

**Mountain Lake Research**

## **PROGRESS REPORT**

**March 1996 - March 1997**

Measuring and modelling  
the dynamic response of  
remote mountain lake ecosystems  
to environmental change

A programme of **Mo**untain **L**ake **R**esearch  
**MOLAR**

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Title MOLAR Progress Report 1/1997. March 1996 - March 1997. Measuring and modelling the dynamic response of remote mountain lake ecosystems to environmental change: A programme of Mountain Lake Research - MOLAR	Serial No. 3705-97	Date 19.7.1997
	Report No. Sub-No. 96061-1	Pages Price 254
Author(s) Bente M. Wathne (Ed.)	Topic group Acid Rain	Distribution
	Geographical area Europe	Printed NIVA

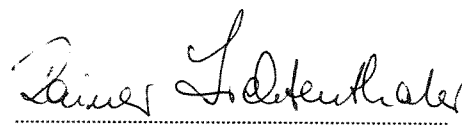
Client(s) Commission of the European Communities	Client ref. ENV4-CT95-0007
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Abstract MOLAR is an extensive European co-operative research project with 23 partners. It is funded within the European Commission Framework Programme IV: Environment and Climate with assistance from INCO. It is co-ordinated by the Environmental Change Research Centre (ECRE) at University College London and the Norwegian Institute for Water Research (NIVA). The project has four major strands also called Work Packages, and progress for the first working year of each of the Work Packages (WP) is reported here. The main part is a summary of the activities under each WP, while in the Appendix detailed reports from each of the contract partners are given. Also reported in Appendix is minutes from Workshops under the different scientific topics in the project.
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4 keywords, Norwegian 1. Høyfjellsjøer 2. Vannkjemi 3. Biologi 4. Europeisk samarbeid	4 keywords, English 1. High mountainlakes 2. Water chemistry 3. Biology 4. European co-operation
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ISBN 82-577-3271-0

  
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# MOLAR Progress Report 1/1997

March 1996 - March 1997

Contract no.: ENV4-CT95-0007

## Measuring and modelling the dynamic response of remote mountain lake ecosystems to environmental change:

### A programme of Mountain Lake Research - MOLAR

#### MOLAR co-operative partners:

01	University College London, UK (coordinator)	(UCL)
02	University of Helsinki, SF	(UHEL)
03	University of Edinburgh, UK	(UED)
04	Norwegian Institute for Water Research, N	(NIVA)
05	Universität Innsbruck, Institut für Zoologie, A	(UIBK)
06	Austrian Academy of Sciences, Limnological Institute, A	(ILIMNOL)
07	Universidad de Barcelona, ES	(FBG)
08	Universidad de Granada, ES	(UGR-ES)
09	University of Bordeaux (URA CNRS), Arcachon, F	(CNRS)
10	Consejo Superior De Investigaciones Cientificas, Barcelona, ES	(CSIC)
11	University of Bergen, Botanical Institute, N	(UIB-BI)
12	University of Bergen, Institute of Zoology, N	(UIB-ZI)
13	CNR-Istituto Italiano di Idrobiologia, Pallanza, I	(CNR-III)
14	University of Liverpool, UK	(ULIV)
15	Institute for Environmental Science and Technology, Dubendorf, CH	(EAWAG)
16	University of Zurich, CH	(UZurich)
17	Charles University, Prag, Czech Republic	(FSCU)
18	Hydrobiological Institute, Ceske Budejovice, Czech Republic	(HBI-ASCR)
19	Institute of Zoology, Bratislava, Slovak Republic	(IZ-SAS)
20	Polish Academy of Sciences, Institute of Freshwater Biology, Kracow, PL	(IFB-PAS)
21	National Institute of Biology, Ljubljana, Slovenia	(NIB)
22	Kola Science Centre, Apatite, Russia.	(INEP)
23	Laboratorio Studi Ambientale, Sezione aria e aqua, Ticino, CH	(LSA)

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## Preface

MOLAR is an extensive European research project with 23 co-operative partners. It is funded within the European Commission Framework Programme IV: Environment and Climate with assistance from INCO. MOLAR builds on the success of the EU funded AL:PE projects.

MOLAR was launched March 1st 1996, and the first project meeting was held two weeks later in Prague. Here the detailed planning of the first working year was discussed and a basis for the MOLAR Project Manual for sampling and analysis was established. The MOLAR Project Manual was published in its first version in May 1996, and 2nd version in September 1996. After agreements at the second project meeting in Barcelona the final version will be published in August 1997.

From December 1996 MOLAR has also had a home page on Internet.

When the Project Proposal was prepared, there were 22 co-operative partners involved in MOLAR. After the project had been accepted by the European Commission, a Swiss Group from Laboratorio Studi Ambientale, Sezione aria e aqua, Ticino (LSA) joined the project and is now working voluntary under the same programme as the rest of the project group.

This Progress Report summarises the activities during the first working year of the project. It is compiled from contributions given by all project partners. Convenores for the four different parts (Work Packages) of the project have been responsible for reporting of the progress within each part.

Oslo, 19. July 1997

*Bente M. Wathne*



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## Summary

MOLAR is an extensive European co-operative research project with 23 partners. It is funded within the European Commission Framework Programme IV: Environment and Climate with assistance from INCO. It is co-ordinated by the Environmental Change Research Centre (ECRE) at University College London and the Norwegian Institute for Water Research (NIVA). MOLAR was launched March 1st 1996, and the first project meeting was held two weeks later in Prague.

This project has four major strands also called Work Packages, and progress for the first working year of each of the Work Packages (WP) is reported here. The main part is a summary of the activities under each WP, while in the Appendix detailed reports from each of the contract partners are given. Convenores for the four different Work Packages have been responsible for reporting of the progress within each part. Reported in Appendix is also minutes from Workshops under the different scientific topics in the project.

The second project meeting was held in Barcelona in April 1997, and gave important information for reporting of the project progress. The main conclusion after the meeting is that the project is working according to plans.

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# 1. INTRODUCTION AND PROJECT OBJECTIVES

MOLAR is an extensive European co-operative research project originally established with 22 partners. After voluntary participation from a third Swiss group (participant no. 23 on the first page) it was extended and is now working with 23 partners.

MOLAR is funded by the European Commission Framework Programme IV: Environment and Climate with assistance from INCO. It is co-ordinated by the Environmental Change Research Centre (ECRE) at University College London and the Norwegian Institute for Water Research (NIVA). A Steering Group of senior scientists from laboratories engaged in the key areas of MOLAR has been established. The Steering Group is responsible for harmonisation of administrative and scientific co-ordination, and an important tool for optimal administration of the total MOLAR project.

The arctic and alpine regions of Europe represent the most remote and least disturbed environments in Europe, yet they are threatened by acid deposition, toxic air pollutants and by climate change. The remote lakes that occur throughout these regions are especially vulnerable for a number of related reasons:

- many mountain lakes have little ability to neutralise acidity because of their low base status, and acid deposition often increases with altitude;
- nitrate levels are higher in mountain lakes because their catchments have little soil and vegetation to take up nitrogen deposition;
- toxic trace metals and trace organics accumulate in the food chain more easily in soft water than hard water lakes, and some pollutants (e.g. mercury, volatile organics) accumulate progressively in cold regions;
- the productivity and ecological dynamics of mountain lakes is strongly controlled by climatic influence on the length of the ice-free season and the period of thermal stratification, yet climatic warming in Europe is predicted to be greatest in arctic-alpine regions.

Because of this sensitivity, remote mountain lakes are not only vulnerable to environmental change, they are also excellent sensors of change, and their sensitivity and high quality sediment records can be used to infer the speed, direction and biological impact of changing air quality and climate. The MOLAR project builds on the success of the EU funded AL:PE (Acidification of Remote Mountain Lakes: Palaeolimnology and Ecology) project, which represented the first comprehensive study of remote mountain lakes at an European level. A major report of the first phase of this project has been recently published (Wathne *et al.* 1995).

This project has **four overall objectives**, each corresponding to a major strand also called Work Package in the proposal:

- to measure and model the dynamic responses of remote mountain lake ecosystems to acid (sulphur plus nitrogen) deposition;

- 
- to quantify and model pollutant (trace metals, trace organics) fluxes and pathways in remote mountain lakes and their uptake by fish;
  - to measure and model the temporal responses of remote mountain lake ecosystems to climate variability on seasonal, inter-annual and decadal time-scales.
  - To continue the development of a high quality environmental database on remote mountain lake ecosystems in Europe and to disseminate results widely to enhance public awareness, environmental education and environmental decision making.

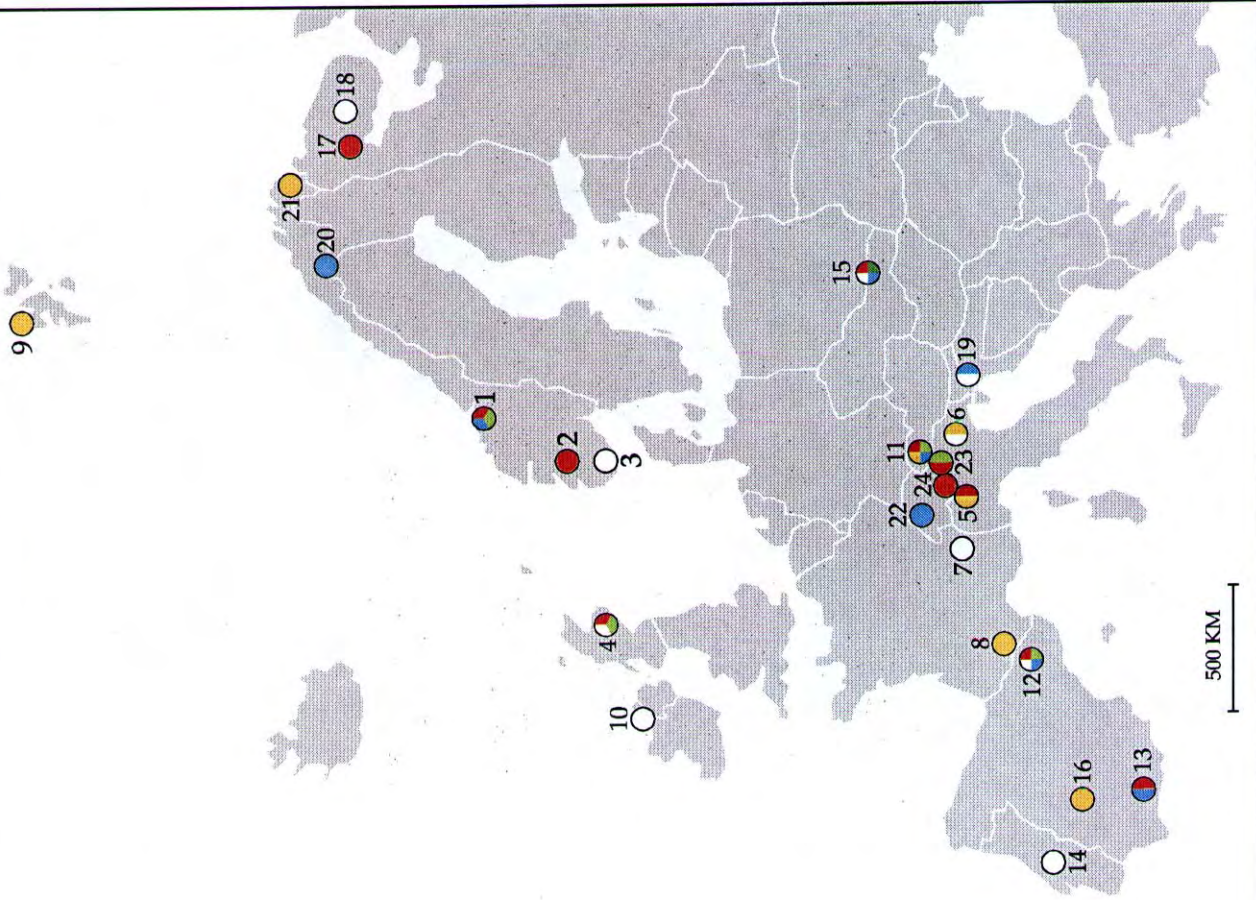
The main deliverables of this project will be the development of predictive models for acidity, pollutant flux and climate variability that can be used in scenario assessment studies, especially those scenarios associated with present and forthcoming UN-ECE protocols and General Circulation Model (GCM) predictions for Europe. A desirable future objective would be the linking of these models to evaluate the interaction between acidity, trace pollutant and climate. However this must inevitably wait until a later phase of the research. In addition to model development, much of the field and laboratory work proposed is innovative for studies of such remote sites, especially:

- the focus on the seasonal dynamics of the lake system;
- the emphasis on nitrogen deposition and its biological impact;
- the study of microbial food webs in relation to acidity;
- the on-site collection and measurement of atmospheric pollutants;
- the use of radio-tracers to validate pollutant transport models;
- the study of trace metals (especially mercury) and trace organic uptake by fish;
- the on-site monitoring of climate conditions and their relationship to water column behaviour;
- the development of a methodology to infer climate trends from the high resolution analysis of recent sediments.

These objectives were unachievable four years ago because of the almost complete lack of information on remote arctic and alpine lakes. It is now possible to carry out such work because of the knowledge gained about individual sites from the AL:PE project with respect particularly to accessibility, morphometry, chemistry, biology, sediment accumulation rate and pollution status.

Figur 1. MOLAR sites: distribution, location and status within the MOLAR/AL:PE network.

Site nr.	Site name MOLAR/AL:PE	MOLAR WP1	MOLAR WP2	MOLAR WP3	MOLAR secondary	Other AL:PE site
1	Ø. Neáðalsvatn	●	●	●		
2	Stavsvatn	●				
3	Lille Hovvatn	●				○
4.1	Lochnagar	●				
4.2	Sandy Loch					○
4.3	Loch nan Eun					○
5.1	Lago Paione Superiore	●			●	
5.2	Lago Faione Inferiore				●	
6.1	Lago Lungo				●	○
6.2	Lago di Latte				●	
7.1	Lac Rond					○
7.2	Lac Combeynod					○
7.3	Lac Blanc					○
7.4	Lac Noir					○
8	Etang d'Aubé				●	
9	Arresjøen				●	
10	Lough Maam				●	○
11.1	Schwarzsee ob Sölden				●	
11.2	Gossenköllesee	●			●	
12.1	Lago Aguillo				●	○
12.2	Lago Redo	●			●	
13	La Caldera	●				
14	Lagua Escura	●				○
15.1	Starolesnianske Pleso	●				
15.2	Terianske Pleso				●	
15.3	Dlugi Staw	●				○
15.4	Zieloni Staw					○
16	Laguna Cimera				●	
17	Chuna	●				
18	Chibini					○
19.1	Zgornje krisko jezero					○
19.2	Jezero Ledvica				●	
20	Lingambergjøem				●	
21	Saanajärvi				●	
22	Hagelsee				●	
23	Jörisee	●				
24	Laghetto Inferiore	●				



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## 2. MOLAR STATUS AFTER THE FIRST WORKING YEAR

### 2.1 MOLAR Work Package 1 (WP1)

#### MOUNTAIN LAKE ECOSYSTEM RESPONSE TO ACID DEPOSITION

*B.M. Wathne and B.O. Rosseland*

The progress reported within MOLAR WP1 follows the main headlines given in the project proposal. The following topics are addressed:

1. On site measurements of sulphur and nitrogen deposition
2. Seasonal variability of water chemistry
3. Seasonal variability of biota
4. Test hypothesis: histological and physiological attributes of fish indicate early acid stress
5. Test hypothesis: microbial activity in pelagic food web increases with acidification intensity

#### 2.1.1 On site measurements of sulphur and nitrogen deposition

Measurements of deposition are running at 11 of the 12 primary lakes in this work package (Figure 1). The minimum requirement is for bi-weekly sampling of bulk-collected precipitation and deposition samples, and analyses are performed for all major ions according to established MOLAR protocol. Sampling and analysis are the responsibility of site operators. CNR has taken the responsibility of the AQC programme. A full AQC programme are instigated and run in conjunction with that for lake water chemistry. A MOLAR Workshop on Sampling, Chemical Analysis and Quality Assurance of Atmospheric Deposition and Lake Water was organised in Pallanza June 5 - 7 1996. (See Appendix B.)

#### 2.1.2 Seasonal variability of water chemistry

Water samples are taken from the surface at the outlet of each lake following the agreed frequency in the Project Proposal: weekly in the ice-melt season, monthly or bi-weekly in summer and bi-monthly in winter. When possible, water samples have been taken at the same time as invertebrate and fish surveys (see below). Sampling and analysis are the responsibility of site operators. The MOLAR chemical AQC programme is run according to the Manual. Intercomparisons of chemical analyses have been organized in July by NIVA and in December, AQUACON 1/96, by CNR-III.

Analytical results from 1996 sampling season have been sent to the chemical centres at CNR-III and NIVA. All main WP 1 lakes have been sampled, but a few analytical laboratories have not yet delivered their results (by April -97). This will be done within the next months after QA procedures at the laboratories.

#### 2.1.3 Seasonal variability of biota

Sampling and analysis of diatoms, zooplankton and invertebrates follow the MOLAR protocols. Sampling is undertaken by site operators on three occasions during the ice-free period for invertebrates and diatoms, and at monthly intervals for zooplankton. Analyses are carried out by the laboratories of site operators, with programmes of taxonomic harmonisation co-ordinated by UCL (diatoms), FSCU (zooplankton) and UiB(ZI) (invertebrates).



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Reports in Barcelona show that the programme and progress for 1996 for diatoms, zooplankton and invertebrates follow the project plan. More details are given under the reports from each of the co-operative partners respectively, UCL (diatoms), FSCU (zooplankton) and UiB(ZI) (invertebrates).

The first MOLAR Biology Workshop was arranged in London 13. - 14. June 1996, and a workshop on Diatom Taxonomy was organised in Helsinki 18. - 19. October 1996, (see Appendix B) A special workshop for chironomids organised by UIB-ZI, is planned for 1997.

#### **2.1.4 Test hypothesis: histological and physiological attributes of fish indicate early acid stress**

The sampling and basic analytical methods followed the new MOLAR FISH PROTOCOL, revised after the Fish Workshop in Arcachon, France, June 1996 (see Appendix B).

Reports given in Barcelona, April 1997, indicated that both histological and physiological parameters seems to be very interesting as indicators of stress symptoms in high mountain lakes.

Histological analyses performed by UIBK, evaluating the first results from Stavsvatn, Arresjøen, Chuna, Schwarzsee, Jörisee and Etang d'Aubè on liver macrophages (melanomacrophages), chloride cells, and gills goblet cells from filaments and lamellae, indicates at present that differences in gill goblet cells seems to be most interesting.

Analyses of fish gills by the use of *Scanning microscopy* have been performed by CNRS on fish caught from 4 lakes, Jörisee, Arresjøen, Stavsvatn and Etang d'Aubè. These analyses seems to demonstrate that fish from lakes where the ionic content was the lowest (Jörisee, Stavsvatn and Etang d'Aubé) presented gills with a relatively abundant proliferation of chloride cells. The apical surface was large and the microvilli density high. In some cases the cells were coalescent. It is generally agreed that these cellular complexes present cellular junction with low resistance. In Arresjøen, the situation appeared different as most of the animals from this site do not present such abundant proliferation of chloride cells. Considering the specific change of ionic concentration that exists between the 3 former sites and lake Arresjøen in terms of NaCl concentration in the water, a direct correlation can be proposed between  $[NaCl]_w$  and chloride cells.

Problems with conservation and shipment of samples of blood plasma, resulted in analyses of plasma chloride from only two lakes. After resampling in 1997, more results will be available to study differences in response between fish from lakes of different water qualities.

#### **2.1.5 Test hypothesis: microbial activity in pelagic food web increases with acidification intensity**

The MOLAR lakes to be studied (Figure 1) have different pelagic food web structures when classified according to the highest trophic level. Some of them still have fish; the more acid ones are fishless; and microbial assemblages may prevail in those with the clearest water and lowest pH. Key processes within such simplified systems are carbon fluxes from phytoplankton to bacteria and protozoa, and feedbacks (including bacterivory by phytoflagellates) between these compartments. In some lakes, the input of organic carbon from the catchment (during the period of snow and ice-melting and from inflows) and its utilisation by bacteria, will be considered.

The following main compartments of the pelagic system in lakes and their interactions are assessed: biomass of bacteria, phytoplankton, heterotrophic nanoflagellates (HNF), ciliates and metazoan zooplankton, total dissolved P, total inorganic carbon, dissolved organic carbon. There are three sampling and analysis stages:



- 
- a) *Sampling for the assessment of biomass in the pelagic food web*
  - b) *Sampling and measurement of fluxes within the microbial loop*
  - c) *Construction of a microbial "model"*

During 1996 a Microbial workshop was organized 16 - 18 May in C. Budijovice (14 participants from 7 institutions from 6 countries). Training of methods was performed and methods were discussed for the final elaboration of sampling and laboratory protocols. (See Appendix B).

Microbiology 1st level was in 1996 investigated in 12 WP1 lakes. Microbiology 2nd level was measured in Øvre Neådalsvatn, Gossenköllesee and Redo. Measurements of 2nd level microbiology were also performed in September in Tatra Mts, however, they could not be fully realised because of sudden weather change and freezing up of the upper lakes. Measurement was done in Popradské pleso for comparison (this lower lake was accessible).

### **2.1.6 Evaluate applicability of various critical load models to mountain lake ecosystems, and develop a linked chemical-biological model for scenario assessment**

When the results from the sampling and analytical programme described here are gathered, they will allow the models to be fully calibrated, and then used to predict chemical and biological consequences of the implementation of UNECE protocols and EU directives for sulphur and nitrogen emissions in Europe.

The models to be used are: the diatom model (DM) (Battarbee *et al.* 1995), the steady-state water chemistry model (SSWC) (Henriksen *et al.* 1990), the first order mass-balance model (FAB) (Posch *et al.* 1993) and the MAGIC-WAND (Jenkins *et al.* 1995). Handling and gathering of the necessary input information was discussed during the Barcelona Meeting. A document will be put together by UCL describing the models and covering the topic of crucial site information for each of the models. Practicle use of the models will also be discussed at a Workshop in Madrid in October 1997.

## **2.2 MOLAR Work Package 2 (WP2)**

### **MEASURING AND MODELLING MAJOR ELEMENT AND POLLUTANT FLUXES IN MOUNTAIN LAKES AND THEIR IMPACT ON FISH**

*R. Psenner*

#### Tasks

---

- |    |                   |   |
|----|-------------------|---|
| 1. | Peter Appleby     | <sup>210</sup> Pb, <sup>137</sup> Cs analysis and modelling |
| 2. | Stan van den Berg | Metal speciation in the water column                        |
| 3. | Jordi Catalan     | Water column profiling, large sediment traps                |
| 4. | Joan Grimalt      | PCB, PAH (from airborne material to fish)                   |
| 5. | Rosario Mosello   | Deposition chemistry, Analytical Quality Control            |
| 6. | Bente Wathne      | Water chemistry, heavy metals                               |
| 7. | Uli Nickus        | Weather stations, snow sampling,                            |

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8.	Hansjörg Thies	Physico-chemistry and hydrology of GKS
9.	Neil Rose	SCP analysis in snow and sediments
10.	Sigurd Rognerud	Metal analysis in fish
11.	Rudi Hofer Reinhard Lackner	Fish pathology and histochemistry
12.	Roland Psenner	Co-ordination WP2, GKS station

### 2.2.1 Climatology and Deposition

**Ulrike Nickus**

Innsbruck University

#### Weather station

According to the demands for WP3 sites an automatic weather station has been installed close to Gossenköllesee, set up at a platform on top of the roof of the Limnological station.

The weather station (Davies Instruments) is equipped with sensors for temperature, humidity and wind, and a rain gauge.

Meteorological variables measured are:

- air temperature
- relative humidity
- wind speed and direction
- precipitation

A data logger stores the output data. With a sampling interval set to 10 minutes it provides both mean values of temperature, humidity and wind (direction and speed) for the respective intervals and extremes like maximum/minimum temperature and gust. Additional parameters (dew point temperature, wind chill) are automatically calculated for each sampling interval by an integrated software.

Measurements started at the end of September 1996 with some interruptions caused by instrumental problems and disturbance (sabotage?) during the first two months. Since mid November 1996, however, the data set of the above mentioned variables is complete. Data are available as EXCEL tables.

#### Atmospheric deposition

##### *Precipitation*

One main topic of the MOLAR project is to estimate the input of atmospheric trace substances to the catchment areas of selected lakes. Compounds of interest are:

- major ions
- nutrients
- mercury and other heavy metals
- radionuclides
- SCP's and
- organic micropollutants.

Major ions and nutrients are determined in both wet and bulk deposition, all other substances only in bulk deposition.

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Since all material which comes into contact with these compounds need a special pre-treatment in order to insure a correct and properly analysis, several precipitation collectors have to be exposed for the distinct substances: one wet-and-dry-only-sampler (WADOS) and 5 bulk collectors (one for major ions and nutrients, one for heavy metals and radionuclides, one for organic micropollutants and two for mercury). All have been installed at the platform on the roof of the Limnological Station about 8 m aboveground.

The sampling interval is generally one week starting with October 1, 1996 - with the exception of mercury being collected on a monthly basis. Major ions are analysed at the Institute of Meteorology and Geophysics, nutrients at the Institute of Zoology and Limnology (both University of Innsbruck). All other samples are distributed to different labs of participating countries as indicated in the MOLAR Project Manual (September 1996).

First results of concentration and total load of major ions and nutrients are available as EXCEL tables including ion balances and a comparison of measured and calculated conductivity used for quality control. Gaps in the data set may occur for lack of sample amount (no precipitation), however, gaps in October and November 1996 are again due to disturbances of the equipment (sabotage?).

#### *Snow pack*

All substances (except mercury) analysed in precipitation samples will also be investigated in the snow pack of the catchment from a site considered representative of the total catchment area. Sampling frequency at Gossenköllesee, in particular, should be once a month.

Snow sampling started at December 12, 1996, when most parts of the catchment area were covered by at least 50 cm of snow. The samples are taken at intervals of 10 cm along a vertical profile from the top of the snow pack down to the ground. Supplementary to sampling for chemical analysis snow density (water equivalent), temperature and stratigraphy of the respective snow cover are determined in detail.

Chemical analysis of the snow samples is organized similar to that of precipitation samples. The same applies to the results for major ions and nutrients which are collected and available in form of EXCEL tables.

## **2.2.2 Lakewater sampling and analysis**

**Hansjörg Thies**

Innsbruck University

### **Surface Water Sampling**

#### *Lake 11.2 (Gossenköllesee, GKS)*

Sampling of lake water chemistry for GKS started in August 1996 according to the procedures described in the MOLAR project manual (draft September 1996, page 20 ff.). All major ions and nutrients were sampled and analysed according to the sampling protocol of WP1, WP2 & WP3 with the necessary sampling frequency. Heavy metals (Hg, Cd, Pb, Cu, Co and Zn) from lake surface were sampled in October 1996 just before ice-on and in February 1997 under 0.5 m ice and samples were sent to NILU. Surface water sampling for heavy metal speciation and for radionuclides was carried out in October 1996 and March 1997 by Peter Appleby. Organic micropollutants in surface water were sampled at the same dates by Joan Grimalt and his team. On this occasion the heavy metal speciation was done by Stan van den Berg. 20 litres of lake surface water were filtered through GF/C-filters in October 1996 and filters were sent to Neil Rose.

#### *Lake 11.1 (Schwarzsee ob Sölden, SOS)*

SOS was visited once in August 1996 by helicopter by Sabine Sommaruga and Karin A. Koinig and sampled for water chemistry.

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## Water column profiling

### *Lake 11.2 (Gossenköllesee, GKS)*

GKS is visited regularly since October, 1, 1996 for water column profiling for temperature, oxygen, pH, conductivity and chlorophyll according to the procedures described in the MOLAR project manual (draft September 1996, page 46 ff). Secchi depth in the lake was almost to the lake bottom.

### *Lake 11.1 (Schwarzsee ob Sölden, SOS)*

SOS was visited once on August 26, 1996 by helicopter by Sabine Sommaruga and Karin A. Koinig for water column profiling.

## Analytical quality control

Analytical quality control of lake water samples is performed in the laboratory of the Institute of Zoology and Limnology by means of in- and inter-laboratory analytical checks. Ion balances and conductivity tests allow regular inter-laboratory analytical checks on each water sample. In case of doubtful results, analyses were repeated. Most analytical results are within the given ranges of tolerance for both ion balances and conductivity tests (cf. Molar manual). Four samples for inter-laboratory analytical checks have been distributed by the Joint Research Centre in ISPRA (Aquacon-Project) to the laboratory of the Institute of Zoology and Limnology regarding the analyses of the parameters Na, K, Ca, Mg, NH<sub>4</sub>, Cl, NO<sub>3</sub>, SO<sub>4</sub>, pH and alkalinity.

We had large problems with water quality because ground water is pumped into the water distribution system at our location (Technical University) because of big building activities in the area (this does not affect the lab of Uli Nickus which is in another quarter of the city). Since the water quality changes quite rapidly, the ion exchanger in our lab is unable to treat the ground water for longer than a few hours. Therefore we will replace our water purification system in April/May 1997 by adding a reverse osmosis cartridge. The analytical system (DIONEX 100) will be replaced by 2 DIONEX 120 systems in order to run cation and anion analysis concomitantly.

### **2.2.3 Sediment traps, coring**

**Karin Koinig, Roland Schmidt, Christian Kamenik**

Innsbruck University & Academy of Sciences

#### **Sediment cores**

Five cores were taken in July 1996 with a gravity corer from 8 m depth and subsampled immediately for density, dry matter and loss on ignition determination. From 3 cores also CHN was analysed.

#### **Sediment traps**

After ice-break in July three sediment traps (Pb, SCP, Diatoms-chrysophytes) were exposed close to the deepest part. Samples from one trap were collected monthly until November (ice-on) for diatoms and chrysophyceans. The other traps were sampled after the formation of the winter cover in November for Pb and SCP analysis.

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## 2.2.4 Isotopes, metal speciation, and modelling

Peter Appleby, Stan van den Berg

Liverpool University

### Direct Measurements of Fallout $^{210}\text{Pb}$

Methods have been developed for measuring  $^{210}\text{Pb}$  concentrations in rainwater samples, and tested on prepared solutions made from a  $^{210}\text{Pb}$  standard. Final assessment of the procedure is presently in progress. Routine measurements will commence once these have been completed. At present, three batches of samples have been received from two stations, Lochnagar (November 1996) and Gossenköllesee (November 1996 and February 1997). Further samples are expected from O.Neådalsvatn, Jorisee, Starolesnianske and Redo.

#### *Existing Data*

Measurements of the  $^{210}\text{Pb}$  flux in Europe (from both soil cores and direct precipitation) are being compiled from the literature. These show that at a local level there is a strong correlation between fallout and rainfall. The higher fallout levels in Central Europe compared to those in Great Britain reflect the usual west to east increase within continents, presumably due to a build of  $^{222}\text{Rn}$  concentrations in the atmosphere as the prevailing winds transport air masses over the land surface.

Fallout at MOLAR sites in the UK, Maritime Europe, or Central Europe can be estimated either from the regression lines to this data, or from the mean concentrations in rainfall, summarised in the following table in which  $P$  denotes the  $^{210}\text{Pb}$  flux (in  $\text{Bq m}^{-2}$ ) and  $R$  denotes the mean annual rainfall (in m).

	Regression Line	Mean Conc $\text{Bq kl}^{-1}$
UK	$P=30+56R$	$76\pm 13$
Maritime Europe	$P=17+43R$	$68\pm 20$
Central Europe	$P=54+71R$	$129\pm 16$

There appears to be very little data on  $^{210}\text{Pb}$  fluxes in Scandinavia or Eastern Europe. Measurements of  $^{210}\text{Pb}$  concentrations in rainfall in northern Norway (Peirson *et al.* 1966) indicate a flux in the range 45-100  $\text{Bq m}^{-2} \text{y}^{-1}$ . The objective of the measurements being carried within the MOLAR programme is to strengthen the data from Western Europe and to provide some basic information on fallout in Norway, Finland and Eastern Europe. Similar compilations are being made of  $^{137}\text{Cs}$  fallout, from both nuclear weapons tests and the 1986 Chernobyl accident. An extensive study of weapons  $^{137}\text{Cs}$  fallout in the UK (Cawse 1983) has shown that here too there is a strong correlation between fallout and rainfall. We do not know of any similar surveys in other parts of Europe.

#### *Programme*

Wet deposition should be collected at each of the WP2 sites (O.Neådalsvatn, Lochnagar, Redo, Jorisee, Gossenköllesee and Starolesnianske Pleso) following the MOLAR Protocol (p.14) and sent to ULIV for  $^{210}\text{Pb}$  analysis. To date we have received samples from:

Lochnagar (November 1996)  
Gossenköllesee (November 1996 and February 1997).  
Jorisee (February 1997)

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### *Methodology*

Methods have been developed for measuring  $^{210}\text{Pb}$  concentrations in rainwater samples, and tested on prepared solutions made from a  $^{210}\text{Pb}$  standard. Final assessment of the procedure is presently in progress. Routine measurements will commence once these have been comp

### Measurements of Fallout Radionuclides via Soil Samples

Soil samples have been received from one site, Lochnagar (February 1997). Measurements on these samples are routine, and will be carried out during the coming months. Depending on the availability of suitable sites, further cores will be obtained from O.Neådalsvatn, Gossenköllesee, Jorisee, Starolesnianske and Redo during the coming spring and summer.

### *Programme*

Wet deposition should be collected at each of the WP2 sites following the MOLAR Protocol (p.18) and sent to ULIV for  $^{210}\text{Pb}$  analysis. To date we have received samples from just one site, Lochnagar (February 1997). One of the difficulties is identifying suitable coring sites in the lake catchment itself due to poor soil cover and the possible impact of snow melt on the soil record. Low level sites off the catchment are a suitable alternative provided they are from locations where there are adequate rainfall data. Identification of suitable sites and collection of the cores should be a priority for this summer/autumn.

### *Methodology*

Measurements on these samples by gamma spectrometry are routine, and will follow the same procedure as for sediment cores.

### Measurements of $^{210}\text{Pb}$ Partition Coefficients in the Water Column

Measurements were carried out on the water column of Gossenköllesee during October 1996, using an INFILTREX II water sampler fitted with a  $1\ \mu\text{m}$  filter and radionuclide Type 1 exchange column. Initial analysis of the filter paper and resin has just been completed. The results indicate that the  $^{210}\text{Pb}$  concentration in the water column was about  $6.5\ \text{Bq m}^{-3}$ , of which 70% was on the particulates and 30% in the filtrate. The  $^{137}\text{Cs}$  concentration was about  $2.8\ \text{Bq m}^{-3}$ , of which 28% was on the particulates and 72% in the filtrate. The suspended sediment concentration was  $0.54\ \text{mg L}^{-1}$ . The  $^{210}\text{Pb}$  and  $^{137}\text{Cs}$  concentrations on the suspended sediments were  $8412\ \text{Bq kg}^{-1}$  and  $1429\ \text{Bq kg}^{-1}$  respectively. Reliable values of these parameters are crucial to modelling transport processes in the water column.

A second set of measurements at Gossenköllesee was performed in March 1997. It is hoped that it will also be possible to carry out measurements at O.Neådalsvatn and Redo.

### *Existing Data*

Measurements of the  $^{210}\text{Pb}$  and  $^{137}\text{Cs}$  (particulate and dissolved) in lake waters are being compiled from the literature. Data on  $^{210}\text{Pb}$  in particular, some of which are given in the following table, are very limited.

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Concentrations of $^{210}\text{Pb}$ in lake water	Particulate $\text{Bq kL}^{-1}$	Dissolved $\text{Bq kL}^{-1}$	Reference
Crystal Lake (Wisc)	1.3	0.6	Talbot & Andren (1984)
Bickford Pond (Mass)	2.1	1.8	Benoit & Hemond (1987 & 1990)
Perch Lake (Ont)	15.0	1.9	Wang & Cornett (1993)
Maskinonge Lake (Ont)	3.2	1.1	Wang & Cornett (1993)

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Values are typically an order of magnitude lower than in rainfall.

The  $^{210}\text{Pb}$  partition coefficient ( $K_D$ ) determined from a number of studies of lake and fluvial waters shows a strong dependence on the suspended sediment concentration  $s$ . A best fit to the data gives the relation

$$K_D = 17.4 s^{-0.48} \times 10^5 \text{ L kg}^{-1},$$

where  $s$  is measured in  $\text{mg L}^{-1}$ . These values suggest that  $^{210}\text{Pb}$  is mainly associated with the particulate fraction. The mean  $^{210}\text{Pb}$  partition fraction ( $f_D$ ), defined as the fraction of the total concentration on particulates, is calculated to be 0.75.

Since there has been no significant deposition of  $^{137}\text{Cs}$  for at least 10 years, any current activity in the water column presumably reflects either transport from the catchment or remobilisation from the bottom sediments.

Data on  $^{137}\text{Cs}$  partition coefficients in lake water suggest that it is significantly more soluble than  $^{210}\text{Pb}$ , but that there is a similarly dependence on the suspended sediment concentration. Reconstructions of weapons  $^{137}\text{Cs}$   $K_D$  value for Cumbrian lakes from sediment records (Appleby, in press) give the relation

$$K_D = 1.4 s^{-0.50} \times 10^5 \text{ L kg}^{-1}.$$

Partition fractions were estimated to be in the range 0.05-0.22. These results are comparable with directly measured  $K_D$  values for Chernobyl  $^{137}\text{Cs}$  in a number of the same lakes (Smith 1994; Smith *et al.*, in press). For particle concentrations in the range  $0.5\text{-}2.2 \text{ mg L}^{-1}$ , the direct measurements gave  $K_D$  values in the range  $0.3\text{-}12 \times 10^5 \text{ L kg}^{-1}$ , with an average value of  $2.7 \times 10^5 \text{ L kg}^{-1}$ .

#### *Programme*

In collaboration with our partners at CSIC Barcelona, measurements of  $^{210}\text{Pb}$  and  $^{137}\text{Cs}$  concentrations in the water column, including the dissolved and particulate fractions, should be measured at the fully equipped WP2 sites (O.Neådalsvatn, Redo and Gossenköllesee) following the MOLAR Protocol (p.22). To date we have carried out measurements on samples from Gossenköllesee in October 1996 and March 1997.

#### *Methodology*

Measurements are carried out using the CSIC INFILTREX II water sampler fitted with a  $1 \mu\text{m}$  filter and radionuclide Type 1 exchange column.

#### *Results*

Results of the measurements at Gossenköllesee are summarised in the following tables.

	Oct. 1996	Mar 1997
Volume sampled (L)	89	177
Wt of particles (mg)	53.59	83.19
Particle conc. ( $\text{mg L}^{-1}$ )	0.60	0.47

Since a  $1 \mu\text{m}$  filter was used, compared to the normal  $0.45 \mu\text{m}$ , these results will underestimate the particulate  $^{210}\text{Pb}$ . Also, since the resin, designed for  $^{210}\text{Pb}$ , clearly did not retain all the  $^{137}\text{Cs}$ , they are likely to underestimate the soluble fraction. Ideally, further measurements should be carried out using a  $0.45 \mu\text{m}$  filter and a cartridge filled with Radionuclide Type II resin.

	<sup>210</sup> Pb		<sup>137</sup> Cs	
	Oct. 1996	Mar 1997	Oct. 1996	Mar 1997
Particulate (Bq kg <sup>-1</sup> )	8412	4161	1429	638
Dissolved (Bq kL <sup>-1</sup> )	2.14	3.02	2.23	1.93
Total (Bq kL <sup>-1</sup> )	7.2	4.98	3.09	2.23
Partition fraction $f_D$	0.70	0.39	0.28	0.13
Partition coefficient $K_D$	$3.93 \cdot 10^6$	$1.38 \cdot 10^5$	$6.40 \cdot 10^5$	$3.31 \cdot 10^5$

## Dating Lake Sediment Cores

Sediment cores have been received from Saanajärvi (October 1996), Lochnagar (February 1997) and Rédo (February 1997). The initial batch of samples from Saanajärvi is presently being counted. Those from Lochnagar will be ready to count at the end of March. The first results from Redo will be available at the end of April. Further cores are expected during the coming months from O.Neådalsvatn, Jorisee, Ledvica, Hagelsee, Gossenköllesee, Starolesnianske, Terianske Pleso and Cimera.

### Programme

Sediment cores collected from the following sites will be dated by <sup>210</sup>Pb and <sup>137</sup>Cs at ULIV. The table indicates the present status of each core.

	Received	Progress
Saanajärvi	17 Jan 1997	50%, good record
Neådalsvatn	16 April 1997	None
Lochnagar	27 Feb. 1997	50 %, good record
Gossenköllesee	No	
Jorisee	No	
Hagelsee‡	No	
Nizne Terianske	17 Mar 1997	None
Starolesnianske Pleso	No	
Ledvica	17 Mar 1997	None
Redo	25 Feb. 1997	None
Cimera	No	

‡ The Hagelsee core is being dated by Mike Sturm (EAWAG), and may also be dated at ULIV as an inter-comparison exercise.

