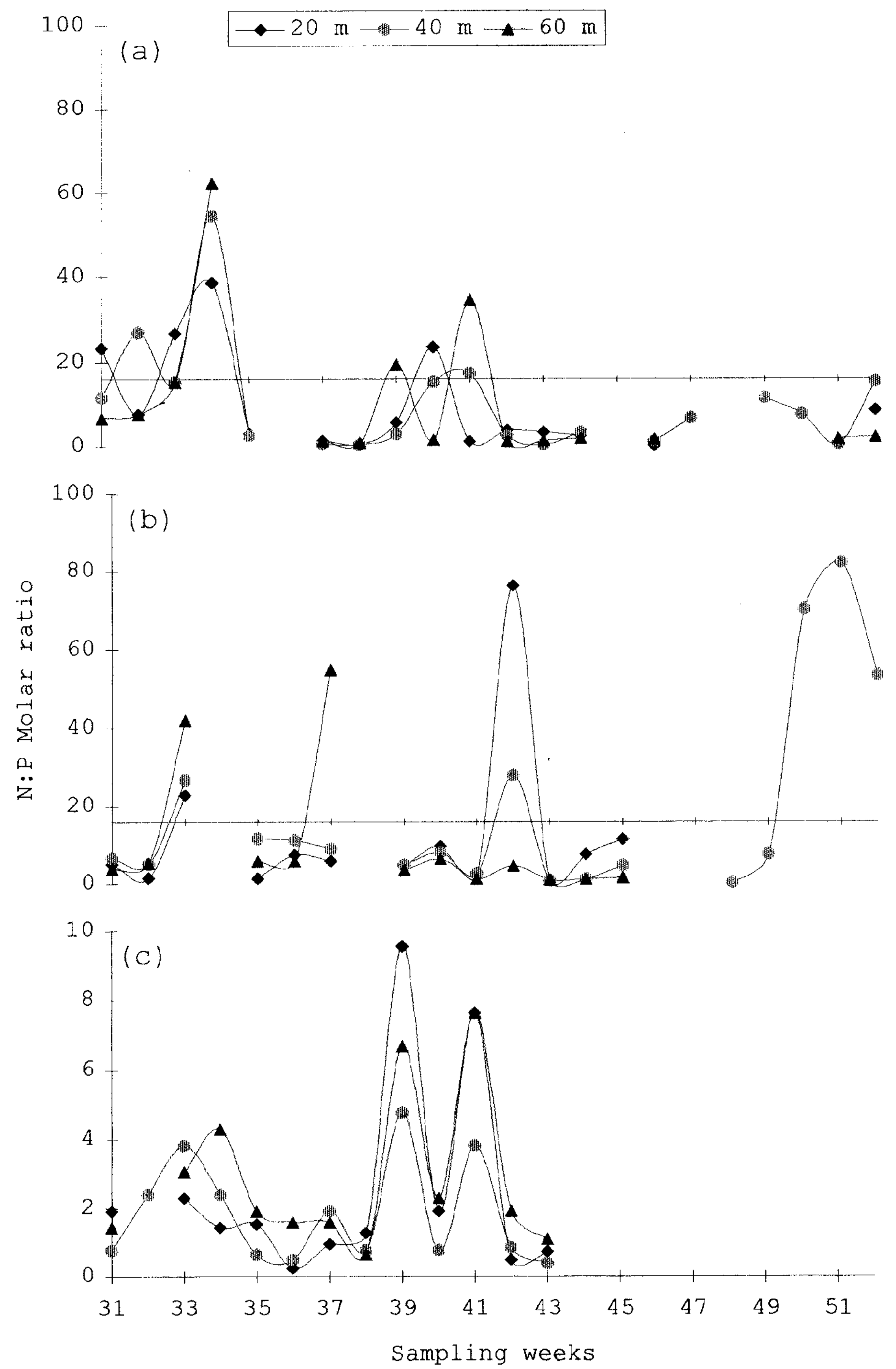


Figure 15. Time plot of Molar N:P ratio at three depths (20, 40 and 60 m) (a) Bujumbura, (b) Kigoma and (c) Mpulungu derived from the ratio of molar total oxidised nitrogen to soluble reactive phosphate. At Bujumbura and Kigoma the Redfield ratio of 16:1 is indicated.

Table 1. Analytical methods and instruments used for limnological sampling (Aug-Dec.95).

Temperature	Thermometers + probe ysi Inc., USA
Dissolved oxygen	Probe ysi Inc., USA
Conductivity	HACH conductivity/TDS meter
pH	HACH pH combination elektrode
Turbidity	HACH nephelometer
Ammonia	Nessler
Phosphate	Molybdenum blue
Nitrate + nitrite	Cd-Cu reduction to nitrite
Nitrite	Azo dye formation
Silicate	Molybdate complex
Chlorophyll a	Spectrophotometric, Milton Roy 301
Light	SA underwater Quantum sensor, Li-Cor

Table 2. Details of visits to sampling sites. Sampling dates at the three stations and their week numbers.

	Bujumbura	Kigoma	Mpulungu
Week 31	01-08-95	01-08-95	01-08-95
32	08-08-95		08-08-95
		09-08-95	
33		15-08-95	
	16-08-95		16-08-95
34	22-08-95	22-08-95	22-08-95
35	29-08-95	29-08-95	29-08-95
36		05-09-95	05-09-95
	06-09-95		
37	12-09-95	12-09-95	12-09-95
38	19-09-95		19-09-95
39		26-09-95	26-09-95
	27-09-95		
40	03-10-95	03-10-95	03-10-95
41		10-10-95	10-10-95
	11-10-95		
42		17-10-95	17-10-95
	19-10-95		
43		25-10-95	25-10-95
	27-10-95		
44		31-10-95	31-10-95
	02-11-95		
45	07-11-95	07-11-95	
			09-11-95
46	14-11-95	14-11-95	14-11-95
47	21-11-95	21-11-95	
			23-11-95
48	n.s.c.o.	28-11-95	28-11-95
49	05-12-95	05-12-95	05-12-95
50	12-12-95	12-12-95	12-12-95
51	19-12-95		19-12-95
		20-12-95	
52			26-12-95
	27-12-95		
		28-12-95	

n.s.c.o.: no sampling carried out

Table 3. Water temperature data (0-100 m) for Bujumbura, Kigoma and Mpulungu. Temperature values in °C.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	26.4	27.5	24.8
	Mean	**25.63**	**25.54**	**24.34**
	Min	24.1	24.3	23.9
	Stdev. (N)	0.6 (50)	0.6 (55)	0.2 (55)
Sep-95				
	Max	26.6	26.1	26.4
	Mean	**25.56**	**25.49**	**24.74**
	Min	24.2	24.5	24.1
	Stdev. (N)	0.7 (41)	0.5 (31)	0.6 (44)
Oct-95				
	Max	27.0	26.5	28.5
	Mean	**25.09**	**25.27**	**25.77**
	Min	24.1	24.1	24.0
	Stdev. (N)	0.8 (44)	0.9 (55)	1.0 (55)
Nov-95				
	Max	26.9	26.3	28.2
	Mean	**25.17**	**25.28**	**26.19**
	Min	24.0	24.1	24.2
	Stdev. (N)	0.7 (44)	0.7 (44)	1.4 (44)
Dec-95				
	Max	26.7	26.8	28.0
	Mean	**25.55**	**25.52**	**26.02**
	Min	23.9	24.2	24.3
	Stdev. (N)	0.9 (44)	0.9 (44)	1.3 (44)

Table 4. Dissolved oxygen data (0-100 m) for Bujumbura, Kigoma and Mpulungu. Values of dissolved oxygen in mg l^{-1}.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	7.1	7.1	8.2
	Mean	**5.52**	**4.2**	**6.1**
	Min	0.0	0.3	3.2
	Stdev. (N)	2.5 (50)	2.6 (55)	1.3 (22)
Sep-95				
	Max	7.3	6.5	7.5
	Mean	**4.79**	**4.4**	**6.08**
	Min	0.0	0.3	4.1
	Stdev. (N)	3.0 (33)	2.1 (20)	1.0 (33)
Oct-95				
	Max	7.1	10.1	9.1
	Mean	**3.54**	**3.1**	**6.25**
	Min	0.0	0.1	4.1
	Stdev. (N)	2.9 (44)	2.6 (55)	1.0 (55)
Nov-95				
	Max	7.3	7.9	8.4
	Mean	**3.96**	**5.02**	**5.4**
	Min	0.0	1.2	1.9
	Stdev. (N)	3.0 (44)	1.8 (44)	2.2 (44)
Dec-95				
	Max	7.5	7.9	9.2
	Mean	**4.74**	**4.79**	**5.96**
	Min	0.0	0.1	3.4
	Stdev. (N)	3.1 (44)	2.2 (44)	1.5 (33)

Table 5. Turbidity data (0-100 m) for Bujumbura, Kigoma and Mpulungu. Values of turbidity in NTU.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	1.64	0.56	0.81
	Mean	**0.56**	**0.40**	**0.61**
	Min	0.25	0.28	0.44
	Stdev. (N)	0.3 (50)	0.2 (55)	0.2 (55)
Sep-95				
	Max	1.09	0.52	0.86
	Mean	**0.54**	**0.43**	**0.61**
	Min	0.32	0.28	0.38
	Stdev. (N)	0.3 (41)	0.2 (31)	0.2 (44)
Oct-95				
	Max	0.74	0.91	3.52
	Mean	**0.47**	**0.50**	**0.76**
	Min	0.31	0.34	0.37
	Stdev. (N)	0.2 (42)	0.2 (55)	0.6 (55)
Nov-95				
	Max	5.18	0.69	1.75
	Mean	**0.78**	**0.50**	**0.87**
	Min	0.25	0.31	0.50
	Stdev. (N)	0.8 (44)	0.2 (44)	0.4 (44)
Dec-95				
	Max	1.87	0.63	1.21
	Mean	**0.64**	**0.44**	**0.91**
	Min	0.29	0.28	0.63
	Stdev. (N)	0.4 (43)	0.2 (44)	0.3 (44)

Table 6. Conductivity data (0-100 m) for Bujumbura, Kigoma and Mpulungu. Values of conductivity in µS cm^{-1}.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	680	689	673
	Mean	**662.4**	**661.4**	**658.0**
	Min	649	647	614
	Stdev. (N)	7.0 (50)	9.7 (55)	7.5 (55)
Sep-95				
	Max	696	671	668
	Mean	**671.7**	**660.0**	**654.3**
	Min	649	654	620
	Stdev. (N)	14.3 (41)	4.9 (31)	10.3 (44)
Oct-95				
	Max	704	675	665
	Mean	**689.0**	**657.3**	**657.5**
	Min	668	618	650
	Stdov. (N)	7.8 (44)	14.2 (33)	2.7 (55)
Nov-95				
	Max	705	676	666
	Mean	**688.0**	**652.0**	**659.4**
	Min	640	625	652
	Stdev. (N)	9.4 (44)	15.7 (33)	2.6 (44)
Dec-95				
	Max	697	683	n.a.
	Mean	**676.5**	**654.6**	n.a.
	Min	665	620	n.a.
	Stdev. (N)	8.8 (44)	14.5 (44)	n.a.

n.a. : data not available

Table 7. Data on pH (0-100 m) for Bujumbura, Kigoma and Mpulungu.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	9.17	9.42	9.25
	Mean	**8.81**	**8.86**	**8.86**
	Min	8.37	8.26	7.97
	Stdev. (N)	0.2 (50)	0.3 (55)	0.3 (55)
Sep-95				
	Max	9.00	9.39	9.41
	Mean	**8.72**	**9.04**	**9.21**
	Min	8.29	8.62	9.09
	Stdev. (N)	0.2 (41)	0.3 (31)	0.1 (44)
Oct-95				
	Max	9.11	9.46	9.29
	Mean	**8.82**	**8.85**	**9.07**
	Min	8.60	8.52	8.72
	Stdev. (N)	0.1 (44)	0.2 (55)	0.1 (55)
Nov-95				
	Max	9.19	9.39	9.18
	Mean	**8.71**	**8.98**	**9.03**
	Min	7.28	8.61	8.80
	Stdev. (N)	0.5 (44)	0.2 (44)	0.1 (44)
Dec-95				
	Max	9.19	9.36	9.14
	Mean	**8.94**	**8.91**	**8.80**
	Min	8.65	8.55	8.46
	Stdev. (N)	0.1 (44)	0.2 (44)	0.2 (44)

Table 8. S.R.P. data (0-100 m) for Bujumbura, Kigoma and Mpulungu. Values of S.R.P. in mg l^{-1}.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	0.19	0.25	0.13
	Mean	**0.03**	**0.05**	**0.06**
	Min	0.00	0.00	0.02
	Stdev. (N)	0.05 (29)	0.05 (30)	0.03 (30)
Sep-95				
	Max	0.49	0.30	0.09
	Mean	**0.12**	**0.08**	**0.05**
	Min	0.00	0.00	0.00
	Stdev. (N)	0.13 (22)	0.08 (17)	0.02 (24)
Oct-95				
	Max	0.45	0.32	0.12
	Mean	**0.14**	**0.12**	**0.06**
	Min	0.00	0.01	0.01
	Stdev. (N)	0.12 (24)	0.08 (30)	0.03 (30)
Nov-95				
	Max	0.55	0.26	0.15
	Mean	**0.15**	**0.05**	**0.09**
	Min	0.02	0.01	0.01
	Stdev. (N)	0.14 (18)	0.05 (24)	0.04 (24)
Dec-95				
	Max	0.28	0.11	0.13
	Mean	**0.08**	**0.02**	**0.04**
	Min	0.00	0.00	0.00
	Stdev. (N)	0.08 (24)	0.03 (24)	0.03 (24)

Table 9. Ammonia data (0-100 m) for Bujumbura, Kigoma and Mpulungu. Values for ammonia in mg l-1.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	0.07	0.10	0.01
	Mean	**0.014**	**0.021**	**0.001**
	Min	0.00	0.00	0.00
	Stdev. (N)	0.02 (27)	0.03 (30)	0.00 (30)
Sep-95				
	Max	0.10	0.15	0.00
	Mean	**0.020**	**0.097**	**0.000**
	Min	0.00	0.04	0.00
	Stdev. (N)	0.03 (22)	0.03 (17)	0.00 (24)
Oct-95				
	Max	0.1	0.17	0.00
	Mean	**0.017**	**0.049**	**0.000**
	Min	0.00	0.00	0.00
	Stdev. (N)	0.02 (24)	0.06 (30)	0 .00 (30)
Nov-95				
	Max	0.08	0.00	0.14
	Mean	**0.015**	**0.000**	**0.029**
	Min	0.00	0.00	0.00
	Stdev. (N)	0.02 (24)	0.00 (24)	0.05 (24)
Dec-95				
	Max	0.18	0.08	0.01
	Mean	**0.030**	**0.013**	**0.000**
	Min	0.00	0.00	0.00
	Stdev. (N)	0.05 (24)	0.02 (24)	0.00 (24)

Table 10. Oxydized nitrogen data (0-100 m) for Bujumbura, Kigoma and Mpulungu. Values of nitrate and nitrite in mg l-1.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	0.17	0.15	0.13
	Mean	**0.07**	**0.09**	**0.06**
	Min	0.03	0.03	0.02
	Stdev. (N)	0.03 (27)	0.04 (24)	0.03 (26)
Sep-95				
	Max	0.12	0.14	0.11
	Mean	**0.05**	**0.08**	**0.05**
	Min	0.02	0.04	0.01
	Stdev. (N)	0.03 (18)	0.03 (17)	0.03 (24)
Oct-95				
	Max	0.14	0.16	0.10
	Mean	**0.07**	**0.09**	**0.04**
	Min	0.02	0.03	0.01
	Stdev. (N)	0.04 (24)	0.04 (30)	0.02 (24)
Nov-95				
	Max	0.16	0.12	n.a.
	Mean	**0.07**	**0.06**	n.a.
	Min	0.02	0.01	n.a.
	Stdev. (N)	0.04 (21)	0.04 (9)	n.a.
Dec-95				
	Max	0.12	0.16	n.a.
	Mean	**0.06**	**0.07**	n.a.
	Min	0.00	0.00	n.a.
	Stdev. (N)	0.04 (18)	0.05 (12)	n.a.

n.a. : data not available

Table 11. Silicate data (0-100 m) for Bujumbura, Kigoma and Mpulungu. Values of silicate in mg l-1.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	3.10	1.76	2.90
	Mean	**1.30**	**1.15**	**0.98**
	Min	0.97	0.52	0.30
	Stdev. (N)	0.61 (27)	0.36 (30)	0.47 (30)
Sep-95				
	Max	4.20	1.76	1.18
	Mean	**1.64**	**1.08**	**0.78**
	Min	0.86	0.50	0.57
	Stdev. (N)	1.12 (22)	0.34 (17)	0.18 (24)
Oct-95				
	Max	5.53	1.76	1.51
	Mean	**1.96**	**0.51**	**0.86**
	Min	0.76	0.18	0.58
	Stdev. (N)	1.12 (24)	0.4 (30)	0.32 (30)
Nov-95				
	Max	2.58	1.23	1.05
	Mean	**1.43**	**0.57**	**0.81**
	Min	0.83	0.28	0.72
	Stdev. (N)	0.57 (24)	0.25 (24)	0.12 (6)
Dec-95				
	Max	5.30	1.22	n.a.
	Mean	**1.86**	**0.59**	n.a.
	Min	0.83	0.25	n.a.
	Stdev. (N)	1.42 (24)	0.28 (14)	n.a.

n.a. : data not available

Table 13. Chlorophyll *a* data (0-100 m) for Bujumbura, Kigoma and Mpulungu. Values of chlorophyll *a* in µg l-1.

		Bujumbura	Kigoma	Mpulungu
Aug-95				
	Max	2.15	1.42	2.48
	Mean	**0.91**	**0.61**	**1.38**
	Min	0.00	0.06	0.00
	Stdev. (N)	0.47 (45)	0.31 (36)	0.6 (34)
Sep-95				
	Max	5.42	1.90	2.19
	Mean	**1.04**	**0.94**	**1.04**
	Min	0.07	0.00	0.19
	Stdev. (N)	0.92 (35)	0.55 (18)	0.52 (27)
Oct-95				
	Max	4.73	1.78	17.26
	Mean	**1.19**	**0.73**	**1.78**
	Min	0.11	0.00	0.19
	Stdev. (N)	0.92 (36)	0.49 (36)	3.22 (45)
Nov-95				
	Max	3.38	n.a.	2.65
	Mean	**1.55**	n.a.	**0.75**
	Min	0.13	n.a.	0.00
	Stdev. (N)	0.99 (36)	n.a.	0.68 (36)
Dec-95				
	Max	4.74	4.59	1.71
	Mean	**1.51**	**1.76**	**0.57**
	Min	0.17	0.00	0.00
	Stdev. (N)	1.13 (36)	1.32 (33)	0.49 (36)

n.a. : data not available

Table 12. Vertical extinction coefficient ($\varepsilon\lambda$, m^{-1}) and compensation point (C.P., m) for all stations sampled during August 1995-December 1995.

	Bujumbura		Kigoma		Mpulungu	
Week	$\varepsilon\lambda$	C.P.	$\varepsilon\lambda$	C.P.	$\varepsilon\lambda$	C.P.
31	0.103	44.8	n.a.	n.a.	0.155	29.2
32	0.137	33.5	n.a.	n.a.	0.134	34.6
33	0.134	34.4	0.087	52.2	n.a.	n.a.
34	0.120	38.5	0.079	57.9	0.048	62.6
35	0.060	71.9	0.083	56.3	n.a.	n.a.
36	0.114	40.6	0.108	42.7	0.068	55.2
37	0.122	37.8	0.083	55.9	0.152	30.2
38	0.077	59.7	n.a.	n.a.	0.054	73.4
39	0.120	38.5	0.109	42.3	0.079	52.4
40	0.105	44.1	0.073	64.2	0.071	57.7
41	0.160	28.2	0.098	46.9	0.103	45.0
42	0.145	31.6	0.096	48.7	0.143	32.3
43	0.112	40.6	0.112	41.1	0.348	13.1
44	0.127	28.8	0.081	56.0	0.116	38.5
45	0.161	28.8	n.a.	n.a.	0.112	40.0
46	0.202	22.8	0.110	42.1	0.099	44.1
47	0.109	42.2	0.115	40.0	0.079	53.0
48	n.a.	n.a.	n.a.	n.a.	0.071	56.3
49	0.060	76.6	0.108	42.7	0.093	45.2
50	0.081	56.9	0.108	42.8	0.063	71.2
51	0.121	37.9	0.099	46.3	0.104	44.0
52	0.188	24.4	n.a.	n.a.	n.a.	n.a.
Mean	0.12	41	0.10	49	0.11	46
Stdev.	0.04	14.39	0.01	7.46	0.07	15.12

n.a. : data not available

Appendix 1. Results of the limnological sampling. Place 1 = Bujumbura, 2 = Kigoma and 3 = Mpulungu.