### Results

Initial results from Saanajärvi and Lochnagar indicate that both cores contain relatively good sediment records. The small sample sizes have not so far presented any major difficulties. The radionuclide profiles from Lochnagar are comparable to those from two earlier cores from this lake.



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## Magnetics and Trace Metals on Lake Sediment Cores

This work will be commenced once further progress has been made with the dating program.

### Trace metal speciation in the water column (C.M.G. van den Berg)

Preliminary work was carried out to make our instrumentation suitable for field use by running it on batteries. A peristaltic pump was put together using a 12 V, Watson Marlow pump, and a single channel pump head. Batteries have been ordered for the voltammetric system. This system can be run on batteries for determination of labile (reactive) metal concentrations. Mains power is still required if total metal determinations are carried out which require in-line UV-digestion by a 100 W high pressure mercury vapour lamp. We intend to take this instrumentation for *in-situ* analyses of lead and other metals in lake waters this spring.

An improved method for determination of lead analysis using CSV rather than ASV (i.e. using ligand competition), specifically for freshwater, is in progress. Tests had to be carried out using several ligands with some success with one ligand. It is hoped that this method will be ready for use this spring.

Heavy metal concentrations (Pb, Cd, Cu, Co, Zn, Hg) are being measured in each of the fish containing WP2 lakes (Øvre Neådalsvatn, Redo, Gossenköllesee, Jörisee) by NILU. The results, when available, will be normalised against  $^{210}\text{Pb}$ .

## Modelling

The WP2 programme indicates that we should develop models for the transport of trace metals, organics, SCPs and radionuclides in mountain lake-catchment systems, including

- ⇒ uptake within the biota
- ⇒ incorporation within the sediment record.

Although these two strands will in many respects be relatively independent they do have many things in common, including:

- ◇ modelling lake water concentrations, taking into account direct atmospheric deposition, catchment/lake transport, remobilisation from the sediment record;
- ◇ speciation within lake waters
- ◇ reconstruction of the impact of historical events from the sediment record.

### *Physiographic Parameters*

There are a number of essential physiographic parameters that must be determined as well as possible. These include:

- catchment area;
- lake area, volume, depth (max & mean), bathymetry;
- rainfall, runoff, water residence time.

### *Catchment/Lake Transport*

Although catchment/lake transport rates for atmospherically deposited pollutants are normally assumed to be low there are situations, particularly in steep catchments with deep snow cover and thin soils, where much higher transport rates are possible. Since systematic variations in conditions leading to high catchment/lake transport rates could be a dominating factor controlling variations in the lake record there does need to be an objective assessment of this possibility. Detailed monitoring is not feasible.  $^{210}\text{Pb}$  budgets may give some indication.

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### ***Water Column Processes***

Factors essential to models of water column processes include:

Chemical speciation, (operational) partition coefficients, suspended sediment concentrations and size distribution, particle fluxes, outflow losses.

Again, detailed measurements are not possible, and we must make use of existing data from the literature or previous studies, supported by additional measurements where there are seen to be crucial gaps.

### ***Sediment Records***

Topics that need addressing include:

Sediment focusing, sediment mixing, pore-water transport, physical and chemical remobilisation.

### ***Systems and Budgets***

Models should relate to well defined systems. A first order priority for any system is establishment of a conceptual framework that includes pollutant budgets.

### ***Implementation***

Mr Alexei Koulikov, an experienced radioecologist from the A.N.Severtzov Institute, Moscow, has been appointed to carry out this work. He has taken up the post from 1 February 1997. Alexei has had considerable experience in modelling pollutants in freshwater systems, and in particular the radiocaesium contamination of fish.

## **2.2.5 PCB and PAH**

### **Joan Grimalt**

CSIC, Barcelona

Samples of airborne PCBs and PAHs have been collected at REDO in July 1996 and at GKS during two occasions, in October 1996 and in March 1997 by means of a large volume collector for air. At the same time, an automatic large volume pump has been used (cf. chapter 4) for collecting dissolved and particulate PCBs and PAHs in the water column. The distribution and concentration of gaseous and particulate substances in air and lake water differs considerably between sites (data available in diskette).

## **2.2.6 SCP**

### **Neil Rose & Ewan Shilland**

#### **Samples and analytical progress**

Below is a summary of the samples so far received from Local Site Operators and the analyses performed to date.

#### **1.1 ØVRE NEÅDALSVATN**

<b>Samples Received</b>	<b>Analysis</b>
Sediment core - OVNE4	×
Sediment Trap (18/7/96 - 8/9/96)	×
Lake water filters - 20 litres - (July, August & September 1996)	✓
Snow profile 13/2/97 (150cm in 10cm slices)	×
Bulk Deposition Samples (1/10/96 - 31/1/97) *	×

\* Very low sample volumes (c. 70ml out of a total of 3 - 5000 ml) - unlikely to find any SCP - see Gossenköllesee below. It is essential to filter as much sample as possible - especially at these cleaner sites.

### 1.2. REDO

Samples Received	Analysis
Sediment core - RCM2	×
Sediment Trap (8/9/96 - 9/10/96)	×

Very few samples from this primary MOLAR site. No deposition, snow or lake water samples!

### 1.3. GOSENKÖLLESEE

Samples Received	Analysis
Sediment core - GSK II	✓ (½ !)
Sediment Traps (NO & NW) - 19/11/96 *	×
Lake water filter - 20 litres - 5/11/96	✓
Bulk deposition - 1/10/96 - 26/11/96 **	✓

\* No more data - other date needed: 2 traps - a shallow and a dep one - are installed now!

\*\* More volume needed if possible at these clean sites: volume will be pooled (2 litres)!

### 1.4. JÔRISEE

Samples Received	Analysis
Lake water filters - August & December 1996	×
Bulk deposition filter (12/7/96 - 15/8/96)	×
Snow profile (97.5 cm in 7.5 cm slices)	×

No sediment core received yet.

### 1.5. STAROLESNIANSKE

Samples Received	Analysis
Bulk Deposition - 18/10/96 - 6/11/96 & 3/1/97 - 22/1/97	✓
Snow cores - 30/1/97 - A (60cm) & B (90cm) in 10 cm slices	✓

### 1.6. LOCHNAGAR

Samples Received	Analysis
Sediment Core - NAG8	✓
Soil core - 40cm	×
Sediment Trap (Annual for 1991 - 1996)	✓
Bulk Deposition filters (29/8/96 - 5/2/97)	✓ (most)
Rime sample - 28/12/96	✓
Lake ice core - 23/2/97 & 9/3/97	×

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## Missing samples

The following samples have therefore not been received.

	Sed Core	Sed Trap	Snow	Deposition	Water	Soil *
Øvre Neådalsvatn		> 8/9/96		>31/1/97		X
Redo		> 9/10/96	X	NONE	NONE	X
GOS		> 19/11/96	X	> 26/11/96	NONE	X
Jorisee	X	NONE		> 15/8/96		X
Star		NONE		> 22/1/97	NONE	X
Lochnagar		> 30/8/96	<20cm snow!	> 5/2/97	NONE	

\* Not in original protocol - see below.

LSO's - Please send ALL missing samples as soon as possible.

## Analytical problems

### INSUFFICIENT SAMPLE

In some instances, insufficient sample has been filtered. This is a particular problem at the cleaner sites (Øvre Neådalsvatn, Gossenköllesee). Please filter as much lake water or deposition sample as possible. With deposition this can be a problem as there may be insufficient sample collected.

If necessary, and again if possible, it would be better to leave the collector longer (monthly) in order that there is enough sample to filter. Filtering a very small sample (< 500ml of deposition) has little worth. This is something we did not know at the beginning of MOLAR! THIS IS ESPECIALLY IMPORTANT AT CLEANER SITES.

Similarly, please filter as much lake water as possible. 20 litres should be seen as a minimum.

### FILTERS

Please use only glass fibre filters (Whatman GF/C). These dissolve in hydrofluoric acid. However, they do leave a precipitate which can be removed by hydrochloric acid. With large filters, there is a lot of this precipitate and it can be difficult to dissolve. Please try and use the smallest filters that you can. In addition please try and use as few filters per sample as possible.

### SNOW

Apart from the lack of snow at Lochnagar this year, snow profiles appear to be of limited value for SCP work. This is again a discovery from MOLAR! This is because snow is only a temporary storage place for SCP and eventually all will be released to the catchment beneath. It appears that SCP move downwards through the snow column (see Results below) and therefore little information is gained from snow profiles.

## RESULTS

### SEDIMENT CORES

WP3 - Saanajarvi & Hagelsee

WP2 - Lochnagar

The Lochnagar SCP profile compares well with the AL:PE 1 core. The peak occurs approximately 0.5 cm below the older core suggesting a sediment accumulation rate of about 1mm a year.

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Gossenköllesee has been prepared and is half counted.

### SEDIMENT TRAPS

Little sediment trap data so far for MOLAR. However, as an example, annual trap data for Lochnagar exist for 1990/91 - 1995/96. These have been calculated in terms of 'number of particles per day' for the sampling period and show remarkably consistent data.

Year	1990/1	1991/2	1992/3	1993/4	1994/5	1995/6
Lochnagar	10.6	*	12.5	11.1	14.0	**

\* - no data

\*\* - yet to be analysed

It may be advantageous in MOLAR to change the SCP protocol for sediment traps. This would mean that traps could be emptied on an annual basis - but that a second trap at a 'near surface' depth (c. 2m) should also be deployed. This is outlined further in the draft SCP model (see below).

### BULK DEPOSITION

Recently received samples have yet to be analysed. Samples for Gossenköllesee, Starolesnianske and Lochnagar have so far been analysed.

Gossenköllesee yielded little information despite some significant sample volumes filtered where available. Only one sample (5/11/96 - 12/11/96) yielded SCP. This may be a problem at these cleaner sites and it is worth stressing again that it would be better to make the sampling interval longer, possibly monthly, in order that there is sufficient sample. This should be left to the discretion of the LSO, but if there is likely to be less than 1 litre available for SCP analysis then the sample could be left longer, if possible.

Also, it is important to remember that SCP settle out relatively quickly, so if samples are left standing for any length of time before sub-sampling and filtering then there will be no SCP in the sub-sample anyway. PLEASE REMEMBER TO HOMOGENISE THE SAMPLE BEFORE FILTERING!!

This information is important for two reasons. First, in order that we get an idea of episodicity, but second and most importantly the input of atmospheric deposition is the most important parameter in the SCP model. Without it we cannot do anything!. For this it is essential that we get an idea of total deposition per unit area at the site. The input to the model would be on an annual basis and so could be gained by adding together the individual sample inputs. BUT not if these are just a string of zeroes!

Fine interval samples are only of use where the data is reliable. If this is not the case then extend the sampling interval. The episodicity is secondary to the need for SCP input data.

At sites with higher deposition, the finer sampling may not be a problem. Of the 9 samples for Lochnagar (28/8/96 - 30/11/96) only one failed to have any SCP in it, despite samples of only 1-200 ml on occasion. The results suggest that SCP deposition could be episodic as there are one or two samples with considerably higher deposition than the others. However, as there is only one SCP absence in the samples this may suggest a continuous input with episodes superimposed on the top. A longer dataset is needed to confirm this.

Once there is more data we will look to see whether periods of high or low deposition are associated with any other data e.g. rainfall, wind direction etc.

None of the samples analysed from Starolesnianske showed any SCP.

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## SNOW PROFILES

At present only the snow profile from Starolesnianske has been analysed for SCP. Profiles have been received from Øvre Neådalsvatn and Jorisee. A maximum of 21cm depth of lying snow was recorded in December. It was considered that this was insufficient for a profile!

The Starolesnianske results are of interest in that they show a trend in increasing SCP concentration towards the bottom of the profile. It is suggested that this profile is due to the ablation of SCP through the column. This raises the question of whether the particles continue to ablate through and therefore end up out of the profile and on the rock/soil/vegetation beneath. It would seem likely that this is the case - and so snow profiles therefore are of limited value in SCP studies unless snow is permanent and accumulating. Snow and ice at these sites should therefore be considered 'temporary storage' locations and it maybe that there is little reason to further sample snow profiles for SCP.

Instead it is more important to determine a total deposition of SCP per unit area. Snow will be one contributor to this, but the measurement of SCP in profiles is not necessary to do it.

It remains to be seen whether these patterns are repeated at other sites, or indeed at the same site through time. If the ablation hypothesis is correct, the profiles will change over the course of the winter.

## LAKE WATER

Few water samples have so far been analysed. Results are so far inconclusive.

## SCP MODEL

One of the aims of MOLAR WP2 is to develop a model to try and better understand the relationship between SCP stored in the lake sediment and that which is deposited from the atmosphere. In order to start doing this a preliminary attempt at an SCP model has been attempted. The details of this can be circulated if necessary, but briefly, the model aims to assess direct and indirect inputs via the lake and catchment as well as SCP sinks such as sediments in littoral and deep water (coring) areas, soil, and those leaving the system via the outflow.

There are a large number of assumptions made in the model and discussion is needed with experienced modellers in order to take this further. A number of essential measurements are needed for the model and these are listed below. Many are included as part of the MOLAR sampling protocol, but there are also changes that need to be made. A list of all measurements (physical, SCP and others) are listed below. The SCP measurements will be made by analysis of the samples - others will need to be sent by LSO although these are mostly areas and volumes etc..

It has been assumed that some SCP could enter the lake by erosion of catchment soils. This requires a great deal of information not readily available within MOLAR and at this early stage of the model it may be best not to worry about this too much. Such an input is likely to be small compared with other processes. In addition this component of the model is at best guesswork. Information from experienced soil workers is needed to decide how to take this on.

The main changes to the (SCP) sampling protocol are as follows. All need to be considered with the specific site in mind:

- The deployment of a shallow sediment trap as well as a deep one. Both to be emptied annually (more frequently if LSO can)
- Less stress on high frequency deposition samples - more stress on accurate larger long term samples.
- A littoral sediment core?

- 
- A soil core
  - Information on inflow and outflow volumes and SCP concentration in streams by filtering waters.
  - Detailed catchment and lake information.

## NEW REQUIREMENTS AND PROTOCOL CHANGES

Although these changes are quite late - there is still more than one year of sampling left in MOLAR. The full wish list of information and samples is given below. We know that some of these are impractical or very difficult to obtain but many of the samples are already being collected.

### LIST OF PHYSICAL PARAMETERS

- Lake area
- Area of lake surface overlying deep water accumulating sediments
- Area of littoral (the rest!)
- Fraction of littoral containing sediment material
- Lake volume
- Water residence time
- Catchment area
- % of catchment covered by bare rock
- Fraction of bare rock that runs off directly into lake only over rock i.e. no soil or vegetation between deposition point and lake edge
- % of catchment covered by soil and vegetation
- Radius of sediment traps

### MEASUREMENTS

- Accumulation rate of soil in catchment ?
- Rate of soil erosion ?
- Length of eroding shoreline ?
- Estimate of annual volume of water input by discrete streams
- Estimate of annual volume of outflow
- Length of deployment of deep water sediment trap (approx. annual)
- Total dry mass of sediment collected by deep water sediment trap
- Length of deployment of surface water sediment trap (approx. annual)
- Total dry mass of sediment collected by surface water sediment trap
- Sediment accumulation rate (from  $^{210}\text{Pb}$  dating of sediment core)
- Accumulation rate of littoral sediments ?
- Mass of suspended solids per unit volume of lake water (filter known amounts - dry mass before and after)

### SCP MEASUREMENTS

- Bulk deposition
  - annual total per unit area (single measurement or multiple added together)
  - multiple collectors in catchment to determine variability ??
  - continue regular bulk deposition (weekly, fortnightly) to get indication of deposition episodicity.
- Soil core profile - (sub-samples from Peter Appleby?)
- Littoral sediment core (or surface sediments?)
- Deep water sediment core
- Filtered known volume of discrete inflow streams (as often as possible)

- 
- Filtered known volume of outflow stream (as often as possible)
  - Surface sediment trap (annual)
  - Deep water sediment trap (annual)
  - Filtered known volume of lake surface water (as often as possible)

### **2.2.7 Øvre Neådalsvatn**

**Bente Wathne, Leif Lien**

Niva, Oslo

Bulk deposition is sampled weekly since 1978 for major ions and heavy metals, and for Hg since 1996, all by NILU. Snow pack sampling is planned for April 1997, also for soil cores. Surface water sampling is done since 1993 every 2-3 weeks, heavy metals in July and September 1996 and February 1997. The sediment core for organics, SCP and <sup>210</sup>Pb and other constituents was done in September 1996. Sampling dates for SCP in precipitation, snow and lake water was done in September 1996 and February and is planned for April 1997.

## **2.3 MOLAR Work Package 3 (WP3)**

### **CLIMATE VARIABILITY AND ECOSYSTEM DYNAMICS AT REMOTE ALPINE AND ARCTIC LAKES**

*R.W. Battarbee and N.G. Cameron*

Work Package 3 of the MOLAR project is concerned with the study of climate variability and ecosystem dynamics at remote lakes. Progress within Work Package 3 was reported during workshops at the MOLAR Barcelona meeting and short, written reports based on these data are presented in the following pages. Necessarily there is overlap with tasks which are also the concern of Work Packages 1 and 2.

Routine on-site sampling for Work Package 3, as set out in the MOLAR project manual, has been carried out by site operators. Where necessary the material collected or data have been transferred to the relevant analysts. In some cases, for example for the intensive sampling of biota or for sediment coring, one-off visits to MOLAR lakes, which will not be repeated during the project, were made during 1996 by the specialists involved. Other sub-projects, which do not involve field work, have collated and made preliminary analyses of off-site data. Progress during the first year is therefore reported both by site operators and those responsible for the specialist analyses. A brief summary of the progress made within Work Package 3 sub-projects is given below and the interim reports of specialist analysts and site operators follow.

#### **2.3.1 Weather records over the last 200 years and correlations of records of weather patterns between lowland meteorological stations and montane sites**

Roy Thompson and Anna Agustí-Panareda have begun to assemble long records of temperature, pressure and precipitation from sites across Europe. They have examined how representative the records at particular sites are of regional temperatures. Preliminary temperature reconstructions have been made using a Scandinavian series and warming trends plotted. The likely errors associated with the techniques used are considered and a number of tasks for the second year of the project set out. Related to this work, David Livingstone is examining the relationship between lowland meteorological records and conditions at montane sites. The results and practical aspects of deploying automatic weather stations in remote mountain areas are evaluated for each of the MOLAR sites, including the Work Package 3 sites.



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### **2.3.2 Seasonal variability of physical, chemical and biological characteristics of lakes**

Seasonal variability of physical (excluding the continuous recording of meteorological variables), chemical and biological characteristics of sites have been monitored during the ice-free season and at a reduced frequency during the winter period. In most cases it has been possible to collect data as timetabled in the work plan. There has been minimal loss of data as a result of site inaccessibility or equipment failure. For this sub-project in particular reporting intersects with that both for Work Packages 1 and 2. However, progress with sampling is presented for: Øvre Neådalsvatn (Leif Lien), Hagelsee (Andre Lotter), Saanajärvi (Atte Korhola and Sanna Sorvari), Redo (Jordi Catalan and Sergi Pla), Nizne Terianske (Ferdinand Sporcka and Elena Stefkova), Gossenköllesee (Roland Schmidt, Karin Koinig and Christian Kamenik).

### **2.3.3 Harmonise taxonomy of key indicator taxa and model their distribution in relation to environmental variables**

The sub-project to harmonise the taxonomy of key indicator taxa and model their distribution in relation to environmental variables is central to maintaining analytical quality control and producing training sets that are applicable between MOLAR sites and to new sites in the future. To this end harmonisation of diatom (reported by Nigel Cameron), chironomid (reported by Gunnar Raddum) cladoceran (reported by Jan Fott) and chrysophyte taxonomy (reported by Christian Kamenik) is being carried out in advance of assembling new training sets or adding to existing training sets. The progress resulting from a number of workshops (see Appendix B), slide exchanges and a planned iconograph is reported.

### **2.3.4 Long-term variability in ecosystem dynamics from recent palaeolimnological records**

The sub-project to establish long-term variability in ecosystem dynamics from recent palaeolimnological records is reported by each of the laboratories responsible. The lakes (and people responsible) are Øvre Neådalsvatn (Nigel Cameron), Hagelsee (Andy Lotter), Saanajärvi (Atte Korhola and Sanna Sorvari), Lake Redo (Jordi Catalan and Sergi Pla), Nizne Terianske (Ferdinand Sporcka and Elena Stefkova), Gossenköllesee (Roland Schmidt, Karin Koinig and Christian Kamenik). Sediment coring was carried out at all sites during 1996 and material has been distributed to the laboratories responsible for specialist analyses. Preliminary data from some sites were presented at the Barcelona meeting.

### **2.3.5 Model the relationship between weather patterns and lake dynamics, validate the model against the sediment record, and forecast lake response to alternative climate scenarios**

The sub-project to model the relationship between weather patterns and lake dynamics, validate the model against the sediment record, and forecast lake response to alternative climate scenarios awaits the input of data from all three Work Packages and their various sub-projects. Protocols for data transfer and the form of the MOLAR database have been produced by Einar Heegaard and John Birks. A MOLAR modelling meeting is planned in the near future to discuss in detail the construction of the model from contemporary data collected in MOLAR and application of the model to sediment records during the instrumental period.

The goals of the MOLAR programme have been fulfilled for the first year in all Work Package 3 sub-projects. Sampling and data analyses are largely on schedule. The challenge during the second year of the project will be to maintain the intensity of sampling programmes and operation of equipment at the same time as analysing data, maintaining quality control and transferring the results to the MOLAR database. Most importantly, the integration of data from Work Package 3 with that from Work Packages 1 and 2 will begin through Work Package 4. This is concerned with integrating data, constructing a dynamic model of mountain lake ecosystems and its validation against palaeolimnological records during the period of instrumental records.

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## 2.4 MOLAR Work Package 4 (WP 4)

### INTEGRATING ACTIVITIES

*S. Patrick, , E. Heegaard, H.J.B. Birks and B.M. Wathne*

The three field-based work packages are linked and given coherence by a programme of integrated activities. The integrating activities are designed to ensure the standardisation and harmonisation of field and laboratory methods, the reporting of data, centralised storage, retrieval and analysis of data, and the presentation and dissemination of results. Under this part of MOLAR also the annual meetings are organised.

#### 2.4.1 Meetings and Workshops

The project was launched at the first MOLAR Meeting March 12. - 16. 1996 in Prague. Here many details were planned for the first working year of the project, and the development of a protocol for sampling and analysis started. In Appendix A the agenda for the Prague Meeting is given. During summer 1996 the first version of the MOLAR Manual was produced and printed. In December 1996 it was incorporated in at the MOLAR home page at Internet:

<http://prfdec.natur.cuni.cz/hydrobiology/molar/welcome.html>.

A group of Workshops to address the different topics within MOLAR were also planned in Prague. Minutes or short reports for these Workshops are given in Appendix B.

At the second MOLAR meeting, in Barcelona during 21 - 25 April 1997, the current status for all the four Work Pages were discussed. The agenda for the Barcelona Meeting is given in Appendix C.

The original reports from each of the contracting institutions in MOLAR are presented in Appendix D.

#### 2.4.2 Data transfer

The first year of the MOLAR project has been used to establish how and where to transfer the data. Due to the danger of losing data this has been a priority for the first part of the development of the data-base. All results should, in the first instance, be sent to the responsible scientists, who will save a copy of all the results (data) that he/she receives. The results, after being checked for errors, will be sent to Bergen (UIB-BI) and there incorporated into the MOLAR data-base/archive. First all files that are sent to Bergen will be stored in a general archive, which will include all the results from the MOLAR project. This archive will be the basis for the data-base programming. All data transfer will be by e-mail, and the format will be ASCII or XL-spreadsheets, the latter is preferred. The scientific content of these files is to be decided by the scientists responsible for the data. However, a series of codes should also be included. These codes will be unique for each sample and will consist of several singular codes. These have or will be discussed with the Bergen group.

Although some decisions are still outstanding most of the protocols for data-transfer and coding of data are complete and in operation.

#### 2.4.3 Data-base development and statistical analysis

The data-base as such will consist of series of smaller data-bases, one for each scientific field, which will be linked together through the coding. This will be developed towards the end of the MOLAR-project. Together with the major data-base planned in Bergen, there are data-bases at NIVA in Oslo that

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includes water-chemistry and fish data. There is a data-base in London (UCL) for diatom data. However, at the end all the data concerning the MOLAR project will be deposited in the Bergen data-base.

There have been some general questions received concerning how to analyse the data obtained. All such questions have been answered by UIB-BI (Einar Heegaard or John Birks).

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### 3. REFERENCES

Wathne, B.M. Patrick, S.T., Monteith, D., and Barth, H. (Eds.): AL:PE PROJECT PART 1: AL:PE - Acidification of Mountain Lakes: Palaeolimnology and Ecology. AL:PE 1 Report for the periode April 1991 - April 1993. Ecosystems Research Report Vol. 9. European Commission Brussels. 1995

Wathne, B.M. (Ed.) MOLAR Project Manual 1st Draft. May 1996.

Wathne, B.M. (Ed.) MOLAR Project Manual 2nd Draft. September 1996.

MOLAR Home page on Internet (<http://prfdec.natur.cuni.cz/hydrobiology/molar/welcome.html>).

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**Appendix A. Agenda for the Prague Meeting  
March 1996.**

# First MOLAR meeting Prague: March 12 - 16 1996: Provisional Agenda

## Tuesday 12th

20.00 Steering Group meeting

## Wednesday 13th

9.00-9.30 Registration

9.30-13.00

Chair: S. Patrick

Welcome & practical arrangements J. Fott  
 Molar: the view from Brussels H. Barth / INCO  
 Molar: administrative overview S. Patrick  
 Molar: science overview & timetable S. Patrick  
 Work Package 1: overview B. Wathne  
 Work Package 2: overview R. Psenner  
 Work Package 3: overview R. Battarbee  
 Sampling & analytical methodologies for Molar  
 Meteorology D. Livingstone  
 Deposition R. Mosello  
 Major water chemistry B. Wathne  
 Snow R. Psenner  
 Chemical AQC R. Mosello

14.00-19.00

Chair: M. Johannessen

Methodologies continued  
 Water column profiling J. Catalan  
 Organic micropollutants J. Grimalt  
 Metals B. Wathne  
 Microbiology V. Straskabova  
 Invertebrates/Chironomids G. Raddum  
 Zooplankton J. Fott  
 Diatoms N. Cameron  
 Chrysophytes R. Schmidt  
 Cladocera J. Fott  
 Biological transects R. Battarbee  
 Sediment coring & sub-sampling N. Rose  
 Sediment traps R. Psenner  
 Soil cores P. Appleby  
 Fish sampling & analyses B-O Rosseland  
 Climate data collation & harmonisation R. Thompson  
 Data transfer UiB(BI)

## Thursday 14th

9.00-13.00 Work Package 1 workshop

14.00-18.00 Work Package 2 workshop

18.00-19.00

Chair: R. Psenner

New sites: slide presentation  
 Jezero Ledvich A. Brancelj  
 Limgambergtj B. Wathne  
 Saanajavi A. Korhola  
 Hagelsee A. Lotter  
 Jorisee K. Hanselmann  
 The AASER Project J. Brittain

## Friday 15th

9.00-13.00 Work Package 3 workshop

14.00-16.30

Chair: R. Battarbee

Report of workshop convenors  
 WP1 B. Wathne  
 WP2 R. Psenner  
 WP3 R. Battarbee

16.30-18.30

Chair: B. Wathne

MOLAR financial management D. Abbey  
 AL:PE2 report status B. Wathne  
 AL:PE/MOLAR publication strategy R. Battarbee, R. Psenner  
 Invitation to next meeting J. Catalan??

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## **Appendix B. Minutes from Workshops 1996**

- **MOLAR Workshop Microbiology, C. Budejovice 16. - 18. May 1996**
- **MOLAR Biology Workshop, London 13.- 14. June 1996.**
  - Diatom group**
  - Chironomid group**
  - Cladocera group**
- **MOLAR Workshop on Sampling, Chemical Analysis and Quality Assurance of Atmospheric Deposition and Lake Water, Pallanza 5. - 7. June 1996.**
- **MOLAR Fish Workshop,**
- **MOLAR Diatom Taxonomic Workshop, Helsinki 18. - 19. October 1996.**

MOLAR Workshop Microbiology, C. Budejovice May 1996

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WORKSHOP May 16 - 19

Program:

May 16 evening - GET-TOGETHER PARTY at the institute  
7 p.m. - ? with some food and drinks

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May 17, 9 - 12 a.m. DISCUSSION + PRESENTATION OF RESULTS  
1 - 3 p.m. \* sampling protocole - any questions,  
comments, changes etc. appr. 20 min.  
Vera Straskrabova \* microbiology 1st level 1 - 2 h  
Karel Simek, Mirek - comments etc. to the laborat. protocole  
Macek, Jarda Vrba - results on microbial numbers and  
and others biomasses from mountain lakes:  
Marisol Felipe Redo, Tatra lakes, Sumava  
lakes, La Cladera, anybody else?  
- uncertainties, wishes for some methodical  
demonstration, etc.  
\* microbiology 2nd level  
Jirka Nedoma - primary production - comparison of the  
Lluis Camarero two proposed methods (our protocole and  
Lluis), technical problems, interpretation,  
extracellular production, *results from  
mountain or other acid or oligotrophic  
lakes*, any wishes for demonstration or  
further discussion (for the next day)  
Karel Simek - elimination of FLB, protozoan grazing -  
two methods - interpretation, technical  
problems, *results from mountain or acid lakes*  
3 - 6 p.m. DEMONSTRATION  
Karel Simek \* elimination of FLB, preparation of FLB  
6 p.m. - ? we will go to eat and drink to a pub (will be  
specified later)

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May 18, 9 - 10 a.m. DISCUSSION+PRESENTATION OF RESULTS  
Jirka Nedoma \* 2nd level microbiology  
- bacterial production - thymidin+leucin,  
Marisol Felipe two methods for thym. measurement,  
interpretation..., *results from mountain or  
acid lakes*  
10 - 12 a.m. DEMONSTRATION  
Jirka Nedoma bacterial production, primary production  
Mirek Macek preparation of FLB, elimination of FLB  
Ciliates etc  
12 a.m. LUNCH somewhere in the surroundings  
1 - ? p.m. DEMONSTRATIONS, DISCUSSIONS etc  
6 - ? p.m. CLOSING SESSION WITH DINNER

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May 19 ----- departure  
LOCKING FORWARD TO SEE YOU HERE!  
VERASTR



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BEFORE THE WORKSHOP - PRE - TRAINING:

- May 13 10 a.m. at the institute: Brigitte Hinder + Isabella Baur  
counting and sizing of bacteria, distinguishing  
hetero- and autotrophic flagellates etc.  
With Karel Simek and Mirek Macek
- May 14 9 a.m. at the insitute: B. Hinder + I. Baur + M. Villar  
+ J.M. Medina: counting and sizing of bacteria,  
distinguishing hetero- and autotrophic  
flagellates, bacterial production  
With Karel Simek, Mirek Macek and Jirka Nedoma
- May 15 8 a.m. departure to the lake Plesne (Sumava Mts,  
acidified, 1000 m a.s.l., forested watershed)  
B. Hinder + I. Baur + M. Villar + J.M. Medina  
*Please take "field" clothes (transport by car,  
walking a short distance an easy path,  
sampling from rubber boat)*  
Demonstration of sampling, taking samples for  
further elaboration. With Jarda Vrba
- May 16 9 a.m. B. Hinder + I. Baur + M. Villar + J.M. Medina +  
Cristiana Callieri + K. Wiackowski  
at the institute: ciliates, picocyanobacteria,  
HNF, elimination of FLB ...  
With Mirek Macek and Karel Simek
- During May 16 the last participants will come:  
Toni Wille + Marisol Felipe + Lluís Camarero
- 
-

Conclusions:

1. Sampling protocole:

Minor changes were proposed:

- sampling depths specified: upper end of sampler 1 m below surface, lower end of the sampler 1 m above bottom
- separate sample for PICY preserved by 1% formaldehyde + Na cacodylate

C. Callieri will send the protocole for fixative preparation to HBI (immediately), psampling protocole will be corrected and immediately sent to all sampling operators. Finally it will be sent to B. M. Wathne and to all participants.

2. Laboratory protocole 1st level:

Minor changes were proposed:

- comments on filters used
- changes in responsibility of persons
- concentration of DAPI

Will be corrected in HBI and sent finally to B.M. Wathne and to all participants.

3. Field and laboratory protocole 2nd level:

Discussions and alternative methods for all measurements:

- primary production - direct measurements in 5 depths
- measurements at 6 light intensities enabling estimates of primary production for different depths, days and seasons (Lluis)
  - chlorophyll analyses recommended according to protocole by Lluis
  - acid bubbling method not recommended
  - recommendations: total  $^{14}\text{C}$  org. in acidified sample after 24 hours = total C fixation, both celullar and extracellular, both in phytoplankton and bacteria
- $^{14}\text{C}$  incorporation on 0.2um filters = cellular C fixation by the whole assemblage (incl. bacterial uptake of extracel. algal release)
- initial inorg. C concentration; added inorg. C recommended not too high compared to initial inorg. C in the lake
  - after exposition no fixation of samples - immediate filtration

bacterial production - thymidine and leucine methods: recommendations concerning added concentrations (saturation curve), incubation time (linear uptake), concentration of TCA and filtration or centrifuging (no own experience with centrifuging - will be examined this year)

bacterial elimination - total elimination recommended in the lakes where protozoans are scarce.

Protocols will be corrected and modified according to discussions and immediately sent to all participants for a feedback. After corrections they will be changed and finally sent to B. Wathne.

**Plans for season:**

The data from 1st level microbiology - it is requested to send the data to HBI at the latest in January 1997. They will be gathered from all sites WP 1 and sent to databank to Norway. We do not suppose to send data on 2nd level microbiology to databank - without qualified interpretation and details on methods they are useless.

**Next meeting on microbiology:**

It is desirable to meet before the next ice-free period to discuss the data and experience from the season 1996. The most effective way seems to be one day more included before the project MOLAR meeting in Barcelona next February to March.

MOLAR Workshop Microbiology, České Budějovice, 16 - 18 May, 1996

List of participants

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## **MOLAR BIOLOGY WORKSHOP**

The first MOLAR biologists workshop was held at the Environmental Change Research Centre, University College London on Thursday 13 and Friday 14 June 1996.

There were 33 participants in the workshop which was divided into 3 groups. A chironomid group of 9 workers chaired by Steve Brooks (NHM), a cladoceran group of 8 people chaired by Jan Fott (FSCU), a diatom group of 13 people led by Nigel Cameron (ECRC) and a sub-group of the diatomists - 4 chrysophyte cyst analysts led by Roland Schmidt and Christian Kammenik (ILIMNOL).

Initially the group met as a whole to discuss the aims of the workshop and also at the end of the meeting to minute their discussions & decisions. The database manager for the project, Einar Heegaard (Botanical Institute, University of Bergen), also gave a talk on the arrangements for data transfer. Separate minutes will be available from the group leaders. A list of participants is attached. The diatom groups discussions are outlined below.

### Diatom workshop ECRC, UCL 13/14 June 1996

Our discussions centred around the areas highlighted by Rick Battarbee in his opening address, the essential areas of concern in WP3:

#### CORES & CALIBRATION TRAINING SETS

Whether concerned with diatoms, chrysophytes, cladocera or chironomids we require:

1. Standard methods - coring, sub-sampling, preparation techniques, identification criteria, nomenclature. These must involve agreed protocols and rigorous quality control procedures.
2. Collection of appropriate environmental variables. Relevant to the biological datasets and the aims of the project, but also as an archive for future use. These include chemical parameters such as pH and TP, and physical data including various possible temperature measurements.
3. An appropriate statistical basis for any calibration set - in terms of number of sites, coverage of the environmental gradients of interest and maximising analogues for species assemblages in the past.
4. A good database system is required.

In the diatom group the discussions centred around the protocols given in the MOLAR Project Manual (Draft of May 1996) for Sediment coring and sub-sampling p66 ff. & the sampling of diatoms in living communities and sediment traps p69 ff.

## Sediment Coring & Sub-Sampling

Disagreement remains over the necessity and possibility of a 2 mm sub-sampling interval. Some lakes have already been sampled (Gossenkollesee at 2.5 mm intervals last year) and Hagelsee (at 5 mm intervals during May 1996). The ECRC's stable, fine extrusion rig, which was used to sub-sample the Saanajarvi core at 2 mm intervals during May 1996, was demonstrated. In all lakes it is best to get the highest resolution available even though a better resolution may still be available from a rapidly accumulating lake sediment using a thicker slice than from a slowly accumulating sediment with a 2 mm slice. The concern of MOLAR is the last 200 years so we must aim for the highest resolution possible. Given that some cores have now been taken & sliced, a compromise is that higher diatom counting sums should be used for those core which have been sampled at coarser intervals. A *minimum* of 100 valves per level was suggested for contiguous 2 mm samples, this should be increased proportionately for thicker slices. This does not however, resolve the problem of dealing with DW/LOI data taken at coarser resolution.

Although not part of the diatom workshop, it was emphasised that DW/LOI analyses of all cores is a baseline & essential for correlation of all cores, regardless of CNS analyses.

An obvious, but critical point, is that we must take more than the number of cores suggested as a minimum in the manual. It is always better to have too much sediment and in MOLAR we have a many analytical techniques requiring sediment. The cost of multiple trips for coring is prohibitive both in time and money.

The suggestion was made that where possible it would be worth while examining an opened core for lithological description. However, this is not practicable with some corers and at some sites.

The amount of sediment indicated for grain size analysis is low for some of the granulometric techniques outlined by Mike Sturm. However, where laser-based granulometry is available the amount (0.5 g wet weight) given in the MOLAR manual is appropriate. Fieldworkers should be aware of this and again take additional cores where laser-granulometry is not available.

## Diatom Sampling Protocols: Living Communities & Sediment Traps

At the diatom workshop there was some discussion of diatom taxonomy. At this early stage of the project, the problematic taxa have not been isolated. There are, however, generally problematic genera and species groups (Cyclotella, Achnanthes, Aulacoseira, Fragilaria) which were discussed briefly. An agreement was made that once we had selected the lakes to be included in an extended ALPE/MOLAR training set efforts would be put into taxonomic harmonisation and an 'iconograph' - an informal photographic record of common problematic taxa would be made.

Further than this we have agreed to carry out a limited

analytical quality control (AQC) exercise. To some extent the lakes fall into 2 types, those with planktonic diatom floras and those with mainly benthic diatom floras. The idea was put forward that a group of 3 analysts (Sanna, Andre, Karin) dealing with the former would exchange and count slides and a group of 3 analysts dealing with the latter (Sergi, Elena, Nigel) would exchange and count slides. A comparison would then be made between the 3 counts for each of the 6 sites. In this way differences in taxonomic concepts can be identified quickly.

For sediment traps the MOLAR manual refers to the examination of uncleaned sedimenting material (SM) for the enumeration of live, dead and broken diatom cells prior to the examination of cleaned material. The purpose of this is to gain an approximate idea of sources of SM eg. from resuspension vs. recently living cells. A percentage count of these classes of cell/valve will be adequate.

It is permissible to amalgamate SM if necessary, given that the monthly amounts of SM are likely to be low and that in many published studies between trap variability has been shown to be small. Our primary aim is to have enough SM for analyses. Clearly an alternative would be to use larger traps, so long as the aspect ratio is the same. It should be noted that at three lakes: Ovre Neadalsvatn, Lake Redo and Gossenkollersee; sediment trapping at bi-annual intervals is also required by WP2. Site operators should be aware of this when sampling and distributing SM collected at the intervals required by WP2.

In diatom counting of SM and core assemblages we should routinely count chrysophyte cyst numbers so that both cyst and diatom concentrations can be counted and if required cyst to valve ratios can be calculated. The microsphere technique (Battarbee & Kneen 1982) was reiterated as the method for calculating fossil concentrations. Copies of this publication and the ECRC protocol for preparing diatom samples and slides were distributed to those who required this information.

Living diatom material, both periphyton and plankton should be preserved with Lugol's Iodine. However, where SEM is planned the group from ILIMNOL argued that formaldehyde is a preferable preservative as they believe that Lugol's Iodine can damage silica surfaces.

The biological transect was discussed. In addition to the need to sample on a side of the lake which is comparable with other lakes (lightest aspect), it is also desirable to include the greatest diversity of benthic diatom habitats (substrates), for example epilithon, epiphyton, epipsammon, epipelon. The protocol (p 73 paragraph 1) should also be amended so that rather than sampling at prescribed horizontal intervals it maybe more appropriate to sample at approximately even vertical intervals. The spacing of the transect samples will vary with the depth of the photic zone and maximum depth of the study lake. However, a minimum of 5 sampling stations with samples from all the benthic habitats is required. The means of sampling will vary between groups and may include: a boat and transect line using an Ekman



grab, divers picking samples and using some type of closed-chamber epilithon sampler (see protocol for reference), or at Lake Redo the use of a robot sampler.