date	place	Depth	T°	D.O.	C.	pH	Turb.	S.R.P	NH4-N	NO3-N	SIO2	Chla
01-08-95	1	0	26.2	7.01	656	9.12	0.34	0.05	0.00	0.03	1.055	1.10
01-08-95	1	10	25.8	6.99	654	9.15	1.30					1.26
01-08-95	1	20	25.8	6.97	649	9.14	0.41	0.00	0.01	0.04	1.060	1.46
01-08-95	1	30	25.8	6.94	656	9.16	0.40					1.30
01-08-95	1	40	25.8	6.93	657	9.14	0.40	0.01	0.01	0.04	1.049	1.23
01-08-95	1	50	25.8	6.90	658	9.17	0.42					0.00
01-08-95	1	60	25.8	6.83	658	9.14	0.47	0.02	0.01	0.05	1.062	1.21
01-08-95	1	70	25.7	6.50	659	9.15	0.40					1.19
01-08-95	1	80	24.3	0.00	675	8.93	0.70	0.19	0.07	0.04	3.100	0.30
01-08-95	1	90	24.2	0.00	677	9.02	0.55					0.21
01-08-95	1	100	24.1	0.00	677	8.92	0.40					
08-08-95	1	0	26.1	6.94	659	8.75	0.25	0.00	0.00	0.03	1.004	0.66
08-08-95	1	10	25.9	7.04	659	8.77	0.26					0.77
08-08-95	1	20	25.9	6.92	659	8.77	0.30	0.01	0.00	0.04	1.015	0.76
08-08-95	1	30	25.9	6.89	659	8.77	0.34					0.69
08-08-95	1	40	25.9	6.85	659	8.77	0.32	0.00	0.01	0.05	0.992	0.70
08-08-95	1	50	25.8	6.86	659	8.79	0.30					0.72
08-08-95	1	60	25.8	6.83	659	8.79	0.30	0.01	0.00	0.04	0.967	0.66
08-08-95	1	70	25.8	6.80	660	8.84	0.31					
08-08-95	1	80	25.8	6.72	659	8.85	0.28	0.00	0.00	0.06	1.027	0.74
08-08-95	1	90	24.3	0.00	659	8.83	0.20					
08-08-95	1	100	24.2	0.00	674	8.65	0.17	0.11	0.00	0.08	2.725	0.22
16-08-95	1	0	26.1	6.92	665	8.85	0.30	0.01	0.01	0.08	1.007	0.74
16-08-95	1	10	25.9	6.93	664	8.85	0.32					0.95
16-08-95	1	20	25.9	6.93	664	8.84	0.35	0.00	0.00	0.07	0.972	1.16
16-08-95	1	30	25.9	6.91	664	8.84	0.37					1.07
16-08-95	1	40	25.9	6.86	664	8.83	0.37	0.01	0.00	0.08	0.970	1.04
16-08-95	1	50	25.9	6.84	665	8.84	0.37					0.99
16-08-95	1	60	25.9	6.81	665	8.82	0.38	0.01	0.00	0.08	1.084	0.89
16-08-95	1	70	25.9	6.82	666	8.78	0.35					0.78
16-08-95	1	80	25.8	6.71	668	8.73	0.33	0.00	0.01	0.09	1.246	0.35
16-08-95	1	90	24.9	2.79	670	8.68	0.13					0.15
16-08-95	1	100	24.4	0.00	680	8.68	0.16	0.08	0.00	0.17	2.475	0.11
22-08-95	1	0	26.3	6.89	663	8.55	0.45	0.00	0.03	0.04	1.016	1.34
22-08-95	1	10	25.9	6.91	662	8.55	0.55					1.38
22-08-95	1	20	25.9	6.87	662	8.55	0.45	0.00	0.02	0.06	1.000	1.22
22-08-95	1	30	25.9	6.84	662	8.54	0.47					1.13
22-08-95	1	40	25.9	6.80	662	8.54	0.40	0.00	0.04	0.06	0.980	0.97
22-08-95	1	50	25.8	6.70	662	8.54	0.53					1.42
22-08-95	1	60	25.8	6.57	662	8.52	0.35	0.00	0.05	0.06	0.972	0.91
22-08-95	1	70	25.4	4.30	662	8.5	0.45					
22-08-95	1	80	24.9	2.23	669	8.41	0.25	0.00	0.03	0.12	1.875	0.26
22-08-95	1	90	24.8	1.12	671	8.38	0.30					
22-08-95	1	100	24.7	0.31	677	8.37	0.20	0.00	0.02	0.14	2.325	0.13
29-08-95	1	0	26.4	7.10	659	8.85	0.48	0.11	0.01	0.05	1.084	1.60
29-08-95	1	10	26.2	6.50	654	8.96	0.71	0.07	0.02	0.05	0.989	2.15
29-08-95	1	20	26.2	7.00	655	9.03	0.37	0.05	0.01	0.06	1.068	1.30
29-08-95	1	30	26.0	6.30	649	9.03	0.49	0.10				1.31
29-08-95	1	40	26.0	6.30	658	9.04	0.42	0.06	0.01	0.06	1.011	1.23
29-08-95	1	50	26.0	5.90	657	8.88	0.49	0.08				1.35
29-08-95	1	60										
29-08-95	1	70										
29-08-95	1	80										
29-08-95	1	90										
29-08-95	1	100										
06-09-95	1	0	26.2		649	8.85	0.45	0.01	0.01		0.938	0.86
06-09-95	1	10	26.0		654	8.86	0.64					0.99
06-09-95	1	20	26.0		656	8.93	0.42	0.00	0.01		1.017	1.00
06-09-95	1	30	26.0		653	8.95	0.62					0.96
06-09-95	1	40	26.0		660	8.95	0.42	0.01	0.03		0.986	0.99
06-09-95	1	50	26.0		657	8.94	0.76					1.05
06-09-95	1	60	26.0		660	8.94	0.47	0.01	0.02		0.960	0.97
06-09-95	1	70	26.0		655	8.94	0.84					1.23
06-09-95	1	80										
06-09-95	1	90										
06-09-95	1	100										
12-09-95	1	0	26.1	6.96	655	8.82	0.28	0.10	0.01	0.04	1.061	1.35
12-09-95	1	10	25.9	6.95	654	8.84	0.73					1.38
12-09-95	1	20	25.9	6.93	654	8.8	0.38	0.14	0.03	0.04	1.071	1.38
12-09-95	1	30	25.9	6.90	651	8.77	0.35					1.06
12-09-95	1	40	25.9	6.87	653	8.77	0.33	0.18	0.01	0.02	1.046	1.07
12-09-95	1	50	25.9	6.84	655	8.76	0.35					0.72
12-09-95	1	60	25.8	6.42	662	8.66	0.54	0.27	0.04	0.09	2.175	0.24
12-09-95	1	70	24.8	1.96	661	8.52	0.25					