Monthly phytoplankton sampling was discussed. In the manual (p 72) the phytoplankton sample was to be concentrated from 250 ml of water collected from the surface water above the deepest point of the lake. Given that phytoplankton can develop at different levels in the water column it was suggested that an amalgamation of water from the whole water column would be better. This could either be collected using a simple tube sampler, a tube with a pump or Rutner bottle. It was also suggested that samples could be taken along with the depth profiles for water chemistry. For example the agreement at Ovre Neadalsvatn is that Jan Fott will pass on plankton samples for diatom and chrysophyte analysis to Nigel Cameron.

### Environmental Variables

It was felt that the diatom group has some experience of creating training sets and that the selection of appropriate environmental variable would not be a great problem. Water chemistry parameters are as agreed in Prague. Of primary interest is pH, but all other parameters must be included in the training set for possible future use and interest.

### Appropriate Statistical Basis

The present ALPE training set contains 118 surface sediments. The MOLAR project will introduce surface sediments from at least 3 new sites. It may be necessary to include these because they contain high abundances of taxa not present in the ALPE training set. In addition possible training sets from the Austrian Alps, Swiss Alps, Finland and Kola Peninsula may contain suitable subsets of lakes appropriate to an extended MOLAR training set. The purpose of adding these sites is to cover a longer pH gradient and to fill any gaps in the existing range of chemistries. The aim would be to maximise the presence of analogues in the training set for the MOLAR core assemblages. However, it is essential that taxonomic quality is maintained whilst carrying out the amalgamation of training sets.

### Database

Database issues were discussed by Einar Heegaard. From the diatom perspective it is important that we translate to one coding system, that used in ALPE is the DIATCODE system and should be continued in MOLAR. Also that the NIVA site numbers are used.

Subject: address/e-mail list of MOLAR workshop participants  
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## MOLAR Diatom Analytical Quality Control (AQC)

### Introduction

The need for taxonomic precision in quantitative palaeoenvironmental reconstruction is highlighted by Birks (1994). Whilst the effectiveness of taxonomic harmonisation and AQC (Analytical Quality Control) in diatom analysis was established during the PIRLA (Kingston 1986) and SWAP projects (Kreiser & Battarbee 1988, Munro et al. 1990, Stevenson et al. 1991). In the MOLAR Project the first stage in harmonisation of diatom taxonomy has been carried out, and has involved both Work Package 1 (epilithic diatom studies) and Work Package 3 (core diatom assemblages & epilithon) analysts. Relevant diatom workshops, associated with both the MOLAR, and the related AL:PE, projects have been held. For example in AL:PE 2, a diatom workshop was held at the Limnology Laboratory, Mondsee in March 1994. A MOLAR biologist's workshop was also held at the ECRC, UCL in June 1996 which included a diatom workshop. A meeting concerned with diatom training sets held at the Department of Physical Geography, University of Helsinki in October 1996 involved further discussion of diatom taxonomy between a number of MOLAR diatomists. There have also been a number of informal meetings between MOLAR diatomists to discuss the taxonomy of mountain lake diatoms. Following these efforts to harmonise diatom taxonomy, the efficacy of workshop discussions and agreements will be tested by carrying out an AQC exercise. The need for additional diatom taxonomic harmonisation will depend upon the results of the analysis of the AQC exercise.

The MOLAR diatom AQC exercise should be carried out at a relatively early stage of the Project. This is because it will be most useful to report and act on our findings before taxonomic concepts become more difficult to modify, for example when data is collated in the database. We are approaching the end of the first year of the Project, having collected and prepared a great deal of epilithic & core diatom material. The MOLAR Barcelona meeting in Spring 1997 will provide an opportunity to report upon the progress of the diatom investigations and have a smaller taxonomic workshop. Late 1996 to early 1997 would seem therefore to be an appropriate time to carry out the diatom AQC exercise.

### Procedure

In the MOLAR Project, diatom analysis is applied to both living and fossil diatom communities and assemblages respectively. However, fossil assemblages are generally the most taxonomically diverse. These surface sediment assemblages are also components of the diatom/water chemistry training set which means that taxonomic consistency between analysts is imperative. As agreed at the 1996 MOLAR Biologist's Workshop in London, we should therefore concentrate the AQC exercise upon the sediment core diatom assemblages of Work Package 3. However, diatomists involved only in Work Package 1 (epilithon) are most welcome to participate and likewise epilithic samples from Work Package 3 sites can also be contributed. In addition we would be pleased to incorporate epilithic or core samples from analysts concerned with MOLAR 'secondary sites' for example Laguna Cimera (analysed by Manolo Toro).

The AQC procedure established during the SWAP project (see Kreiser & Battarbee 1988 or Munro et. al. 1990 or Stevenson et.al. 1991) will be followed. In MOLAR our diatom AQC should be 'blind', and unlike the SWAP AQC, count sheets and counts for each sample should not be supplied with the slides. Each analyst will select a typical, preferably well preserved, sample from their core. This sample may be from any depth in the core. Multiple slides should be prepared from the cleaned diatom suspension prepared from this sample and one slide should be sent to each of the participating laboratories. Given that analysts prefer to count with different valve concentrations it may be useful to mount two or three coverslips on each slide, each with a different valve concentration. It should be emphasised that the diatom slides need to be of a quality suitable for counting, with an even spread of diatom valves and absence of agglutination. The key requirement is that the coverslips & slides are prepared from the same, homogenised, cleaned diatom solution. It would also be useful to retain enough of the prepared suspension and make up additional slides for the contingency of loss or breakage of slides in the post, further analysts joining the AQC exercise, or the need for SEM study, for example.

We are concerned essentially with core diatom assemblages from MOLAR Work Package 3. The seven sites involved are: Ovre Neadalsvatn, Lake Redo, Gossenkollersee, Terianske Pleso, Jezero Ledvich, Saanajavi, Hagelsee. The respective analysts are: Nigel Cameron, London; Sergi Pla, Barcelona; Karin Koinig, Innsbruck; Elena Stefkova, Bratislava; Miljan Sisko, Ljubljana; Sanna Sorvari, Helsinki; Andre Lotter, Bern.

Therefore at least six additional slides should be prepared from each of these lakes and posted to the other six analysts as soon as possible. We are all aware that a range of familiar & unfamiliar diatom assemblages exist within the project and all analysts cannot necessarily be expected to count a sample from all six additional sites. At our meeting in London it was originally suggested that the sites might be grouped into those with a large planktonic diatom component (*Cyclotella* dominated floras found by Sanna, Andy & Karin) and those with a larger benthic diatom component (*Achnanthes/Aulacoseira* dominated floras found by Sergi, Elena & Nigel). This would leave Miljan with a unique, high pH flora. However, following our small Helsinki meeting it is apparent that these divisions are not so straightforward. Ideally all analysts would count all slides but this may not be possible, given the wide range of floras existing within MOLAR and the time involved in becoming familiar with all of these. Therefore, it was suggested that we would aim to have at least 2-3 external analysts counting diatoms from each site, plus the 'home' analyst, to give us 3-4 counts for comparison per sample. However, to give everyone the opportunity to at least examine the other diatom material and decide whether or not to count it, each analyst should send a slide to all the other analysts. Once the analysts concerned have received diatom slides from the other labs, if they could then e-mail me to say which sites they intend to count so that I can check that there are enough counts per site for comparison in the AQC exercise. For AQC core samples, a count of c. 500 valves per sample is required.

Where possible the diatom analysts involved should make a photographic record of common or problematic taxa. Sanna Sorvari & Jan Weckstrom are producing a document from the Helsinki Meeting which includes photographs of the taxa discussed there. This will be circulated to MOLAR diatomists.

As the co-ordinating laboratory for the MOLAR diatom investigations, data should be sent by disc or e-mail to ECRC, UCL. The data from each lab should be sent as a Tilia file, as untransformed, raw counts (NOT percentages) & the coding system should be DIATCODE. For those who do not already have a hard copy, DIATCODE is available on the WWW:

<http://www.geog.ucl.ac.uk/~abeare/Checklist.html>

In the first instance inter-laboratory comparisons will be made by comparing histograms of common species percentages. It may be that a multivariate technique will be appropriate in highlighting the similarities or dissimilarities between the counts of whole diatom assemblages. John Birks & Einar Heegaard may be able to advise us on, or assist us with, an appropriate ordination technique for this, but I hope that this would not involve them in too much additional work.

#### Optional epilithic diatom AQC

It may be useful to carry out separate epilithic diatom AQC, particularly for analysts concerned only with epilithic diatoms (Barbara Kaweka, Pedro Sanchez-Castillo)? Work Package 1 is concerned with diatom epilithon only. The lakes involved are: Chuna, Ovre Neadalsvatn, Stavsvatn, Lochnagar, La Caldera, Lake Redo, Paione Superiore, Gossenkollersee, Dlugi Staw, Starolesnianske Pleso, Jorisee; a total of eleven sites. Work Package 3 is also concerned with diatom epilithon from the same sites as the core material: Ovre Neadalsvatn, Lake Redo, Gossenkollersee, Terianske Pleso, Jezero Ledvicah, Saanajavi, Hagelsee. The first three of the WP3 lakes are also part of WP 1. This means that there are 15 potential epilithic AQC sites and there is also the possibility of including secondary sites such as Laguna Cimera. If there is some interest in AQC for epilithic samples I would be pleased to participate in and organise this using the same protocol as for the core material. The only difference being that count of c. 250 valves per sample would be adequate to characterise the epilithon at each site.

#### Timetable

I hope that it will be possible for all the Work Package 3 core slides to be exchanged between analysts before the end of November 1996. This would allow us four to six weeks to complete the counting, enter the data and transfer the 'Tilia' files to London by early to mid-January 1997. We would then have some time to analyse the data for discussion at the Barcelona MOLAR meeting.

When you have read this message, please could you reply to say that you have received it and are happy, or otherwise, with its contents.

## References

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- Nigel Cameron, ECRC, UCL November 5 1996



## MOLAR CHIRONOMID WORKSHOP

Notes from the meeting at Dept. Geography, UCL, 13-14 July 1996

**Present:** Steve Brooks (Co-ordinator) (Natural History Museum, London, UK); Kiko Granados (Univ. Madrid, Spain); Godtfred Halvorsen (Univ. Bergen, Norway); Heikki Olander (Univ. Helsinki, Finland); Jon Sadler (Univ. Birmingham, UK); Maria Rieradeval (Univ. Barcelona, Spain); Øyvind Schnell (Univ. Bergen, Norway).

### 1. Standard methods.

- Cores will be taken from the deepest part of each lake.
- Sub-samples will be taken at 2 mm intervals. Subsamples will be measured or weighed prior to sampling for chironomid head capsules. Sufficient material will be processed to produce a minimum of 100 head capsules for each subsample. Any sediment remaining will be re-weighed to ascertain concentration of head capsules in each sub-sample. Subsamples will be deflocculated, if necessary, in 10% KOH warmed to 60°C for 15 minutes. The subsamples will be passed through a sieve with a mesh size of between 90-105 µm. Head capsules will be picked out from a Bogorov sorting tray. Jon Sadler will send a sorter to each participant. Head capsules will be slide-mounted in a permanent medium such as Euparal or DMHF [water soluble]. Jon Sadler to provide each participant with address of DMHF supplier.

- **Identification criteria.** Following the workshop many taxonomic and nomenclatural problems were resolved. In addition, Steve Brooks will circulate a character matrix and provisional names for Tanytarsini to be amended and added to as necessary as the project progresses. Godtfred Halvorsen will circulate drawings of the European Tanypodinae showing the positions of the cephalic setae to supplement the key of Kowalyk (1985 *Can. Ent.* 117: 67-106.). Again these can be amended and added to as necessary as the project progresses. We AGREED that it would be necessary to hold another workshop in about 12 months when we can further standardise the taxonomy since preliminary results of analysis will by then be available. The venue and date of this workshop to be arranged in due course.

### 2. Appropriate environmental variables.

- **chemical:** major ions, pH, LOI, temperature-depth profile.
- **physical:** secchi depth, maximum depth, surface area, macrophyte cover and substrate type [presence/absence].

### 3. Appropriate statistical basis.

- **number of sites:** minimum of 30.
- **coverage of gradient:** broad gradients covering the variables listed above, especially temperature, pH and nutrient gradients.

### 4. Database system.

- Database in EXCEL format recording top and bottom of each subsample. In TILIA format record the top of each subsample. Øyvind Schnell to compile the chironomid data from all sites in the chironomid training set.

Species coding to be 8-letter, the first four letters from the first letters of the generic name, the last four letters from the first letters of the specific name.

5. **Communication.** We will continue to keep each other up-to-date on progress by e-mail. I am happy to continue to act as coordinator of the chironomid group if that is acceptable.

6. **Circulation.** Copies to all those listed above plus Petr Bitusik, Nigel Cameron, Wolfgang Hofmann, Anton Brancelj.

Steve Brooks, 17 June 1996

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## WP3 WORKSHOP in London (June 13 - 14, 1996)

### CLADOCERA group

A group of 9 people chaired by Jan Fott (FSCU) met in order to discuss research of recent and sediment zooplankton, mostly Cladocera, in the Work Package 3 of the MOLAR project. The output of our discussions are arranged according to the outline given by Rick Battarbee in his opening address (see the 'minutes' from the diatom group):

### 1. Standard methods

(a) The technique of taking cores was not discussed as the responsibilities for coring lie outside the group.

(b) Subsampling the cores for sediment Cladocera (draft project manual, p. 68): The same subsamples will be used for pigment extraction and for Cladocera analysis. The subsamples will go first to CNR, the way of subsampling and mailing are described in the protocol for WP3 pigment analysis (the new version sent by Andrea Lami to the London meeting). One subsample used for the both pigment and Cladocera analysis should be at least 3 g wet weight. After pigment extraction the centrifugation sediments will be transferred quantitatively into plastic bags, with their original wet weight indicated, and will be sent to the respective cladoceran analysts.

Freezing and acetone extraction of sediment samples does not interfere with the later analysis of cladoceran remains (tested by Jan Fott and Mirka Prazakova).

(c) Extraction of cladoceran remains from the sediment, preparation of slides and counting: Mirka Prazakova demonstrated her permanent slides with stained (chlorazol black) cladoceran remains in polyvinyl alcohol. They were found very instructive but for the routine work in WP3 a less laborious method of Wolfgang Hofmann will be adopted (see the protocol 'Sediment Cladocera analysis: extraction from the sediment, preparation of slides, determination and counting').

(d) Field sampling for recent zooplankton will be carried out by the same methods as in AL:PE 2. Jan Fott will write the protocols for zooplankton sampling in both WP1 and WP3.

(e) Quality control procedures: The quality control will include not only taxonomy (which does not seem to be a major problem) but also counting and determination of numbers per unit sediment. During the sampling season 1996 two test samples of sediments will be taken in the Swiss Alps, Slovenian Alps, the Tatras, and in Finland. The sediments will be subsampled and sent to Wolfgang Hofmann, Anton Brancelj, Atte Korhola and Jan Fott. In each of the four participating laboratories eight subsamples will be analysed. The results, expressed as numbers per gram wet sediment, will be sent to Prague. The evaluation of the exercise will be done by Jan Fott and Martin Cerny.

(f) Nomenclature, Species codes: The nomenclature will follow the last (1978) edition of Illies: *Limnofauna Europaea*. The species codes will be composed of the first 4 letters of the generic name, followed by the first 4 letters of the species name. Species lists will be ordered alphabetically.

(Reference: Illies J. (ed.), 1978: *Limnofauna Europaea*, 2nd edition, Gustav Fisher Verlag, 532 p.)

(g) Remains of Ostracoda and cocoons of Turbellaria will be counted together with Cladocera, if found in sufficient numbers.

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## 2. Transfer functions, calibration sets

It is felt that Cladocera as indicators of the past history of lakes by means of transfer functions are not so well established as e.g. diatoms. The MOLAR's Work Package 3 may serve, however, as a start in such a direction.

Within the Cladoceran Group there are two studies in progress (outside MOLAR) that use the principle of transfer functions in a similar way as they are used with diatoms: (I) a study including 53 lakes in Northern Fennoscandia, relating Cladocera from surface sediment to 27 environmental variables (Atte Korhola), (II) a similar study on 68 lakes in Switzerland (Wolfgang Hofmann). The lakes in both the sets, however, do not follow MOLAR criteria (like position above the tree line, or intact catchments).

Before the London meeting no attempt has been made as for creating Cladocera calibration sets and consequently, no sampling in this direction will be carried out this year. But it would be convenient to combine efforts with the two remaining WP3 groups and obtain subsamples or duplicate samples of surface sediments for analyses of Cladocera. Sampling surface sediments for calibration sets (diatoms, cladocerans, chironomids) in the Tatras is planned for the next year.

## 3. Environmental variables

Environmental variables of potential value for Cladocera calibration sets were discussed extensively. But it will be necessary to reach agreement with the remaining two WP3 groups, in order to make use of their future sampling expeditions (and offering them samples from those of ours).

Environmental variables as they were discussed in the group:

### Basic morphometric information on the lake and surroundings:

- maximum depth
- surface area
- retention time (even an estimate)
- altitude, information on the tree line
- vegetation in the catchment, expressed as the approximate coverage (%), e.g. bare rock (granite) 30%, grass 60%, dwarf pine 10%.

### Physical

- the highest yearly subsurface temperature
- ice cover period
- Secchi depth\*

### Chemical

- pH\*, Alkalinity\*
- conductivity\*
- TOC\*
- TP\*

### Biological

- chlorophyll-a\*
- recent zooplankton (WP3 sampling protocol)
- fish (presence/absence, state of populations present)

\* ..... sampled according to the AL:PE protocol - late summer, subsurface sample at or near the outlet.

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#### **4. Good database system**

The recommendations of Einar Heegaard will be followed.

#### **5. List of participants**

Atte Korhola, Milla Rautio (UHEL)

Wolfgang Hofmann (MPI PLOEN)

Anton Brancelj (NIB)

Marina Manca (CNR)

Vladimir Korinek, Jan Fott, Mirka Prazakova, Martin Cerny (FSCU)

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# MOLAR Workshop on Sampling, Chemical Analysis and Quality Assurance of Atmospheric Deposition and Surface Waters

## Site:

Pallanza, Italy, 5. - 7. June 1996.

## Aims:

- To focus on all the practical aspects of sampling and analysis of atmospheric deposition, surface waters and water profiling
- To review and approve the manual/protocol for sampling and analysis of atmospheric deposition, surface waters and analytical quality control

## Invited participants:

- Site operators where chemistry of deposition is measured
- Responsible of the analytical measurements

## Programme:

### **Atmospheric deposition and surface water, WP1**

(R. Mosello/B. Wathne)

- Sampling
- Documentation of the sampling site
- Chemical variables
- Analytical methods suggested

### **Atmospheric deposition and surface water, WP2, 3**

- Heavy metals
- Organic contaminants
- Isotopes
- Carbonaceous particles

(NILU, T. Berg)  
(J. Grimalt)  
(P. Appleby)  
(N. Rose)

### **Snow pack**

- Sampling
- Documentation
- Analysis

(U. Nickus/R. Psenner)

### **Analytical Quality Control**

- BCR Certified Reference Materials
- Intercomparison: the AQUACON project
- Intercomparison: ICP-NIVA exercises
- Use of intercomparison results in the MOLAR project

(JCR, Environ. Institute)  
(JCR, Environ. Institute)  
(NIVA, H. Hovind)  
(R. Mosello)

### **Check and validation of results**

(R. Mosello)

### **Mailing results to the data centres**

(B. Wathne)

### **Discussion of the draft and approval of the manual, including in more detail:**

- Surface water and atmospheric deposition
- Water column profiling
- Part of spheroidal carbonaceous particle analysis

### **11 h 7. June - Conclusions**

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## **MOLAR Workshop on Sampling, Chemical Analysis and Quality Assurance of Atmospheric Deposition and Lake Water**

In Pallanza, Italy, 5-7 June 1996, 18 scientist working on deposition and water chemistry in the MOLAR project were gathered for this Workshop. The workshop participants were both site operators and responsables of the analytical measurements. The MOLAR participants also had the pleasure of hearing H. Muntau from ISPRA lecturing on BCR Certified Reference Materials and the AQUACON project.

The workshop was organised by Rosario Mosello and Andrea Lami from the CNR III in Pallanza, and the organisers were recognised for their excellent administration and accomplishment by the participants.

### **Aims:**

- To focus on all the practical aspects of sampling and analysis of atmospheric deposition and lake water chemistry
- To review and approve the manual/protocol for sampling and analysis of atmospheric deposition, lake water and analytical quality control

### **Conclusions and notes from the workshop:**

1. Updated parts of the manual should be sent to Bente M. Wathne at NIVA(Box 173 Kjelsås, 0411, Oslo, Norway, e-mail: bente.wathne@niva.no) within the last week of June.
2. A list of existing meteorological stations within a distance of 200 km from each site and their working period should be sent to: Dr. Roy Thompson, (Dept. of Geology and Geophysics, University of Edinburgh, King's Buildings, West Mains Road, Edinburgh, Scotland, e-mail: egph08@castle.edinburgh.ac.uk) as soon as possible.
3. Precipitation (bulk) samplers for heavy metals shown and demonstrated at the workshop may be rented or bought from Norwegian Institute for Air Research (NILU). Please contact Torunn Berg (NILU, Box 100, 2007 Kjeller, Norway).
4. Precipitation (bulk) samplers for mercury shown and demonstrated at the workshop may be rented or bought from Swedish Environmental Research Institute (IVL) in Gothenburg. Please contact Torunn Berg for details.
5. Snow sampling equipment shown and demonstrated at the workshop may be ordered through Uli Nickus (Inst. of Meteorology, Innrain 52, A-6020 Innsbruck, Austria, e-mail: ulrike.nickus@uibk.ac.at).
6. Laboratories who are not normally analysing Al fractions (RAL, ILAL) may send some samples to NIVA for analysis. Please contact NIVA (Bente Wathne or Håvard Hovind) directly for agreement on sending/returning sampling bottles.
7. Methods for reactive and inlabile Al (RAL, ILAL) should be listed in the manual together with the other methods.
8. The MOLAR EXCEL LAKE FORM was accepted as standard form for data check and transmission of results from surface water and water profiling chemical analysis.
9. The MOLAR EXCEL RAIN FORM was accepted as standard form for data check and transmission of results from chemical analysis of precipitation.

- 
10. The participants were reminded of the great importance of the intercomparison work in international projects. It is mandatory for the MOLAR laboratories to participate in at least one of the intercomparisons organised either by CNR-III or NIVA.
  11. Attention was drawn to the forthcoming status report to be prepared for Brussels after the first project year. All data for sampling and analysis in 1996 should be sent to the respective responsables by the end of February 1997.
  12. The manual will be restructured so that all sampling for deposition, surface waters and profiling will be treated together and not according to type of sample (i.a. organic compounds in deposition, sediments, fish and water in one chapter).
  13. A mailing list will be annexed showing where and to whom the samples and results should be sent. This mailing list will also be added to the "home page" prepared for Internet by colleagues in Prague.
  14. Annexed to the manual is also the updated list from the proposal showing the sampling and analysis programme for the different Work Packages and sites.
  15. Clarification is still needed for parts of the water profiling manual, and for how to divide the precipitation samples between the different analysing groups (SCP, organics, heavy metals for WP2).
  16. An overview is needed showing which sites that have deposition stations and also which of them that are using bulk and which of them that have wet only sampling.
  17. None of the sites seem to have run-off measurements as standard today.

5/7-96

Bente M. Wathne



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# MOLAR - FISH GROUP

*Minutes of the first MOLAR FISH Workshop, Arcachon, France, June 14, 1996.*

Report by: Bjørn Olav Rosseland, NIVA

## Background

Background for the meeting was to in detail go through the sampling protocol for fish tissue and organs, prepared by the different responsible laboratories, and to finalise the procedures to fit the field situation the groups will be working in.

## Meeting

The meeting took place at Laboratoire de Neurobiologie et Physiologie Comparées in Arcachon, France, and the host of the meeting, Jean-Charles Massabuau (J-CM), had prepared the final programme for the one day workshop (see Annex 1). Eight participants took part, coming from Norway, Switzerland, Austria, France and Spain (see List of Participants, Annex 2). The meeting started at 9<sup>00</sup> and was finished by 20<sup>00</sup>.

1. After welcoming from J-CM, Bjørn Olav Rosseland (BOR) gave a short introduction to the workshop, focusing on the complexity of the MOLAR protocols compared to the AL:PE 1&2 sampling. The headlines during the day would be: blood sampling, histological sampling (gill, liver and kidney), sampling for heavy metals (fillet, liver and kidney), organic pollutants (fillet and liver) and otoliths for age determination.
2. Each of the responsible persons (J-CM - blood and EM of gills, Reinard Lackner - histology, Sigurd Rognerud - heavy metals, Lourdes Berdie Rabanaque - organics and BOR - otoliths) gave comments to the manuals provided for the sampling.
3. Each responsible person had brought sampling equipment for the lakes of the other groups, and details in the preparation of samples were given.
4. J-CM had provided live rainbow trout for sampling technique exercises. Each responsible person demonstrated their particular methods for sampling and preparation of samples.
5. To actually perform an exercise under "field conditions" (in the garden of the institute), revised necessary changes in the protocols. By demonstrating and discussing various ways of sampling the same organ or tissue, the group decided on one standard sampling technique to be followed strictly by each group. In some cases, the *new protocol* differ in many ways from the previous version.
6. Each responsible person for the national testfishing and sampling programme performed practical exercise of the complete fish sampling programme until each detail of sampling became familiar.
7. A fish sampling order list was made during the exercise (Annex 3).
8. All sampling methods were recorded on video by J-CM, and will after editing be sent to each responsible laboratory.

- 
9. The host had ordered sunny weather for the field exercise and excellent gourmet facilities for the nutritional exercise.
  10. Limericks were provided for the official dinner (Annex 4).

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## Annex 1

### MOLAR Fish Meeting in Arcachon, France

Arcachon le 22 May 1996

Hello colleagues!

It is now time to send you some news about our workshop. You will find enclosed a list of the people who will participate.

We will have about 80-100 trout to play with. They will be kept in an external tank and the practical training will be held in a garden in front of the lab. No tables and no chairs, everybody on the grass!... I have ordered for a sunny day, but if we have problems with the weather, it will be possible to work inside. With, or without, tables and chairs!

Of course each person who is doing a demonstration should come with the material required for performing the corresponding sampling. If you have special requirements (tools, products...), please contact me.

For those who are organizing or centralizing analyses, I guess that you have special requirements. I propose that you should come with 11 packages, corresponding to the 11 lakes we have to sample or, alternatively and well prior to the meeting, you could send them to Arcachon by post. We could distribute the packages to the fish-person (i.e. fisherwoman or fisherman) in Arcachon. The perfect package would include a protocol for an efficient field sampling in bad conditions, appropriate tubes for good travelling, etc.... What I don't know about is the dissection material. Each package can contain scalpel blades or disposable scalpels but is it necessary to provide tools like scissors and tweezers? If some people need such equipment, please ask for them as soon as possible. I can centralize your requests and complaints on the e-mail.

With Bjorn and Bernard, we also planned to perform an otolith reading demonstration/discussion. We will have a microscope and a video-camera. Bring the otoliths you never succeed to read!

To help, I have been through the fish sampling protocols Bjorn gave us in Prague. This is a proposed list of material for each analytical program. Please do not hesitate to correct me on the e-mail. I did it very rapidly because I have really a lot of reports to write right now (like everybody I guess) and everything at the same time!!!

Fish population sampling (Bjorn)

for X fish / lake

tubes for stomach contents for those who are not ready to do them

tubes for otoliths

tubes for scale (brown trout)

Blood ionic composition (Jean - Charles)

for 6 fish / lake

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plastic syringes and various size of needles  
Pasteur pipettes and suction bulbs  
tubes for travel by Federal Express

Scanning electron microscopy of gill filaments (Jean - Charles, Suzanne Dunel)  
for 5 fish / lake  
solutions and buffers ready to prepare fixatives  
scalpel and/or razor blades  
tubes for travel by Federal Express

Electronic microscopy of gill filaments (Jean - Charles, Suzanne Dunel)  
for 5 fish / lake  
solutions and buffers ready to prepare fixatives  
scalpel and/or razor blades  
tubes for travel by Federal Express

Note: We were not supposed to do the electronic microscopy in Arcachon but I would like to save a unique opportunity to have these samples.

Fish histology, optic microscopy (Rudy)  
for 20 male fish / lake  
tubes with formalin for all tissues  
tubes for otoliths  
figures for fish dissection  
protocol form  
scalpel blade

Heavy metal (Sigurd)  
for 25 fish of different size in the interval 15-30 cm / lake  
scale and otolith tubes  
polyethylene bags for bones, dorsal and epiaxial muscles, liver and kidney  
Organic pollutants (Lourdes - Berdie)

*We will have to discuss a lot with Lourdes - Berdie for this highly specialized protocol!!!*

for X male fish / lake  
Specially cleaned material. (inorganic alkaline soap, ultrasonic bath, distilled water, Milli-Q water). For example, I have no Milli-Q water in Arcachon)  
aluminium foil  
disposable scalpel (?)  
sticking paper for aluminium foil, able to resist to - 20°C

I am ready to get any comments on the e-mail.

Waiting for you in Arcachon, 9 a.m. in the lab or in front of the lab, looking at the beach (remember the red arrow on the enclosed map).

JC

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## Annex 2

### *MOLAR Fish Meeting in Arcachon, France*

#### List of participants (June 14, 1996)

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---

*and some kind laboratory members,*

Line BOURASSEAU

Laboratoire de Neurobiologie et Physiologie Comparées

Université Bordeaux I et CNRS Fax: (33) 56 83 03 50

Place du Dr Peyneau

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Tel: (33) 56 83 03 28

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Place du Dr Peyneau

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Alexia LEGEAY

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Laboratoire de Neurobiologie et Physiologie Comparées Fax: (33) 56 83 03 50

Université Bordeaux I et CNRS

Place du Dr Peyneau

33120 Arcachon France

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## Annex 3

### *MOLAR fish sampling order*

*Two peoples is definitively better!!!!!!*

Before starting with a fish, prepare aluminium foil, paper and dissection tools (tweezers, scissors, razor blades, syringes....)

#### 1- Blood sampling

Heparanized a 2 or 5 ml syringe. Take the blood sample from the ventral aspect of the tail. You should get 1.5-2 ml of blood.

Put off the needle and fill an hematocrit tube, seal it with the hematocrit paste, centrifuge. Place the remainder of the blood in a 1.5-2 ml centrifuge tube and separate the plasma from the pellet (red blood cells and leucocytes; 9-10 min and 10 000 rpm), and fill it into a new centrifuge tube for transportation to J-C.

*Don't forget to measure the hematocrit and to collect the plasma when the pretty noise will stopped. For the plasma, just sample the upper part. Don't go to close to the pellet.*

2- Weigh the fish and measure its length from the noose to the end of the tail. Note on envelope.

3- Excise the 1st gill arch for the scanning and electron microscopy (to J-C). Cut 6 to 8 segments with the razor blade by using the small dissection table that has been so kindly provided. Cut the bones.

Place the sample in the corresponding tubes, notice at what time you did it and the corresponding number. Already note the time at which you will have to change the bath.

4- Excise the 2nd gill arch for histology (Reinhard). Put it in formalin.

5- Open the abdomen.

. Empty the bill bladder with a 1 ml syringe. If the bladder is fairly full, fill it into a centrifuge tube, mark it and send to Reinhard.

6- Cut the liver:

One little piece in formalin to Reinhard

Cut the remaining in two pieces. One must be used for the heavy metals and placed in a plastic bag to Sigurd. The other one is for the organics to Lourdes/Joan and it must be kept in aluminium. Tag the aluminium staff with a sticker.

7- In the posterior part of the open abdomen, cut 1 cm of kidney and put it in formalin with the liver to Reinhard.

In the anterior part, cut 5 cm of kidney for the heavy metal and put it in a plastic bag for Sigurd.

---

8- Muscles. Remember the Leif demonstration!!!

With a scalpel, cut along the fish length just above the lateral line. Cut vertically in the anterior and posterior region. Then, starting from the anterior, peel off the skin with a tweezer. Cut in the middle. Separate the flesh from the body by cutting from the back.

Put one piece in the plastic bag for the heavy metals to Sigurd

Put the other one in an aluminium foil for the organics to Lourdes; add a sticker.

9- Scales. Turn the animal onto the other side. Eliminate the mucus and then collect with a scalpel or your knife some scales from the part between the dorsal fin and adipose fin, above the lateral line. Put the scales in the special tiny envelope provided by Bjorn. Don't forget to fill the corresponding questionnaire.

10- Otoliths. Remember the demonstration by Bjorn!!!! Take your best knife and open the roof or the head in order to see the brain. You remember where should be the otoliths, try to find them. You need two big ones. Put them in a plastic bags that you place into the envelope. If you can not find them, keep the head alive (not in water as it can not breathe anymore!!) and send it like that to Bjorn.

11- Congratulation, you have finish your first fish. There is no more noise from the centrifuge but did you collect the plasma? Measure the hematocrit? Check the bath for the scanning and electron microscopy? Nothing to do ??? Start with a new fish....

1- Blood sampling

Heparanized a 2 or 5 ml syringe. Take the blood sample from the ventral aspect....



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## Annex 4

### Limericks from the official dinner, Arcachon June 14, 1996

*Author: Bjørn Olav Rosseland*

Dedicated to Brigitte:

*A Microbiologist girl  
came down to join the fishermens world  
Dipping tweezers in trout brain  
she cannot be in sain  
Her otoliths shines like a pearl.*

Dedicated to Lourdes:

*There once was a lady from Spain  
Cutting fish on aluminium frame  
It started to slip  
She couldn't hold the grip  
Now her protocol has changed-it's a shame*

Dedicated to Jean-Charles:

*For years we have planned for this workshop  
A beach with MOLARE-girls is just top!  
In addition we'll see  
Castles which free  
Can guide us through heavenly wineshops!*

*Jean-Charles is a good friend and host  
Holding meeting by the most lovely MOLARE coast  
Here we have been sucking blood -  
cutting gills - biles have flood  
We'll be back probably as Vampyre ghosts*

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## **Agenda for MOLAR Fish Workshop, Tuesday 22 April 1997**

Responsible: Bjørn Olav Rosseland

### ***Report from field work 1996 (All groups)***

- Performed field work 1996
- How did the manual function in the field situation
- Recommendations for changes in manual
- Analyses of data, status
- New ideas of important data to be included
- Sampling program 1997

### ***Report from the special groups***

- Report on population structure-age determinations (Bjørn)
- Report on Heavy metals in muscle , kidney and liver (Sigurd)
- Report on Histology of kidney, liver and gills (Rudi & Reinhart)
- Report on blood physiology (Jean-Charles)
- Report on Gill histology/chloride cells etc. Jean-Charles
- Report on statistics - have we filled out all parts necessary for the statistical evaluations?

### ***Summary***

- Recommendations for changes in sampling programme
- Recommendations for changes of manual
- Total plan for sampling/re-sampling 1997

Bring as many overhead presentations as possible of your data, as I need to summarize your presentations in the plenum meetings on Thursday and Friday

# **MOLAR:**

**A programme of MOuntain LAake Research**

DIATOM TAXONOMIC WORKSHOP

IN HELSINKI 18.-19.10 1996

*Jan Weckström, Sanna Sorvari, Nigel Cameron, Karin Koinig & André Lotter*

## Molar-project: diatom taxonomic workshop in Helsinki 18-19.10.1996

(KLB = Krammer & Lange-Bertalot, Süßwasserflora)

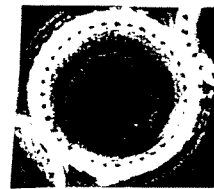
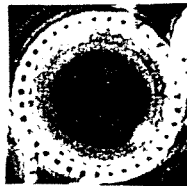
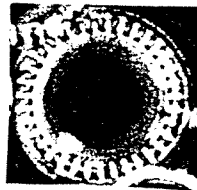
### Aulacoseira

#### *alpigena*

- Girdle view
- separated and slightly curved rows of pores
  - small spines
  - if you can't see the valve view, then sometimes difficulties to separate it from *A. distans v. distans*, if the pores are not clearly curved
  - for picture, see KLB fig. 31:1

#### Valve view

- one marginal areolae row
- no puncta, clear septum
- similar to *A. perglabra v. floriniae*, but when focusing up and down, you can see a twisting effect. There can also be one separated areolae row on the outer side of the edge, and some rows going inside the valva towards the valva center



#### *ambigua*

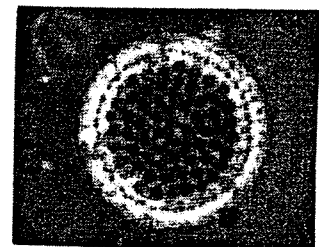
- Girdle view
- clear visible and curved puncta
  - small spines, thick silicified edges and very distinct septa
  - for pictures, see Camburn and Kingston (1986)

- Valve view
- fine puncta
  - very distinct septum

#### *distans v. nivalis*

- Girdle view
- straight 3-7 rows of separated puncta
  - spines hardly visible in LM
  - diameter usually bigger than the height
  - flat girdle
  - for pictures, see Camburn and Kingston (1986)

- Valve view
- valve face punctate, "honeycomb" structure
  - no septum



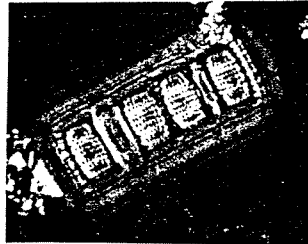
#### *italica subs. subarctica type 1*

- Girdle view
- clear visible, curved puncta
  - usually long spines
  - sometimes in LM a pore visible in the marginal spines
  - usually long and narrow girdles
  - for pictures, see Camburn and Kingston (1986) and Haworth (1988; figs. 43 & 44)

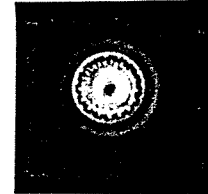
- Valve view
- probably quite similar to *A. italica subs. subarctica type 2*

*italica subs. subarctica*  
type 2

- slightly/hardly separated, curved puncta
- clearly visible spines, which are shorter than in **type 1**, but longer than in **A. alpigena**
- girdle usually shorter and wider than in **type 1**



- puncta in different focus plan
- valve face randomly punctate
- clearly distinct septum
- valva usually gold or slightly green coloured
- the shape of the edge is like a row of separated "towers"



*nygaardii*

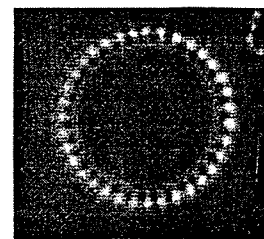
- very fine puncta, sometimes hard to distinguish in LM
- punctas in a straight row
- for pictures, see Camburn and Kingston (1986)

- periphery of valve face ornamented with one irregular marginal row of areolae
- valve face unornamented
- a spine (1-1.5  $\mu\text{m}$ ) is located every 2-3 areolae

*perglabra v. floriniae*

- one row of areolae
- when focusing a straight "ghost striae" appears under the areolae row (it's clearly a line, whereas in **A. alpigena** the "ghost striae" consist of separated puncta
- for pictures, see Camburn and Kingston (1986)

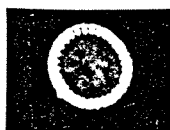
- one marginal areolae row, the remaining valve face is unornamented
- similar to **A. alpigena**, but when focusing, elongated "line" crosses the edge (no twisting effect)
- when focusing from the areolae disc down to the mantle the areolae are "running down" over the edge



Cyclotella

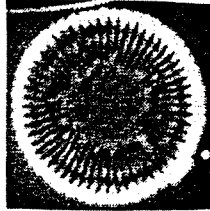
*comensis*

- very heterogenous group, several morphotypes
- striae clearly separated, radial and varying in length
- small, diameter usually between 5 and 12  $\mu\text{m}$
- central area flat, tangential or undulating, sometimes with "knobs", and varying in size
- in the central area usually one central fultoportula
- after Roger Flower, there should be a stellate pattern in the centre of the valve, if NOT he uses the name **C. kuetzingiana v. minor**
- for pictures of other morphotypes, see Wunsam *et al.* (1995; fig. 6)

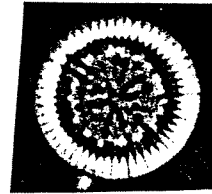
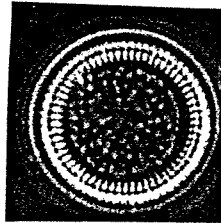


*krammerii*

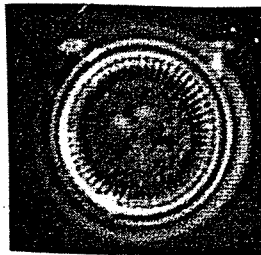
- usually bigger than 10  $\mu\text{m}$
- valva face slightly undulate to nearly flat
- size and ornamentation of puncta varying in the central zone
- striae of unequal length, 12-18 in 10  $\mu\text{m}$
- striae length more than half of cell diameter
- see KLB 2/3, fig. 65:4-6 and page 60, and Håkansson (1990)

*rossii* type 1

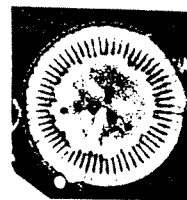
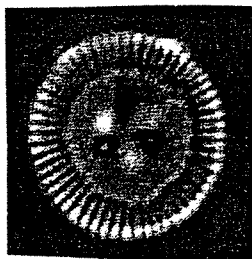
- "ordinary" *C. rossii*, described in KLB 2/3, page 60, fig. 64:1-8
- radial striae of slightly unequal length and without shadowlines
- puncta usually organized as different numbers of radial rows, BUT also valvas with randomly organized puncta
- marginal fultoportulae on every second or third interstria

*rossii* type 2

- striae shorter and thicker than in type 1
- usually 2-4 puncta in a row
- usually 3 rows, "organized as the symbol of Mercedes-Benz"

*rossii* type 3

- striae clearly separated and shorter than in type 1
- three clear puncta situating more or less in the valve center forming an "triangle"
- puncta clearly bigger than in type 1 and type 2, but smaller than in *C. ocellata*



## Eunotia

Descriptions follow Stevenson *et al.* (1991)

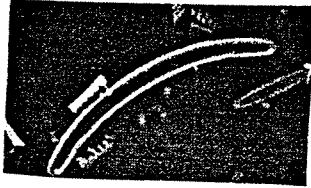
*curvata* - width > 3  $\mu\text{m}$   
- striae < 20/10  $\mu\text{m}$



*curvata v. subarcuata*

- width > 3  $\mu\text{m}$
- striae < 20/10  $\mu\text{m}$
- as *E. curvata*, but shorter
- Roger Flower uses the name *E. curvata v. attenuata* !