12-09-95	1	80	24.4	0.00	668	8.47	0.25	0.49	0.01	0.09	3.150	0.07
12-09-95	1	90	24.3	0.01	671	8.46	0.43					
12-09-95	1	100	24.3	0.06	671	8.51	0.41	0.34	0.10	0.08	3.950	0.15
19-09-95	1	0	26.6	7.26	678	8.33	0.37	0.13	0.01	0.04	0.958	5.42
19-09-95	1	10	26.0	7.29	679	8.38	0.31					2.69
19-09-95	1	20	26.0	7.24	680	8.37	0.30	0.14	0.00	0.03	0.895	1.99
19-09-95	1	30	25.9	7.21	678	8.46	0.25					1.11
19-09-95	1	40	25.9	7.16	678	8.5	0.22	0.19	0.00	0.03	0.898	0.90
19-09-95	1	50	25.9	7.04	679	8.58	0.24					0.79
19-09-95	1	60	25.8	6.66	675	8.58	0.19	0.07	0.00	0.03	0.860	0.90
19-09-95	1	70	25.2	3.96	685	8.49	0.20					
19-09-95	1	80	24.9	2.64	689	8.44	0.20	0.14	0.00	0.12	1.750	0.20
19-09-95	1	90	24.3	0.04	688	8.43	0.22					
19-09-95	1	100	24.2	0.03	693	8.29	0.24	0.28	0.04	0.04	4.200	0.22
27-09-95	1	0	26.1	6.97	683	8.98	0.26	0.02	0.00	0.04	1.006	0.80
27-09-95	1	10	26.0	6.94	681	9	0.30					1.13
27-09-95	1	20	26.0	6.91	682	8.98	0.27	0.01	0.00	0.03	1.000	0.81
27-09-95	1	30	26.0	6.89	681	8.99	0.25					0.93
27-09-95	1	40	26.0	6.86	681	8.99	0.28	0.04	0.01	0.04	0.953	0.90
27-09-95	1	50	26.0	6.85	679	8.98	0.26					0.86
27-09-95	1	60	25.9	6.82	680	8.99	0.29	0.00	0.01	0.03	0.954	0.75
27-09-95	1	70	25.0	3.40	685	8.87	0.35					
27-09-95	1	80	24.4	0.00	694	8.72	0.30	0.11	0.05	0.10	2.425	0.35
27-09-95	1	90	24.3	0.00	696	8.69	0.30					
27-09-95	1	100	24.3	0.00	696	8.66	0.60	0.00	0.06	0.08	3.750	0.26
03-10-95	1	0	26.2	7.00	681	8.98	0.25	0.02	0.00	0.02	1.049	0.48
03-10-95	1	10	26.1	7.01	680	8.95	0.38					1.14
03-10-95	1	20	26.1	7.00	681	8.95	0.42	0.00	0.02	0.02	1.082	1.12
03-10-95	1	30	26.1	6.97	678	8.94	0.33					1.07
03-10-95	1	40	26.0	6.95	682	8.94	0.30	0.00	0.00	0.04	1.004	0.83
03-10-95	1	50	26.0	6.81	681	8.97	0.27					0.89
03-10-95	1	60	25.0	2.88	686	8.93	0.30	0.13	0.01	0.08	1.725	0.57
03-10-95	1	70	24.7	1.30	693	8.73	0.22					
03-10-95	1	80	24.5	0.11	696	8.68	0.18	0.10	0.00	0.10	2.275	0.11
03-10-95	1	90	24.3	0.00	698	8.68	0.20					
03-10-95	1	100	24.2	0.00	694	8.6	0.27	0.14	0.01	0.03	2.825	1.20
11-10-95	1	0	26.5	7.00	685	8.97	0.50	0.08	0.02	0.06	1.138	0.93
11-10-95	1	10	26.2	7.05	685	8.97	0.53					1.88
11-10-95	1	20	26.2	6.99	684	8.97	0.43	0.13	0.02	0.04	1.302	1.66
11-10-95	1	30	25.4	5.23	687	8.89	0.23					1.63
11-10-95	1	40	25.0	4.86	691	8.84	0.18	0.02	0.02	0.14	2.250	0.33
11-10-95	1	50	24.8	4.36	691	8.79	0.25					0.17
11-10-95	1	60	24.8	3.71	691	8.79	0.25	0.01	0.02	0.14	2.625	0.22
11-10-95	1	70	24.5	2.51	694	8.79	0.21					
11-10-95	1	80	24.4	1.14	696	8.7	0.20	0.45	0.02	0.06	3.950	0.13
11-10-95	1	90	24.2	0.08	700	8.66	0.25					
11-10-95	1	100	24.1	0.00	704	8.68	0.25	0.39	0.10	0.04	5.525	0.37
19-10-95	1	0	27.0	6.56	693	8.91	0.38	0.04	0.00	0.02	0.757	1.06
19-10-95	1	10	25.7	6.58	684	8.9	0.44					2.40
19-10-95	1	20	25.7	6.44	684	8.89	0.40	0.01	0.00	0.02	1.012	1.71
19-10-95	1	30	25.6	6.06	684	8.9	0.54					1.88
19-10-95	1	40	25.0	3.28	687	8.82	0.35	0.06	0.00	0.08	1.321	4.73
19-10-95	1	50	24.8	2.10	690	8.72	0.21					2.39
19-10-95	1	60	24.7	1.73	692	8.72	0.29	0.20	0.00	0.12	1.760	1.05
19-10-95	1	70	24.5	0.85	693	8.69						
19-10-95	1	80	24.4	0.26	695	8.67	0.25	0.19	0.00	0.13	1.760	0.56
19-10-95	1	90	24.3	0.10	695	8.75						
19-10-95	1	100	24.2	0.04	696	8.74	0.19	0.31	0.00	0.10	1.760	0.46
27-10-95	1	0	25.4	6.67	668	8.9	0.34	0.11	0.03	0.04	0.995	2.01
27-10-95	1	10	25.3	6.66	680	9.09	0.32					1.96
27-10-95	1	20	25.3	6.60	672	9.11	0.35	0.07	0.03	0.06	0.985	2.40
27-10-95	1	30	25.3	6.54	679	9.07	0.30					1.99
27-10-95	1	40	24.9	2.56	687	8.93	0.26	0.21	0.01	0.02	1.717	1.01
27-10-95	1	50	24.7	1.91	693	8.76	0.27					0.89
27-10-95	1	60	24.6	1.24	694	8.71	0.25	0.21	0.01	0.13	2.225	0.76
27-10-95	1	70	24.5	0.38	696	8.64	0.41					
27-10-95	1	80	24.3	0.04	697	8.63	0.42	0.22	0.06	0.13	2.750	0.41
27-10-95	1	90	24.2	0.02	699	8.63	0.44					
27-10-95	1	100	24.3	0.05	699	8.64	0.34	0.23	0.03	0.05	3.200	0.45
02-11-95	1	0	25.7	7.00	684	8.28	0.53	0.04	0.00	0.04	0.908	1.74
02-11-95	1	10	25.6	6.96	682	8.01	0.41					2.12
02-11-95	1	20	25.6	6.92	640	7.28	0.44	0.03	0.00	0.04	0.902	2.01
02-11-95	1	30	25.3	5.96	691	8.17	4.30					1.24
02-11-95	1	40	25.0	3.16	687	8.05	0.34	0.07	0.00	0.12	1.454	0.97
02-11-95	1	50	24.5	2.41	684	7.89	0.23					0.70
02-11-95	1	60	24.6	1.12	691	7.84	0.31	0.16	0.00	0.16	1.760	0.48
02-11-95	1	70	24.5	0.57	694	7.85	0.27					
02-11-95	1	80	24.4	0.23	695	7.84	0.15	0.24	0.00	0.13	1.760	0.37
02-11-95	1	90	24.3	0.06	696	7.85	0.23					
02-11-95	1	100	24.2	0.00	698	7.87	0.13	0.29	0.00	0.09	1.760	0.24

01-08-95	2	30	26.0	6.78	657	8.93	0.30					1.06
01-08-95	2	40	26.0	6.72	658	8.91	0.25	0.05	0.05	C.07	0.938	0.91
01-08-95	2	50	25.9	6.54	658	8.9	0.21					0.83
C1-08-95	2	60	25.2	6.24	659	8.89	0.26	0.05	0.01	0.08	C.986	0.61
01-08-95	2	70	25.1	2.33	661	8.81	0.20					
01-08-95	2	80	24.6	1.19	667	8.78	0.18	0.12	0.05	0.14	1.719	0.13
01-08-95	2	90	24.6	0.74	670	8.75	0.20					
01-08-95	2	100	24.5	0.37	672	8.71	0.20	0.16	0.05	0.13	1.557	0.06
09-08-95	2	0	26.0	6.89	652	9.28	0.25	0.05	0.03	0.06	0.603	
09-08-95	2	10	26.0	6.80	653	9.28	0.33					
09-08-95	2	20	26.0	6.78	655	9.23	0.25	0.09	0.01	0.05	0.926	
09-08-95	2	30	26.0	6.68	655	9.18	0.26					
09-08-95	2	40	26.0	6.24	653	9.16	0.22	0.03	0.01	0.06	0.784	
09-08-95	2	50	25.9	5.08	654	9.09	0.26					
09-08-95	2	60	25.7	4.44	655	9.06	0.25	0.05	0.01	0.12	1.253	
09-08-95	2	70	25.6	3.51	663	8.87	0.25					
09-08-95	2	80	25.4	2.85	667	8.8	0.20	0.25	0.01	0.15	1.394	
09-08-95	2	90	25.3	0.44	674	8.71	0.16					
09-08-95	2	100	24.4	0.30	676	8.67	0.16	0.02	0.00	0.14	1.760	
15-08-95	2	0	25.9	6.79	647	9.05	0.31	0.00	0.00	0.04	0.886	0.40
15-08-95	2	10	25.9	6.76	650	9.02	C.36					0.43
15-08-95	2	20	25.9	6.75	653	9	0.28	0.00	0.00	0.06	1.115	0.51
15-08-95	2	30	25.9	6.74	653	8.98	0.27					0.50
15-08-95	2	40	25.9	6.72	654	8.96	0.29	0.00	0.00	0.07	1.022	0.90
15-08-95	2	50	25.8	6.13	654	8.94	0.25					0.83
15-08-95	2	60	25.6	5.42	663	8.92	0.23	0.00	0.00	0.11	0.998	0.48
15-08-95	2	70	25.3	3.27	666	8.8	0.23					
15-08-95	2	80	25.0	1.86	679	8.77	0.17	C.07	0.00	0.14	0.963	0.30
15-08-95	2	90	24.7	1.03	679	8.75	0.21					
15-08-95	2	100	24.7	1.01	681	8.7	0.2C	C.03	0.00	0.14	1.542	0.58
22-08-95	2	C	26.C	7.05	656	8.43	0.30	0.03	0.00		0.665	0.45
22-08-95	2	10	26.0	7.11	652	8.43	0.33					C.69
22-08-95	2	20	26.0	6.96	652	8.43	0.39	0.01	0.00		1.041	C.75
22-08-95	2	30	26.0	6.56	654	8.46	0.32					1.09
22-08-95	2	40	25.8	6.28	652	8.45	0.28	0.04	0.01		1.760	C.86
22-08-95	2	50	25.7	5.24	655	8.55	0.26					C.69
22-08-95	2	60	25.3	3.98	658	8.54	0.21	0.03	0.01		1.672	0.29
22-08-95	2	70	25.0	2.87	663	8.48	0.22					
22-08-95	2	80	27.5	1.28	660	8.52	0.23	0.09	0.01		1.194	0.19
22-08-95	2	90	24.9	0.74	665	8.5	0.25					
22-08-95	2	100	24.5	0.65	672	8.26	0.28	0.09	0.01		1.518	0.14
29-08-95	2	0	25.9	6.87	656	9.42	0.25	0.05	0.07	0.04	0.515	0.66
29-08-95	2	10	25.9	5.60	656	9.38	0.30					0.80
29-08-95	2	20	25.9	4.00	656	9.2	C.23	0.04	0.00	0.03	1.022	0.61
29-08-95	2	30	25.9	2.40	657	9.13	C.30					0.96
29-08-95	2	40	25.8	1.97	658	9.11	C.31	0.03	C.05	0.08	1.313	1.42
29-08-95	2	50	25.5	1.73	666	9.08	0.25					0.90
29-08-95	2	60	25.2	1.56	668	8.94	0.24	0.05	0.05	0.05	C.939	0.37
29-08-95	2	70	25.1	1.50	668	8.87	0.22					
29-08-95	2	80	25.0	1.37	670	8.83	0.15	0.04	0.10	0.10	1.523	0.21
29-08-95	2	90	24.7	1.01	688	8.76	0.19					
29-08-95	2	100	24.3	0.33	689	8.73	0.19	0.07	0.08	0.14	1.107	0.24
C5-09-95	2	0	26.0	6.52	654	8.98	0.35	0.04	0.12	0.06	0.695	0.51
05-09-95	2	10	25.9	6.52	654	8.95	0.36					1.14
C5-09-95	2	20	25.9	6.52	654	8.91	0.34	0.07	0.11	0.05	1.244	1.01
05-09-95	2	30	25.9	6.31	655	8.91	0.32					0.85
05-09-95	2	40	25.7	5.52	655	8.88	0.35	0.04	0.C9	0.05	0.766	1.71
05-09-95	2	50	25.6	5.13	655	8.8	0.36					1.90
05-09-95	2	60	25.3	5.31	656	8.79	0.30	0.07	0.07	0.07	0.867	1.36
05-09-95	2	70	25.0	4.55	658	8.73	0.25					
05-09-95	2	80	24.8	2.75	662	8.71	0.20	0.01	0.08	0.11	1.445	0.22
05-C9-95	2	90										
05-09-95	2	100										0.34
12-09-95	2	0	26.1		659	9.39	0.31	0.00	0.15	0.04	1.048	0.29
12-C9-95	2	10	26.1		656	9.36	0.30					1.22
12-C9-95	2	20	26.1		656	9.36	0.27	0.08	0.10	C.04	1.C46	0.93
12-C9-95	2	30	26.1		657	9.35	0.30					0.62
12-C9-95	2	40	25.8		658	9.34	0.30	0.03	0.04	C.06	1.156	1.10
12-09-95	2	50	25.5		658	9.34	0.28					1.09
12-09-95	2	60	25.4		660	9.31	0.25	0.01	0.11	0.06	1.104	1.81
12-09-95	2	70	25.3		660	9.31	0.25					
12-09-95	2	80	25.0		662	9.15	0.24	0.00	0.12	0.08	0.766	0.85
12-09-95	2	90	24.9		666	8.87	0.30					
12-09-95	2	100	24.5		670	8.82	0.35	0.00	0.15	0.14	1.570	-C.02
26-09-95	2	0	26.1	6.34	657	9.35	0.31	0.19	0.07	0.04	0.849	
26-09-95	2	10	26.1	5.66	658	9.32	0.25					
26-09-95	2	20	26.1	5.59	658	9.28	0.25	0.10	0.09	0.06	1.015	
26-09-95	2	30	25.8	5.30	660	9.21	0.30					
26-09-95	2	40	25.6	4.56	663	9.09	0.30	0.08	0.07	0.06	1.110	
26-09-95	2	50	25.5	4.28	663	9.03	0.21					