*naegeli* - width < 3  $\mu\text{m}$   
- striae > 20/10  $\mu\text{m}$



## Frustulia

*rhomboides v. viridula*

- distinctive feature is the RAPHE CANAL, reaching all the way to the ends.
- Gap in the striae at the apices
- central area is asymmetric
- more silica at one side of raphe nodes
- for more information see Haworth *et al.* (1988), KLB 2/1 fig. 96:1-3 and Stevenson *et al.* (1991) page 74

## Navicula "subtilissima group"

*cumbriensis*

- 28-34  $\mu\text{m}$  long, 3.5-4  $\mu\text{m}$  wide, 42-45 striae/10  $\mu\text{m}$
- valve very long and narrow, with subcapitate ends
- central area hardly widened at all or nearly lanceolate
- striae strongly radial around the centre,  $\pm$  straight near the centre, but curved where the direction changes
- striae density does not change
- see Haworth *et al.* (1988)

*hoeferii* (Cholnoky)

- 34-36  $\mu\text{m}$  long, 6.5-7.5  $\mu\text{m}$  wide, 34-38 striae/10  $\mu\text{m}$
- valve  $\pm$  semi-lanceolate to linear-elliptical, with bluntly sub-capitate to capitate ends
- valva is more rounded than *N. hoeferii* sensu Ross and Sims
- axial area  $\pm$  parallel with slight thickening along the raphe
- central area appearing narrowly rhombic on the outside but absent on the inner side
- striae radial around the central area to convergent towards the apices

- striae interrupted by a lanceolate-shaped longitudinal rib (see KLB2/1 fig. 79:28), which is clearly visible under LM
- striae only clearly visible around the central area
- see Stevenson *et al.* (1991) page 76 and Hustedt 1930-66 vol. III page 97

*hoeflerii* sensu Ross  
and Sims

- 27-35  $\mu\text{m}$  long, 4.5-7  $\mu\text{m}$  wide, 36-39 striae/10  $\mu\text{m}$
- valve  $\pm$  linear, narrowing suddenly toward the capitate ends  $\longrightarrow$  sharp "shoulders"
- axial area  $\pm$  parallel
- central area narrowly elliptical
- striae radial around the centre, centre stria are irregularly longer and shorter so that the longer ones are more widely spaced along the axial area
- striae appear mottled except for those near the central area which are more widely spaced and less interrupted

*madumensis*

- 31-39  $\mu\text{m}$  long, 5.5-7  $\mu\text{m}$  wide, 36-42 striae/10  $\mu\text{m}$
- valve narrowly linear-elliptical with narrowly rostrate to subcapitate ends, curved shaped
- axial area  $\pm$  parallel, in a clearly thickened internal rib which extends through the central area
- central area very small and narrowly elliptical
- striae radial around the centre, complex about the change and straight towards the apices
- striae with uniform density

*subtilissima*

- 17-32.5  $\mu\text{m}$  long, 3-4.7  $\mu\text{m}$  wide, 39-48 striae/10  $\mu\text{m}$
- valve linear, narrowing towards the rostrate to capitate ends
- axial area slightly widening towards the centre
- central area  $\pm$  circular and about half the width of the valve
- striae clearly radial around the centre and visible in LM
- striae around the central area are regularly or irregularly shortened and are clearly more widely spaced
- recognizable under LM by the narrow linear shape and apparently wide central area
- see Stevenson *et al.* (1991)

**Pinnularia**

*microstauron* v. *caudata* - see KLB 2/1, fig. 192:11-13

*microstauron* - as in KLB 2/1 without **P. caudata**

*microstauron*  
type 1 - small, like **P. caudata**, BUT it has *rounded* ends instead of capitate  
- for picture, see Schmidt and Psenner (1992; p.42, fig. p)



- microstauron*  
type 2
- small, rounded ends
  - distinctive feature is the central area with a clear fascia just on one side
  - for picture, see Schmidt and Psenner (1992; p.42,fig. n)

### Thalassiosira

- pseudonana*
- formal *Cyclotella nana*, see KLB 2/3 fig. 60:6
  - very small, diameter usually around 5 µm
  - valve face unornamented
  - very short striae
  - distinctive features are 3-5 marginal processes, which occur as lighter "spots" between the striae
  - valve usually "pale" which makes it sometimes hard to discover

### Some nomenclature and amalgamation agreements:

- 1) *Achnanthes stolidus* should be *Navicula schmassmannii*
- 2) *Achnanthes minutissima* group will be amalgamated for MOLAR
- 3) *Cyclotella comta* should be *C. radiosa*
- 4) *Pinnularia interrupta* should be *P. biceps*
- 5) The genus *Anomoeoneis* should be *Brachysira*

\* There was some disagreement about the *Cyclotella glomerata* which occurred in Nigels, Sannas and Jans slides. André argues that it is probably *Cyclotella pseudostelligera*, but we are not sure which one it is. This is mainly a nomenclature problem, which will be solved before combining the training sets. Until that we use the same names as before.

\* There was also discussion about the different forms of *Achnanthes helvetica*. The *A. helvetica* described in KLB 2/4 fig. 10:12-15 should be called as *A. austriaca* v. *helvetica*. To separate the other forms see Flower and Jones (1989).

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\* The pictures were provided by Karin Koinig, Peter Rosen and Sanna Sorvari

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**Appendix C. Agenda for the Barcelona Meeting  
April 21 - 25 1997**

## AGENDA

### ***Monday 21 April***

20:00 Steering Committee meeting.

### ***Tuesday 22 April***

9:00-10:00 Registration

10:00-10:30 Welcome

10:30-11:00 Coffee break

11:00-12:30 Methodological workshops

room a) Plankton (V. Straskrabova, J. Fott)

room b) Fish (B. Rosseland)

room c) Invertebrates and Chironomids (G. Raddum)

room 17) Climatology and meteorology (R. Thompson, D. Livingstone)

12:30-14:00 Lunch break

14:00-15:30 Methodological workshops

room a) Plankton workshop

room b) Fish

room c) Invertebrates and Chironomids

room 12) Snowpack (U. Nickus)

lab 5) Diatoms workshop (N. Cameron, S. Pla)

15:30 -16:00 Coffee break

16:00-17:30 Methodological workshops

room a) Plankton workshop

room b) Fish

room 14) WP-3 sampling: (water column, sediment coring, biological transects, sediment traps) (N. Rose, J. Catalan, N. Cameron)

### ***Wednesday 23 April***

9:00-10:30 Methodological workshops

room a) Atmospheric deposition and surface water (R. Mosello)

room b) Chrysophytes (R. Schmidt)

10:30-11:00 Coffee break

11:00-12:30 Methodological workshops

room a) Atmospheric deposition and surface water

room b) WP-2 sampling (J. Grimalt, P. Appleby)

12:30-14:00 Lunch break

12:30-15:30 Diatoms workshop

14:00-15:30 Methodological workshops

room a) Modelling workshop (R. Battarbee, J. Catalan, C. Curtis, P. Appleby, D. Livingstone)

15:30 -16:00 Coffee break

16:00-17:30 Methodological workshops

room a) Modelling workshop

### ***Thursday 24 April***

9:00-10:30 WP-1 scientific discussion (B. Wathne)

10:30-11:00 Coffee break

11:00-12:30 WP-1 scientific discussion

12:30-14:00 Lunch break

14:00-15:30 WP-2 scientific discussion (R. Psenner)

15:30 -16:00 Coffee break

16:00-17:30 WP-2 scientific discussion

18:00-19:30 Slide show

21:30 Molar dinner

### ***Friday 25 April***

9:00-10:30 WP-3 scientific discussion (R. Battarbee)

10:30-11:00 Coffee break

11:00-12:30 WP-3 scientific discussion

12:30-14:00 Lunch break

14:00-15:30 WP-4 discussion (S. Patrick)

15:30 -16:00 Coffee break

16:00 - 17:00 Closing and invitation to next meeting (S. Patrick)

17:30 Steering committee meeting

## WORKSHOPS

### Plankton

Tuesday 22 April 1997, 11:00-17:30, room A  
Responsible: V. Straskrabova, J. Fott

#### **11:00 - 12:30 Plankton. First Level.**

Evaluation of data on 1st level from all lakes from 1996, including both microbial communities and metazooplankton. Information based on all data available will be prepared by Vera Straskrabova and Jan Fott for all participants. Conclusions and recommendations will be discussed. Proposed topics of discussion:

- Precision and accuracy,
- Intercalibration plan
- What to do with "scarce" organisms - PICY, CIL?
- How much effort is worthwhile?
- Should we cancel some special samplings?
- Should we change or improve the sampling program for next year?
- conversion from bio-volumes to organic carbon carbon partitioning among the different compartments remarks on the taxonomy of CIL and HNF

#### **14:00 - 15:30 Plankton. First/Second Level.**

Reports on lakes where 2nd level (and/or dense sampling of 1st level) was investigated (reports should not be longer than 10 min).

- Redo
- La Caldera
- Gossenkoellesee
- Jorisee
- Ovre Neadalsvatn

Authors are requested: (i) to prepare some material for their presentations in the form which could be disseminated to participants (to save time), (ii) to prepare a list of methodological difficulties for further discussion.

#### **16:00 - 17:30 Plankton. Second level**

Discussion on methodological difficulties, interpretation problems etc. during 2nd level measurement, and recommendations to site operators and analysts for the coming season, such as:

- separation of phytoplankton and bacteria
- "saturation concentrations" of thymidine and leucine
- DIC analysis in cases when concentration is very low and alkalinity
- negative (probably the problem only in Czech and Slovak lakes)
- what parameters (more) are recommended to be analyzed for a better interpretation and explanation
- how accurate is measurement of the elimination of bacteria in cases
- where grazers are so scarce?
- any recommended changes in sampling strategy, methods etc.

## **Fish Workshop**

Tuesday 22 April 1997, 11:00-17:30, room B  
Responsible: Bjørn Olav Rosseland

### ***Report from field work 1996 (All groups)***

- Performed field work 1996
- How did the manual function in the field situation
- Recommendations for changes in manual
- Analyses of data, status
- New ideas of important data to be included
- Sampling program 1997

### ***Report from the special groups***

- Report on population structure-age determinations (Bjørn)
- Report on Heavy metals in muscle, kidney and liver (Sigurd)
- Report on Histology of kidney, liver and gills (Rudi & Reinhart)
- Report on blood physiology (Jean-Charles)
- Report on Gill histology/chloride cells etc. Jean-Charles
- Report on statistics - have we filled out all parts necessary for the statistical evaluations?

### ***Summary***

- Recommendations for changes in sampling programme
- Recommendations for changes of manual
- Total plan for sampling/re-sampling 1997

Bring as many overhead presentations as possible of your data, as I need to summarize your presentations in the plenum meetings on Thursday and Friday

## **Invertebrates and chironomids**

Tuesday 22 April 1997, 11:00-15:30, room C  
Responsible: G. Raddum

- Discussion of the sampling programme in 1996. What has been done, remarks about the sites, sampling conditions, problems during sampling, etc.
- Status of the work for the different sites
- Harmonizing of taxonomic work and quality/level of species identification. (What is the most important task for the biological work. We need to start a discussion about this so we at the end have the best possible database to evaluate)
- What will be the most important groups of the invertebrates for a biological training set of high mountain lakes.
- Data transportation format
- Authors of data reports, final reports etc.

I feel we need to start talking about the points mentioned. I do not think we can conclude about all of them at the meeting, since some of the topics are characterized like processes that we have to go into. Other items arising during the workshop are welcome.



## Climate and Meteorology

Tuesday 22 April 1997, 11:00-12:30, Room (Aula) 17  
Responsible: R. Thompson and D. Livingstone

- 11.00-11.05. General Introduction (Roy Thompson)
- 11.05-11.12 Climate change in European mountains (Roy Thompson)
- 11.12-11.20. Summary of climatic change reconstruction work being undertaken in Edinburgh. (Anna Augusti-Paranda)
- 11.20-11.25 Uses of AWS Data (David Livingstone)
- 11.25-12.15. Results and/or practical difficulties of deploying AWSs (5 mins max) in remote mountain areas. each site)

Country	Site	Speaker
Austria	Gossenkolle	Uli Nickus
Scotland	Lochnagar	Neil Rose
Norway	Ovre Neadale	Leif Lien
Finland	Saanajarvi	Atte Korhola
Slovakia	Pleso/Lesna	F Sporka
Slovenia	Jezero	Anton Brancelj
Spain	Estany Redo	Marc Ventura
Italy	Lago Paione	Andrea Lami
Switzerland	Jorisee	Kurt Hanselmann
Switzerland	Hagelseew	D Livingstone

- 12.15-12.30 General discussion

### **DISCUSSION TOPICS**

- Data availability from Met. stations close to Molar sites.
- AWS Data exchange.
- Using AWS Data to improve climate reconstructions.

## **WP-3 Sampling**

Tuesday 22 April 1997, 16:00-17:30, room (aula) 14  
Responsible: N.Rose, J. Catalan, N. Cameron

### ***16:00-16:30 Water column profiling***

- Evaluation of current sampling status and practical difficulties at the different sites: O. Neadalsvatn, GKS, Redo, Terianske, Ledvicah, Saanajavi, Hagelsee, Cimera, Laghetto Inferiore
- Revision of the Project manual protocols
- Discussion of the data sending procedure and time schedule

### ***16:30-16:50 Biological transects***

- Sampling progress at the sites
- Revision of the project manual protocols

### ***16:50-17:10 Sediment coring and sediment traps***

- Sampling progress at the sites
- Revision of the project manual protocols

### ***17:10- 17:30 Any other business***

## **Atmospheric deposition and surface water**

Wednesday 23 April 1997, 9:00-12:30, room A  
Responsible: R Moselo, B. Wathne

### ***Sampling:***

- which rain/lake stations are active?
- Problems in the sampling.

### ***Analyses:***

- results of the intercomparisons exercises (AQUACON freshwater and rainwater, NIVA?). Problems in the analytical methods.

### ***Data validation and mailing:***

- Data validation and mailing to the co-ordination centres (rainwater Pallanza, Freshwater NIVA, Oslo).  
Diskette with the Excel form for the validation and mailing of rain/lake results. Criteria of validation (ionic balance, comparison between measured and calculated conductivity). Results of the screening of the rain/lake data received in the co-ordination centres.

### ***Update of the MOLAR manual.***

### ***Other***

## Chrysophytes

Wednesday 23 April 1997, 9:00-10:30, Chrysophytes  
responsible: R. Schmidt

In the chrysophyte workshop, we would like to discuss taxonomic harmonisation and problems in cyst quantification.

As time for SEM investigations is too short, we are depending on SEM pictures for taxonomic discussions. So we ask everyone who is interested in cyst taxonomy to bring his pictures to the workshop.

As there are only three people working on chrysophytes we think there will be enough time to discuss problems which arise from the discussions (no strict timetable).

## **WP-2 sampling**

Wednesday 23 April 1997, 11:00-12:30, room b  
Responsible: P. Appleby, J. Grimalt

### ***Objectives of the modelling***

- Sediment records, biota?
- Radionuclides, heavy metals, organics, SCPs?

### ***Acquisition of essential parameters***

- Atmospheric deposition, transport parameters, partition coefficients, sediment records.
- Data uncertainties/gaps and means for remedying them.

### ***Implementation of the modelling***

- Personnel: ULIV involvement will include myself and Alexei Koulikov, with advice from Uppsala (Lars Hakanson). My main experience is with sediment records. Alexei Koulikov has had a good experience in modelling Cs137 in fish.
- Coordination: Different groups and components will have different specific views and needs, but many of the underlying problems will be similar. To make the most efficient use of what will always be a very limited data set it would be helpful to have a good overview.

These are the issues of main concern to us and which we would like to include within a coordinated agenda.

## **Modelling**

Wednesday 23 April 1997, 14:00-17:30, room A

Responsible: R. Battarbee, J. Catalan, C. Curtis, P. Appleby, D. Livingstone

The aims of the workshop are:

- to present and/or discuss some of the models we are going to apply in MOLAR, and identify the objectives addressed with them
- to define the availability (or possible acquisition) of essential data and parameters
- to discuss the implementation of the modelling and time schedules

## **AGENDA**

Wednesday 23 April

- 14:00 - 14:45 WP-1 modelling (to be developed by C. Curtis)
- 14:45-15:30 WP-2 modelling (to be developed by P. Appleby)
- 15:30-16:00 Coffee break
- 16:00-16:15 Climatic change on decadal and centennial timescales (R. Thompson)
- 16:15-16:30 Reconstructing 200 years of climate change at MOLAR sites (A. Agusti-Panareda)
- 16:30-16:45. Linkages between water-temperatures and air-temperatures (D. Livingstone)
- 16:45-17:30 Linking physical and biogeochemical models: a multiple approach through DYRESM-WP, AQUASIM and other models in development (J. Catalan, D. Livingstone)

## WP-1 Scientific Discussion

Thursday 24 April 1997, 9:00-12:30, room A  
Responsible: B. Wathne

### ***MOUNTAIN LAKE ECOSYSTEM RESPONSE TO ACID DEPOSITION***

The main goal of the discussions is to go through the different parts of our programme under WP 1, to clarify the status of the MOLAR work at this stage. What have been achieved through our work in the first MOLAR year and what is still left to investigate to be able to address the questions raised? On the basis of status for each of the WP's we should decide if necessary additional actions have to be taken in addition to the plan we have already described. Conclusively, for each of the topics the following list should be the basis:

- Status after the first sampling season
- Sampling procedures/programme for next season
- Additional actions necessary

#### ***Thursday 24 April***

Chair: B. Wathne

- 9.00 Brief introduction B. Wathne
- 9.10 On site measurements of sulphur and nitrogen deposition R. Mosello
- 9.40 Seasonal variability of water chemistry B. Wathne/R. Mosello
- 10.00 Seasonal variability of biota G.Raddum/J.Fott/R. Battarbee
- 11.00 Test the hypothesis that histological and physiological attributes of fish can be used to indicate early stress B.O. Rosseland/R.Hofer/J.-C. Massabuau
- 11.20 Test the hypothesis that microbial activity in the pelagic food web increases with acidification V. Straskrabov / J. Fott
- 11.40 Evaluate applicability of various critical load models to mountain chemical-biological model for scenario assessment lake ecosystems and develop a linked R. Battarbee

## **WP-2 Scientific Discussion**

Thursday 24 April 1997, 14:00-17:30, room A  
Responsible: R. Psenner

### ***MEASURING AND MODELLING MAJOR ELEMENT AND POLLUTANT FLUXES IN MOUNTAIN LAKES AND THEIR IMPACT ON FISH***

- Pollutant deposition sampling and analysis
- Allocation of pollutants to source and the role of dust
- Tracking pollutant pathways within the lake -catchment system
- Effects of trace metals and organic pollutants on fish
- Modelling pollutant fluxes in mountain lake-catchment systems using radiotracers and SCP





## **WP-3 Scientific Discussion**

Friday 25

~~Thursday 24~~ April 1997, 9:00-12:30, room A

Responsible: R. Battarbee

### ***CLIMATE VARIABILITY AND ECOSYSTEM DYNAMICS AT REMOTE ALPINE AND ARCTIC LAKES***

- Obtain and harmonise instrumental weather records over the last 200 years
- Correlate records of weather patterns between lowland meteorological stations and montane sites, and measure local weather patterns
- Assess the seasonal variability of physical, chemical and biological characteristics of sites
- Harmonise taxonomy of key indicator taxa and model their distribution in relation to environmental variables
- Establish long-term variability in ecosystem dynamics from recent palaeolimnological records
- Model the relationship between weather patterns and lake dynamics, validate the model against the sediment record, and forecast lake response to alternative climate scenarios

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## **Appendix D. Original Reports from the contractors of MOLAR.**

**Detailed reports for Partner 5 and 14 are incorporated in chapter 2.2 MOLAR Work  
Package 2 (WP2)**

*Environmental Change Research Centre, University College London*

## **MOLAR First Year Progress Report**

(Work Package 1 & Work Package 3 and Work Package 2 sediment coring at Øvre Neådalsvatn)

### Fieldwork

Sampling of diatom epilithon has been carried out by the site operators at Lochnagar and at Øvre Neådalsvatn. Material has been returned to the ECRC laboratory and slides have been prepared for diatom analysis. The sediment traps in Øvre Neådalsvatn have been sampled according to the MOLAR timetable & protocols and this material is undergoing analysis. Further sediment trap samples will be transferred from NIVA to ECRC.

Sediment coring was carried out at Øvre Neådalsvatn on 7/9/96 and 8/9/96 according to the protocols given in the MOLAR manual. Cores were taken within a small area around the deepest point of the lake in 15.5 - 17.5 m water depth. Six cores were collected and extruded at fine intervals (see MOLAR manual) on site or, in the case of one core, immediately following transport down from the lake.

The cores are coded as follows and are to be allocated for the analyses set out in the MOLAR project manual p94 ff:

- OVNE 4: Work Package 3 diatom/chrysophyte, SCP, <sup>210</sup>Pb, magnetic analysis
- OVNE 5: Work Package 3 grain size, cladoceran analysis
- OVNE 6: Work Package 3 chironomid analysis
- OVNE 7: Work Package 2 Master core
- OVNE 8: WP2/WP3 Backup
- OVNE 9: WP2/WP3 Backup

### Transect

Following the MOLAR protocol, two transects were carried out in a North-South direction using an Ekman grab to recover material from different water depths.

From transect A-B samples of diatom habitats such as rock, mud, moss, filamentous algae, sand and liverwort were taken in water depths from <1.0m-3.2 m.

From transect C-D samples were recovered from 4.6m - 14.0 m water depth.

These samples are being analysed at present.

## Laboratory analyses

Material from cores OVNE 1 - OVNE 3 in the AL:PE project is archived.

Loss-on-Ignition - LOI; Percentage Dry Weight - DW; and Wet Density - WD analyses have been carried out on a number of these cores. The usefulness of high resolution analyses is demonstrated by a comparison of the lithostratigraphies of the earlier AL:PE 1 cores from Øvre Neådalsvatn compared with the new MOLAR cores from this lake (Figures 1 & 2).

Diatom and chrysophyte sample and slide preparation has been carried out on the surficial (c. 0-20 cm) sediments of OVNE 4. This material is undergoing analysis and the remainder of the core is in preparation at present. Material for analysis at external laboratories eg. pigment,  $^{210}\text{Pb}$  has been transferred, or is being transferred to the respective laboratories.

## Taxonomic Workshops

Diatom workshops held in London during June 1996 and Helsinki in October 1996 are reported in the Appendix. The preliminary results of the WP1/WP3 diatom harmonisation and Analytical Quality Control (AQC) exercise was discussed at diatom workshops held during the Barcelona MOLAR Meeting (see below).

At this point sediment core diatom slides have been circulated from 8 sites to all MOLAR diatomists. These lakes are: Øvre Neådalsvatn, Gossenkollesee, Saanajarvii, Jezero Ledvicah, Lake Redo, Hagelsee, Laguna Cimera and Terianske Pleso. Epilithic diatom slides have been circulated from 5 sites: Øvre Neådalsvatn, Saanajarvi, Jezero Ledvicah, Lake Redo and Dlugi Staw.

Preliminary data representing the analysis of 25 core and epilithic diatom slides are shown in Figure 3a and 3b. The coding of samples is as follows: first 2 letters - lake, 3rd letter sample type (C - core; E - epilithon), letters 4 and 5 - analyst. Only species occurring at percentages of more than 10% are shown. The results of this exercise are not discussed here as not all the data have been collected. See below.

A number of points were discussed during the Barcelona diatom workshop and list of points for action agreed upon:

1. An end of June 1997 deadline was set for submission of further core or epilithon AQC counts to Nigel Cameron (ECRC). Data to be submitted as previously agreed, ie. as raw counts, format (Tilia) and coding (DIATCODE).

2. Nigel Cameron to send out a taxon list from AL:PE/SWAP. These taxon codes to be used in preference to the DIATCODE "Current Code".

3. Andy Lotter explained the format for input of Excel files into Tilia. This is particularly useful for Miljan Sisko and Elena Stefkova.

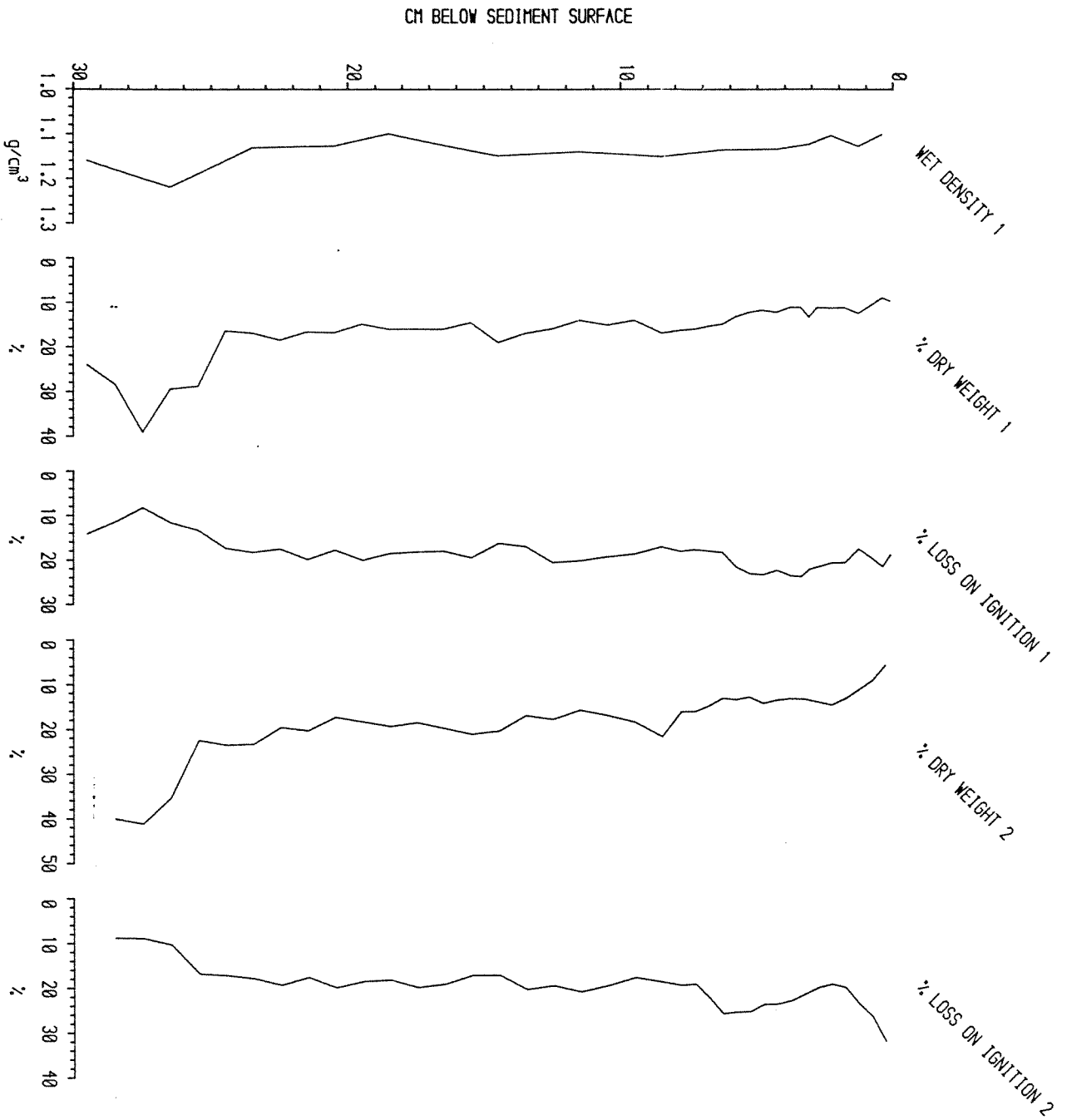
4. It was agreed that a MOLAR diatom monograph, analogous (perhaps smaller!) to that produced in the North American PIRLA project, would be produced. MOLAR diatomists should routinely take light micrographs (LM) to represent the typical composition of their lake floras, both from core and epilithic material. Any diatoms from MOLAR, and to some extent associated mountain lake sites, can be included. We should, however, concentrate on the MOLAR sites. A >5% abundance cut off level was suggested for the key taxa, but other critical taxa can be photographed. SEM photographs can also be included for fine detail, but it is the LM record that will be the main content of the monograph. Photographic PRINTS should be sent to Nigel Cameron who will compile the document. The level of magnification of diatoms under the microscope and enlargement of prints is left to each diatomist. The idea is to produce quickly and easily a useable MOLAR diatom 'flora' whilst carrying out routine counting. The production of the taxonomic record should not divert us too much from the main task of using diatoms to look at diatom-environment responses and for environmental reconstruction. However, it is important to include standard diatom taxonomic information with each print (but see below) eg. length, breadth, striae count in 10 micrometers, and if necessary a brief (colloquial will do, not necessarily botanical) description of the key features and note of the site of origin. Ideally with each batch of photographic prints, enlarged by the same amount!, one print should be a photograph of the scale of a micrometer slide. In this way it need not be necessary to measure the dimensions mentioned above for every valve. Anyone interested in the dimensions of a particular valve can use a ruler and transfer dimensions from the micrometer photograph. Phase-contrast, brightfield and DIC illumination are all acceptable, but it would be best to indicate which has been used for each photo or group of photographs.

Photographs for the diatom monograph should be sent to Nigel Cameron by the end of December 1997.

5. Anyone noticing eg. taxonomic errors in the ALPE training set or having queries about the identity of particular taxa should send Nigel Cameron a list of these (eg. Karin Koinig has produced such a list for checking).

6. There will not be a separate MOLAR diatom workshop during the coming year. Our next meeting will be at the MOLAR Meeting in Slovenia in 1998. However, contact will be maintained by e-mail and post, and also through contact with allied national and international projects involving diatom analysis (eg. NORD-CHILL, ?CHILL, ?EDDI).

Figure 1



Ovri Neaddalsvatn  
OVNE4

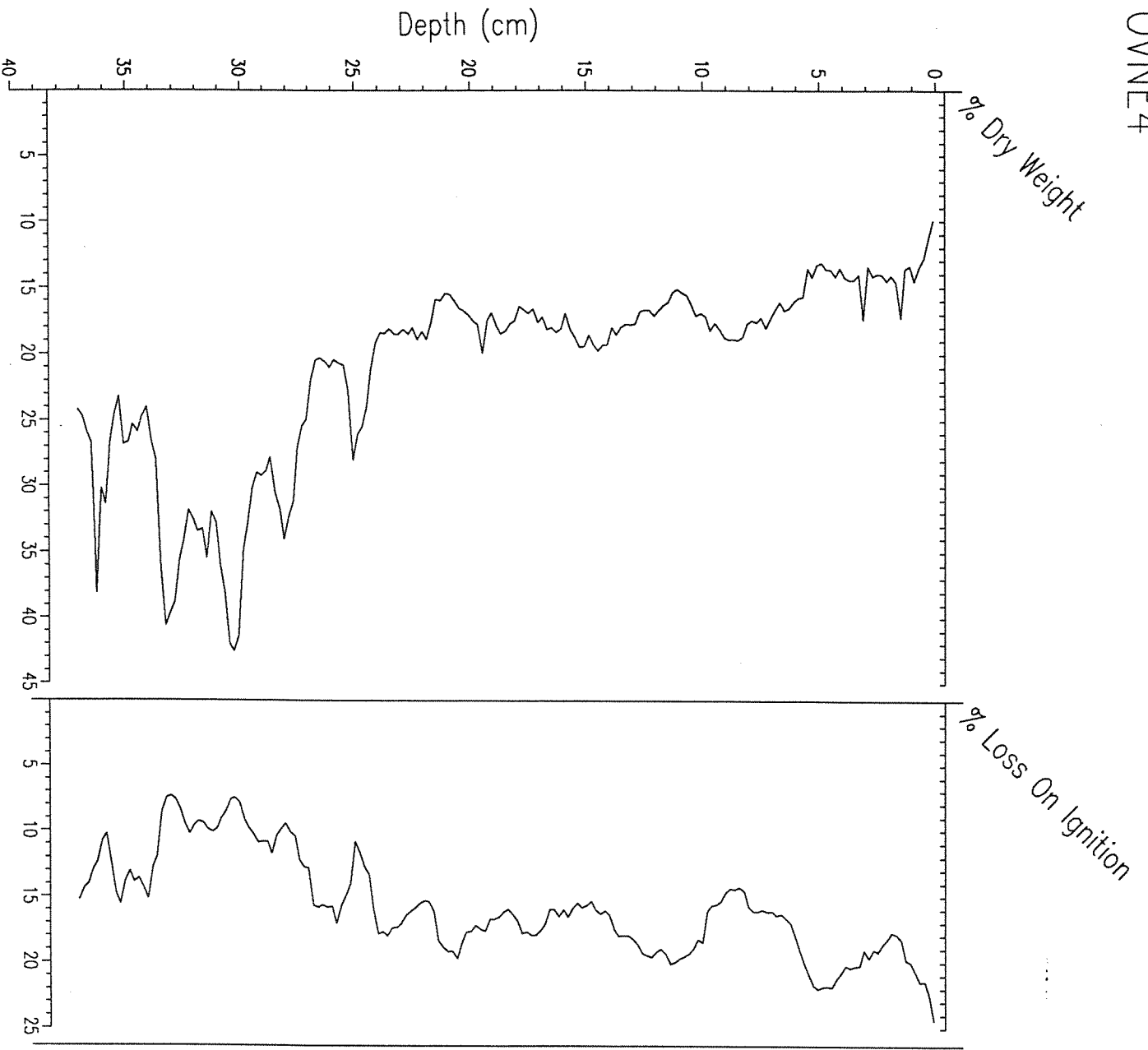


Figure 2



Figure 3a. MOLAR DIATOM AQC, PRELIMINARY RESULTS,  
 22 SPECIES > 10% FROM 326 TAXA

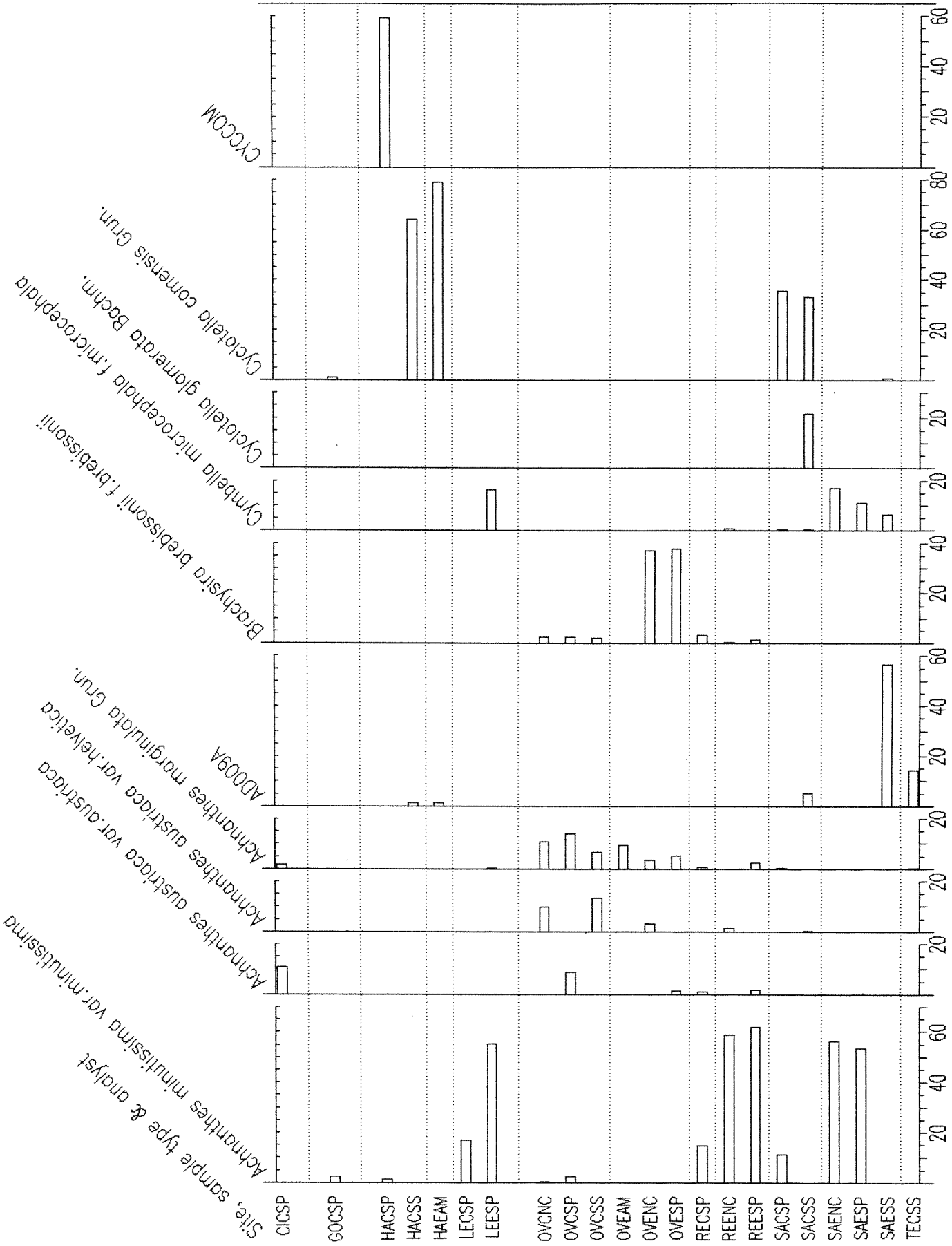
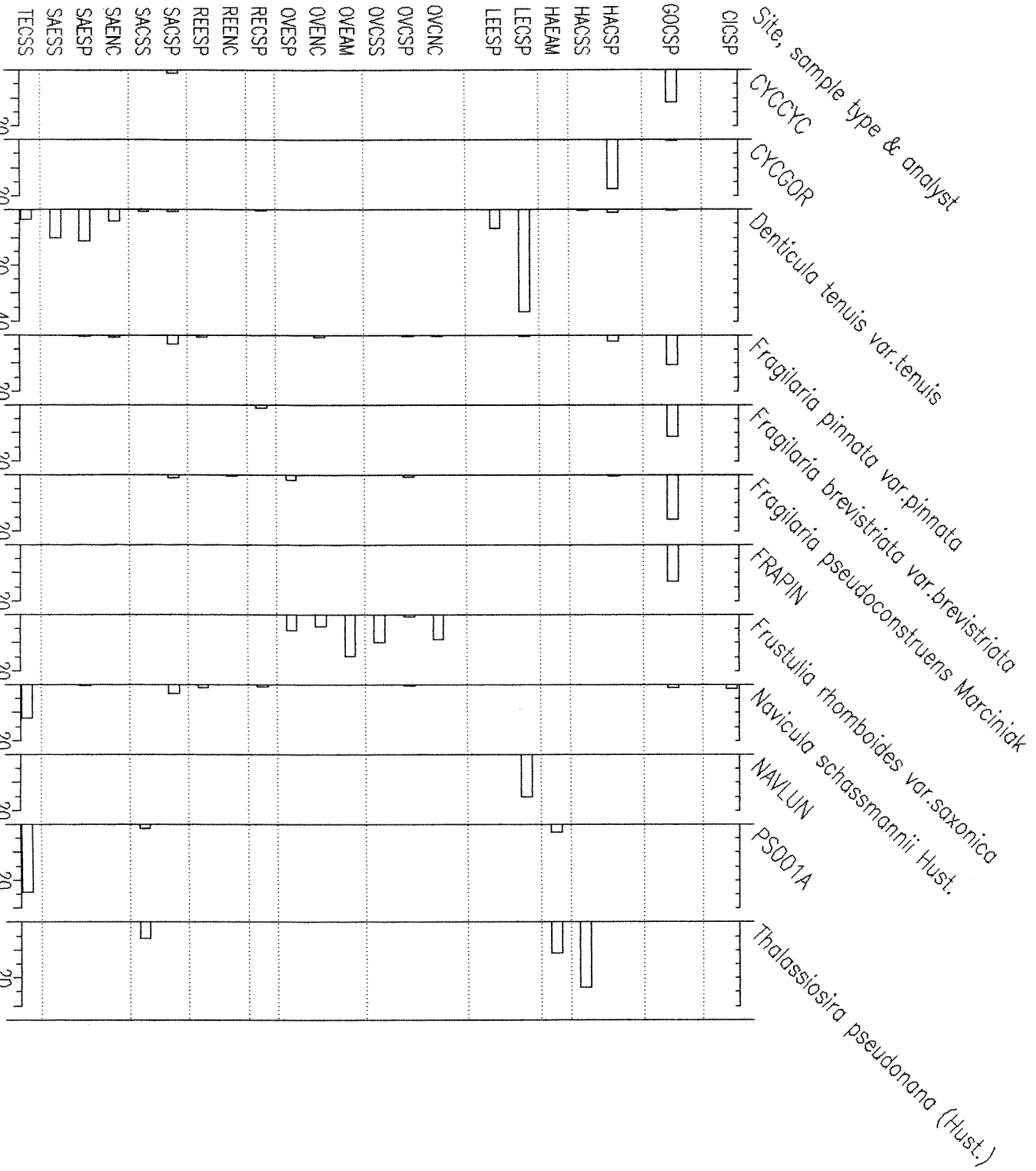


Figure 3b. MOLAR DIATOM AQC, PRELIMINARY RESULTS,  
 22 SPECIES > 10% FROM 326 TAXA



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## Partner 2

### THE FIRST MOLAR YEAR - A FINNISH PROGRESS REPORT

Report March 1 1996 - February 28 1997

Site Manager: Dr. Atte Korhola, University of Helsinki, Finland

#### 1. Summary of the advancement of the project

Intensive work on the MOLAR project by the Laboratory of Physical Geography, University of Helsinki, began on March 1 1996 with the appointment of Sanna Sorvari and Milla Rautio as researchers 100% funded by this project. Since their appointment a considerable amount of fieldwork has been done on our subarctic research site Lake Saanajärvi.