26-09-95	2	60	25.3	4.10	663	8.83	0.25	0.15	0.08	0.11	0.497	
26-09-95	2	70	24.9	2.15	665	8.78	0.22					
26-09-95	2	80	24.6	0.36	668	8.77	0.15	0.15	0.08	0.12	1.760	
26-09-95	2	90	24.6	0.31	669	8.73	0.20					
26-09-95	2	100	24.6	0.30	671	8.62	0.18	0.30	0.12	0.14	1.502	
03-10-95	2	0	26.5	7.68	656	9.21	0.31	0.05	0.07	0.03	0.029	
03-10-95	2	10	26.4	7.62	656	9.12	0.35					
03-10-95	2	20	26.4	7.46	656	9.12	0.34	0.04	0.08	0.04	0.614	
03-10-95	2	30	26.4	6.66	655	8.96	0.35					
03-10-95	2	40	26.1	6.23	660	8.95	0.36	0.06	0.10	0.05	1.134	
03-10-95	2	50	25.9	6.15	660	8.81	0.37					
03-10-95	2	60	25.7	5.58	662	8.75	0.34	0.08	0.10	0.06	0.790	
03-10-95	2	70	24.7	4.74	668	8.64	0.30					
03-10-95	2	80	24.4	2.94	670	8.61	0.35	0.05	0.09	0.08	0.017	
03-10-95	2	90	24.2	2.41	675	8.56	0.45					
03-10-95	2	100	24.2	1.35	675	8.52	0.32	0.22	0.13	0.09	1.760	
10-10-95	2	0	26.3	7.50	656	9.46	0.30	0.07	0.00	0.07	0.316	0.51
10-10-95	2	10	26.2	7.25	659	9.25	0.32					0.46
10-10-95	2	20	26.2	3.76	659	9.07	0.32	0.06	0.01	0.06	0.946	0.59
10-10-95	2	30	26.1	3.31	659	8.99	0.29					0.56
10-10-95	2	40	26.0	3.51	660	8.97	0.26	0.05	0.00	0.07	0.273	0.75
10-10-95	2	50	25.9	2.83	664	8.94	0.25					1.78
10-10-95	2	60	24.8	2.10	664	8.82	0.25	0.16	0.00	0.11	0.567	0.05
10-10-95	2	70	24.4	1.86	668	8.82	0.35					
10-10-95	2	80	24.1	1.78	671	8.8	0.20	0.20	0.01	0.16	1.379	0.06
10-10-95	2	90	24.1	0.69	674	8.7	0.22					
10-10-95	2	100	24.1	0.50	675	8.7	0.20	0.17	0.00	0.11	1.129	0.00
17-10-95	2	0	26.5	10.08	650	8.64	0.45	0.06	0.14	0.09	0.241	0.56
17-10-95	2	10	26.4	0.14	644	8.91	0.31					0.69
17-10-95	2	20	26.4	5.49	627	8.99	0.69	0.01	0.15	0.09	0.284	0.75
17-10-95	2	30	26.3	1.90	655	8.99	0.48					0.78
17-10-95	2	40	25.8	2.52	618	8.92	0.35	0.03	0.17	0.09	0.183	1.28
17-10-95	2	50	25.1	1.90	620	8.88	0.34					1.18
17-10-95	2	60	24.5	0.64	639	8.66	0.35	0.18	0.14	0.15	0.267	0.29
17-10-95	2	70	24.2	0.35	660	8.65	0.26					
17-10-95	2	80	24.2	1.00	652	8.65	0.45	0.17	0.09	0.15	0.449	0.10
17-10-95	2	90	24.2	0.52	661	8.65	0.27					
17-10-95	2	100	24.1	0.39	663	8.77	0.31	0.13	0.13	0.11	0.275	0.02
25-10-95	2	0	25.9	8.02		8.88	0.35	0.10	0.01	0.08	0.222	1.33
25-10-95	2	10	25.9	3.84		8.98	0.35					0.93
25-10-95	2	20	25.9	3.70		8.99	0.35	0.12	0.00	0.06	0.249	1.04
25-10-95	2	30	25.9	3.03		9.01	0.36					1.04
25-10-95	2	40	25.9	2.67		8.98	0.35	0.15	0.00	0.06	0.435	1.07
25-10-95	2	50	24.7	1.33		8.86	0.31					1.12
25-10-95	2	60	24.6	1.23		8.81	0.35	0.22	0.00	0.11	0.383	1.74
25-10-95	2	70	24.4	0.89		8.75	0.37					
25-10-95	2	80	24.3	0.52		8.75	0.30	0.32	0.01	0.15	0.409	0.42
25-10-95	2	90	24.3	0.36		8.72	0.35					
25-10-95	2	100	24.3	0.34		8.72	0.25	0.30	0.01	0.13	0.794	0.19
31-10-95	2	0	26.2	5.80		9.06	0.40	0.02	0.02	0.03	0.341	1.15
31-10-95	2	10	25.9	4.62		8.98	0.40					1.33
31-10-95	2	20	25.9	3.24		8.95	0.45	0.01	0.00	0.04	0.294	1.30
31-10-95	2	30	25.9	2.91		8.94	0.34					1.25
31-10-95	2	40	25.9	2.67		8.94	0.36	0.09	0.00	0.06	0.297	0.55
31-10-95	2	50	25.6	2.47		8.81	0.34					0.72
31-10-95	2	60	24.8	1.69		8.8	0.22	0.16	0.00	0.11	0.397	0.34
31-10-95	2	70	24.4	0.81		8.72	0.31					
31-10-95	2	80	24.2	0.76		8.68	0.26	0.15	0.00	0.13	0.348	0.21
31-10-95	2	90	24.2	0.51		8.6	0.27					
31-10-95	2	100	24.2	0.40		8.57	0.34	0.14	0.00	0.11	0.575	0.14
07-11-95	2	0	26.0	7.05		9	0.44	0.02	0.00	0.04	0.503	
07-11-95	2	10	26.0	5.50		8.97	0.42					
07-11-95	2	20	26.0	4.60		8.96	0.32	0.01	0.00	0.06	0.524	
07-11-95	2	30	26.0	4.02		8.81	0.34					
07-11-95	2	40	25.8	3.69		8.79	0.36	0.02	0.00	0.05	0.470	
07-11-95	2	50	25.1	3.57		8.77	0.24					
07-11-95	2	60	24.8	3.50		8.72	0.27	0.08	0.00	0.07	1.073	
07-11-95	2	70	24.7	3.48		8.72	0.27					
07-11-95	2	80	24.5	3.26		8.7	0.21	0.05	0.00	0.11	0.654	
07-11-95	2	90	24.2	2.96		8.7	0.21					
07-11-95	2	100	24.2	1.50		8.65	0.26	0.26	0.00	0.12	1.232	
14-11-95	2	0	26.1	7.34	625	9.27	0.35	0.01	0.00		0.353	
14-11-95	2	10	26.1	6.24	625	9.11	0.35					
14-11-95	2	20	26.1	6.28	625	9.06	0.37	0.01	0.00		0.392	
14-11-95	2	30	26.0	5.87	630	9.01	0.30					
14-11-95	2	40	26.0	5.66	632	8.9	0.35	0.01	0.00		0.366	
14-11-95	2	50	25.3	5.51	660	8.84	0.30					
14-11-95	2	60	24.9	5.48	665	8.8	0.22	0.04	0.00		0.635	
14-11-95	2	70	24.7	5.44	665	8.78	0.25					
14-11-95	2	80	24.5	4.47	666	8.71	0.25	0.09	0.00		0.484	

14-11-95	2	90	24.3	2.23	668	8.7	0.21					
14-11-95	2	100	24.1	1.24	671	8.61	0.25	0.14	0.00		0.947	
21-11-95	2	0	26.0	7.81	640	9.39	0.45	0.04	0.00		0.355	
21-11-95	2	10	26.0	7.66	641	9.37	0.36					
21-11-95	2	20	26.0	7.35	645	9.34	0.35	0.01	0.00		0.340	
21-11-95	2	30	26.0	7.31	648	9.23	0.35					
21-11-95	2	40	25.8	6.51	650	9.23	0.30	0.02	0.00		0.375	
21-11-95	2	50	24.8	5.60	661	9.21	0.23					
21-11-95	2	60	24.7	5.54	666	9.18	0.30	0.03	0.00		0.583	
21-11-95	2	70	24.6	5.19	669	9.04	0.25					
21-11-95	2	80	24.6	4.76	669	8.99	0.18	0.03	0.00		0.737	
21-11-95	2	90	24.6	2.52	674	8.94	0.30					
21-11-95	2	100	24.4	2.30	676	8.91	0.25	0.06	0.00		0.748	
28-11-95	2	0	26.3	7.92	631	9.2	0.45	0.02	0.00	0.03	0.322	
28-11-95	2	10	26.2	7.87	635	9.2	0.45					
28-11-95	2	20	26.1	7.58	640	9.19	0.45	0.01	0.00		0.672	
28-11-95	2	30	26.1	6.29	642	9.12	0.45					
28-11-95	2	40	25.7	5.00	648	9.08	0.47	0.08	0.00	0.01	0.440	
28-11-95	2	50	25.5	4.42	651	9.02	0.40					
28-11-95	2	60	25.0	4.34	655	8.97	0.49	0.01	0.00		0.674	
28-11-95	2	70	24.8	4.30	656	8.96	0.40					
28-11-95	2	80	24.6	4.24	660	8.94	0.50	0.05	0.00	0.02	0.282	
28-11-95	2	90	24.6	4.04	662	8.93	0.40					
28-11-95	2	100	24.5	3.30	666	8.9	0.45	0.06	0.00		0.426	
05-12-95	2	0	26.3	7.91	641	9.36	0.35	0.03	0.00	0.03	0.247	4.19
05-12-95	2	10	26.3	7.66	643	9.17	0.32					3.33
05-12-95	2	20	26.3	6.42	652	9.12	0.36	0.00	0.00		0.370	3.11
05-12-95	2	30	26.3	5.52	660	9	0.28					3.11
05-12-95	2	40	26.0	4.98	662	8.98	0.34	0.01	0.00	0.04	0.698	2.43
05-12-95	2	50	25.6	4.68	667	8.82	0.36					3.06
05-12-95	2	60	25.4	4.65	668	8.8	0.34	0.01	0.00		0.456	1.40
05-12-95	2	70	25.2	4.39	671	8.75	0.20					
05-12-95	2	80	24.8	4.02	680	8.73	0.32	0.08	0.00	0.01	0.711	0.50
05-12-95	2	90	24.5	2.35	681	8.69	0.18					
05-12-95	2	100	24.3	0.99	683	8.69	0.25	0.09	0.00		0.835	0.00
12-12-95	2	0	26.6	7.60	620	9	0.45	0.00	0.03	0.01	0.448	1.58
12-12-95	2	10	26.4	7.41	624	8.99	0.45					3.15
12-12-95	2	20	26.2	7.11	628	8.95	0.45	0.00	0.00		0.444	4.59
12-12-95	2	30	25.9	6.77	631	8.92	0.32					1.58
12-12-95	2	40	25.6	6.70	634	8.84	0.29	0.00	0.06	0.06	0.485	1.53
12-12-95	2	50	25.4	4.90	640	8.82	0.25					1.31
12-12-95	2	60	25.2	4.70	642	8.8	0.25	0.02	0.01		0.632	0.77
12-12-95	2	70	24.8	4.41	650	8.76	0.24					
12-12-95	2	80	24.6	4.31	650	8.74	0.26	0.03	0.02	0.02	1.218	0.59
12-12-95	2	90	24.6	3.63	652	8.7	0.22					
12-12-95	2	100	24.4	1.36	660	8.67	0.20	0.11	0.04		1.028	-0.72
20-12-95	2	0	26.4	7.63	648	9.31	0.35	0.00	0.01	0.06	0.345	3.02
20-12-95	2	10	26.4	7.42	650	9.27	0.30					2.93
20-12-95	2	20	26.4	7.21	652	9.24	0.32	0.00	0.07			0.63
20-12-95	2	30	26.3	6.90	655	9.11	0.35					0.72
20-12-95	2	40	26.0	6.86	658	8.98	0.35	0.00	0.08	0.05		1.76
20-12-95	2	50	25.8	6.71	659	8.95	0.25					0.86
20-12-95	2	60	25.6	5.21	661	8.92	0.25	0.06	0.00			
20-12-95	2	70	25.4	4.42	665	8.86	0.25					
20-12-95	2	80	24.7	3.92	666	8.84	0.30	0.05	0.00	0.05		
20-12-95	2	90	24.4	2.53	663	8.81	0.30					
20-12-95	2	100	24.3	1.32	668	8.8	0.21	0.07	0.00			
28-12-96	2	0	26.8	7.45	642	9.14	0.32	0.00	0.00	0.15	0.345	3.06
28-12-96	2	10	26.6	5.36	643	9.1	0.30					0.99
28-12-96	2	20	26.6	4.99	649	9.03	0.30	0.00	0.00			2.93
28-12-96	2	30	26.5	4.88	651	9	0.28					2.21
28-12-96	2	40	26.4	4.83	651	8.94	0.30	0.00	0.00	0.14		2.07
28-12-96	2	50	25.6	4.39	657	8.9	0.42					0.77
28-12-96	2	60	24.8	2.92	660	8.89	0.22	0.00	0.00			0.18
28-12-96	2	70	24.5	2.27	662	8.82	0.20					
28-12-96	2	80	24.2	0.74	667	8.8	0.22	0.00	0.00	0.16		0.41
28-12-96	2	90	24.2	0.22	668	8.59	0.15					
28-12-96	2	100	24.2	0.14	669	8.55	0.19	0.00	0.00			0.09
01-08-95	3	0	24.8	8.17	650	8.76	0.55	0.02	0.00	0.06	0.405	1.46
01-08-95	3	10	24.5	8.06	648	8.73	0.45					2.48
01-08-95	3	20	24.4	7.07	644	8.72	0.45	0.03	0.00	0.03	0.490	1.76
01-08-95	3	30	24.3	6.20	655	8.7	0.52					1.34
01-08-95	3	40	24.3	6.88	659	8.71	0.54	0.05	0.00	0.02	0.720	1.82
01-08-95	3	50	24.3	6.02	663	8.73	0.53					2.05
01-08-95	3	60	24.3	6.32	660	8.73	0.56	0.04	0.00	0.03	0.471	1.79
01-08-95	3	70	24.3	6.40	660	8.74	0.52					
01-08-95	3	80	24.2	6.41	661	8.72	0.57	0.04	0.00	0.04	0.735	2.16
01-08-95	3	90	24.3	6.34	661	8.71	0.52					
01-08-95	3	100	24.4	6.19	673	8.69	0.53	0.05	0.00	0.11	0.810	1.36
08-08-95	3	0	24.7		655	8.68	0.53	0.08	0.01	0.03	0.631	0.67

08-08-95	3	10	24.5		614	8.65	0.52					1.31
08-08-95	3	20	24.5		648	8.73	0.52	0.06	0.01		0.630	1.54
08-08-95	3	30	24.5		653	8.69	0.51					1.14
08-08-95	3	40	24.4		655	8.55	0.46	0.04	0.00	0.05	0.600	1.09
08-08-95	3	50	24.4		654	8.71	0.45					0.91
08-08-95	3	60	24.4		657	8.68	0.45	0.09	0.00		0.965	0.58
08-08-95	3	70	24.3		653	8.68	0.45					
08-08-95	3	80	24.3		657	8.65	0.45	0.10	0.00	0.06	0.967	1.15
08-08-95	3	90	24.3		659	8.62	0.44					
08-08-95	3	100	24.4		660	8.64	0.45	0.11	0.00		0.949	0.93
16-08-95	3	0	24.0		659	8.75	0.41	0.04	0.00		1.122	
16-08-95	3	10	24.3		660	8.74	0.40					
16-08-95	3	20	24.3		660	8.39	0.38	0.05	0.00	0.06	1.166	
16-08-95	3	30	24.3		661	8.66	0.38					
16-08-95	3	40	24.3		659	8.75	0.39	0.03	0.00	0.06	1.080	
16-08-95	3	50	24.3		661	8.74	0.38					
16-08-95	3	60	24.3		660	7.97	0.36	0.05	0.00	0.08	1.311	
16-08-95	3	70	24.2		660	8.7	0.37					
16-08-95	3	80	24.1		662	8.63	0.34	0.08	0.00	0.13	1.056	
16-08-95	3	90	24.0		661	8.61	0.31					
16-08-95	3	100	24.1		662	8.49	0.30	0.13	0.00	0.08	1.086	
22-08-95	3	0	24.8	7.12	662	9.06	0.59	0.02	0.00	0.02	1.249	1.90
22-08-95	3	10	24.3	6.97	660	9.16	0.56					1.73
22-08-95	3	20	24.3	6.73	661	9.2	0.60	0.04	0.00	0.03	1.124	1.94
22-08-95	3	30	24.3	6.35	661	9.21	0.59					1.36
22-08-95	3	40	24.2	6.25	661	9.25	0.42	0.04	0.00	0.05	1.143	0.99
22-08-95	3	50	24.2	5.61	661	9.21	0.40					0.78
22-08-95	3	60	24.1	5.02	660	9.2	0.36	0.04	0.00	0.09	1.414	0.67
22-08-95	3	70	24.1	5.02	660	9.2	0.31					
22-08-95	3	80	24.1	4.46	660	9.2	0.34	0.10	0.00	0.09	1.491	-0.27
22-08-95	3	90	24.1	3.50	662	9.18	0.30					
22-08-95	3	100	23.9	3.15	663	9.14	0.32	0.09	0.00	0.11	2.900	0.54
29-08-95	3	0	24.7		665	9.01	0.45	0.03	0.00	0.03	1.104	1.89
29-08-95	3	10	24.7		659	9.12	0.44					2.02
29-08-95	3	20	24.6		659	9.2	0.44	0.05	0.00	0.04	1.027	2.14
29-08-95	3	30	24.6		657	9.12	0.41					1.97
29-08-95	3	40	24.5		660	9.22	0.38	0.06	0.00	0.02	0.996	1.84
29-08-95	3	50	24.6		658	9.14	0.34					1.14
29-08-95	3	60	24.4		660	9.11	0.35	0.05	0.00	0.05	0.303	0.86
29-08-95	3	70	24.4		659	9.14	0.33					
29-08-95	3	80	24.3		659	9.16	0.31	0.06	0.00	0.09	0.727	
29-08-95	3	90	24.3		660	9.11	0.31					
29-08-95	3	100	24.2		659	9.18	0.29	0.08	0.00	0.08	0.754	
05-09-95	3	0	24.8		645	9.41	0.51	0.01	0.00	0.02	1.018	
05-09-95	3	10	24.6		629	9.41	0.49					
05-09-95	3	20	24.4		630	9.4	0.50	0.08	0.00	0.01	0.974	
05-09-95	3	30	24.3		629	9.31	0.47					
05-09-95	3	40	24.2		620	9.23	0.45	0.04	0.00	0.01	0.904	
05-09-95	3	50	24.3		641	9.3	0.64					
05-09-95	3	60	24.4		656	9.28	0.58	0.06	0.00	0.05	0.968	
05-09-95	3	70	24.3		653	9.26	0.49					
05-09-95	3	80	24.3		641	9.3	0.52	0.08	0.00	0.04	1.036	
05-09-95	3	90	24.3		650	9.33	0.53					
05-09-95	3	100	24.3		652	9.3	0.43	0.05	0.00	0.06	1.182	
12-09-95	3	0	25.3	6.49	653	9.27	0.58	0.03	0.00	0.02	0.689	1.74
12-09-95	3	10	24.7	6.42	655	9.22	0.62					2.03
12-09-95	3	20	24.6	6.23	656	9.2	0.53	0.04	0.00	0.02	0.571	1.22
12-09-95	3	30	24.5	5.64	657	9.2	0.38					1.04
12-09-95	3	40	24.4	5.52	660	9.18	0.36	0.05	0.00	0.05	0.669	0.69
12-09-95	3	50	24.4	5.48	661	9.14	0.40					0.70
12-09-95	3	60	24.4	5.41	664	9.16	0.45	0.06	0.00	0.05	0.580	0.90
12-09-95	3	70	24.3	5.10	659	9.09	0.46					
12-09-95	3	80	24.3	4.97	659	9.11	0.46	0.07	0.00	0.07	0.588	0.67
12-09-95	3	90	24.2	4.32	660	9.15	0.33					
12-09-95	3	100	24.1	4.43	661	9.12	0.35	0.09	0.00	0.07	0.971	0.43
19-09-95	3	0	26.4	7.48	658	9.21	0.45	0.04	0.00	0.01	0.673	0.67
19-09-95	3	10	25.8	7.43	657	9.23	0.45					1.44
19-09-95	3	20	25.5	7.35	657	9.23	0.44	0.03	0.00	0.02	0.676	1.62
19-09-95	3	30	25.5	7.22	657	9.22	0.45					1.38
19-09-95	3	40	25.4	7.23	657	9.27	0.44	0.05	0.00	0.02	0.661	1.26
19-09-95	3	50	25.2	7.14	658	9.17	0.44					1.34
19-09-95	3	60	24.9	6.75	658	9.18	0.43	0.06	0.00	0.02	0.650	1.25
19-09-95	3	70	24.6	6.21	658	9.12	0.44					
19-09-95	3	80	24.5	5.92	661	9.21	0.45	0.06	0.00	0.05	0.798	0.83
19-09-95	3	90	24.4	5.32	660	9.19	0.43					
19-09-95	3	100	24.4	5.21	658	9.16	0.43	0.07	0.00	0.09	0.777	0.30
26-09-95	3	0	26.1	7.33	668	9.18	0.38	0.00	0.00	0.03	0.629	0.62
26-09-95	3	10	25.9	7.34	661	9.19	0.39					0.82
26-09-95	3	20	25.8	7.43	663	9.18	0.34	0.01	0.00	0.05	0.590	0.93
26-09-95	3	30	25.2	6.76	663	9.18	0.31					2.19