The first few months of the project were spent on the improvement of existing and addition of new fieldwork equipment (e.g. boat, weather station, sampling equipments, bottles) as well as collection of background data on our study lake. The fieldwork started in May with the collection of six parallel surface sediment cores from the deepest part of the lake from ice. The main fieldwork season, during which the lake was sampled for water chemistry, phyto- and zooplankton, and epilithic diatoms, commenced in July 1996, although occasional water chemistry samples were collected already during the ice-melt period. During the open-water season (June 4 - September 24), the lake was sampled twice a month for complete water chemistry from the deepest point of the lake (24 m) using a water column profiling and 10 depths. The summer field work has provided more than 100 high-quality water chemistry samples. During the ice-cover period, the sampling frequency was reduced to one complete profile sampling every second month. The water chemistry was analysed in the Laboratory of Physical Geography and Lammi Biological Station supervised by Dr. J. Virkanen using the internationally agreed standards.

In addition, samples for zoo- and phytoplankton analyses were collected from the pelagic area and samples for periphyton analyses from littoral zones. Sediment traps for investigating the relationship between living organism communities and those in thanatocoenoses were also installed in the lake.

The automatic weather station was established on the shore of L. Saanajärvi at the beginning of July 1996. Since then, almost continuous measurements of 7 meteorological variables (air temperature, epilimnetic water temperature, relative humidity, wind speed, wind direction, infrared radiation, precipitation) has been carried out, mostly by using 30 minute mean values. However, because of problems associated with the energy supply, some interruptions in the operation of the station were faced during the first few weeks after installation.

#### 2. Water chemistry measurements and physical data

Water chemistry samples were taken twice a month during the open water period and approximately once every two months during the winter. Samples for major ions, TOC, SO<sub>4</sub>, Si, NH<sub>4</sub>-N, and NO<sub>2</sub>-N. were sent immediately to the Laboratory of Physical Geography for analysis, whereas total phosphorus and nitrogen were frozen and dealt with later. Oxygen, pH, temperature

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and conductivity were measured *in situ* using equipment from HANNA Instruments. Alkalinity was measured in the laboratory within 24 hours. Selected chemical parameters and lake characteristics are listed in Table 1.

Table 1. Chemical and physical parameters and lake characteristics of Lake Saanajärvi. Values in parenthesis express the range.

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Parameter	Value
Latitude	69°3' N
Longitude	20°52' E
Altitude	679.4 m asl
Water shed	460.59 ha
Lake area	69.86 ha
Max. depth	24 m
Secchi	5.7-10.4 m
Max. surface temperature	15.4°C
pH	6.1-7.3
Conductivity	24.2-31.7
Alkalinity	
Oxygen	9.45-12.9 mg/l

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### 3. Plankton studies including chlorophyll-a

Both phyto- and zooplankton samples were taken bi-monthly during the ice-free period from the deepest part of the lake (24 m) and the littoral. Five depths (0, 2, 5, 10, 24 m) were sampled in the pelagic and two in the littoral (0, 2 m) with a core-type water sampler. 250 ml of water was stored for phytoplankton analyses and 10 l for zooplankton (sieved through 50 µm). In addition, phytoplankton qualitative samples were taken from both habitats with a 10 µm net, and zooplankton qualitative samples with 100 µm and 50 µm nets from the pelagic and littoral respectively. In the littoral, qualitative sampling was performed from very shallow water. In the pelagic also several vertical zooplankton hauls were taken from the water column using a 200 µm plankton net.

Phytoplankton was dominated by chrysophytes and diatoms, chlorophytes were also abundant. Quantitative analyses are in progress. The crustacean zooplankton community was formed by ten species of which the copepods *Cyclops abyssorum* and *Eudiaptomus graciloides* were most abundant. *Holopedium gibberum* was the dominant cladoceran. The table in Appendix lists the preliminary species data of phyto- and zooplankton. Table 2 compares the abundance of calanoids, cyclopoids and cladocerans during the sampling season. The more precise counting, and identification of rotifers, is in progress.

A composite sample for chlorophyll-a was taken from ten depths simultaneously with plankton sampling. 2-3 l of water were filtered immediately at the lake from each depth. Filters were frozen for analyses and chlorophyll-a analysis is in progress.

Table 2. Abundances of groups Calanoida, Cyclopoida and Cladocera

Group	Mean abundance ind./m <sup>3</sup>	Maximum abundance ind./m <sup>3</sup>	Minimum abundance ind./m <sup>3</sup>
Calanoida	439	626	200
Cyclopoida	131	330	5
Cladocera	81	180	5

#### 4. Sediment studies

The sediment of the L. Saanajärvi seems to be of good quality containing well preserved diatom frustules and chironomid head capsules. However, considerable problems are associated with the preservation of cladoceran remains. Counting of diatom, cladocera and chironomid samples from the sediment cores is in progress. Preliminary results of diatom analysis, including the application of the currently available inference models for predicting lakewater temperature and pH, have already been assembled (Sorvari *et al.*, 1997).

Six sediment cores from Lake Saanajärvi were collected during 5.5-11.5. 1996 with a Glew corer. The sediment cores were taken from the deepest part of the lake (24 m) from ice. Each core was extruded in the field at 2 mm intervals from 0 to 20 cm and the rest of the core was subsampled at 5 mm intervals. Due to the small diameter of the core (65 mm) extra cores were taken (recommended 4 cores). Subsamples were moved to plastic bags and stored at 4°C in the Laboratory of Physical Geography, Helsinki. PhD student Philippa Noon from the Environmental Change Research Centre (ECRC, University College London) helped with the sediment coring.

Subsamples from core 1. were immediately stored frozen and transported to Dr. Andrea Lami, Pallanza (Italy) for pigments analysis in June 1996. Core 2. is stored for chironomid analysis and for loss-on-ignition (LOI) in the Laboratory of Physical Geography. PhD student Heikki Olander is responsible for chironomid analysis which will be carried out during 1997-1998. From master core 3. 0.5g of wet sediment was subsampled for chrysophyte analysis. The chrysophyte material was sent to Dr. Nigel Cameron (ECRC, London) for further analysis in June 1996. In Autumn 0.2g of wet sediment was subsampled and prepared for diatom analysis. The rest of the sediment was dried and the loss-on-ignition analysis carried out. Sediment datings and SCP were impossible to do at the master core due to the small amount of available material. Therefore core 4. was selected for dating and SCP-analysis. Subsamples of SCP were dried and 0.1g of each subsample sent to Dr. Neil Rose to ECRC (London) and the dating material to Prof. Peter Appleby to University of Liverpool. Final results of the SCP-analysis are already available and dating analysis are in progress. Cladocera analysis is also in progress from core 5, core 6. is stored for back-up.

Sediment traps were placed in the Lake Saanajärvi in the beginning of July. The traps are located at two different depths (10 m and 23 m). Accumulated material was collected monthly during the open-water season and after the autumn overturn traps were left for the ice-cover period. Trap

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assemblages consisted mainly of suspended and resuspended planktonic diatoms (*Cyclotella* and *Aulacoseira* species).

## 5. Other activities

A diatom taxonomic workshop for potential amalgamation of AL:PE, Swiss and Finnish Lapland diatom calibration data-sets was held in Helsinki in October 1996 with the participation of Drs. N.G. Cameron (London), K. Koinig (Innsbruck), A.F. Lotter (Bern) and S. Sorvari and J. Weckstrom (Helsinki). The workshop provided a high-quality taxonomic monograph which will be very useful in the identification of certain problematic diatom taxa characteristic of high mountain lakes. (see Appendix)

### People involved:

Dr. **Atte Korhola**, Lab of Physical Geography, University of Helsinki. National coordinator of the project. Responsible for cladocera analysis of the Finnish site. Supervisor of S. Sorvari, H. Olander, and J. Weckström.

PhD student **Sanna Sorvari**, Lab of Physical Geography, University of Helsinki, responsible for modern and fossil diatom analysis.

PhD student **Milla Rautio**, Div. of Hydrobiology, University of Helsinki, responsible for zooplankton analysis.

PhD student **Maria Laamanen**, Div. of Hydrobiology, University of Helsinki, responsible for phytoplankton analysis.

PhD student **Heikki Olander**, Lab of Physical Geography, University of Helsinki. Responsible for chironomid analysis.

PhD student **Jan Weckström**, Lab of Physical Geography, University of Helsinki. Responsible for the development of a modern diatom-environment calibration data-set for northern Finland.

PhD student **Juhani Virkanen**, Lab of Physical geography, University of Helsinki, responsible for water chemistry determinations.

PhD student **Seppo Hassinen**, Lab of Physical Geography, University of Helsinki, responsible for meteorological measurements.

Mc.S. **Petri Shemeikka**, Lab of Physical Geography, University of Helsinki, laboratory assistant.

Mc.S. **Matti Horttanainen**, Lab of Physical Geography, University of Helsinki. Field assistant.

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Appendix 1. List of plankton species found in the water column during the open water period

PHYTOPLANKTON

**Cyanoprokaryota**

*Chroococcus* sp.  
*Cyanodictyon planctonicum*  
*Cyanodictyon reticulatum*  
*Microcystis reinboldii*

**Cryptophyta**

*Cryptomonas ovalis*  
*Cryptomonas* sp.  
*Katablepharis ovalis*  
*Rhodomonas lacustris*

**Dinophyta**

*Gymnodinium* spp.  
*Gyrodinium* sp.

**Chromophyta**

**Prymnesiophyceae**

*Chrysochromulina* sp.  
*Pseudopedinella* sp.

**Chrysophyceae**

*Bitrichia chodatii*  
*Chrysidiastrum catenatum*  
*Chrysolykos skujai*

*C. rossii*  
*C. schumannii*  
*Cymbella* sp.  
*Denticula tenuis*  
*Denticula* sp.  
*Eunotia* sp.  
*Fragilaria arcus* var. *arcus*  
*Fragilaria* sp.  
*Navicula* spp.  
*Nitzschia* sp.  
*Pinnularia* sp.  
*Surirella* sp.  
*Synedra* sp.

*Dinobryon bavaricum*  
*D. bavaricum* var. *vanhöffenii*  
*D. cylindricum*  
*D. crenulatum*  
*D. divergens*  
*D. sertularia*  
*D. sociale* var. *americana*

**Conjugatophyceae**

*Cosmarium* sp.  
*Kephyrion* sp.  
*Mallomonas pulchella*  
*Mallomonas* spp.  
*Paraphysomonas* sp.  
*Pseudokephyrion* sp.  
*Spiniferomonas* sp.  
*Stighogloea deoderleinii*  
*Uroglena americana*  
*Uroglena* sp.

**Diatomophyceae**

*Achnanthes minutissima*  
*Achnanthes* sp.  
*Asterionella formosa*  
*Aulacoseira italica* subsp. *subarctica*  
*A. Italica* subsp. *subarctica* type II  
*A. Italica* var. *valida*  
*Cyclotella antiqua*  
*C. bodanica* var. *lemanica*  
*C. comensis*

*Tabellaria fenestrata*  
*T. flocculosa*

**Chlorophyta**

**Chlorophyceae**

*Ankistrodesmus* sp.  
*Carteria* sp.  
*Chlamydomonas* sp.  
*Crucigeniella rectangularis*  
*Elakatothrix gelatinosa*  
*E. genevensis*  
*Koliella* sp.

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*Monoraphidium dybowskii*  
*Monoraphidium* sp.  
*Oocystis lacustris*  
*Spondylosium planum*  
*Tetrastrum komarekii*  
*T. staurogeniaeforme*

## ZOOPLANKTON

### **Cyclopoida**

*Cyclops abyssorum*

### **Calanoida**

*Eudiaptomus graciloides*

### **Cladocera**

*Holopedium gibberum*

*Daphnia longispina*

*Bythotrephes longimanus*

*Bosmina obtusirostris*

*Alonella nana*

*Alonella excisa*

*Chydorus sphaericus*

*Polyphemus pediculus*



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## Partner 3

### MOLAR SCIENCE REPORT

**Department of Geology and Geophysics  
Edinburgh University**

**Roy Thompson  
Anna Agustí-Panareda**

#### **Data gathering**

We have begun assembling monthly time series of temperatures, pressure and precipitation. The monthly temperature records in our data base presently consist of: 23 long series of 208 years (1781-1988) in central Europe; 19 series of 101 years (1890-1990) in the Scandinavian area; 5 series of 100 years in Russia; 16 series of 28 years (1952-1979) in Spain and France; and about 50 series of 58 years (1931-1988) in the Alpine region and Britain. There are fewer long series for monthly precipitation, namely 20 series of 200 years in Europe. Most pressure series are short, except for the series of 200 years from Edinburgh, Geneva and Basel, as well as the series from Saentis (1883-1988), Zurich (1864-1988) and Paris (1874-1987).

#### **Study of climatic spatial variability**

Before making a reconstruction of the climate at the Molar sites it is necessary to know how a given climatic variable varies in space (from one site to another). That is to say, we need to know how representative a particular site is of its surrounding area. We have carried out spatial variability studies for monthly and seasonal temperature in the Pyrenees and northern Scandinavian. Monthly temperature at our highest elevation reference series site in the Pyrenees (Pic du Midi) is better correlated with French sites in winter and with Spanish sites in spring. Generally, correlations are highest along a south-west north-east direction. In contrast, for Norway, Sweden and Finland, the spatial variation of temperature is found to be more isotropic, that is, the correlation coefficient between temperature series decreases radially.

#### **Climate reconstruction for the last 200 years using stepwise multiple regression**

The ability of our method to reconstruct climate back in time for a given site or region depends on three main factors. Namely, (i) the homogeneity of the reference time series used, (ii) the representativeness of the reference sites for the given region and (iii) the local climatic lapse rate. The mean error associated with our reconstructions has been computed for the Scandinavian region. For northern Scandinavia annual temperature prediction errors are less than 0.3 °C. In the south of Scandinavia reconstruction errors are closer to 0.1 °C. Annual prediction errors are three times less than typical monthly errors. We anticipate errors of less than 0.1 °C for annual temperature reconstructions at most of the Molar sites due to factor (ii).

As a preliminary example of our work, the warming trend per century has been calculated using 208 year reconstructed series in Scandinavia. Contours of the warming trend are plotted in figure a. Note the decrease in warming trend from the west (0.4 °C/century) to the east (0.0 °C/century). There are two errors associated with the accuracy of the trend. Namely, the error of the reconstruction (factors

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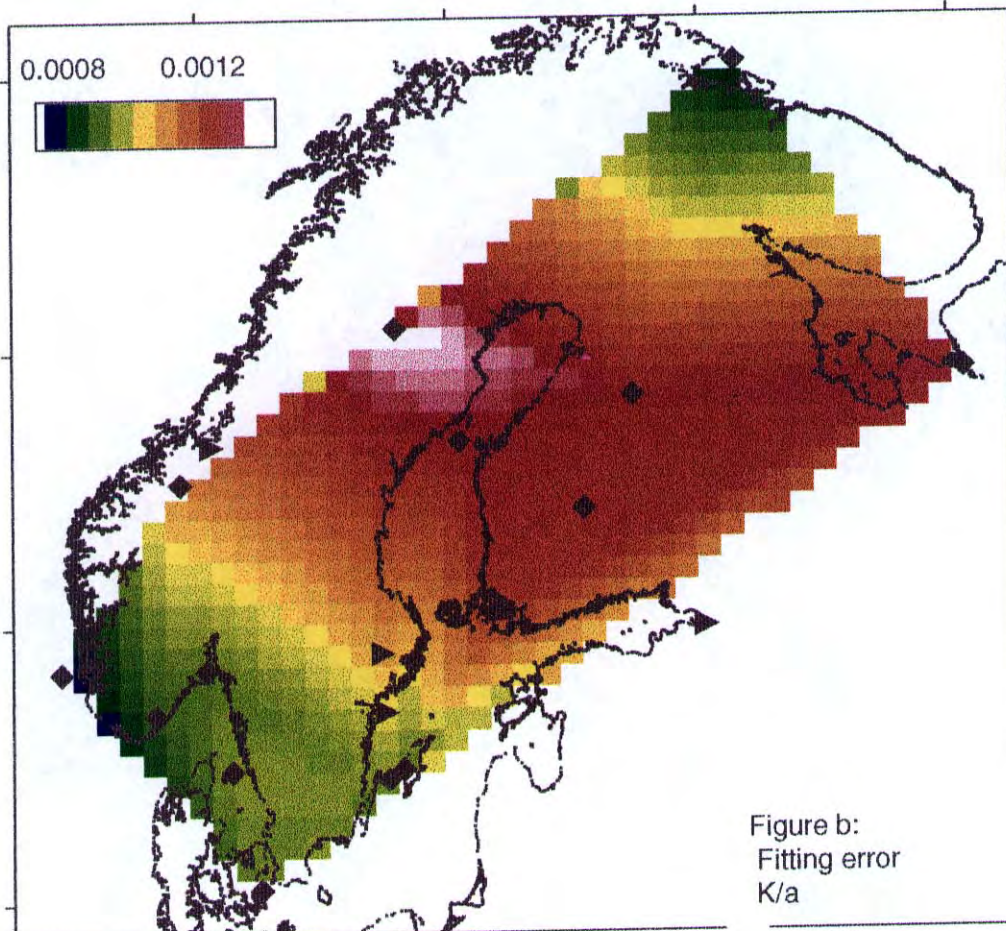
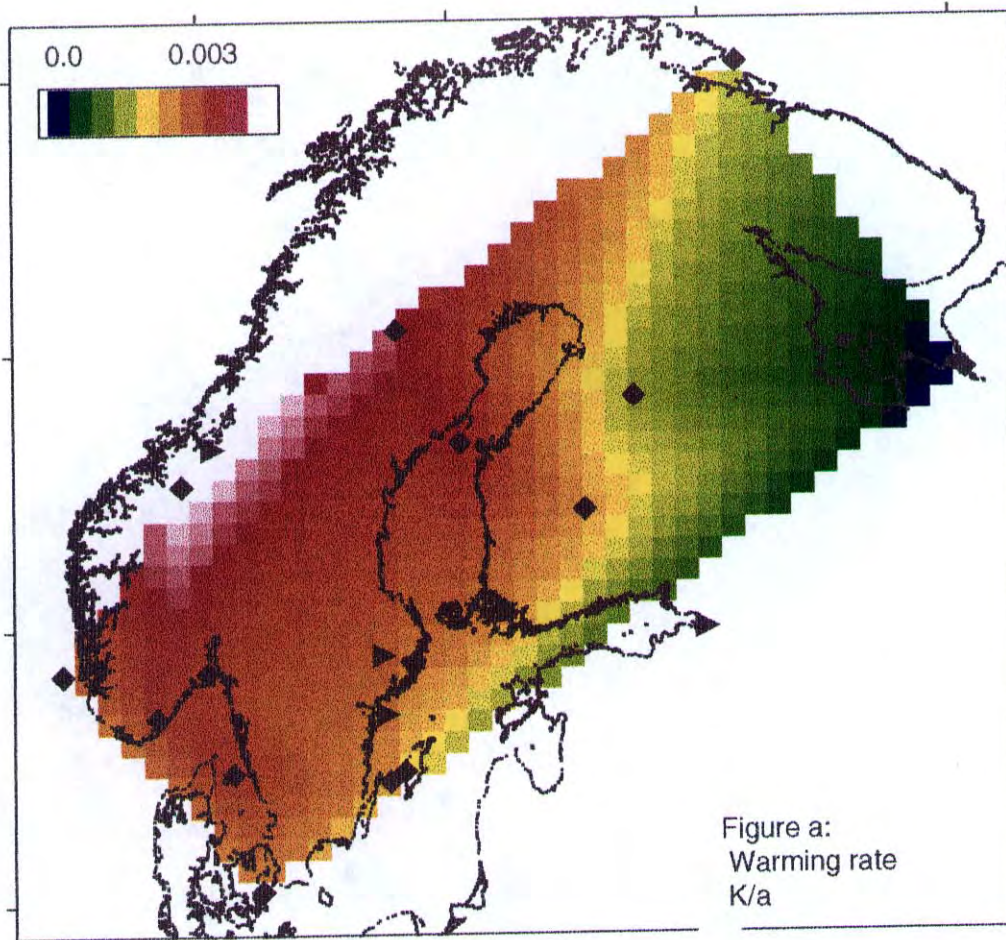
(i), (ii) and (iii)) and also the error of fitting the linear trend in the series (Figure b plots the spatial variability in the fitting error).

The fitting error is largest in the central and eastern areas of Scandinavia where the temperature variance is also highest.

### **Future work**

The main tasks to be undertaken in the next 12 months are:

1. To check the homogeneity of the reference series.
2. To extend the reference series to the present day (1997).
3. To acquire additional climatic data in local areas. e.g. Pyrenees, S.Alps.
4. To apply the multiple regression method to all work package III sites.
5. To integrate our climate work with data obtained from the automatic weather stations and hence to take into account local climatic effects in our reconstructions.
6. Finally, to reconstruct variations in radiation, growth season and ice cover duration at the Molar sites for use in modelling studies of the temporal responses of remote mountain lakes to climatic variability.



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RESULTS AND/OR PRACTICAL DIFFICULTIES OF DEPLOYING AWSs IN REMOTE  
MOUNTAIN AREAS.  
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SUMMARY

The first phase of the automatic weather station work has been extremely successful. Installation of the ten MOLAR automatic weather stations (AWS) was completed between July and October 1996. Tower damage from winter storms has been repaired. All stations are now fully operational again.

If the AWSs can be run for the full MOLAR period and hence sample as wide a range of synoptic and local circulation situations as possible they will not only provide an excellent meteorological data base for remote mountain regions but also allow accurate reconstructions of past climate change to be made at the MOLAR sites. Transfer functions with lowland and midland meteorological data should permit the variations of many climatic and water parameters to be reconstructed for modelling work.

While it was originally hoped to generate monthly climatic series for the last 200 years, there now appears to also be scope to reconstruct daily series for perhaps the last ten years (i.e through the ALPE monitoring period) at all ten AWS sites.

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ULI NICKUS (AUSTRIA)  
SITE: GOSENKÖLLESEE

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- \* MOLAR site near Innsbruck.
- \* American weather station.
- \* Parameters: Air pressure, temperature (max, min, mean ), precipitation, relative humidity, wind direction, wind speed, dew point, wind chill.
- \* Rain gauge: incremental measuring device, there is something to heat the water which prevents freezing.
- \* The computer in the AWS has some software to calculate mean values, max, min temperature every ten minutes.
- \* It is possible to print the data or to store the data into X files.

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NEIL ROSE (SCOTLAND)

SITE: LOCHNAGAR

\*\*\*\*\*

- \* Molar site is located at Balmoral (AWS has been painted green).
- \* Installed on 29th August (1996).
- \* Parameters: Wind speed, wind direction, air temperature, relative humidity, air pressure, relative humidity, rainfall.
- \* The nearby Cairngorms weather station since has been operating since 1985.
- \* Problems: November (?), December (?). Strong winds damaged the wind direction measuring device.
- \* Weather data available from station nearby (Institute of Hydrology ) to use in the overlapping period in order to compare with AWS data.
- \* Large variability of wind speed, back wall sheltering of Lochnagar affects the measurements of wind direction.

LEIF LIEN (NORWAY)

SITE: ØVRE NEÅDALSVATN

\*\*\*\*\*

- \* Operating since July 1996.
- \* It stopped in January for two months.
- \* The AWS will operate until at least Oct 1997.
- \* Parameters: wind speed average, wind speed max, wind direction, air Temperature, humidity, solar radiation, net radiation, precipitation (no measurements of snow).
- \* There is another met station nearby (500m horizontal, 500m vertical from lake).
- \* Nearest met. stations down at sea level are at two airports quite close to the site.
- \* Data from stations nearby might be possible to obtain from the Met. Institute.

ATTE KORHOLA (FINLAND)

SITE: SAANAJÄRVI

\*\*\*\*\*

- \* Site located at northeast corner of Finland.
- \* Water temperature sensor measures continuously the temperature of the lake.
- \* Parameters: AWS Includes all sensors except air pressure.
- \* Installed 1st of August 1996 and it has worked more or less continuously since.
- \* Problems at the beginning with battery (it was not strong enough), and it had to be changed.
- \* AWS is a Finnish model.
- \* Warm period during the first two weeks of ????
- \* Wind speed correlated with lake temperature.
- \* Profile of water temperature measurements: thermal stratification of lake during the warm period.
- \* There is a met station located on top of a hill near the MOLAR site which is run by the Finnish Met office. Until now there hasn't been any negotiation to exchange the data, and it is quite expensive

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to get data from the Finnish Met office.

Question: \* Snow depth and snow water content.

FERDINAND SPORKA (SLOVAKIA)

SITE: NIZNE TERIANSKE

\*\*\*\*\*

- \* Snow cover ?
- \* Vegetation ?
- \* Location of Molar site: 49 o 10'N 20o 00' E, elevation=1941m.
- \* Lake area
- \* AWS has been moved to a new location.
- \* AWS was installed on 15th August 1996, stop measuring 15th October 1996 (in winter the measurements stopped).
- \* Problems with AWS: 30th Aug-19th Sep. AWS stopped due to problems with battery.
- \* There is a weather station nearby, it might be possible to get data.

ANTON BRANCELJ (SLOVENIA)

SITE: JEZERO

\*\*\*\*\*

- \* Station is on top of roof.
- \* AWS was installed in September 1996 and it has been nearly continuously working until the 10th of March (-20oC, ice and high wind speed affected the wind speed detector).
- \* Parameters: Temperature, relative humidity, precipitation.
- \* Stanaresna station
- \* Scanate lake - There is an astronomical institute located there which measures various meteorological parameters (AWS) and exchange of data is possible.

MARC VENTURA (SPAIN)

SITE: ESTANY REDO

\*\*\*\*\*

- \* AWS was installed at the beginning of October 1996.
- \* In winter 140 km/h winds made the tower fall down. One month later the AWS was installed again, and then there were some problems with the battery. Now it works properly.

ANDREA LAMI (ITALY)

SITE: LAGO PAIONE SUPERIORE

\*\*\*\*\*

- \* Elevation of Molar site = 2200 meters.
- \* All parameters are measured except air pressure.
- \* The station runs with battery.
- \* The AWS was installed in August 1996 and it has been working until now.



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\* There has been almost no summer in 1996 (very cold) at the Molar site.

KURT HANSELMANN (SWITZERLAND)

SITE: JÖRISEE

\*\*\*\*\*

- \* Snow already in September 1996 in the Alps.
- \* The mast of the AWS is 10m high, and it has stayed straight.
- \* Water parameters to obtain radiation transfer functions into water (radiation reflected and into the water).
- \* All meteorological parameters including long wavelength radiation.
- \* Problems: - Light in shields, freezing (electricity is needed in order to heat instruments and it has to be produced), animals do not respect the fence and eat electrical connections.
- \* Data has been measured from three different positions, in order to see what corrections have to be made to the data when it is transferred to other places and elevations.

DAVID LIVINGSTONE (SWITZERLAND)

SITE: HAGELSEEWLI

\*\*\*\*\*

- \* Parameters: air temperature, precipitation, wind speed and wind direction, relative humidity (it does not work at temperatures below 0oC).
- \* The mast of the AWS was bent due to the snow accumulated on the string holding the mast. This can only have caused problems to the wind direction sensors.
- \* Mostly NE wind.

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## DATA TRANSFER

The first set of AWS data from Switzerland, Scotland, Slovakia, Slovenia and Norway have been sent to EAWAG-Zurich.

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## POSTSCRIPT

### 1. WMO DATA

Since the Barcelona meeting we have succeeded in obtaining daily meteorological data for over eight parameters from some 2000 European WMO stations covering the time period of operation of the MOLAR work package-3 sites. This significant enhancement of our data base opens up a disconcertingly large range of additional possibilities for statistical climatological analyses [MOLAR.2 or a work package-x needed?].

- (i) most gaps in the MOLAR AWS records should now be able to be filled.
- (ii) Quantitative differences between lowland, valley and mountain weather,

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in the vicinity of the MOLAR stations, can now be investigated for a range of time scales.

(iii) The representativeness of the long-term lowland stations for valleys close to the MOLAR mountain sites can be statistically assessed.

(iv) It may be possible to parameterise empirically some additional meteorological variables (e.g. global radiation, relative humidity) in terms of the long-term variables (air pressure, air temperature and precipitation), and to assess the accuracy of such parameterisations.

(v) Reconstructions of many daily meteorological variations at the MOLAR sites, e.g. for use in modelling studies, may now be possible for each day for the last five to ten years.

## 2. LOCAL DATA

Additional data from local nets, i.e. from within a few km of the MOLAR AWS sites and especially from similar altitudes, however, remains as an important gap to be filled where ever possible. It is needed in order to determine local lapse rates and exposure. Radiation data in mountain areas, and information on its spatial coherence [the Hanselmann phenomenon] also remains in particularly scarce supply.

RT/APA/DL (27-5-1997)



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## Partner 4

**Contractor:** Norwegian Institute for Water Research (NIVA)

**Leading Scientist:** Bente M. Wathne

**Scientific Staff:** Bjørn Olav Rosseland, Leif Lien, Sigurd Rogenrud, Dick Wright (NIVA)  
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### I OBJECTIVES FOR THE REPORTING PERIOD

- Scientific co-ordination of MOLAR
- Co-ordinate Work Package 1 activities, including special responsibility for fish in Work Package 1 and 2, and general water chemistry (see Appendix F and G)
- Sampling and analysis after the agreed MOLAR programme for Neådalsvatn, Stavsvatn, Limgambergtjern and Arresjøen (see Appendix E).
- Heavy metal analysis in deposition and lake water for Redo and Gossenköllesee
- Produce the first version of the MOLAR Project Manual

### II OBJECTIVES FOR THE NEXT PERIOD

- Scientific co-ordination of MOLAR
- Co-ordinate Work Package 1 activities, including special responsibility for fish in Work Package 1 and 2, and general water chemistry
- Sampling and analysis after the agreed MOLAR programme for Neådalsvatn, Stavsvatn, Limgambergtjern and Arresjøen
- Heavy metal analysis in deposition and lake water for Redo and Gossenköllesee
- Report WP 1 results and edit annual progress for the total project

### III MAIN RESULTS OBTAINED

#### *SUMMARY REPORT OF SAMPLING AT THE NORWEGIAN SITES*

##### 1. ØVRE NEÅDALSVATN - WP 1, 2, 3 SUMMARY REPORT OF SAMPLING

Leif Lien, NIVA

The sequence of the different MOLAR subjects follow the "Project Manual" (Wathne 1996):

#### Meteorology

Aanderaa weather station measure every 30 minutes: Air temperature, humidity, wind speed (average and max.), wind direction, precipitation, water temperature (outlet), radiation (in and reflecting).

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Operating from 18. July 1996. Stopped 20 January 1997.  
Under repair. Planned to operate until September 1997.

**Atmospheric deposition**

- Direct deposition** Bulk deposition sampled weekly since ca 1978 analysed for major ions and heavy metals. Hg sampled from 1996. All by NILU.
- Snow pack** Sampling planned in April/May 1997
- Soil cores** Sampling planned in July 1997

**Surface water**

**Major ions and nutrients**

Sampled every 2-3 week since 1993 for major ions and from July 1996 also for nutrients.

**Heavy metals** Sampled July 1996, September 1996, February 1997.

**Heavy metals (Speciation)**

Not sampled. No plans for sampling

**Radionuclides** Not sampled. No plans for sampling

**Organic micropollutants**

Not sampled. No plans for sampling

**Water column profiling**

(Temperature, Secchi disk, Oxygen, pH, Conductivity, Chlorophyll.)

Sampled in: July, August, September 1996, and February 1997.  
Will be sampled in April/May, and three times during summer 1997.

**Invertebrates**

(Quantitative samples from 5 m and deepest area. Qualitative samples from lake littoral, inlet- and outlet stream.)

Sampled in July, August and September 1996.  
Will be sampled at corresponding times in 1997.

**Microbial (Pelagic) food webs - 1st level (including zooplankton)**

(Bacteria, heterotrophic nanoflagellates, ciliates, picocyanobacteria, phytoplankton, and zooplankton.)

Sampled in July, August and September 1996.  
Will be sampled at corresponding times in 1997.

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**Microbial (Pelagic) food webs - 2nd level**

Sampled in August 1996.  
Will be sampled at similar time in 1997.  
**Primary production, <sup>14</sup>C** Measured in August 1996.  
Will be measured at similar time in 1997.

**Sediment coring**

(Organics, <sup>210</sup>Pb, dry weight, loss-on-ignition, spheroidal carbonaceous particles, metals, chironomid, pigment and CNS, grain size, and cladocera.)

Sampled September 1996.

**Diatoms (living)**

**Littoral and plankton diatoms**

Sampled in July, August and September 1996.  
Will be sampled at similar times in 1997.

**Diatom transect**

Not performed in 1996. Not planned in 1997

**Sediment traps for Diatoms, <sup>210</sup>Pb, SCP, and Chrysophycean**

Introduced in July 1996. Emptied in September 1996.  
Will be emptied in July and September 1997.

**Chrysophycean**

**Sediment core**

Sampled in September 1996

**Plankton samples**

Sampled in July, August, and September 1996.  
Will be sampled at similar times in 1997.

**Spheroidal Carbonaceous Particles**

**Sediment**

Sampled in September 1996

**Sediment trap**

Sampled in September 1996  
Will be sampled in July and September 1997.

**Snow**

Sampled in February 1997. Planned to sample in April/May 1997

**Bulk Deposition**

Sampled by NILU, and sent to UCL.

**Lake water**

Sampled in July, August, and September 1996.  
Will be sampled at similar times in 1997.

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### **Organic Micropollutants**

<b>Sediment core</b>	Sampled in September 1996
<b>Wet-only deposition</b>	Not sampled
<b>Dry deposition</b>	Not sampled
<b>Bulk deposition</b>	Not performed in 1996. Planed for summer season 1997
<b>Snow</b>	Could be sampled in April/May 1997
<b>Water</b>	Not performed in 1996. Could be planed in 1997
<b>Air</b>	Not performed in 1996. Could be planned in 1997

### **Fish sampling**

<b>Test fishing</b>	Planned in August/September 1997
<b>Fish physiology</b>	Planned in August/September 1997
<b>Fish histology</b>	Planned in August/September 1997
<b>Heavy metals</b>	Planned in August/September 1997

### **Organic micropollutants**

Planed in August/September 1997

### **Data flow**

On request by MOLAR participants/responsibles, some data have been mailed.

## **2. STAVSVATN - WP 1.**

Leif Lien, NIVA

### **Meteorology**

Not included in WP 1. Meteorological station near by.

### **Atmospheric deposition**

Not included in WP 1. Some data available from near by NILU stations.

### **Surface water**

<b>Major ions and nutrients</b>	Sampled July, August, September (2), and December 1996 (Sampled each September/October since 1986 for major ions)
<b>Heavy metals</b>	Not included in WP 1. Sampled July 1996, September 1996.

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### **Invertebrates**

(Quantitative samples from 5 m and deepest area. Qualitative samples from lake littoral, inlet- and outlet stream.)

Sampled in July and September 1996.

Will be sampled at corresponding times in 1997.

### **Microbial (Pelagic) food webs - 1st level (including zooplankton)**

(Bacteria, heterotrophic nanoflagellates, ciliates, picocyanobacteria, phytoplankton, and zooplankton.)

Sampled in July, August and September 1996.

Will be sampled at corresponding times in 1997.

### **Sediment coring**

(Organics, <sup>210</sup>Pb, dry weight, loss-on-ignition, spheroidal carbonaceous particles, metals, chironomid, pigment and CNS, grain size, and cladocera.)

Not included in WP 1. (Some parameters sampled in the AL:PE project)

### **Diatoms (living)**

#### **Littoral and plankton diatoms**

Sampled in July, August and September 1996.

Will be sampled at similar times in 1997.

### **Chrysophycean**

#### **Sediment core**

Not included in WP 1. (Sampled in the AL:PE project)

### **Fish sampling**

Not originally included in WP-1. Sampled in September 1996

#### **Test fishing**

Performed by Norwegian Institute for Nature Research in August/September 1996.

#### **Fish physiology**

Sampled in September 1996. Re-sampling of blood in 1997.

#### **Fish histology**

Sampled in September 1996.

#### **Heavy metals**

Sampled in September 1996.

#### **Organic micropollutants**

Sampled in September 1996.

### **Data flow**

On request by MOLAR participants/responsible, some data have been mailed.

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## 9 ARRESJØEN - WP 1 Secondary site

S. Rogenrud, NIVA

### Surface water

**Major ions and nutrients**      Sampled June 1996

## 20 LIMGAMBERGTJERN - WP 1 Secondary site

S. Rogenrud, NIVA

### Surface water

**Major ions and nutrients**      Sampled June, August, September, and October 1996

## *SUMMARY REPORT ON FISH*

Bjørn Olav Rosseland, NIVA

The sampling programme for fish in Work Package 1 and 2 was to follow the descriptions in the "Project Manual" (Wathne 1996): Prior to the sampling period, representatives for the national laboratories responsible for performing the testfishing and analysing the different fish tissues, participated in a workshop in Arcachon, France on the 14th of June, 1996, see report from the meeting (Appendix B).

Based on the practical performance under field conditions, several procedures had to be revised. A video tape was made showing the different modified procedures, and circulated to all laboratories prior to the field work in 1996.

Kits for special tissue and blood sampling was sent from each responsible institution to the different groups, according to manual. With only few exceptions, sampling were performed as planned, and samples delivered successfully to the analysing laboratories by special mail.

In 1996, five lakes were sampled: Arresjøen and Stavsvatn (Norway), Chuna lake (Russia), Jörisee (Switzerland) and Etang d'Aubè (France), see Table 1. To be able to get more representative age groups for the analyses of heavy metals in tissue, Stavsvatn and Jörisee will be resampled in 1997.

At the MOLAR Meeting in Barcelona, Spain, another Fish Workshop was held on the 22nd of April 1997, see Agenda. Reports were given from the field work, and the practical experience with the manual was discussed. No major revision of the existing manual was necessary. Based on the at present results, decisions on resampling for 1997 was taken, and the programme for 1997 was set, see Table 1. Additional water chemistry parameters was discussed, related to the analysed concentrations of heavy metal in fish tissue (see report from Sigurd Rognerud, NIVA, Work Package 2).

Plans for a third Fish Workshop was discussed. It will be held at Kola, Russia, in 1998.

Table 1 .Status for fish sampling and analyses pr. April 1997.