26-09-95	3	40	24.9	6.65	651	9.16	0.32	0.02	0.00	0.05	0.657	1.78
26-09-95	3	50	24.8	6.27	657	9.15	0.31					0.99
26-09-95	3	60	24.5	6.25	658	9.09	0.30	0.02	0.00	0.07	0.661	0.69
26-09-95	3	70	24.5	5.51	657	9.09	0.30					
26-09-95	3	80	24.4	4.89	658	9.09	0.29	0.07	0.00	0.10	0.771	0.42
26-09-95	3	90	24.3	4.86	661	9.11	0.27					
26-09-95	3	100	24.2	4.12	662	9.1	0.24	0.07	0.00	0.11	0.972	0.19
03-10-95	3	0	26.2	7.28	658	9.13	0.55	0.04	0.00	0.03	0.678	0.48
03-10-95	3	10	26.0	7.15	659	9.11	0.53					1.25
03-10-95	3	20	26.0	6.87	658	9.12	0.53	0.04	0.00	0.04	0.678	1.01
03-10-95	3	30	25.8	6.68	657	9.12	0.54					1.12
03-10-95	3	40	25.3	6.14	657	9.11	0.55	0.05	0.00	0.02	0.703	2.26
03-10-95	3	50	25.0	5.93	655	9.11	0.44					2.14
03-10-95	3	60	24.7	5.75	655	9.11	0.44	0.05	0.00	0.06	0.691	1.23
03-10-95	3	70	24.5	5.38	656	9.06	0.42					
03-10-95	3	80	24.4	5.07	663	9.04	0.42	0.04	0.00	0.07	0.687	0.53
03-10-95	3	90	24.2	4.69	660	8.99	0.39					
03-10-95	3	100	24.0	4.66	665	8.72	0.42	0.04	0.00	0.10	0.846	0.30
10-10-95	3	0	26.6	5.84	656	9.13	0.59	0.02	0.00	0.04	0.689	0.93
10-10-95	3	10	26.4	5.92	656	9.12	0.55					1.15
10-10-95	3	20	26.4	5.89	657	9.12	0.54	0.01	0.00	0.04	0.583	1.34
10-10-95	3	30	26.2	5.84	659	9.29	0.44					1.04
10-10-95	3	40	26.1	5.68	653	9.18	0.43	0.02	0.00	0.04	0.657	1.12
10-10-95	3	50	26.1	5.54	653	9.11	0.44					0.94
10-10-95	3	60	25.7	5.20	657	9.07	0.38	0.01	0.00	0.04	0.631	0.98
10-10-95	3	70	25.1	4.86	660	9	0.38					
10-10-95	3	80	24.7	4.45	658	9.05	0.36	0.03	0.00	0.07	0.653	0.62
10-10-95	3	90	24.7	4.08	654	9.05	0.37					
10-10-95	3	100	24.7	5.87	650	9.09	0.42	0.02	0.00	0.07	0.688	0.46
17-10-95	3	0	27.4	7.68	656	9.12	0.80	0.09	0.00	0.01	0.628	3.90
17-10-95	3	10	27.1	7.75	656	9.1	0.95					4.13
17-10-95	3	20	26.9	7.40	654	9.1	0.48	0.04	0.00	0.01	0.813	1.09
17-10-95	3	30	26.3	7.18	655	9.08	0.54					1.02
17-10-95	3	40	26.2	6.81	655	9.07	0.36	0.09	0.00	0.04	0.680	1.18
17-10-95	3	50	25.9	6.61	656	9.03	0.39					0.98
17-10-95	3	60	25.1	6.16	654	9.03	0.25	0.05	0.00	0.05	0.765	0.74
17-10-95	3	70	24.8	5.94	657	9.01	0.25					
17-10-95	3	80	24.8	5.97	657	8.99	0.23	0.05	0.00	0.03	0.700	0.40
17-10-95	3	90	24.7	5.54	660	8.95	0.24					
17-10-95	3	100	24.7	5.38	658	9.04	0.27	0.09	0.00	0.02	0.824	0.29
25-10-95	3	0	28.5	9.10	663	9.2	2.50	0.12	0.00	0.04	1.400	14.51
25-10-95	3	10	27.6	8.84	659	9.16	2.90					17.26
25-10-95	3	20	27.2	7.85	658	9.17	0.60	0.08	0.00	0.03	1.509	3.26
25-10-95	3	30	27.0	7.50	658	9.12	0.60					1.42
25-10-95	3	40	26.4	6.94	656	9.08	0.50	0.10	0.00	0.02	1.482	0.72
25-10-95	3	50	26.2	6.86	657	9.07	0.50					0.59
25-10-95	3	60	25.7	6.46	658	9.06	0.50	0.07	0.00	0.04	1.504	0.85
25-10-95	3	70	25.2	6.29	657	9.03	0.60					
25-10-95	3	80	24.8	5.85	658	8.99	0.40	0.10	0.00	0.04	1.469	0.34
25-10-95	3	90	24.7	5.44	656	9.05	0.50					
25-10-95	3	100	24.7	5.30	660	9.09	0.40	0.09	0.00	0.04	1.502	0.19
31-10-95	3	0	27.5	7.25	659	9.09	0.99	0.05	0.00		0.725	2.64
31-10-95	3	10	27.4	7.10	659	9.11	0.81					2.05
31-10-95	3	20	27.0	7.04	659	9.12	0.60	0.06	0.00		0.753	0.93
31-10-95	3	30	26.9	6.83	658	9.13	0.46					0.70
31-10-95	3	40	26.6	6.83	658	9.1	0.44	0.10	0.00		0.757	0.48
31-10-95	3	50	26.2	6.49	659	9.09	0.39					0.43
31-10-95	3	60	25.6	6.24	659	9.07	0.48	0.09	0.00		0.728	0.42
31-10-95	3	70	25.3	6.00	659	9.03	0.43					
31-10-95	3	80	25.0	5.75	660	9.01	0.41	0.06	0.00		0.748	0.32
31-10-95	3	90	24.9	5.63	660	8.91	0.38					
31-10-95	3	100	24.5	4.99	660	9.01	0.48	0.06	0.00		0.766	0.22
09-11-95	3	0	28.2	7.73	660	9.15	0.61	0.03	0.00		0.721	1.41
09-11-95	3	10	28.0	7.69	663	9.11	0.61					2.10
09-11-95	3	20	27.8	7.61	661	9.12	0.59	0.08	0.00		0.730	2.85
09-11-95	3	30	27.1	7.48	663	9.05	0.42					0.78
09-11-95	3	40	26.9	7.31	659	9.05	0.40	0.07	0.00		0.819	0.66
09-11-95	3	50	26.6	6.99	652	9.03	0.42					0.43
09-11-95	3	60	26.0	6.77	657	9.04	0.39	0.11	0.00		0.761	0.32
09-11-95	3	70	25.7	6.56	658	9.03	0.40					
09-11-95	3	80	24.8	6.31	657	9.05	0.35	0.13	0.00		0.754	0.35
09-11-95	3	90	24.4	5.64	659	9.07	0.34					
09-11-95	3	100	24.4	4.86	663	9.04	0.43	0.14	0.00		1.046	0.21
14-11-95	3	0	27.7	8.41	666	9.18	1.40	0.10	0.00			1.28
14-11-95	3	10	27.7	8.17	661	9.11	1.20					1.57
14-11-95	3	20	27.7	8.18	660	9.08	1.00	0.09	0.00			1.55
14-11-95	3	30	27.7	8.18	659	9.03	1.10					1.26
14-11-95	3	40	26.6	7.67	658	9.03	0.90	0.08	0.00			0.45
14-11-95	3	50	26.2	7.50	659	9.04	0.80					0.27
14-11-95	3	60	25.9	7.44	659	9.04	0.70	0.09	0.00			0.29