Site	Lake	Sampled	Age NIVA	Heavy metals NIVA	Histol. Kidney, liver, gill UIBK	Blood CNRS	Gill Scanning CNRS	Histology EMS CNRS	Organics CSIC
1	Arresjøen	1996	done	done	done	missed	done	prepared	prepared
3	Chuna	1996	prepared	local?	done				
4	Øvre Neådalsv	1997							
5	Stavsvatn	1996 1997	done	done	done	missed	done	prepared	prepared
12.1	Estany Redo	1997							
13	Etang d'Aubè	1991,1994 1996, 1997	coming	done	done	done	done	prepared	prepared
17.2	Gossen- köllesee	1997							
24	Jörisee	1996 1997	done	done	done	missed	done	prepared	prepared

### Heavy metal in fish.

Sigurd Rogenrud, NIVA

In 1996 we collected fish samples from 4 lakes (Arresjøen, Jörisee, Etang d'Aubé and Stavsvatn), and the total of 89 individuals (25, 15, 25, 24, respectively) were analysed for metals in liver and kidney and mercury in muscle. We did a broad screening of elements (Na, Mg, Ca, Ti, Mn, Fe, Hg, Co, Cu, Zn, As, Se, Pb, Sr, Mo, Ag, Cd, Cs, La, Ce) in kidney and liver and these results were presented as a scatterplot matrix together with data (length, weight, age) from each individual fish. We want to couple information like covariation, similarities, concentration gradients etc. in the liver and kidney scatterplots) with lake chemistry, atmospheric deposition of trace elements and ecosystem structure. The data will be analysed in a multivariate statistical test and the results will be coupled with the data from physiology and histology of each individual fish. We want to test if changes in physiological parameters and/or changes in histology like lipid degeneration of the liver, can be coupled to metal stress or high metal concentrations in fish from the most diluted lakes. In 1997, 3 more lakes will be sampled (Gossenköllesee, Øvre Neådalsvatn, and Estany Redo). We also want to extend our data set in Jorisee with 10 more individuals of salmo trutta in the size-group 10-20cm. Based on conclusions from our preliminary results, the Fish-group has also asked the MOLAR Steering Committee to see if there is possible to get data on accumulation rates of Hg, Se, Pb, Cd, Zn and Cu in recent sediments from all of our study lakes. We want to compare accumulation rates of metals in fish with accumulation rates of metals in sediments to get timecompatible data in our statistical analysis.

### **SUMMARY REPORT ON WATER CHEMISTRY AND ADMINISTRATION**

Bente M. Wathne, NIVA

Water chemistry have been sampled from all the MOLAR lakes according to the MOLAR Project Manual. Water samples are taken from the surface at the outlet of each lake following the agreed frequency in the Project Proposal: weekly in the ice-melt season, monthly or bi-weekly in summer and

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bi-monthly in winter. Only few sites are delayed with respect to transfer of analytical results (4 lakes from 2 areas have not transferred their data). When all results are received the data will be analysed and stored at the databases at NIVA and CNR-III.

Deposition samples and lakewater samples from Gossenköllesee, Redo and Øvre Neådalsvatn are analysed by Norwegian Institute for Air Research (NILU) according to plans.

A MOLAR Workshop on Sampling, Chemical Analysis and Quality Assurance of Atmospheric Deposition and Lake Water was organised in Pallanza June 5 - 7 1996. (See Appendix B.) Here the sampling methods and the analytical methods were discussed and the agreed methods used as a basis to update the MOLAR Project Manual.

During the first working year of the project, much effort was put into production of the MOLAR Project Manual. The first draft was printed in May 1996 after preparation and discussions during the first MOLAR meeting in Prague. After workshops under the different MOLAR topics (see Appendix B), the second version of the Project Manual was printed in September 1996. During the Barcelona meeting the MOLAR Project Manual was discussed and agreed with only minor changes. These changes are now taken in, and the final version of the MOLAR Project Manual will be printed during summer 1997.

Data bases are prepared for storing of both water chemistry results and fish information at NIVA. These databases should be working databases used during the project and before final storing in the main database at UIB.



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## Partner 6

### MOLAR Report for the period: 1-3-1996 to 28-2-1997

**Contractor:** Institute for Limnology  
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**Leading scientist:** Prof. Dr. R. Schmidt

**Scientific staff:** Mag. K. A. Koinig, C. Kamenik, J. Knoll

**Site.** Gossenköllesee, Tyrol, Austria

a) sediment cores (WP2 and 3)

5 cores were taken in July 96 with a gravity corer from 8 m water depth and immediately subsampled into thin sections (514 samples from 2.5 and 5 mm core sections). From all these WD, DW and LOI were analyzed, from core 3 additionally CHN. Subsamples were distributed according to the workpackages 2 and 3. Chrysophycean cyst assemblages were studied in SEM.

1997: Chrysophycean analyses from Terianske Pleso and Hagelsee  
Diatom analyses Gossenköllesee

b) sediment trap samples (WP2; WP3)

After ice-break in July 3 sediment traps (Pb, SCP; Diatoms/Chrysos) were located and samples collected monthly until November (ice-set). Chrysophycean cyst-analyses were started.

1997: Continuing Gossenköllesee  
Chrysos from Terianske Pleso

c) Phytoplankton, epilithon/epiphyton (WP1 and 3)

From July until November phytoplankton and littoral epilithon/epiphyton was sampled monthly. At a transect in July epilithic diatoms were collected (1 - 9 m) by divers.

1997: Continuing Gossenköllesee

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## Partner 7

**Contractor:** University of Barcelona, Department of Ecology (FBG)

**Responsible scientist:** Jordi Catalan

**Scientific staff:** Lluís Camarero, Marisol Felip, Maria Rieradevall, Sergi Pla, Marc Ventura, Frederic Bartomeus.

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### I. OBJECTIVES FOR THE REPORTING PERIOD:

- On site measurements of sulphur and nitrogen deposition on L. Redó (Pyrenees)
- Monthly measurements of surface water chemistry in L. Redó
- Invertebrate sampling during the ice-free period in L. Redo
- Monthly sampling of the pelagic food web in L. Redó
- Measurement of phytoplankton and bacteria activities in L. Redó
- Installation of an automatic weather station in Lake Redó
- Snow collection and chemical composition measurement in L. Redó
- Sedimenting particles sampling in Lake Redó
- Monthly measurements of physical, chemical and biological characteristics in the water column of L. Redó (Pyrenees) and L. Cimera (Gredos)
- Development of taxonomic system for chrysophytes
- Harmonise taxonomic procedures for key indicator taxa
- Sediment coring in L. Redó and L. Cimera

### II. MAIN RESULTS OBTAINED:

The first 6 month were devoted to development and harmonisation of methods as scheduled.

*On site measurements of sulphur and nitrogen deposition on L. Redó (Pyrenees) and surface water chemistry.*- We started collection of dry and wet deposition on shore of L. Redó during October as scheduled. Unfortunately, several unexpected large snowfalls covered the collecting devices quite early in December and, as a consequence, no further measurements of these variables have been possible throughout the winter. As soon as the collecting device will be free of snow and ice, we will re-start measuring. The short data series available up to now do not allow for significant comments, all weekly samples analysed has shown pH values between 5.2 and 5.7. From 20th to 22nd of January, 1997, there was a Saharian dust event in form of snowfall at the lake altitude, the melted snow showed pH 7.02 and 182  $\mu\text{eq l}^{-1}$  alkalinity. Surface chemistry in L. Redo have been carried out since July, 1996. We still have to record longer time series for meaningful results since variability has been low until now.

*Invertebrate sampling during the ice-free period in L. Redo .*-Samples to study the seasonal changes of contemporary invertebrates were taken accordingly with the methodology stated in the Project Manual. To the three scheduled sampling times (July, August and October), one more was added

(September) in order to better cover the seasonal variability. The accompanying table details the number and locations of the samples collected.

	July 17th	August 8th	September 11th	October 9th
Stony littoral	3	3	3	3
Profundal 20m	3	3	3	3
Profundal 27-30m	-	-	3	-
Profundal 40-50m	4	3	2	-
Inlet	1	1	1	-
Outlet	1	1	1	1
Outlet 200m	1	1	1	1
Outlet drift	1	1	1	1
TOTAL samples	14	13	15	9

Nearly all samples collected have already been sorted, and taxonomic identification to order and/or family have been carried out for some groups of organisms. In the littoral zones, macroinvertebrates increased with time from July to October. This increase was especially significant in September, when the crustaceans populations (chydorids) increased coinciding with a large growth of zygnetatales algae in the shallow littoral. If we do not consider this group, a progressive tendency of increasing mean abundance was shown for most invertebrates, except the plecopterans that had a maximum at the beginning of the summer seasons.

In the profundal zone, two different areas were sampled. The deepest one (around 50 m deep), in the centre of the lake, revealed that no fauna was inhabiting those sediments at any moment of the sampling program. At depths of 20-30 m, in a relatively flat area, where mosses and *Nitella* sp. are present, the macroinvertebrate community was composed by low numbers of Sphaericidae, Oligochaeta and Chironomidae larvae. All groups showed a slight increase in numbers in September, although heterogeneity between samples is quite high.

*Monthly sampling of the pelagic food web in L. Redó.* - Starting in July, 96 a monthly sampling is being carried in L. Redó for biomass evaluation of bacteria, phytoplankton, heterotrophic nanoflagellates, ciliates, rotifers and crustaceans. Samples are collected each 3 m and they have already been analysed and counted until February, 1997. Longer data series are required to establish seasonal trends for the main species.

*Measurement of phytoplankton and bacteria activities in L. Redó.* - Bacteria activities and bacterial grazing were measured in July and August 1996. Interpretation of the results needs further research. In relation with phytoplankton, we have adapted a set of computer programs (E.J.Fee 1990, *Can. Tech. Rep. Fish. Aquat. Sci.* 1740) for the modelling of primary production in high mountain environments, where photoinhibition due to UV radiation is an important factor. Field measurements were carried out during the ice-free period, from the last week of June to the second week of August. The data collected were: a) environmental variables related with microbial activity: continuous record of irradiance, vertical temperature profiles in the lake, light extinction in the water column, wind speed, relative humidity and air temperature; b) *in situ* photosynthesis measurements at five depths (1, 5, 20, 35 and 55 m) in the lake, and c) determination of P-I curves at five depths (1, 9, 18, 35 and 55 m), and derivation of the photosynthetic parameters for modelling photosynthesis and primary production.

At the same time than *in situ* photosynthesis was measured, we determined the P-I curves for samples taken at 1 and 30 m. We used this curves to model photosynthesis in the whole water column. Despite

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we used only two curves, it is remarkable that the model simulates the carbon fixation during the incubation time almost exactly. Another result is that photosynthetic rates are maximum at mid depth, whereas near the surface and at the bottom are much lower. This behaviour may explain the formation of the deep chlorophyll maximum during summer. To model photosynthesis in a more detailed way, we measured P-I curves at five depths in August, 1996. There were clear differences in the curves with depth. From the vertical profiles of photosynthesis, Chl $a$  and light extinction, we built a model of primary production. The results showed again that the highest photosynthetic activity takes place at mid depth. A second result is that the primary production in the whole water column was almost the same during three consecutive days, despite the fact that irradiance was higher the second day.

*Installation of an automatic weather station in Lake Redó.*- An automatic weather station was installed the 10th of October, 1996, and a termistor chain in 15th of January, 1997.

*Monthly measurements of physical, chemical and biological characteristics in the water column of L. Redó (Pyrenees) and L. Cimera (Gredos).*- Since July, 96. profiles of physical, chemical and biological variables are carried out with measurements each 3 m, analytical work is carried out within the corresponding sampling month, the patterns appearing will be exposed in coming reports, when a whole year of variability will be covered.

*Development of taxonomic system for chrysophytes; and harmonisation of taxonomic procedures for key indicator taxa.*- Continuous effort is being made in refining taxonomy and procedures, in that sense contact with other specialist within the project have been very fruitful. Concerning chrysophyte cyst a large database for the Pyrenees is on development with an accompanying photography collection of the material.

*Sediment coring in L. Redó and L. Cimera* Sediment coring has been completed at the two lakes and material has been distributed to the respective specialist for the analytical task.

### **III. OBJECTIVES FOR THE NEXT REPORTING PERIOD:**

For the next reporting period all periodical sampling objectives will continue, most of the core analyses will be completed and especial effort will be dedicated to model development in relation with WP-3 objectives.

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## Partner 8

**Contractor/Subcontractor:** Universidad de Granada. Instituto del Agua

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### I. OBJECTIVES FOR THE REPORTING PERIOD

Completion of the tasks included in WP 1 for **lake La Caldera** and Diatom sampling and analysis (WP 3).

### II. OBJECTIVES FOR THE NEXT PERIOD

Development of the activities scheduled within WP 1 for the second year of the Project. In addition we will pay particular attention to:

- Deposition sampling and analysis
- Estimation of bacterivory
- Ciliate taxonomic determination
- TOC and DOC measurement
- Measurements of photosynthetic rates

### III. MAIN RESULTS OBTAINED

Samples were taken in four occasions (July 27, August 20, September 20 and October 10) at the pelagic area of the lake as no superficial inlet or outlet exist. On each sampling date, three-four depths were sampled along the vertical profile. We performed five estimates of primary production and bacterial production: 18.7.96, 5.8.96, 7.8.96, 20.9.96 and 23.9.96.

The sampling and analytical protocols followed standard techniques agreed by convenors and lead laboratories (compiled in the Project manual).

The most noticeable results, refer to:

After several years of persistent drought and consistent volume reduction, the lake has become completely recovered so that "usual" morphometric characteristics were registered. The thaw period spanned until middle of August and so during the July sampling, more than 80% of the lake surface was covered by ice.

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No definite thermocline was observed. Surface water temperature ranged from 1.5°C (July, 24) to 10.1 °C (August, 20). In relation to the physical and chemical parameters measured in the lake water, the most noticeable characteristics -in comparison with previous data- are: An increase in the Calcium content, reaching values (average for the profile) of 5.32-5.34 mg.l<sup>-1</sup>; Very high Nitrogen content (greater than 375 TN.l<sup>-1</sup>) which shows a steady decrease during the ice free period, and Total phosphorus values smaller than measured in previous years.

Phytoplankton was dominated by Chrysophycean species, reaching "population" densities close to 50.000 cell.ml<sup>-1</sup>, which represent the highest values ever registered in the lake. It is also noteworthy the almost absence of Cyanophycean species. Chlorophyll *a* values ranged (on average) from 0.6 to 1.8 Tg.l<sup>-1</sup>, within the range of previous years' measurements, although it is interesting to point both the unusual peak found after the thaw and the lack of a "seasonal" pattern during the summertime.

Bacterial abundance showed values smaller than 10<sup>6</sup> cell.ml<sup>-1</sup>, again below the averaged figures so far estimated. The detection of filamentous forms is also remarkable.

Two coexisting species/forms of Ciliates have been observed, reaching population densities of between 13 and 37 cell.ml<sup>-1</sup> at the end of the ice-free period.

Three species of large-sized zooplankton, namely *Mixodiaptomus laciniatus*, *Daphnia pulicaria* and *Hexarthra bulgarica*, each of them having a rather scarce numerical representation were present.

Note: an additional (not included in the report) sampling performed in November showed a considerable populatin increase, particularly for *M. laciniatus*.

Gross primary production measurements ranged between 0.37 and 3.25 Tg C.l<sup>-1</sup>.h<sup>-1</sup>, quite comparable to values reported for this lake. However, the depicted "seasonal" pattern was different as the maximun values were measured by the end of the summer.

Values obtained for bacterial production (between 0.05 and 0.20 IR H-TdR pmol.l<sup>-1</sup>.h<sup>-1</sup>) were rather low.

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## Partner 9

### MOLAR REPORT 1997

Jean-Charles Massabuau

**Contractor:** Centre National de la Recherche Scientifique (CNRS)

**Subject area:** Fish, fish physiology

**Leading scientist:** Jean-Charles Massabuau arctic

**Scientific staff:** Suzanne Dunel-Erb (CNRS, Strasbourg), Jean Forgue (Univ. Bordeaux I), Bernard Rivier (Cemagref, Aix en Provence), Charles Roqueplo (Cemagref, Bordeaux).

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#### I OBJECTIVES FOR THE REPORTING PERIOD

- Organising a fish-meeting in Arcachon
- Organising and co-ordinating a test fishing in lake Aubé (French Pyrénées)
- Analysing fish blood and selected parameters of gill histology (scanning microscopy) for the lakes sampled during the period 1996-1997.

#### II OBJECTIVES FOR THE NEXT PERIOD

- Co-ordinating fish blood haematology
- Analysing fish blood and selected parameters of gill histology (scanning microscopy) for the lakes sampled during the period 1997-1998.
- Performing a test fishing in lake Estany Redo (Spanish Pyrénées)

#### III MAIN RESULTS OBTAINED

##### Fish-meeting in Arcachon

On the behalf of the fish group a workshop was organised by the Laboratoire de Neurobiologie et Physiologie Comparées on June, 1996 in Arcachon, France. Eleven scientist, coming from 5 different countries (Swiss, Austria, Spain, Norway and France) participated to the meeting. The aim was to co-ordinate the fish sampling technique that will be used by different peoples throughout the Molar sites and to develop standardised tools that could be used at larger scale.

A practical training of fish dissection and tissue and blood sampling was performed, commented and criticised. A video-movie of the operation was recorded. The Arcachon laboratory realised a first draft of the movie (based on the re-organised rush) which was send to the participants in charge of field sampling. A final and polished version is scheduled with professional movie makers (CNRS Audio-

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visual). It could be joined to a next report. The aim will be to disseminate videos of the fish sampling protocol.

They could be used as a technical manual applicable in field research. In complement, packages in the kit format (presented in small plastic boxes), to prepare tissues in the field for optical, scanning and electronic microscopy and to sample blood plasma were produced. It is planned to publicise the elaborated recipes. Following this meeting, the group is today able to successfully sample and prepare in the field (for sending throughout Europe) various fish tissues to analyse in the laboratory.

### **Test fishing in Aubé**

Lake Aubé was testfished from 10-13 September 1996. It is worthwhile to recall first that during the first test fishing we performed in this lake in September 1991, 69 *S. trutta*., 9 lake charr *Salvelinus namaychus* and 1 chub *Leuciscus cephalus* were caught. There was no arctic charr *S. Alpinus*. During the second test fishing performed in September 1994, 13 *S. trutta*, 65 *S. alpinus* and 2 minnows *Phoxinus phoxinus* were caught. No *S. Namaychus* was caught. Today, in September 1996, arctic charr *Salvelinus alpinus* and trout *Salmo trutta* appeared to be present. Indeed, a total of 127 specimens of arctic charr and 1 trout were caught.

Based on information gathered from the local angling association, we know that arctic charr was introduced for the first time in the lake in 1992 at age 0+ as summer fingerlings (It was very likely the direct consequence of our 1991 campaign. Indeed, we tell that trouts appeared in a bad physiological condition in this extremely diluted water solution).

Considering the result of the 1996 campaign, it seems obvious that since its introduction this fish is excluding other species from the lake: the lake charr could be already eradicated and the brown trout disappearing.

Tissues and blood samples from arctic charr were successively sampled and sent to the different participants. Oxygen and temperature profiles were determined. A video-movie was realised whose aim was to characterised (i) fish sampling technique in the field in a remote mountain lake and (ii) with the use of professional divers and underwater camera, the biotope where the arctic charr were preferentially caught.

### **Physiological analysis**

*Scanning microscopy* (n = 5 fish per site): Fish caught from 4 lakes, lake Joeri (Switzerland), lake Arresjoen (Spitzberg, Norway), lake Stavsvatn (Norway) and lake Aubé (French Pyrénées) were sent fixed to the CNRS where they were dehydrated and gold coated or embedded for scanning or electronic microscopy. They were examined in scanning microscopy. For TEM, resin blocks are available if required. The analysis is still under progress but it appears already clear that fish from lakes where the ionic content was the lowest (lake Joeri, lake Stavsvatn and lake Aubé) presented gills with a relatively abundant proliferation of chloride cells. The apical surface was large and the microvilli density high. In some cases the cells were coalescent. It is generally agreed that these cellular complexes present cellular junction with low resistance. In lake Arresjoen, the situation appeared different as most of the animals from this site do not present such abundant proliferation of chloride cells. Considering the specific change of ionic concentration that exists between the 3 former sites and lake Arresjoen in terms of NaCl concentration in the water, a direct correlation can be proposed between  $[NaCl]_w$  and chloride cells. This has already been described in laboratory experiments (Laurent, Hobe, Dunel-Erb, 1985, Cell & Tissue Research, 240: 675-692) but it will have to be confirmed in the present field conditions during the year 1997-98.

*Plasma ion analysis.* Blood sampling was performed in the 4 lakes cited above. For various technical reasons, plasma samples from only 2 lakes reached the Laboratoire de Neurobiologie et Physiologie Comparées. Analysis are in progress. Plasma sampling from the missing sites should be repeated during the next year.



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### **Age determination**

Otolith reading for age determination is a fundamental point in the analysis of fish physiology when one has to correlate exposition time to various environmental conditions, accumulation rates and fish ages. In the case of fishes living in extremely diluted waters, it is well known that otolith reading becomes extremely difficult. Considering lake Aubé, this is definitively true while the recent history of introduction of arctic charr is well known: in autumn 1996, they were either 2 or 4 years old but despite this relatively simple situation, there is a clear disagreement between readings performed in France and other partners. For example, in 1994 it has been proposed that some of the arctic charr living in Aubé were up to 26 years old. In an attempt to clarify this situation, we are currently examining 1 otolith for each of the 127 fishes caught in autumn 1996. The others will be sent to the partners for peer expertise and eventual standardisation.

## **FIRST YEAR OF THE DEVELOPMENT OF THE MOLAR PROJECT**

**PARTNER: Consejo Superior de Investigaciones Científicas. Department of Environmental Chemistry. Barcelona.**

**From 1th March 1996 to 28 of February 1997**

### **POLLUTANT DEPOSITION SAMPLING AND ANALYSIS.**

The decoupling of organic pollutants between the gas and particulate phase in the atmosphere of Lakes Redo and Gossensköllesee have been investigated. Samples have been collected in summer (Redo, July 1996), fall (Gossenkoellesee, October 1996) and winter (Redo, February 1997; Gossenkoellesee, March 1997) in these two lakes. Sampling has been performed with a high volume pump equipped with glass fiber filters and polyurethane foams. These samples have then been analyzed following the methods described in the MOLAR Manual.

A wet/dry deposition sampler has been purchased and installed in Lake Redo. The instrument has been equipped with batteries for operation without connection to external power sources. Logistic problems derived from the climatology of Redo site are being solved. A bulk deposition sampler for organic analysis has also been installed in this site.

Several recovery tests on polycyclic aromatic hydrocarbons (PAH) and organochlorinated compounds (OC) have been performed to evaluate the yields of the methods for analysis of these compounds in wet and dry deposition samples.

Bulk deposition samples (dissolved and particulated) from Gossenkoellesee and Jorisee Lake (JR) have been received in the lab and are being analyzed at present.

### **ALLOCATION OF POLLUTANTS TO SOURCE AND THE ROLE OF DUST**

Snow cores from Redo and Gossenkoellesee have been collected. Some of those collected in Redo are representative of a Saharan dust deposition episode. These samples have been divided in vertical sections and the analyses (dissolved and particulate parts) are in progress.

### **TRACKING POLLUTANT PATHWAYS WITHIN THE LAKE**

Samples of the dissolved + colloidal and particulate matter from surface and deep (several depths according to the thermocline profile) waters have been analyzed. A high volume pump equipped with glass fiber filters and XAD-2 resins has been used. Samples have been collected in summer (Redo, July 1996), fall (Gossenkoellesee, October 1996) and winter (Redo, February 1997; Gossenkoellesee, March 1997) in these two lakes. These samples have then been analyzed for PAH and OC following the methods described in the MOLAR Manual.

This pumping system has also been used for the measurement of  $^{210}\text{Pb}$  partition coefficients in the water column of Gossenkoellesee in winter and summer as described above (the samples have been given to Dr. P. Appleby; Environmental Radioactivity Research Centre, Liverpool University).

#### **EFFECTS OF TRACE METALS AND ORGANIC POLLUTANTS ON FISH**

The analyses of the samples received are in progress following the method described in the MOLAR Manual.

#### **SEDIMENT ANALYSES**

The analysis of sediment cores from lakes Ovre Neådalsvatn and Gossenkoellesee are in progress following the methods described in the MOLAR Manual.

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## Partner 11

### MOLAR Report for the period: 1-3-1996 to 28-2-1997 Work Package 4

**Contractor:** Botanical Institute, University of Bergen

**Leading scientist:** H. J. B. Birks

**Scientific staff:** Einar Heegaard

**Address:** Botanical Institute  
University of Bergen  
Allégt. 41, N-5007 Bergen  
Norway

E. Heegaard & H. J. B. Birks

#### Data transfer

The first year of the MOLAR project has been used to establish how and where to send the data. Due to the danger of losing data this has been a priority for the first part of the development of the data-base. All results should, in the first instance, be sent to the responsible scientists, who will save a copy of all the results (data) that he/she receives. The results, after being checked for errors, will be sent to Bergen (Einar Heegaard, John Birks) and there incorporated into the MOLAR data-base/archive. First all files that are sent to Bergen will be stored in a general archive, which will include all the results from the MOLAR project. This archive will be the basis for the data-base programming. All data transfer will be by e-mail, and the format will be ASCII or XL-spreadsheets, the latter is preferred. The scientific content of these files is to be decided by the scientists responsible for the data. However, a series of codes should also be included. These codes will be unique for each sample and will consist of several singular codes. For each scientific field (scientist responsible) these have or will be discussed with the Bergen group.

Although some work is left to be discussed much of the task about data-transfer and coding of data is done.

#### Data-base

The data-base as such will consist of series of smaller data-bases, one for each scientific field, which will be linked together through the coding. This will be developed towards the end of the MOLAR-project. Together with the major data-base planned in Bergen, there are data-bases at NIVA in Oslo that includes water-chemistry and fish data. There will also be a data-base in London (UCL) for diatom data. However, at the end all the data concerning the MOLAR project will be deposited in the Bergen data-base.

#### Statistics

There have been some general questions received concerning how to analyse the data obtained. All such questions have been answered by either Einar Heegaard or John Birks.

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## Partner 12

**Contractor:** Department of Zoology, University of Bergen

**Subject area:** Invertebrates

**Leading scientist:** Gunnar G. Raddum

**Scientific staff:** Arne Fjellheim  
Øyvind A. Schnell

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**Telephone:** 47 55 582236

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### I OBJECTIVES FOR THE REPORTING PERIOD

- Sampling of the sites
- Sorting of the samples
- Identification of invertebrates

### II OBJECTIVES FOR THE NEXT PERIOD

- Finish identification of the recent invertebrates
- Analyse the chironomid head capsules from the MOLAR sites
- Completion of invertebrate part of MOLAR report

### III MAIN RESULTS OBTAINED

#### Sampling and analyses

Site 1. *Øvre Neådalsvatn, Norway* (Table 1)

The lake was sampled 3 times in 1996, in July, August, and September. This in order to document the seasonal variation in the invertebrate populations. The importance of sampling at several dates is illustrated in figur 1. A visit to the lake in September only would have missed the most important species in the deep part of the lake. The bottom samples from 5 meters depth contained 14 chironomid taxa, compared to 9 in 1994. The samples from 17 meters depth contained 12 taxa, slightly more than in 1991 and 1994. Only the chironomids have so far been analysed.

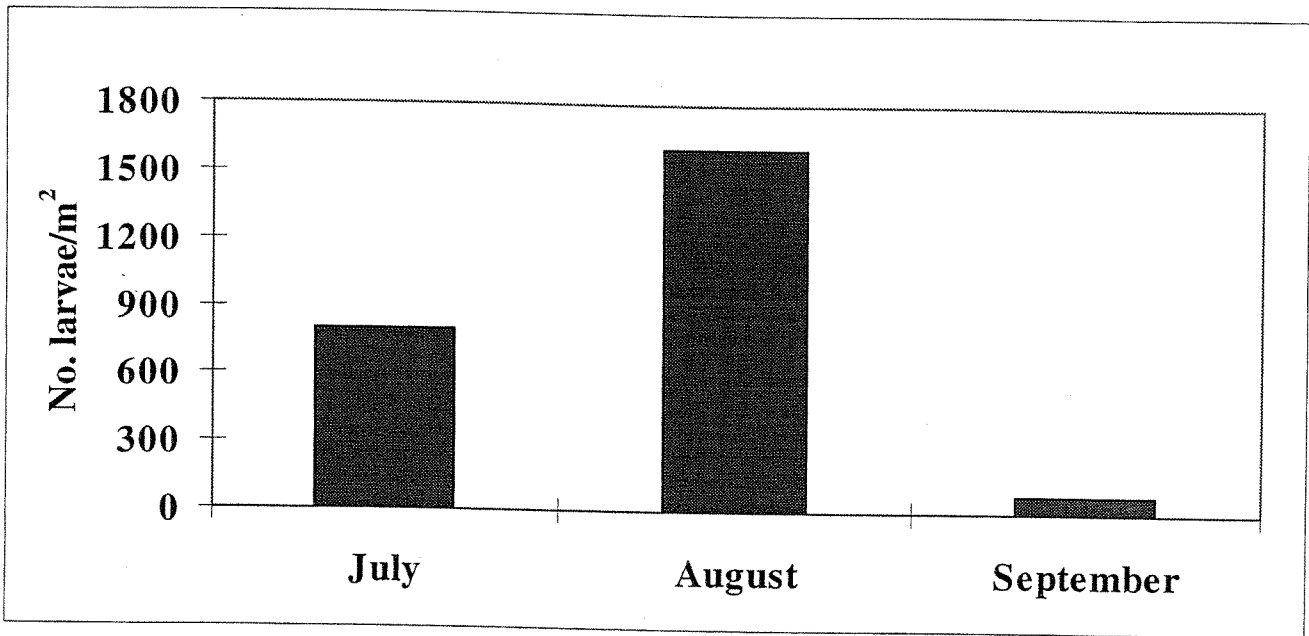


Figure 1. Seasonal variation in the abundance of the chironomid *Heterotrissocladius brundini* Sæther & Schnell in Øvre Neådalsvatn in 1996.

Site 2. *Stavsvatn, Norway* (Table 2)

The lake was sampled twice in 1996. At 5 meters depth 29 chironomid taxa were found. The density of larvae was very high. *Psectrocladius septentrionalis* dominated the samples. The samples from 15 meters depth contained 11 taxa. This is surprising when considering that the samples from 17 meters from 1991 only contained 3 chironomid taxa. Only the chironomids have so far been analysed from the lake.

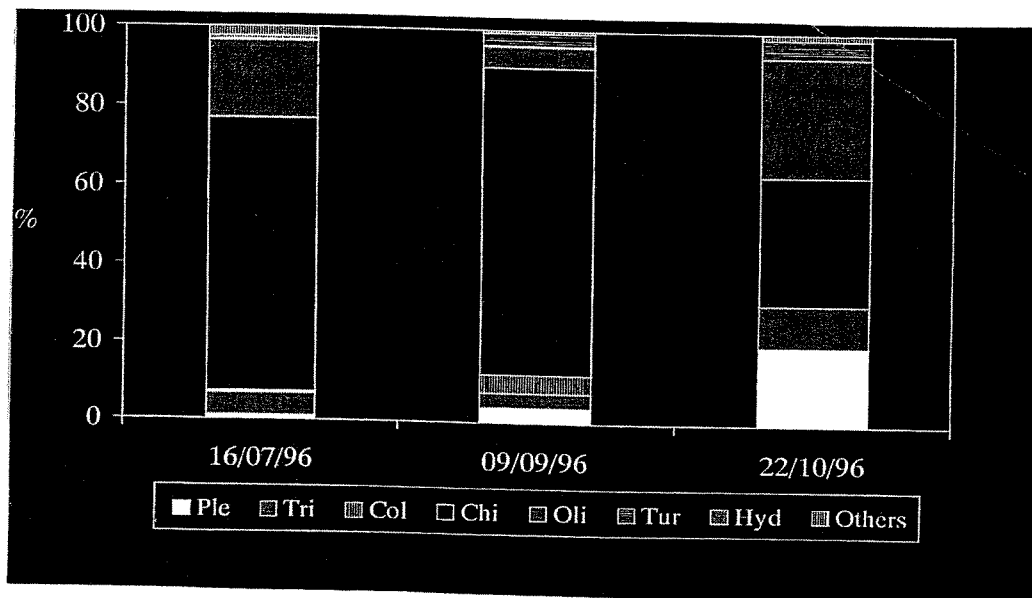


Figure 2. Relative abundance of the main invertebrate groups in kick samples from the littoral zone, the inlet and the outlet rivers of Lago Paione Superiore.

Site 5.1. *Lago Paione Superiore* (Table 3-1, 3-2, 3-3)

The littoral zone, the inlet and the outlet rivers of Lago Paione Superiore were sampled 3 times, in July, September, and October. Only kick samples were taken. A total of 48 invertebrat taxa were recorded. Chironomids and oligochaets dominated the fauna. Figure 2 shows the relative abundance of the invertebrates, while figure 3 shows the same for the chironomid subfamilies.

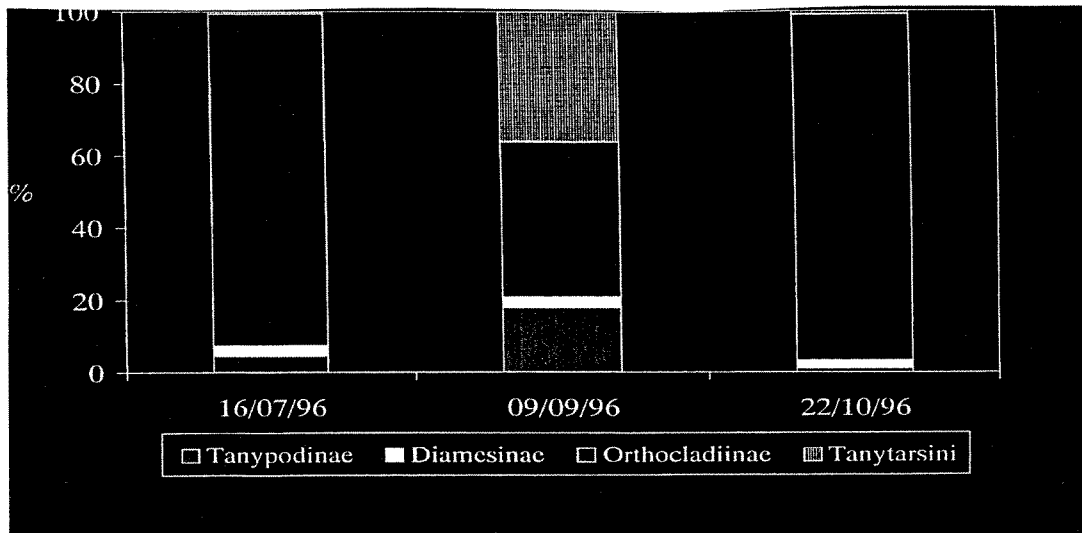


Figure 3. Relative abundance of the chironomid subfamilies.

Site 12.2. *Lago Redó*

Redó was sampled in July, August, September, and October. Most samples are sorted, but not all are yet analysed. In the littoral zone the chydorid population showed a dramatic increase in number of animals *per* sample from July to September, probably caused by a bloom of epilithic algae. This is shown in figure 4, note the logarithmic scale. Figure 5 and 6 shows the relative abundance of chironomids and plecopterans in the littoral zone of Redó.

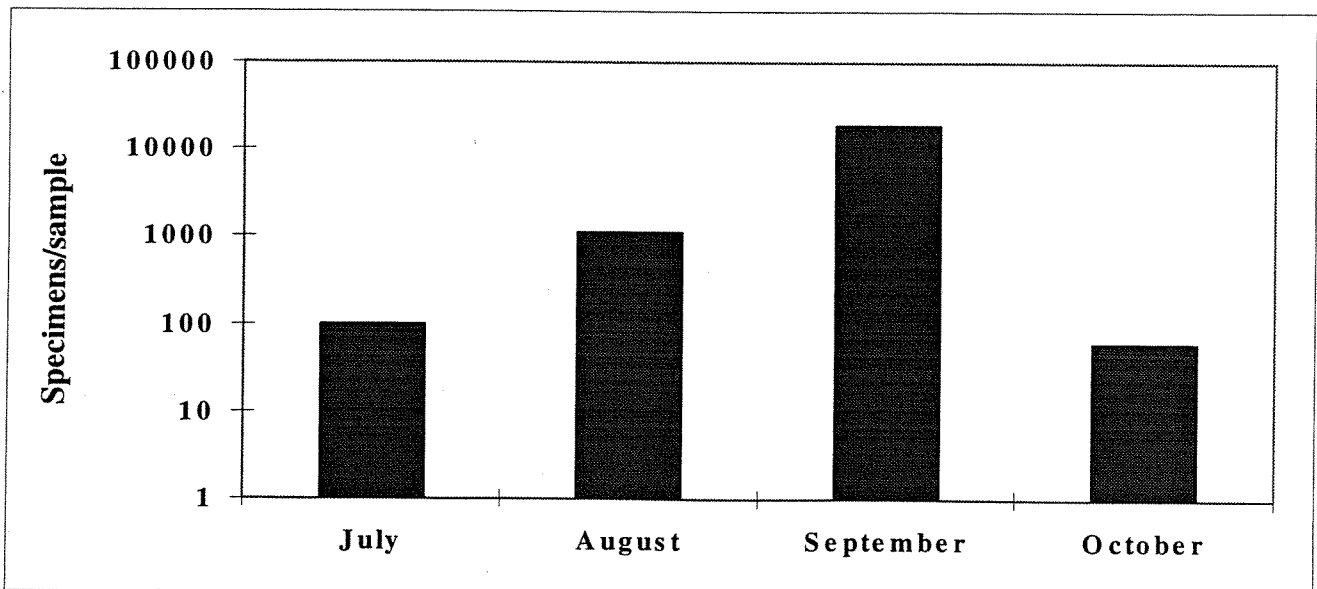


Figure 4. The development of the chydorid population in the littoral zone of Redó.

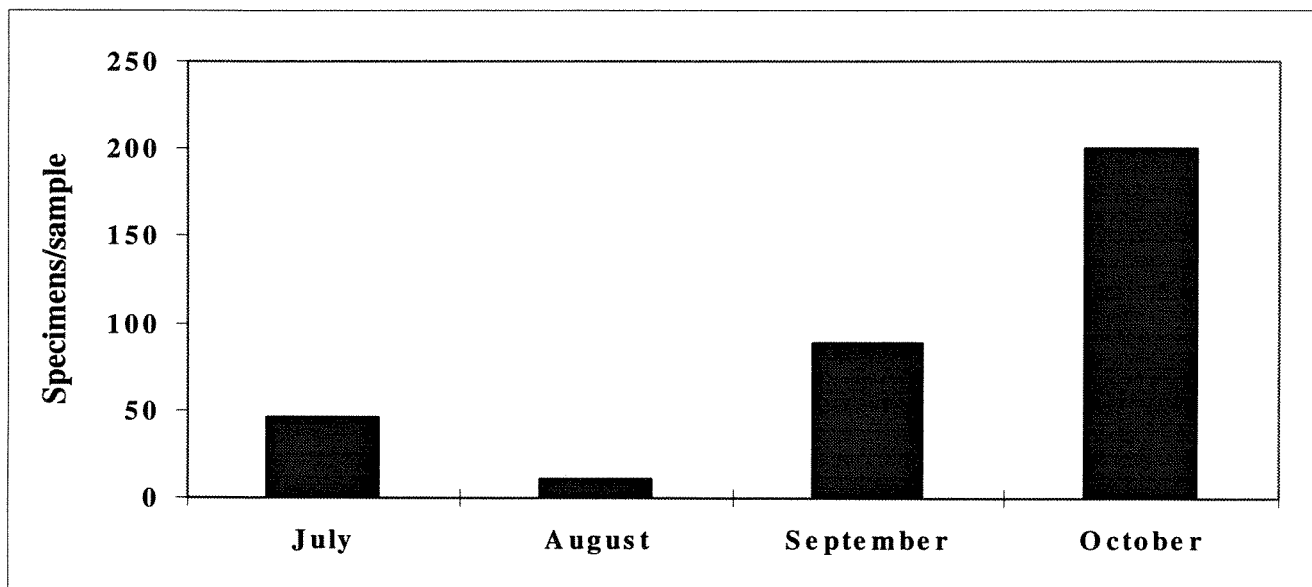


Figure 5. Relative abundance of chironomids in Redó.

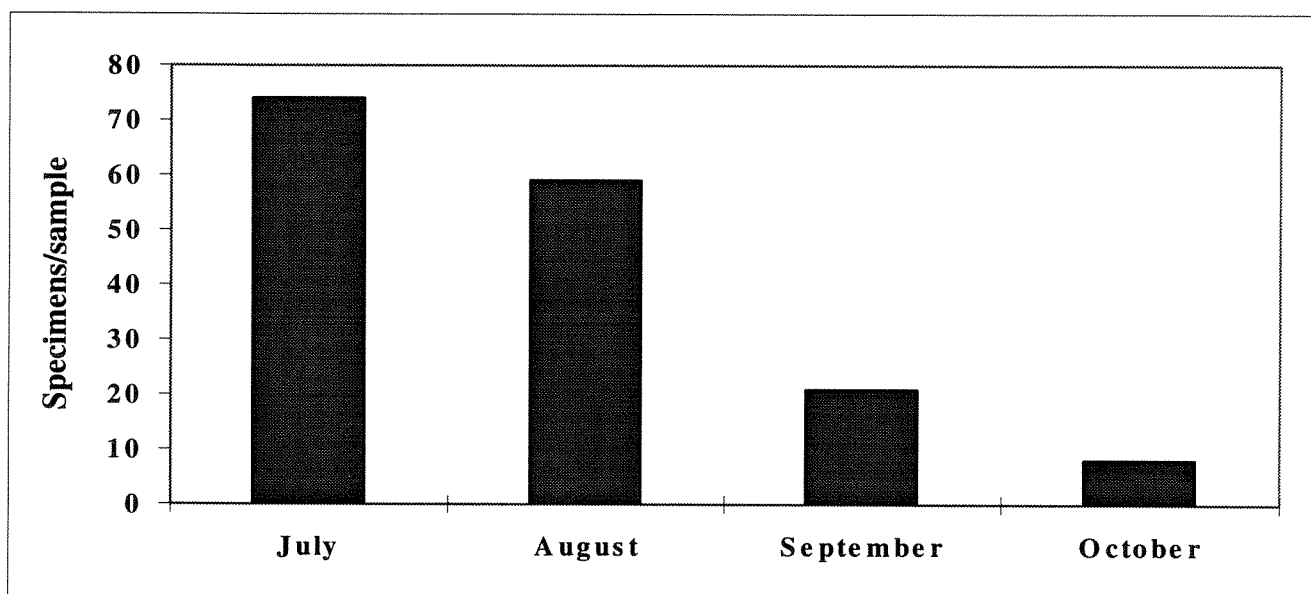


Figure 6. Relative abundance of plecopterans in Redó.

Site 15.3. *Długi Staw* (Table 4-1, 4-2)

The lake was sampled twice, in August and October. Both quantitative and kick samples were taken. Twenty invertebrate taxa were recorded. The deep parts were dominated by nematods and chironomids (figure 7), while the kick samples were dominated by chironomids and oligochaets.



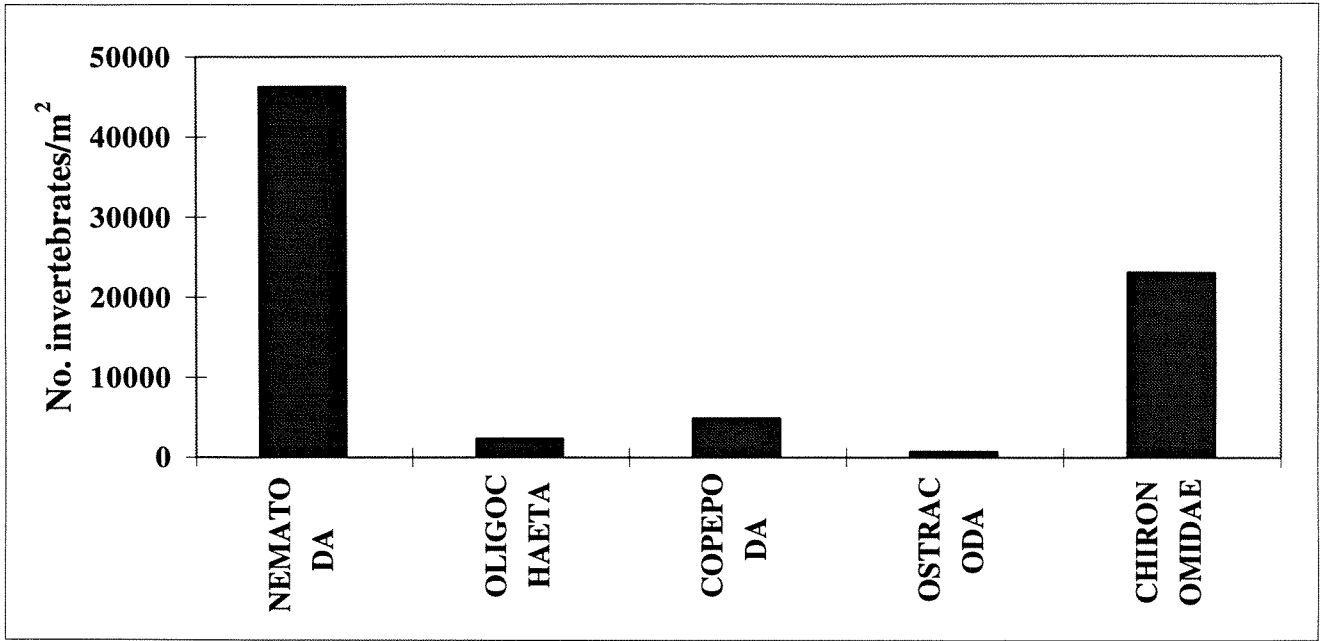


Figure 7. Abundance of the most important invertebrate groups in the deeper parts of Dlugi Staw.

Site 17. *Chuna* (Table 5-1, 5-2, 5-3)

*Chuna* was sampled in July and September 1996. Both quantitative and kick samples were taken. Altogether 43 invertebrate taxa were found. The kick samples were dominated by chironomids and oligochaets, while chironomids dominated the profundal zone (figure 8).

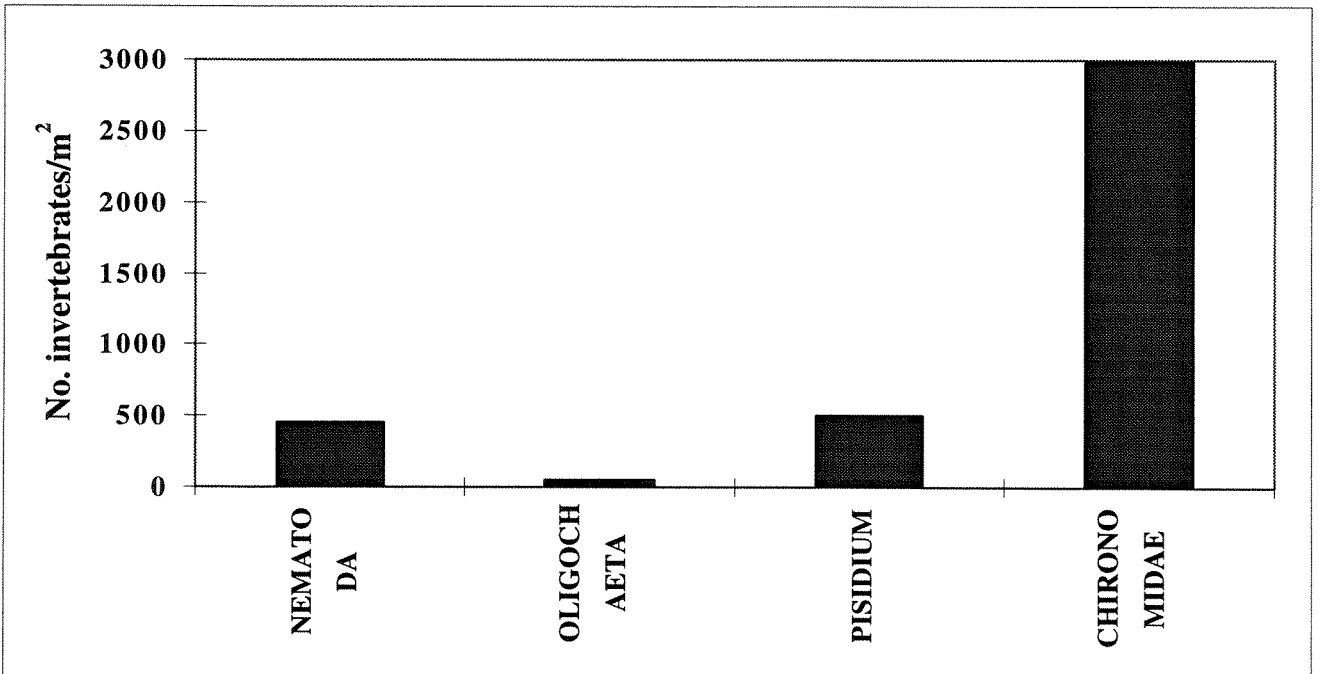


Figure 8. Abundance of the most important invertebrate groups in the profundal zone of *Chuna*.

**Table 1****Øvre Neådalsvatn, Norway**

Date	10/08/94	18/07/96	19/08/96	07/09/96
Depth	5 m	5 m	5 m	5 m
No. samples	6	6	6	4
No. chironomid larvae/ m <sup>2</sup>	2896	534	779	573
No. chironomid taxa	9	4	9	8
<i>Arctopelopia melanosoma</i> (Goetghebuer)	1372	0	16	115
<i>Heterotanytarsus apicalis</i> (Kieffer)	152	0	0	0
<i>Heterotrissocladius grimshawi</i> Edwards	0	0	0	57
<i>Heterotrissocladius brundini</i> Sæther & Schnell	0	344	0	0
<i>Micropsectra insignilobus</i> Kieffer	114	0	0	0
<i>Micropsectra radialis</i> Goetghebuer	0	0	115	0
<i>Mesocricotopus thienemanni</i> (Goetghebuer)	229	38	153	0
<i>Monodiamesa bathyphila</i> (Kieffer)	38	38	0	0
<i>Paratanytarsus hyperboreus</i> Brundin	76	0	38	0
<i>Paratanytarsus penicillatus</i> Goetghebuer	0	0	38	0
<i>Polypedilum (Tripodura) pullum</i> Zetterstedt	0	0	38	57
<i>Procladius</i> spp.	76	115	115	115
<i>Protanypus</i> sp.	0	0	0	57
<i>Psectrocladius (Psectrocladius)</i> spp.	495	0	115	57
<i>Sergentia coracina</i> (Zetterstedt)	0	0	0	57
<i>Stictochironomus rosenshoeldi</i> (Zetterstedt)	0	0	153	57
<i>Tanytarsus cf. lugens</i> (Kieffer)	152	0	0	0
Tanytarsini indet.	191	0	0	0

Date	19/08/91	10/08/94	18/07/96	19/08/96	07/09/96
Depth	17 m	17 m	17 m	15 m	15 m
No. samples	6	6	6	2	6
No. chironomid larvae/ m <sup>2</sup>	6782	3658	2519	3664	420
No. chironomid taxa	8	11	8	7	7
<i>Arctopelopia melanosoma</i> (Goetghebuer)	229	152	0	458	0
<i>Heterotrissocladius brundini</i> Sæther & Schnell	4382	1410	802	1603	76
<i>Heterotrissocladius</i> indet.	0	76	0	0	0
<i>Micropsectra insignilobus</i> Kieffer	0	0	0	0	76
<i>Micropsectra radialis</i> Goetghebuer	76	0	0	115	76
<i>Micropsectra</i> sp.	267	0	0	0	0
<i>Mesocricotopus thienemanni</i> (Goetghebuer)	1143	610	38	1031	0
<i>Monodiamesa bathyphila</i> (Kieffer)	38	38	0	0	0
<i>Paracladopelma nigriflora</i> (Goetghebuer)	0	0	38	0	38
<i>Parakiefferiella bathyphila</i> (Kieffer)	0	38	0	0	0
<i>Parakiefferiella fennica</i> Tuiskunen	572	1029	305	0	0
<i>Paratanytarsus penicillatus</i> Goetghebuer	0	0	38	0	0
<i>Polypedilum (Tripodura) pullum</i> Zetterstedt	0	0	38	115	38
<i>Procladius</i> spp.	0	38	229	115	38
<i>Protanypus</i> sp.	0	38	0	115	0
<i>Psectrocladius (P.)</i> spp	0	191	0	0	0
<i>Psectrocladius septentrionalis</i>	0	38	0	0	0
<i>Sergentia coracina</i> (Zetterstedt)	0	0	954	0	76
<i>Stictochironomus rosenshoeldi</i> (Zetterstedt)	76	0	0	0	0
Tanypodinae indet.	0	0	38	0	0
Tanytarsini indet.	0	0	38	115	0

**Table 2****Stavsvatn, Norway**

<b>Date</b>	<b>24/07/96</b>	<b>23/09/96</b>	
<b>Depth</b>	5 m	5 m	
<b>No. samples</b>	6	4	
<b>No. chironomid larvae/ m<sup>2</sup></b>	4237	23473	
<i>Ablabesmyia longistyla</i>	0	57	
<i>Ablabesmyia monilis</i>	305	401	
<i>Corynoneura</i> sp.	38	57	
<i>Dicrotendipes modestus</i>	0	344	
<i>Heterotanytarsus apicalis</i>	0	916	
<i>Heterotrissocladius brundini</i>	267	0	
<i>Heterotrissocladius grimshawi</i>	0	630	
<i>Heterotrissocladius marcidus</i>	191	172	
<i>Heterotrissocladius</i> indet.	0	229	
<i>Micropsectra insignilobus</i>	0	115	
<i>Micropsectra radialis</i>	38	0	
<i>Paracladopelma nigrigula</i>	0	115	
<i>Parakiefferiella bathophila</i>	38	630	
<i>Paratanytarsus hyperboreus</i>	153	0	
<i>Paratanytarsus penicillatus</i>	229	1088	
<i>Polypedilum</i> ( <i>Tripodura</i> ) pullum	153	401	
<i>Procladius</i> spp.	267	172	
<i>Protanypus</i> sp.	76	0	
<i>Psectrocladius</i> ( <i>Mesopsectrocladius</i> ) <i>barbatipes</i>	0	630	
<i>Psectrocladius</i> ( <i>Psectrocladius</i> ) <i>sordidellus</i>	153	1832	
<i>Psectrocladius</i> ( <i>Psectrocladius</i> ) <i>limbatellus</i> group	0	172	
<i>Psectrocladius septentrionalis</i>	115	11164	
<i>Sergentia coracina</i>	76	859	
<i>Stempellinella brevis</i>	153	344	
<i>Stictochironomus pictulus</i>	0	57	
<i>Stictochironomus rosenshoeldi</i>	1756	1145	
<i>Tanytarsus</i> sp. A	153	344	
<i>Tanytarsus</i> spp. indet.	76	1317	
<i>Zalutschia torntraeskensis</i>	0	57	
Chironomini indet.	0	57	
Orthoclaadiinae indet.	0	115	
Tanypodinae indet.	0	57	
<b>Date</b>	<b>21/08/91</b>	<b>24/07/96</b>	<b>23/09/96</b>
<b>Depth</b>	17 m	15 m	15 m
<b>No. samples</b>	6	6	6
<b>No. chironomid larvae/ m<sup>2</sup></b>	267	1718	1489
<i>Heterotanytarsus apicalis</i>	0	0	382
<i>Heterotrissocladius brundini</i>	0	38	0
<i>Heterotrissocladius marcidus</i>	0	0	229
<i>Heterotrissocladius</i> indet.	0	0	76
<i>Mesocricotopus thienemanni</i>	0	344	115
<i>Polypedilum</i> ( <i>Tripodura</i> ) pullum	0	38	0
<i>Procladius</i> spp.	115	76	76
<i>Protanypus</i> sp.	38	76	38
<i>Sergentia coracina</i>	115	0	0
<i>Psectrocladius</i> ( <i>Psectrocladius</i> ) <i>sordidellus</i>	0	0	38
<i>Stempellinella brevis</i>	0	1031	534
<i>Stictochironomus rosenshoeldi</i>	0	115	0

**Table 3-1**

Lake Patone Superiore	Littoral	Littoral	Littoral	Inlet 1	Inlet 2	Outlet	Littoral	Littoral	Littoral	Littoral	Outlet
	kick A (G) 16/07/96	kick B (F) 16/07/96	kick C (M) 16/07/96	kick 16/07/96	kick 16/07/96	kick (100m) 16/07/96	kick A (G) 09/09/96	kick B (F) 09/09/96	kick C (M) 09/09/96	kick (100m) 09/09/96	
<b>Turbellaria:</b>											
<i>Tricladida</i>											
<i>Crenobia alpina</i>						5				17	
<b>Hydracnellae:</b>											
<i>Arrenurus membranator</i>		4	6		9		1		1		
<i>Gnaphiscus setosus</i>							1		1		
<i>Weitina podagrata</i>			2								
<b>Oligochaeta:</b>											
<i>Enchytraeidae</i> sp. A	79	34		32	92	162	7	3		1	
<i>Enchytraeidae</i> sp. B	1			1	14	1	13	3			
Lumbriculidae										1	
<i>Spylodrilus</i>											
<b>Plecoptera:</b>											
Nemouridae indet.						1				1	
<i>Protonemura</i> pr. <i>caprai</i>						8				1	
<i>Protonemura</i>										1	
pr. <i>Protonemura</i>										1	
Leuctridae											
<i>Leuctra</i>										17	
<b>Trichoptera:</b>											
Limnephilidae indet.	30		72		13	1			2		
<i>Allogamus</i>	1										
<i>Limnephilus</i>							1				
<i>Potamophylax</i>							14	1	1		
Phylopotamidae indet.											
Rhiacophilidae											
<i>Rhyacophyla</i> ( <i>Hyporhyacophila</i> )						6					
<b>Coleoptera:</b>											
Dytiscidae larvae											
<i>Agabus</i>	1		3		1		3	6			
Dytiscidae adults					1						
Hydroptorinae larvae									2		
Hydroptorinae adults	2		1							1	

**Table 3-2**

Lake Paione Superiore		Littoral kick A (G) 16/07/96	Littoral kick B (F) 16/07/96	Littoral kick C (M) 16/07/96	Inlet 1 kick 16/07/96	Inlet 2 kick 16/07/96	Outlet kick (100m) 16/07/96	Littoral kick A (G) 09/09/96	Littoral kick B (F) 09/09/96	Littoral kick C (M) 09/09/96	Outlet kick (100m) 09/09/96
<b>Diptera:</b>											
Culicidae											
<i>Aedes (Ochlerotatus)</i>											
	9	1	2	2	9						
Limoniidae											
		3		2							
Muscidae											
	1	2		2							
Sciariidae											
Simuliidae											
						17					
<i>Prosimulium</i>											
				1							
Tipulidae											
Chironomidae											
<i>Procladius (Holotanypus)</i>											
		19	2				6				
<i>Zavrelimyia</i>											
		40	5				16		50	1	
<i>Diamesa</i>											
											10
<i>Pagastia</i>											
			1	4	3		14				
<i>Pseudodiamesa</i>											
					18		2				2
Diamesini indet.											
				1							
<i>Camptocladius</i>											
				2	3						
<i>Cardiocladius</i>											
							1				
<i>Chaetocladius</i>											
	2				4		1				
<i>Corynoneura pr. lobata</i>											
							70				14
<i>Eukiefferiella breviculcar</i>											
							1086				7
<i>Helmetella</i>											
							53				5
<i>Heterotanytarsus</i>											
							1				
<i>Heterotrissocladius marcidus</i> gr.											
								3	15	39	5
<i>Krenosmittia</i>											
							114				
<i>Linnophyes</i>											
	1			3	15						
<i>Parorthocladius</i>											
							3				79
<i>Pseudosmittia</i>											
										1	
<i>Smittia</i>											
				2	2		1				6
<i>Tvetenia discoloripes</i>											
<i>Micropsectra cf. radialis</i>											
							1				
<i>Micropsectra spur lungo</i>											
							70		3	10	
<i>Neozavrelia</i> (?)											
							55				
<i>Paratanytarsus pr. austriacus</i>											
									2	6	1
<i>Tanytarsinae</i> indet.											
							1				

**Table 3-3**

Lake Paione Superiore	Littoral kick A (G) 22/10/96	Inlet 1 kick 22/10/96	Inlet 2 kick 22/10/96	Outlet kick (100m) 22/10/96
<b>Turbellaria:</b>				
Tricladida				
<i>Crenobia alpina</i>				13
<b>Oligochaeta:</b>				
Enchytraeidae sp. A	6	50	5	7
Enchytraeidae sp. B			3	13
<b>Plecoptera:</b>				
Nemouridae indet.				
<i>Protonemura pr. caprai</i>				
<i>Protonemura</i>				8
<i>pr. Protonemura</i>				2
Leuctridae				
<i>Leuctra</i>				46
<b>Trichoptera:</b>				
Limnephilidae indet.			30	
<b>Diptera:</b>				
Limoniidae		1		
Muscidae			1	
Tipulidae			2	
Chironomidae				
<i>Zavrelimyia</i>				1
<i>Pseudokiefferiella</i>			2	
<i>Chaetocladius</i>			1	
<i>Corynoneura pr. lobata</i>			1	49
<i>Heleniella</i>				30
<i>Limnophyes</i>			2	
<i>Parorthocladius</i>				1
<i>Tvetenia discoloripes</i>				2
<i>Micropsectra cf. radialis</i>				1



**Table 4-2**

DLUGI STAW 19.10.1996	profundal N/m2				kick1	kick2
	1	2	3	4		
NEMATODA	3185	796	2388	21497	1	
OLIGOCHAETA						
Cernovitoviella tatreensis		796	796	796		
- sp.						
Cognettia sphagnetorum					74	
- glandulosa						
- sp						
Marionina sp.						
Eiseniella tetraedra						
CRUSTACEA						
Copepoda				1592	51	14
Ostracoda				796		
COLLEMBOLA					2	2
PLECOPTERA						
Nemuridae juv.						
DIPTERA non. det.				3981	2	
Heterotrissociolus marcidus						
Orthocladinae (juv.)					1	
Micropsectra sp. (M. coracina)				12739		
Tanytarsini (Micropsectra sp.) (juv.)				796		
Chironomidae (amphibiotic)					15	
COLEOPTERA						
MYRIAPODA					1	1



**Table 5-1**

**Chuna Lake**

Date	Inlet		Littoral A		Littoral B		Littoral B		Outlet					
	kick	7.09.	kick	24.07.	kick	7.09.	kick	24.07.	kick	7.09.	kick	24.07.	kick	7.09.
Nematoda indet.	1	4												
Eiseniella tetraedra		1			1		4	18						
Enchytraeidae indet.	1													
Lumbriculidae indet.	11	18					4	2					3	3
Naididae indet.								1						
Sperosperma ferox							8							
Pisidium indet.	2													
Hydracarina indet.			1				1							
Ameletus inopinatus			1				1							
Siphonurus aestivalis							2	1						
Arcynopteryx compacta									1					3
Diura nanseni														
Perlodidae sp. juv.												1		
Nemoura avicularis														1
Colymbetinae indet.		2												



**Table 5-3****Chuna Lake**No. pr. m<sup>2</sup>

Ekman grab

Date	24.07.	7.09.	24.07.	7.09.
Depth (m)	5	5	16	16
Nematoda indet.	23	40	94	297
Lumbriculidae indet.		8	8	
Stylodrilus heringianus		16		16
Oligochaeta indet.		8		
Pisidium indet.	70	24	102	305
Plectrocnemia conspersa		8		
Ablabesmyia spp.	8			
Arctopelopia spp.	16	63	31	63
Micropsectra spp.		242		16
Paratanytarsus spp.	390	141	23	55
Polypedilum (Tripodura) scalaenum			8	
Procladius spp.	414	289	16	55
Protanypus sp.			8	16
Psectrocladius (P.) limbatellus-group			16	
Psectrocladius (P.) psilopterus-group			8	
Sergentia coracina		461	23	39
Tanytarsus spp.	16	149	8	8
Thienemannimyia sp.			8	
Zavreliomyia sp.		8		
Tanypodinae indet.	8	164	23	
Tanytarsini indet.		164		31

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## Partner 13

### Reporting period: from 1-3-1996 to 28-2-1997

**Contractor:** Consiglio Nazionale delle Ricerche

**Leading scientist:** A. Lami

**Scientific staff:** R. Mosello, P. Guilizzoni, M. Manca, A.M. Nocentini, A. Pugnetti, A. Boggero, C. Callieri, R. Bertoni, A. Marchetto, M. Gianatti, R. Bettinetti, G.A. Tartari, V. Libera and M. Contesini

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## I. MAIN OBJECTIVES

- Data collection in the drainage basin of Lake Paione Superiore (LPS) on: meteorological base parameters, amount of precipitation, chemistry of atmospheric deposition, lake chemistry, microbial pelagic food web including bacteria, autotrophic picoplankton, heterotrophic nanoflagellates, ciliates, phytoplankton, zooplankton;
- Sample collection for lake water chemistry analysis on the secondary site, Paione Inferiore (LPI);
- Sediment core analysis for pigments and elemental carbon and nitrogen.
- Investigation of Macroinvertebrates and co-operation with experts to assess the taxonomical benthic refinement;
- Organization of workshop on Analytical Quality Control for chemical analyses;
- Participation in specific workshop for method and data harmonisation.

## II. ACTIVITIES PERFORMED AND RESULTS OBTAINED

### Workpackage 1

#### *Meteorological and volume of precipitation data collection*

In July 1996 an automatic weather station was installed on Lake Paione Superiore. This equipment has provided data on temperature, solar radiation, wind direction and speed, amount of precipitation and lake water temperature (at a depth of about 3m below the surface).

The data collected will be compared with other meteorological data from the region of lake Paione area provided by the Meteorological Service of the Regione Piemonte.

#### *Chemistry of atmospheric deposition*

Atmospheric deposition was sampled at the station of Graniga, located at 1080 m a.s.l., in the same valley where lakes Paione Superiore and Inferiore (2269 and 2002 m a.s.l.) are located.

Samplings and chemical analyses were performed weekly. The volume of precipitation during 1996 was 1853 mm. Results show pH values ranging from 3.5 to 6.75, with a median value of 4.63.

Alkalinity deposition was concentrated in four events, occurring in June and December, with a total

volume of 118 mm (6.3% of the global yearly volume). The main cations are ammonium and hydrogen ion (median values of 35 and 23  $\mu\text{eq l}^{-1}$ ), while sulphate and nitrate (36 and 32  $\mu\text{eq l}^{-1}$ ) are the main anions. On a yearly basis, the volume weighted alkalinity value is 1  $\mu\text{eq l}^{-1}$ .

#### Lake chemistry

The two lakes were sampled five times in 1996, four of them during the ice-free period and the last in December under the snow cover. In LPS we considered three depth levels: one meter below the surface, 5 m and the bottom, while in LPI we took only outflow samples.

The situation is similar to that of the previous years, in fact the mean concentrations of solute in LPS and the surface values in LPI show that total ionic concentrations range between 106-151 and 177-220  $\mu\text{eq l}^{-1}$  in the two lakes respectively, with conductivity values of 7-10 and 10-13  $\mu\text{S cm}^{-1}$  at 20°C.

Figure 1 presents the trends of pH, alkalinity, sulphate and total inorganic nitrogen (TIN), expressed in  $\mu\text{eq l}^{-1}$ , for the two lakes, observed over the last 6 years. The main difference lies in their alkalinity values, which range between 0-10  $\mu\text{eq l}^{-1}$  in LPS (broken line) and between 20-40  $\mu\text{eq l}^{-1}$  in LPI (full line). As a consequence pH is between 5.5-6.0 in LPS, while in LPI the range is 6.1-6.8. Alkalinity and pH values moreover show well-defined seasonal trends, with minimum values at the snow-melt (June-July) when large amounts of pollutants (especially nitrate and sulphate) reach the lakes, and maximum values at the end of the summer and during the snow cover. Minimum summer values of nitrate correspond to maximum phytoplankton uptake. Figure 1 clearly shows a significant increase in pH (particularly in LPS) and a decrease in sulphate and TIN corresponding to the same long-term trends observed in atmospheric depositions.

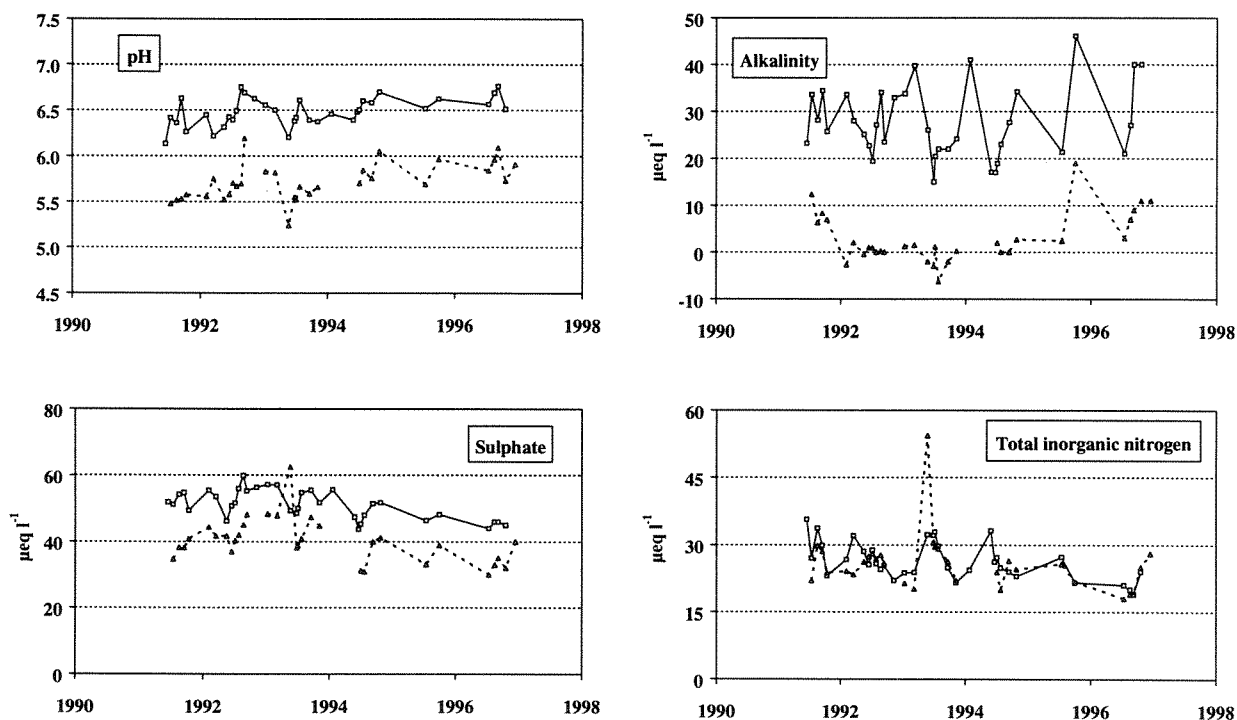


Fig. 1 - Trends of pH, alkalinity, sulphate and total inorganic nitrogen in lakes Paione Superiore (broken line) and Inferiore (full line).

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### *Microbial (pelagic) Food Webs- 1<sup>st</sup> Level*

#### *Bacteria, APP, HNF, ciliates and phytoplankton*

Four samplings were performed during summer/autumn 1996 to count and measure the microorganisms present in the Lake Paione food web. Following the suggested protocol (see Microbial food web protocol by Straskrabova et al.) autotrophic picoplankton (APP), ciliates and phytoplankton were identified, counted and, from biovolume measurements, their biomass expressed in terms of carbon content. Heterotrophic nanoflagellates (HNF) and bacteria were also counted and measured in C. Budejovice to compare different counting procedures.

The first results have shown that the autotrophic fraction of picoplankton is of very little importance compared to the heterotrophic fraction; *Synechococcus* spp. has rarely been found. Ciliates are mainly represented by the two genera *Strombidium* and *Urotricha*. Three phytoplankton groups are present: Chrysophyceae, Dinophyceae and Chlorophyceae. Flagellated forms are the most common, mainly cf. *Chromulina* sp. and *Mallomonas alveolata*.

#### *Zooplankton*

From July to September, the small fraction of zooplankton (rotifers, immature stages of crustaceans) was collected volumetrically (10 l, concentrated on a 40 µm net), at the two selected sampling depths. The samples, preserved in formalin 4% (v/v) were counted and sized entirely, with a distinction of species and developmental stage. We also collected integrated (0-11 m) net zooplankton samples (200 µm net), to determine the abundance and biomass of the large zooplankters (crustaceans, adult stages). Also in this case, the animals were counted and sized distinguishing between species and developmental stages. For taxonomical determinations, we used qualitative 40 µm net samples. Direct measurements of the biomass of large zooplankton (dry weight) were obtained from live integrated samples, collected with the 200 µm net. Carbon content will be measured by a CHN Elemental analyser.

At all dates, the largest numbers of animals were found close to the bottom. In July, *Keratella quadrata* and nauplii of *Cyclops abyssorum tatricus* were equally represented in the bottom volumetric sample. *Daphnia longispina frigidolimnetica* was the dominant species of the large zooplankton fraction, where adults of *Cyclops*, as well as large copepodites, were also represented. In August, the population density of small zooplankton sharply increased. *Keratella* was the most represented species, followed by *Cyclops* nauplii. The large fraction was almost exclusively made up of *Daphnia*, with parthenogenetic females and males in similar proportions. Many eggs and embryos were outside the mother's body, so clutch size could not be measured. However, the ratio total females: eggs+embryos was estimated. In September, crustaceans and rotifers were almost equally represented in the volumetric deep sample, although, *Daphnia* was almost as abundant as *Keratella* here. *Daphnia* was again the most abundant species in the integrated net sample, where it attained its maximum population density. Parthenogenetic females and males were mostly represented, although some ephippial females also appeared. A non-negligible amount of eggs and embryos was found extruded from the brood pouch. The proportion between females and eggs-embryos was estimated as 2.8, indicating that the population was still actively reproducing at that date.

#### *Macroinvertebrates*

Qualitative kick samples were taken during the ice-free period in LPS at 3 littoral, 2 inlet and 1 outlet (100 m downstream) stations, at the same time as data for water chemistry. In July the ice-melt was beginning, while in October the lake was almost covered by 10 cm of ice. A net with a 225 µm mesh aperture was used, attached to a 20×25 cm metal frame, with a 1.5 m long handle. The depth level considered was about 50-100 cm and littoral sampling stations were selected taking account of differences in substratum. It was possible to sample 4 to 6 stations for a total number of 14 samples. The invertebrate material from all the sampling points, fixed in 80% alcohol, was sorted from the sediment in white trays under a stereoscope (magnification up to 100×) after the samples were washed

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over a 225 µm sieve. The macroinvertebrates were then divided into the main orders, mounted on microscope slides with Faure for routine work, identified generally to genus level and counted.

### **Workpackage 3**

#### *Pigment analysis*

Five sediment cores (SAA96 HAG96/2; LEDV4, TERI6 and GSK3) arrived at our Institute in the first year of the contract. Pigment measures have been completed on two core (HAG96/2 and LEDV4) The identification and quantification of the specific carotenoids of algae was performed by High Pressure Liquid Chromatography (HPLC) and about 200 samples was measured so far. The analytical programme will be continued on the other core during 1997.

Part of the time has been devoted to checking and refining the analytical process to ensure the highest degree of comparability of the results obtained. With this aim, several pure pigment standards and a synthetic pigment standard (SUDAN II) was analysed.

The preliminary results will be discussed at the next workshop scheduled for 21-25 April in Barcelona.

#### **Workshop and intercalibration activities**

In 1996 we participated in the 1<sup>st</sup> MOLAR Workshop, held in Prague, Ceck Republic.

We organised a Workshop in Pallanza, 5-7 June 1996, for AQC and the harmonisation of methods of chemical analysis of surface lake water samples and atmospheric deposition.

R. Mosello, in co-operation with B. Wathne, NIVA, is leading the intercalibration exercises for lake water and atmospheric deposition analysis. During 1996 two exercises were performed, dealing with surface water (June) and atmospheric deposition (November).

A. Marchetto is involved in the Diatom intercalibration exercise.

A. Lami attended the ALPFORUM in Chamonix, 10-13 September 1996, presenting a poster on "Limnological research on High Altitude lakes". This Forum was organised by Pôle Européen Universitaire et Scientifique, Grenoble in the framework of the "Convenzione delle Alpi".

C.Callieri in collaboration with the V.Straskrabova group has provided comparative data on bacterioplankton countings and has attended the Workshop on microbial loop held in C.Budejovice in May 1996.

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## Subcontractor to Partner 13

### MOLAR Report for the period: 1-3-1996 to 28-2-1997

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## I. OBJECTIVES FOR THE REPORTING PERIOD

- Water chemistry sampling and analyses for Lago di Latte (Milchsee) and Lago Lungo (Langsee);
- Zooplankton and phytoplankton sampling, species identification, enumeration, biovolume calculation and chlorophyll-a analyses for Lago di Latte and Lago Lungo;
- Chemical analysis of precipitation;
- Elaboration of the obtained data.

## II. ACTIVITIES PERFORMED AND RESULTS OBTAINED

### Workpackage 1

#### *Precipitation data collection*

Atmospheric precipitation chemistry has been analysed during the period 02/10/95-28/01/97 directly at the lake by means of seven bulk samples.

Analyses have been performed also in weekly bulk samples collected at a nearby located station (Riffian) at lower altitude, which is more accessible, for the period May-Dec. 1996. Bulk and wet weekly data are available also for another station (Renon) in the area located at 1700 m altitude, which functions routinely since many years. The deposition data of this last station do not differ significantly from the data measured at the lake itself, while the data recorded in the station Riffian proved to be too much affected from agricultural influence and bird droppings (high ammonia values). The most representing values for the catchment seem therefore the one measured at the lake (Tab. 1), despite the low sampling frequency.

Tab.1 Depositions values (g m<sup>-2</sup> y<sup>-1</sup>) for 1996 at Milchsee (Texelgruppe).

mm	H+	Ca	Mg	Na	K	N-NH <sub>4</sub>	S-SO <sub>4</sub>	N-NO <sub>3</sub>	Cl
1124	0.005	0.17	0.04	0.10	0.10	0.44	0.36	0.26	0.13

The precise quantity of precipitation for whole 1996 could only be measured at Ritten and amounts to 1124 mm, a value similar to the partial measurements performed in the two other stations. The performed analyses confirm that deposition in the area is, in relation to other sites in Europe, rather low, also because of the low amount of precipitation typical for the area, and that a progressive decreasing trend for the sulphur depositions takes place.



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### *Lake chemistry*

Lago di Latte (Milchsee) has been sampled seven times during 1996 and once in January 1997. Samples have been taken at several depths at the deepest part of the lake. The adjoining lake Lago Lungo (Langsee) has been sampled twice. Temperature has been measured for the whole water column while oxygen, pH, conductivity, chlorophyll have been measured at five to six different depths, where also samples for chemical analyses have been taken. The measured chemical variables are: major ions, nitrate ammonia, reactive soluble P, total P, total dissolved P, total dissolved and total nitrogen, TC, TOC, dissolved reactive silica, and iron. Chlorophyll has been calculated according to Goltermann and compared twice with the calculation method proposed in the directions for WP3. The sampling of June was taken during lake thaw and the maximum sampled depth was 5,2 m. Dissolved major ions concentrations were higher in the winter period and lower during summer probably because of dilution due to higher precipitation amounts while their percentage composition remained more or less constant throughout the year. During winter stagnation a marked increase of the concentrations toward bottom was registered.

### *Lake biology*

Zooplankton and phytoplankton samples have been taken at the same depths chosen for chemical analyses and have been not completely worked out yet.

Primary production is in both lakes generally much greater during the ice covered period than in Summer. In Milchsee chlorophyll *a* concentrations are low during Summer, but increase during the winter months up to 5 µg l<sup>-1</sup>. In Langsee concentrations are much higher and can reach 20 µg l<sup>-1</sup> in the hypolimnium.

The phytoplankton of Milchsee is essentially composed of Dinophyceae and Chrysophyceae showing both very small densities. The phytoplankton of Langsee is dominated by a small Zygnemaphyceae (*Staurodesmus controversus*). Also present are Dinophyceae, Chrysophyceae, Cryptophyceae and Chlorophyceae.

Zooplankton of Milchsee is almost exclusively composed of rotifers, mainly *Keratella hiemalis* and *Polyarthra dolichoptera*. Rotifers are in Langsee almost exclusively represented by *Polyarthra dolichoptera* and *Keratella hiemalis* (with a clear preponderance of the former). In both lakes the only copepod species is *Cyclops abyssorum taticus*. Cladocera (*Bosmina* sp., *Chydorus* sp.) are only sporadically found.

In both lakes the development of phytoplankton is controlled by rotifers, but while rotifers in Langsee are strongly in relation with the predatory *Cyclops*, the development in Milchsee depends essentially from the availability of nourishment. Despite the different trophic level of the two lakes, rotifer densities are similar.



Bundesamt für Bildung und Wissenschaft  
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## EU - FORSCHUNGSPROGRAMME Wissenschaftlicher Bericht

Programm	BBW-Nr.
Environment	95.0518-1
	EU-Nr.
	ENV4 - CT95 - 008

Projekttitle.....  
 MOLAR: Measuring and modelling the dynamic response of remote mauntain lake ecosystems to environmental change.