14-11-95	3	70	25.6	6.88	661	9.01	0.70		
14-11-95	3	80	24.8	5.82	662	8.98	0.90	0.10	0.00
14-11-95	3	90	24.7	5.52	663	8.97	0.70		
14-11-95	3	100	24.5	5.21	663	8.99	0.90	0.11	0.00
23-11-95	3	0	28.2	7.18	660	9.11	0.69	0.06	0.00
23-11-95	3	10	28.0	6.85	657	9.13	0.69		
23-11-95	3	20	27.8	6.67	657	9.12	0.68	0.09	0.00
23-11-95	3	30	27.2	5.42	656	9.08	0.64		
23-11-95	3	40	26.8	5.29	658	9.08	0.62	0.12	0.00
23-11-95	3	50	26.1	5.20	656	9.08	0.54		
23-11-95	3	60	26.0	5.05	657	9.05	0.54	0.13	0.00
23-11-95	3	70	24.8	4.39	659	9.02	0.40		
23-11-95	3	80	24.5	3.95	660	8.98	0.41	0.11	0.00
23-11-95	3	90	24.3	2.73	663	8.91	0.38		
23-11-95	3	100	24.3	2.10	663	8.8	0.38	0.15	0.00
28-11-95	3	0	27.9	5.55	657	9.11	0.79	0.02	0.13
28-11-95	3	10	27.4	3.22	656	9.12	0.82		
28-11-95	3	20	27.6	3.00	658	9.07	0.86	0.01	0.13
28-11-95	3	30	26.8	2.50	658	9.05	0.69		
28-11-95	3	40	26.7	2.39	658	9.01	0.69	0.05	0.10
28-11-95	3	50	26.1	2.21	658	9	0.68		
28-11-95	3	60	25.6	2.08	659	8.98	0.69	0.10	0.09
28-11-95	3	70	24.5	2.15	659	8.97	0.63		
28-11-95	3	80	24.4	1.96	662	8.91	0.55	0.12	0.14
28-11-95	3	90	24.2	1.91	660	8.87	0.55		
28-11-95	3	100	24.2	1.85	661	8.84	0.49	0.15	0.11
05-12-95	3	0	28.0	7.19		9.1	0.94	0.08	0.00
05-12-95	3	10	28.0	5.75		9.13	0.71		
05-12-95	3	20	27.8	5.28		9.14	0.72	0.04	0.00
05-12-95	3	30	27.4	5.16		9.12	0.62		
05-12-95	3	40	26.8	5.15		9.06	0.61	0.04	0.00
05-12-95	3	50	26.5	5.15		8.99	0.59		
05-12-95	3	60	26.2	4.86		8.97	0.58	0.01	0.00
05-12-95	3	70	25.3	4.79		8.92	0.54		
05-12-95	3	80	24.7	4.36		8.88	0.50	0.03	0.00
05-12-95	3	90	24.6	3.93		8.89	0.45		
05-12-95	3	100	24.5	3.39		8.92	0.47	0.04	0.00
12-12-95	3	0	27.5	9.21		8.91	0.82	0.01	0.00
12-12-95	3	10	27.5	8.98		8.71	0.76		
12-12-95	3	20	27.4	8.74		8.7	0.63	0.00	0.00
12-12-95	3	30	26.5	7.52		8.69	0.64		
12-12-95	3	40	26.3	7.07		8.66	0.60	0.01	0.00
12-12-95	3	50	25.6	6.83		8.59	0.63		
12-12-95	3	60	25.0	6.57		8.63	0.58	0.02	0.00
12-12-95	3	70	24.4	5.38		8.46	0.58		
12-12-95	3	80	24.4	5.37		8.59	0.61	0.03	0.00
12-12-95	3	90	24.3	5.10		8.64	0.60		
12-12-95	3	100	24.3	5.06		8.63	0.58	0.05	0.00
19-12-95	3	0	27.9			8.74	0.89	0.05	0.00
19-12-95	3	10	27.6			8.78	0.86		
19-12-95	3	20	27.7			8.69	0.85	0.06	0.00
19-12-95	3	30	26.2			8.64	0.86		
19-12-95	3	40	26.1			8.92	0.75	0.07	0.00
19-12-95	3	50	25.1			9.07	0.73		
19-12-95	3	60	24.8			8.57	0.72	0.06	0.00
19-12-95	3	70	24.8			8.62	0.66		
19-12-95	3	80	25.1			8.66	0.67	0.04	0.00
19-12-95	3	90	24.4			8.93	0.66		
19-12-95	3	100	24.3			8.54	0.65	0.05	0.01
26-12-95	3	0	27.5	7.30		8.67	0.94	0.03	0.00
26-12-95	3	10	27.5	7.30		8.74	0.92		
26-12-95	3	20	27.4	7.61		9.1	0.86	0.04	0.00
26-12-95	3	30	27.3	7.32		8.91	0.79		
26-12-95	3	40	26.6	5.76		8.87	0.71	0.02	0.00
26-12-95	3	50	26.1	5.61		8.66	0.70		
26-12-95	3	60	25.8	5.70		8.73	0.66	0.04	0.00
26-12-95	3	70	25.5	5.28		8.76	0.65		
26-12-95	3	80	24.9	4.83		8.65	0.62	0.12	0.00
26-12-95	3	90	24.7	4.58		8.64	0.61		
26-12-95	3	100	24.6	4.49		8.81	0.60	0.13	0.00

Appendix 2. Underwater PAR distribution (in % of incident PAR) and mean secchi disk values (m) at the limnological sampling sites. Place 1= Bujumbura, 2 = Kigoma and 3 = Mpulungu. Numbers 31 to 52 indicate the sampling weeks.

Depth	Place	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47		49	50	51	52
0	1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		100	100	100	100
10	1	28.3	23.7	28.8	26.9	83.2	25.2	24.7	38.9	23.1	19.5	17.6	19.6	54.6	91.0	11.8	15.6	38.2		23.9	44.9	32.4	24.0
20	1	10.8	5.6	6.1	9.0	40.6	7.7	8.7	22.5	6.7	10.0	2.6	4.4	11.2	16.2	8.2	1.9	13.3		13.8	12.8	14.2	2.0
30	1	4.5	1.5	1.6	2.9	18.3	2.8	2.7	12.1	2.3	3.5	0.4	1.2	2.4	3.1	2.9	0.2	3.8		11.0	8.6	2.0	0.3
40	1	1.4	0.4	0.4	0.8	8.5	1.0	0.7	3.8	0.8	1.8	0.1	0.3	0.9	0.3	0.2		1.1		10.0	4.9	0.6	
50	1	0.7	0.1	0.1	0.2	4.3	0.4	0.3	2.2	0.3	0.6	0.1	0.1	0.4	0.0	0.0		0.5		9.2	1.7	0.3	
S.D.	1	9.5	11.7	11.0	10.0	9.7	9.1	11.3	11.2	15.3	14.1	10.5	12.0	11.3	9.7	8.1	9.9	10.4		9.8	6.5	11.3	7.2

Depth	Place	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47		49	50	51	52
0	2			100	100	100	100	100		100	100	100	100	100	100		100	100		100	100	100	
10	2			38.2	44.2	27.9	26.9	37.6		22.0	40.4	39.7	28.0	15.6	39.7		26.7	34.1		28.4	23.4	40.0	
20	2			19.4	26.9	17.5	10.1	16.0		9.9	22.6	11.8	11.5	14.5	29.6		9.5	11.8		10.2	9.1	14.7	
30	2			9.2	9.3	5.8	3.7	7.7		4.9	11.4	4.3	5.6	3.1	7.9		3.2	3.3		4.1	3.3	4.2	
40	2			3.5	3.9	3.6	1.7	3.4		1.7	6.0	2.5	2.6	1.3	3.4		1.2	0.8		1.5	1.3	2.1	
50	2			1.0	1.9	2.2	0.4	1.8		0.4	2.6		0.9	0.4	1.8		0.5	0.3		0.4	0.6		
S.D.	2	14.4	18.7	14.6	16.55	15.35	14.45	13.25		14.4	12.65	10.7	10.75	11.3	9.8	9.8	10.8	10.2	11.2	11.75	12.6	10.9	

Depth	Place	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47		49	50	51	52
0	3	100	100		100		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
10	3	14.9	22.8		100.4		68.2	17.0	81.0	80.3	84.0	28.5	18.1	2.3	62.7	58.4	74.1	67.8	105.9	91.9	48.8	40.6	
20	3	2.6	6.4		110.8		66.9	3.3	51.1	32.0	36.7	13.7	4.1	0.1	8.6	11.5	17.6	29.8	37.3	25.8	35.5	13.5	
30	3	0.7	2.0		28.8		6.6	0.7	19.1	9.4	13.5	4.8	1.4	0.0	2.6	3.2	5.0	8.6	10.4	5.2	14.2	4.0	
40	3	0.2	0.5		6.5		6.4	0.4	8.5	2.8	3.9	1.6	0.4	0.0	1.0	1.0	1.5	3.3	4.4	1.7	7.5	1.6	
50	3	0.1																					
S.D.	3	5.72	8.88	9.58	9.28	9.1	9.03	7.15	12.12	11.23	12.3	13.48	9.62	2.47	4.18	8.48	8.25	8.46	10.52	8.75	11.92	11	13.7

Appendix 3. Example of a limnological sampling form used during this study by all three stations.

LAKE TANGANYIKA RESEARCH PROJECT-LIMNOLOCY-weekly sampling

Station (fullname):		incubation time	START		END
Team sampling:					
Team analysing:		Latitude:	Before sampled water discarded, results data checked by:		
Date (DDMMYY):		Longitude:			
Lake condition:		Hourstart:	Before entering data in computer,data checked by:		
Cloud cover:	from 1 (= no clouds) to 5 (= covered)	Hourend:			

Input right coefficient for radiation; air or water — Air radiation: start | end

SITEA(=H1)	Depth	Secchi Disk			T°	D.O.	Cond.	pH	Turb.	S.R.P	NH4-N	NO3-N	NO2-N	SIO2	Chla	Pr.Prod.	W RAD 1	W RAD 2
9H					°C	mg/l				mg/l							down	up
Burunditime	(m)		start	end	(probe)		uS/cm		NTU	(PO4---)	mg/l	mg/l	mg/l	mg/l	mg/m3	gC/m2-D	umol Sm2	
	0	1.														send		
	10	2.														send		
	20	3.														send		
	30	Avg=														send		
	40															send		
	50																	
	60																	
	70																	
	80																	
	90																	
	100																	

Latitude:	
Longitude:	
Hourstart:	
Hourend:	

Air radiation: start | end

Cloud cover:

COAST					T°	D.O.	C.	pH	Turb.	S.R.P	NH4-N	NO3-N	NO2-N	SIO2	Chla		W RAD 1	W RAD 2
SITE H 2	Depth				°C	mg/l				mg/l							down	up
11 H	(m)	2.	3.	Avg.	(probe)		uS/cm		NTU	(PO4---)	mg/l	mg/l	mg/l	mg/l	mg/m3		umol Sm2	
	0																	
	10																	

Site H 2 is circa 50 meters away from the shore. S. D. = secchi disk depth, C. = Conductivity, S.R.P. = Solluble reactive phosphate after filtering trough 0.45 µm Gelman.
Send = Subsamples for primary production were send to Finland for analysis.
Shaded cells indicate depths were no sampling was carried out.