- Zwischenbericht  
 Schlussbericht

Berichtsperiode : Vom 1.2.96 bis 1.3.97

### Beitragsempfänger

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Dieser Bericht ist ausgefüllt und unterschrieben in zwei Exemplaren dem BBW einzureichen. Es sind die jährlichen Rapporte und der Schlussrapport für die EU-Kommission beizulegen, falls diese dem BBW nicht bereits vorliegen.

Ort und Datum	Unterschrift des Beitragsempfängers
Bern, 5.3.97	

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# MOLAR: Measuring and modelling the dynamic response of remote mountain lake ecosystems to environmental change

**Keywords:** alpine lakes, climate variability, lake sediments, aquatic ecosystems, modelling

## Abstract

The aim of MOLAR is to assess the seasonal variability of physical, chemical and biological characteristics of high-elevation lakes. The relationship between weather patterns and lake dynamics will be modelled using these data. Furthermore, long-term variability in ecosystem dynamics as evidenced by recent palaeolimnological records will be assessed and will allow to evaluate the model against the sediment record as well as forecast lake response to alternative climate scenarios.

During the first year of the MOLAR project the scientific infrastructure has been installed at the Swiss site (Hagelseewli, 2340 m asl) and sedimentological, biological, chemical and physical data has been assembled.

## Results

During the first year of the MOLAR project the site infrastructure was set up and data-collection at Hagelseewli started (see Table 1).

Table 1. Dates for the installation of the site infrastructure and sampling for different analyses at Hagelseewli.

Date	pH	Winkler	conductivity	Alkalinity	NO2	NO3	N tot	NH4	PO4	P tot (filtr.)	SO4	Cl	SiO4	SiO2	DOC	Na	K	Si	Ca	Mg	Fe (filtr.)	Chlorophyll	Echosounding	Secchl-depth	PAR	OTS	Meteo-station	Thermistor-chain	Rain-gauge	Sediment traps	Sediment cores	Plankton hauls		
6.05.96																																	X	
7.05.96																																	X	
5.06.96																																		
11.08.96																											X	I					X	
27.06.96	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	C						X	
9.07.96	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	C						X	
19.07.96																											C	C						
21.08.96	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	C						X	
28.08.96																																		
29.08.96																																	X	
3.09.96	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	C						X	
8.09.96																											C		I				X	
9.09.96																							X											
17.09.96	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	C		C	C	C		X	
1.10.96																								X	X	C	C	C	C	C			X	
14.10.96																									X	X	C	C	C	C				
12.11.96																										X	C							
21.01.97	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					C							
27.01.97																											C							
21.02.97																										X	C							

X: Sampled      I: Installed      C: Changed or controlled

On the basis of 25 echo-sounding tracks a bathymetric map of the basin has been constructed (Fig. 1). Hagelseewli has a simple SW-NE oriented basin morphometry.

In May 1996 several short gravity cores were taken from the ice in the deepest part at 18.5 m of water depth, extruded in 0.5 cm intervals, and stored in plastic bags before further treatment. Water content (Fig. 2a) and loss-on-ignition analyses (Fig. 2b) were carried out for five of these cores. These analyses are forming the basis of the stratigraphical correlation between the different cores. Several additional cores taken from the same location were opened longitudinally and photographed in order to document the sediment stratigraphy. The subsamples of the five cores were used for the following analyses:

Core HAG96-1: (37.5 cm long) diatom and pollen analyses (EAWAG, in progress), SCP (UCL, in progress), chrysophyte cysts (Mondsee, in progress).

Core HAG96-2: (33.5 cm long) fossil pigment and CNS (CNR, in progress), Cladocera (FSCU, in progress).

Core HAG96-3: (36 cm long)  $^{137}\text{Cs}$  and  $^{210}\text{Pb}$  dating, grain size analysis (EAWAG, in progress).

Core HAG96-4: (38 cm long) Chironomid analysis (UCL, in progress).

Core HAG96-5: (37 cm long) stored frozen as reserve.

Twenty-eight additional short sediment cores were taken in August/September 1996 along a longitudinal and latitudinal transect in different water depths. The topmost 1 centimetre is being analysed for diatoms, grain-size, and sediment geochemistry (C, P, N).

In June two thermistor chains were set out at the deepest point: one chain covers the water depths between 0.5 and 5.5 m in 0.5 m intervals and the other between 0.5 and 15.5 m in 1.5 m intervals. The data loggers are recording water temperature in 15 minute intervals in summer and in 30 minute intervals in winter.

Two cylindrical sediment traps have been set in 5 m and 17 m of water depth. The preliminary results indicate very low particle fluxes in Hagelseewli. The values are well below  $1 \text{ g m}^{-2} \text{ d}^{-1}$  (Fig. 3). The material in both traps seems to be exclusively dominated by particles formed in the epilimnion. Horizontal, near bottom transport or resuspension could not be observed during the sampling period. Given the open, sparsely vegetated catchment as well as the low annual productivity the apparent lack of distinct resuspension activities and allochthonous particles is surprising for a lake at this elevation. Detailed analyses of trap material and further sampling will enhance the interpretation of these preliminary results.

In June 1996 a meteorological station was installed on the shore of Hagelseewli (Fig. 4). It is recording wind speed, wind direction, air temperature, total radiation, solar radiation, relative humidity and rainfall in 10 minute intervals. Due to heavy snowfall in January 1997 the mast with the sensors bent and wind measurements might not be reliable for the period of January to March 1997. In September a rain gauge has been installed to measure total winter precipitation.

The open-water season at Hagelseewli is short. The lake was completely ice-free between August and October 1996. Water sampling was carried out on the dates indicated in Table 1. With each water sampling two continuous temperature, conductivity and oxygen profiles were measured at the deepest part of Hagelseewli using an OTS probe. Zooplankton net-hauls as well as chlorophyll samples were also taken.

## Meetings

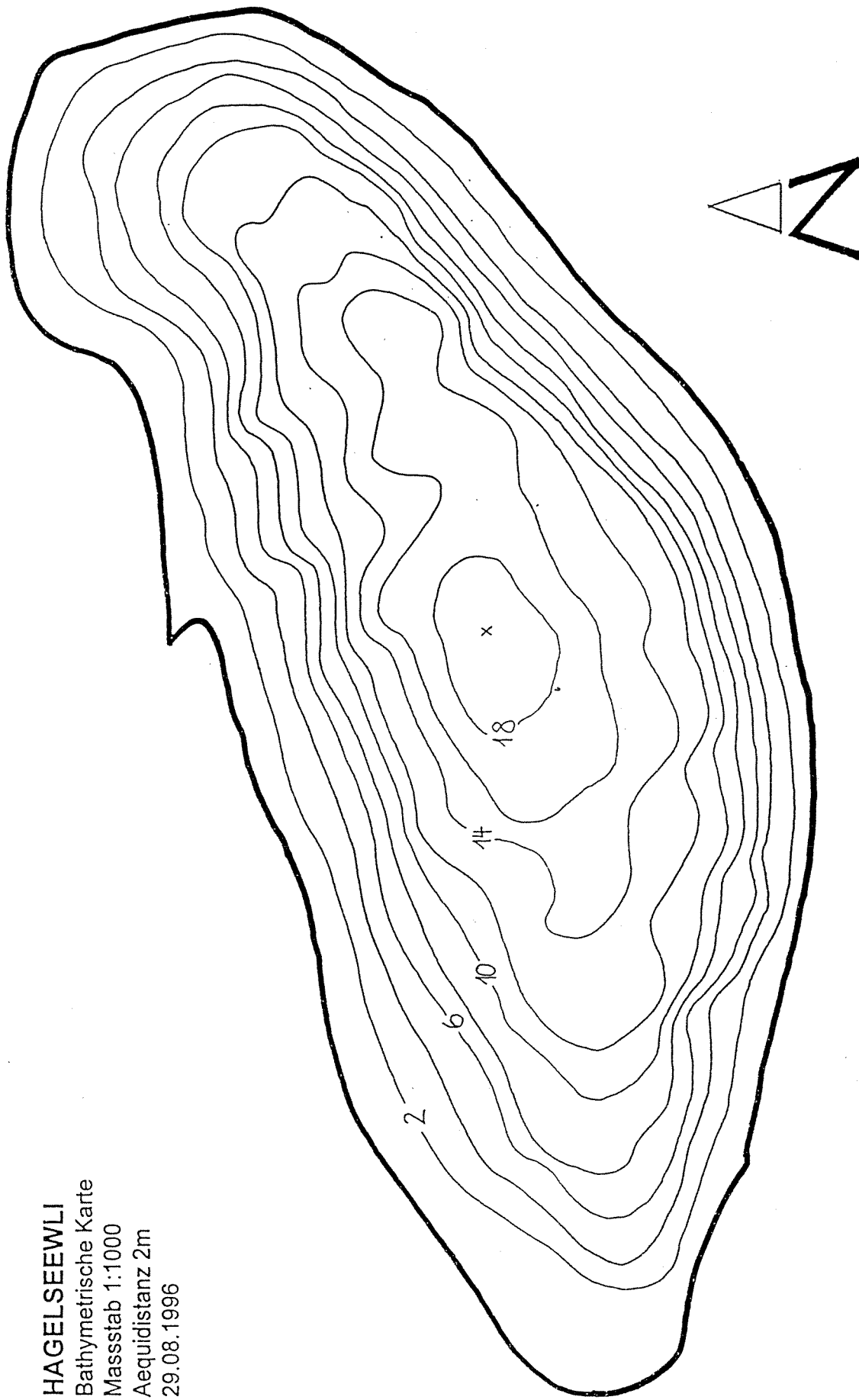
Members of the Swiss MOLAR project attended the following MOLAR workshops:

13/14 June 1996, Biology workshop at UCL in London, UK.

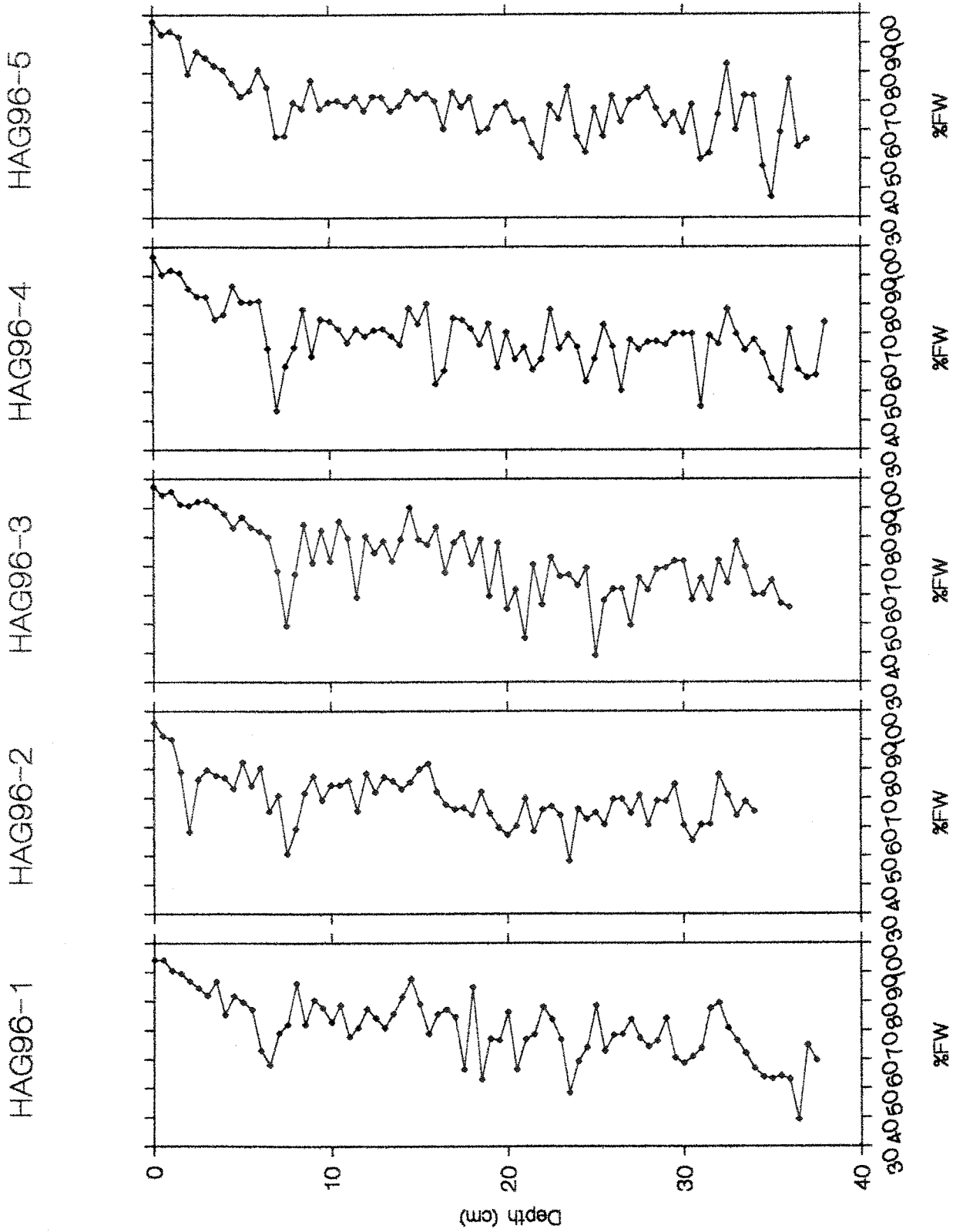
4/6 June 1996, Water chemistry workshop at CNR, Pallanza, I.

19/21 October 1996, Diatom taxonomy workshop at UHEL, Helsinki, SF.

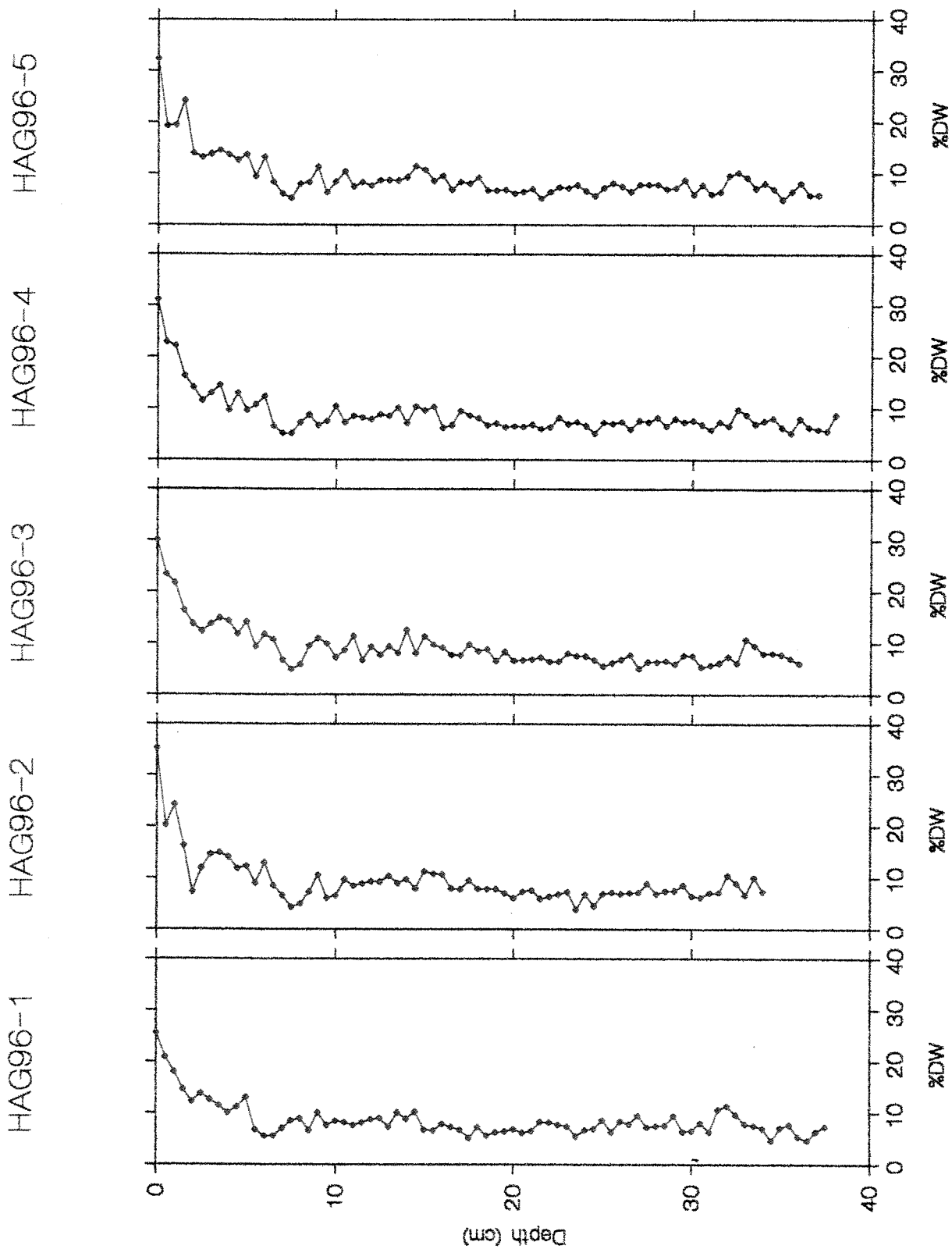
**HAGELSEEWLI**  
Bathymetrische Karte  
Masstab 1:1000  
Aequidistanz 2m  
29.08.1996



**Figure 1** Bathymetric map of Hagelseewli. Scale 1:1000, 2 m equidistance.



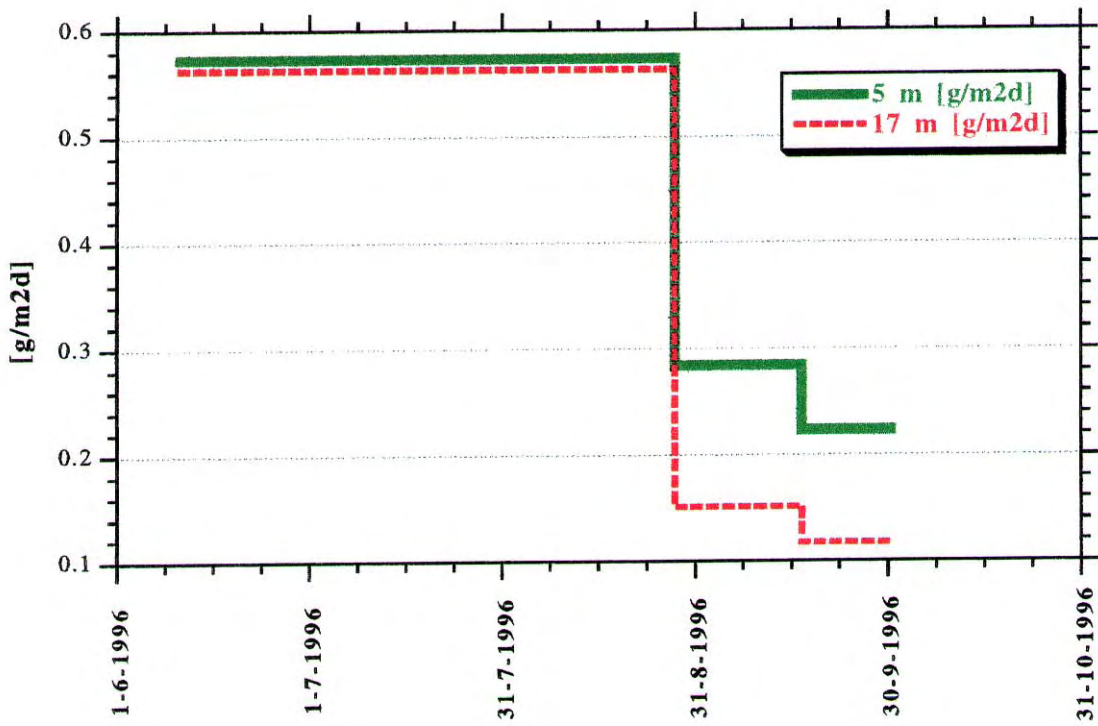
**Figure 2a** Water content in percent fresh weight of five Kajak cores taken in the deepest part of Hagelseewli.



**Figure 2b** Loss-on-ignition at 500°C expressed as percentage dry weight of five cores from the deepest part of Hagelseewli.

# Hagelsee

results sediment traps



**Figure 3** Results of epilimnion (5 m, green) and hypolimnion (17 m, red) sediment traps. The trap yields are expressed as gram per  $\text{m}^2$  and day and plotted against exposition time.





**Figure 4a** Hagelseewli and its catchment at the end of August 1996, seen from the SW.



**Figure 4b** Meteorological station on the shore of Hagelseewli and sampling gear storage hut.

## Introduction

During the first year at Jöri we have

- installed the research station consisting of a small mobile laboratory at lake III, a meteo-station also at lake III and hydro-stations at lakes III, VII and X.
- begun collecting data after the middle of July, as soon as the lakes were accessible again. We continued regular sampling until October. An early snow fall at the beginning of September interrupted the campaigns and since that snow never melted again before winter, accessibility of the stations became more difficult during the second half of the 1996 campaigns. We have so far carried out two winter missions during which we have sampled water from below the ice cover and snow.

## Results

Physicochemical and biological characteristics of lake III: The three lakes which we have chosen for comparative studies differ from each other with regard to the source of the water and the processes in their catchment. Lakes VII and X have a relatively small catchment area; they are primarily fed by snow melt and rain water. Lake III is the largest of a series of small lakes which lie within a cascade of lakes fed during the summer primarily by glacial melt water. This lake is turbid, due to the high content of suspended clay particles. We have concentrated our MOLAR investigations on lake III and have used the two other lakes for comparison.

In tables 1 and 2 we summarize the biological and the chemical parameters of lake III. Figure 1 illustrates the steadily increasing biomass and its genus composition during the 4 summer months. Events, like the early snow fall in September and the following period of snow cover in the catchment led to an appreciable decrease of the phosphate concentration in lake III (figure 2). In addition, we have continuously recorded pH, O<sub>2</sub>, temperature and conductivity in the epilimnion and the temperature at different depths in order to learn more about the physical dynamics of lake III. These data will be presented at a later date.

At all three lakes we collected atmospheric depositions with Bergerhoff-type bulk samplers and with wet only deposition samplers. Analyses included pH, conductivity, K, Ca, Mg, Na, SO<sub>4</sub>, NO<sub>3</sub>, Cl, alkalinity and NH<sub>4</sub>. Figure 1-12 is presented as an example to illustrate the variability of the composition of the precipitation during the season. In addition, we have recorded precipitation, wind speed and direction, irradiation and air temperature to complete the characterization of the changing atmospheric conditions (data not shown).

## Discussion

Disregarding the small logistic and technical difficulties which we had to overcome during this first year at Jöri and some analytical problems which still need to be solved we are pleased with the results obtained so far. The three lakes are well suited to contribute to the MOLAR objectives. In addition, we have already begun with our more detailed studies on the quantitative role of clay minerals as nutrient scavengers and the changes in community diversity as a consequence of environmental events. The data presented clearly illustrate the enormous dynamics which we have to deal with and which make it necessary to do observations with a high time resolution.

Table 1: Biological parameters in Jöri Lake III during the summer season 1996. The concentrations indicate oligotrophic conditions in the lake.

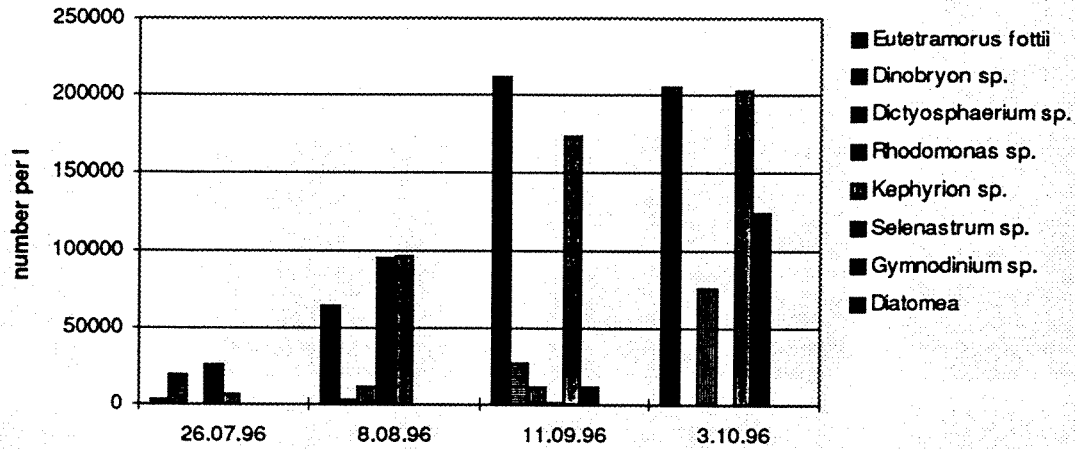
	26.07.96			8.08.96			11.09.96			3.10.96		
	0.5m	4m	19m	0.5m	4m	19m	0.5m	4m	18m	0.5m	4m	16m
Chl a [ $\mu\text{g/l}$ ]	0.4	0.72	1.02	0.38	1.59	0.42	1.24	1.38		2.34	2.12	2.42
number of phytoplankton [ $10^4/\text{l}$ ]	5.43			26.9			43.43			60.77		
number of bacteria [ $10^6/\text{ml}$ ]	1.03	1.58	1.2	1.45	1.51	1.3	1.89	1.6	1.34	1.04	9.79	1.12
grazing rate [ $10^3$ bacteria/h]	9.05						9.27	10.04	1.74			

2. Table: Chemistry of Jörisee III (0.5 m)

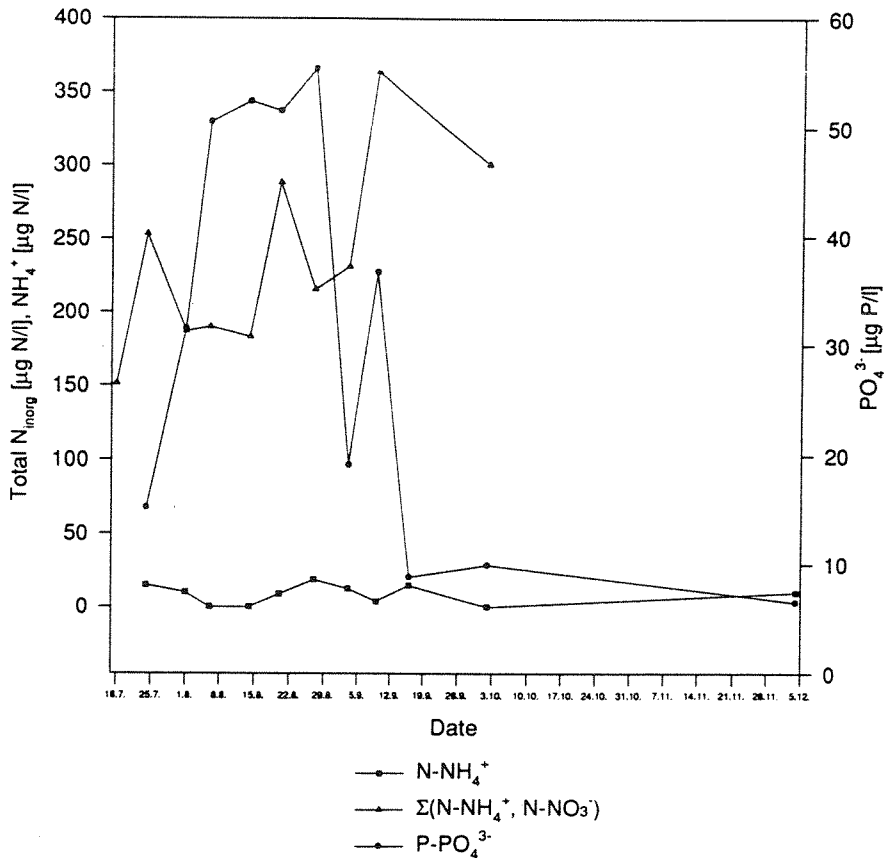
Lake III	Date	pH	Cond. $\mu\text{S/cm } 25^\circ$	Alk. $\mu\text{eq/l}$	$\text{Ca}^{2+}$ mg/l	$\text{Mg}^{2+}$ mg/l	$\text{NH}_4^+$ $\mu\text{g/N/l}$	$\text{Na}^+$ mg/l	$\text{K}^+$ mg/l	$\text{PO}_4^{3-}$ $\mu\text{g/P/l}$	$\text{SO}_4^{2-}$ mg/l	$\text{NO}_3^-$ $\mu\text{g/N/l}$	Cl <sup>-</sup> mg/l	TotN <sub>inorg</sub> $\mu\text{g/N/l}$	TOC mg C/l	Cd $\mu\text{g/l}$	Pb $\mu\text{g/l}$	Zn $\mu\text{g/l}$	Fe $\mu\text{g/l}$	Si mg/l	
	19.07.96	6.74	19.10	47.30	1.94	0.24	0.32	0.24	0.32	0.24	2.90	151.37	0.00	151.37	0.00	0.00	0.00	1.55			
	25.07.96	6.67	19.60	83.00	2.00	0.25	14.81	0.37	0.26	15.21	3.01	238.39	0.28	253.20	0.00	0.00	0.00	2.32			
	02.08.96	6.82	19.30	142.90	2.14	0.27	9.72	0.36	0.24	31.50	3.07	177.16	0.37	186.88	0.00	0.00	0.00	7.74			
	07.08.96	6.73	19.30	164.40	1.86	0.25	b.d.1	0.36	0.25	50.53	3.08	189.93	0.41	189.93	0.68	0.00	0.00	2.91			
	15.08.96	6.46	18.50	48.40	2.04	0.30	b.d.1	0.41	0.31	52.42	2.71	183.00	0.00	183.00	0.00	0.00	0.00	7.34			
	21.08.96	6.80	20.30	111.40	2.15	0.26	8.67	0.39	0.27	51.50	3.25	279.49	0.39	288.16	0.00	0.00	0.00	2.59			
	28.08.96	6.79	19.20	68.10	2.26	0.29	18.56	0.37	0.29	55.44	3.13	196.93	0.27	215.49	0.00	0.00	0.00	2.05			
	04.09.96	6.87	19.70	84.40	2.27	0.30	12.38	0.41	0.48	19.09	3.17	218.81	0.28	231.19	0.00	0.00	0.00	2.32		0.82	
	10.09.96	7.09	18.80	219.05			3.71			36.73	2.53	259.93		263.64						0.86	
	17.09.96	6.42	17.63				14.67			8.76											
	03.10.96	6.9	17.75	121.84			b.d.1			9.97	2.70	300.58		300.58						99.5	
	05.12.96	7.10	66.20				9.86			6.44										17.1	
	17.02.97						18.26			8.80										55.6	0.34
<b>Average</b>		<b>6.78</b>	<b>22.95</b>	<b>109.08</b>	<b>2.08</b>	<b>0.27</b>	<b>9.22</b>	<b>0.37</b>	<b>0.29</b>	<b>28.87</b>	<b>2.96</b>	<b>219.56</b>	<b>0.25</b>	<b>205.77</b>	<b>0.68</b>	<b>0.00</b>	<b>0.00</b>	<b>3.60</b>	<b>57.4</b>	<b>0.67</b>	
<b>St.deviation</b>		<b>0.20</b>	<b>13.06</b>	<b>51.90</b>	<b>0.14</b>	<b>0.02</b>	<b>4.55</b>	<b>0.03</b>	<b>0.07</b>	<b>18.84</b>	<b>0.22</b>	<b>46.17</b>	<b>0.15</b>	<b>46.87</b>				<b>2.31</b>	<b>33.7</b>	<b>0.24</b>	

b.d.1 = below detection limit

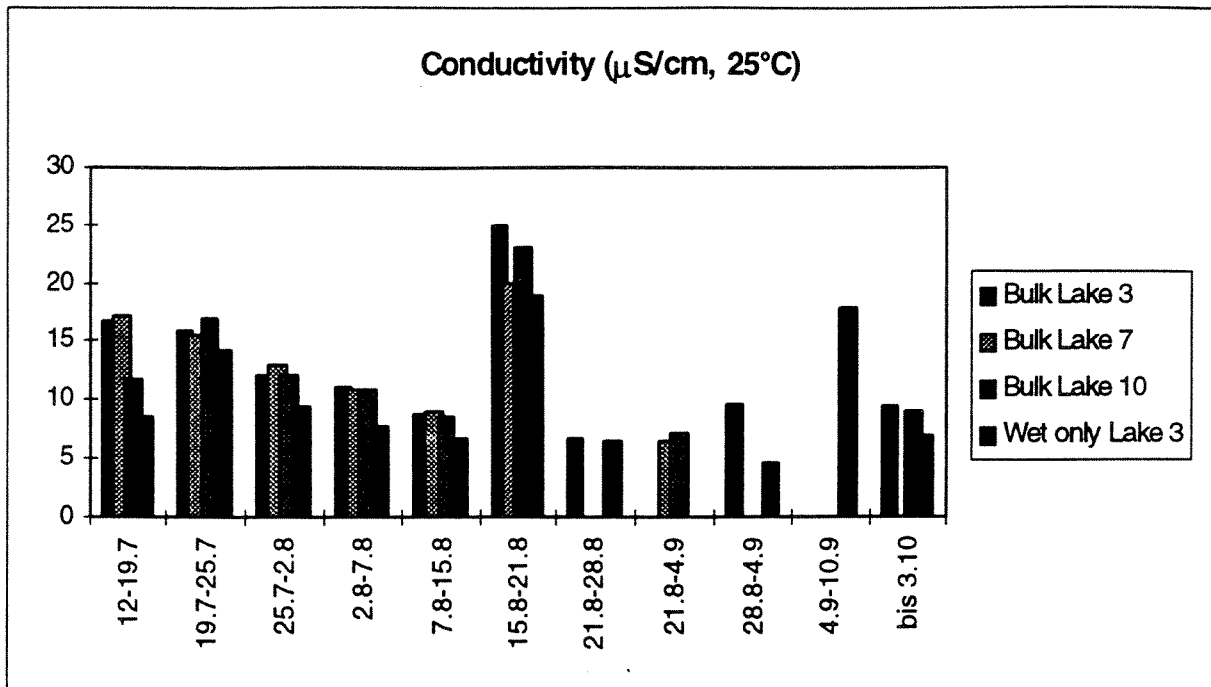
### Planktonic Algal Community in Lake III



**Abb. 1:** Planktonic algal community in Jöri Lake III during summer season 1996. A significant change in algal community composition takes place: in spring *Dinobryon* sp. are dominant, during summer, green algae (*Eutetramorus fottii*, later also *Selenastrum* sp.) and crysophytes (*Kephyrion* sp.) are increasing.



2. It shows the concentration of total N<sub>inorganic</sub> ( $\Sigma(N-NH_4^+, N-NO_3^-)$ ,  $N-NH_4^+$ , and  $P-PO_4^{3-}$  versus time. There are unexpected high phosphorus concentrations in summer. A possible source of phosphorus could be the meltwater.



**Figure 1-12:** The measured conductivity demonstrates the higher concentrations observed in the samples with small precipitation. Towards autumn there is a slight decrease. The correlation with the calculated conductivity was difficult due to the problems while measuring pH in a poorly buffered solution.

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## Partner 17

### **MOLAR - Report for the period March 1966 - February 1997**

Department of Hydrobiology, Faculty of Science, Prague, Czech Republic (FSCU)

Jan Fott

Sites in the High Tatra (Slovakia):

15.1 - Starolesnianske Pleso (site operator: Evzen Stuchlik, FSCU)

15.2 - Terianske Pleso (site operator: Ferdinand Sporka, IZ-SAS)

#### **1. Meetings and organisational activities**

The first meeting of the MOLAR project was held in Prague from 12<sup>th</sup> to 15<sup>th</sup> March, 1966.

Martin Cerny has compiled the MOLAR homepage (<http://www.natur.cuni.cz/~pah/molar/>) which will be gradually improved.

#### **2. Purchase and installation of new equipment**

At the beginning of the project it was essential to buy new equipment, put it in operation and acquire skills

necessary for smooth running of the new methods:

##### Field equipment:

- 2 aluminium boats were transported to the sites (the last stage with use of a helicopter) together with two large aluminium containers for storage of equipment.
- 4 bulk collectors for sampling precipitation (type NILU) were installed in the catchment of the lake Starolesnianske.
- A precipitation collector (type WADOS) for measurement of wet only precipitation was installed at the lake Skalnaté Pleso, where it is under permanent control at the local meteorological station

##### Laboratory equipment and instrumentation

- fluorometer Turner TD-700 for routine determinations of chlorophyll-a in vertical profiles
- spectrophotometer ATI-Unicam, UV2-100 + SuperSipper (calibration of chlorophyll-a measurements, determination of Al)
- system for automisation of conductometry, potentiometry and titrations - titration manager TIM900, two burettes ABU900, conductometer CDM210 (all Radiometer Analytical), balances Sartorius P-150 - (pH, Alkalinity, K2O, Fluoride)
- 3 notebooks for the control of spectrophotometer, fluorometer and titrator
- 2 additional underwater cables for the HYDROLAB profiler, a new pH-probe
- A method for fast measurement of microscopical objects (phytoplankton, zooplankton) was acquired, using a digital calliper in connection with a drawing tube of a microscope. Data are stored directly in an Excel sheet.

The system is used also for counting phytoplankton and zooplankton.

#### **3. Field work**

The field work has been concentrated to the two sites in Slovakia:

15.1 - Starolesnianske Pleso: WP1 and WP2 lake, site operator: Evzen Stuchlik, FSCU, Prague

15.2 - Terianske Pleso, WP3 lake, site operator: Ferdinand Sporka, IZ-SAS, Bratislava

Despite of this formal delimitation, the field work at the two sites was carried out in close collaboration of the Czech and Slovak teams. The work at the Terianske Lake was enlarged by including analyses of pelagic food webs, which is a WP1 activity.



The programme of sampling lakewater (site 15.1- Starolesnianske pleso) and precipitation in one week intervals, which started in November 1994 as a part of the AL:PE programme, has continued without interruption. The sampling design was improved by installation of 4 bulk collectors (type NILU) in the catchment of Starolesnianske Pleso and 1 wet only WADOS collector at Skalnaté Pleso. Special attention was paid to the comparison of the 1966 data with the 1964&65 data.

Main field activity in 1996 (full sampling means all parameters incl. profiling, profiling means chemistry and chlorophyll-a on the vertical profile, 4.5m intervals):

DATE	Type of activity	Notes
12.8. - 24.8.1996	Beginning of the field work: - coring 15.2: assistance to the British team - installation of two aluminium boats and containers at 15.1 and 15.2 - installation of the bulk collectors - the first full sampling (biology, chemistry) at the both lakes	
4.9.1996	- profiling 15.2	unsuccessful, bad weather
5.9.-15.9.1996	- attempt to measure microbiology level II at 15.1 (by HBI-ASCR)	unsuccessful, 15.1 was covered by a snow slush
18.9.-20.9.1996	- the second full sampling at the both lakes - coring several lakes for sediment chemistry and remains of Cladocera	15.1 already covered with ice, on the both sites true winter conditions, we missed the chance to sample SCP at the end of the ice-free period
3.10.1996	- profiling 15.2	
17.10. 1996	- the third full sampling at 15.2	15.2 still ice-free
1.11.1996	- installation of the WADOS collector at the Skalnaté Lake	
18.12.- 19.12.1996	- the first full winter sampling of the both lakes, beginning of the snow study at 15.1	the both lakes frozen

Additional sampling of invertebrates and diatoms at 15.1 was carried out on 8.6., 1.8. and 28.9. by the Slovak team (IZ-SAS).

Summary of the field activity: The unpredictable and exceptional weather (winter conditions in September) was the main factor influencing our field activity in 1996. Nevertheless, the samples were duly taken and the requirements of the project were met. The SCP study in bulk precipitation was delayed until January 1997.

#### 4. Laboratory analyses (samples from 15.1 and 15.2)

- water chemistry - lakewater and precipitation
- participation in the chemical intercalibration
- chlorophyll-a from vertical profiles
- phytoplankton - abundance and biovolume

- zooplankton - abundance, dry weight, biovolume
- measuring and weighing of single zooplankters in order to obtain length-weight relationships

### 5. Plan of the field work in the High Tatra (Slovakia), 1997

Arrival	Departur e	No. persons	Activity
20.1.	22.1.	2	snow
17.2.	19.2.	2	snow
10.3.	16.3.	14	SP, NT, snow, coring
14.4.	16.4.	8	SP, NT, snow
26.5.	30.5.	11	SP, NT, snow, invertebrates
26.6.	4.7.	7	SP, NT
16.7.	18.7.	3	NT
28.7.	1.8.	5+2	SP, NT, invertebrates
13.8.	15.8.	3	NT
25.8.	29.8.	12	SP, NT
10.9.	12.9.	3	NT
22.9.	26.9.	15	SP, NT, ICP, invertebrates
8.10.	10.10.	3	NT
20.10.	24.10.	7	SP, NT
5.11.	7.11.	3	NT
8.12.	12.12.	5	SP, NT, snow

SP, NT ..... full sampling programme of the pelagic zone at the lakes 15.1 Starolesnianske and 15.2 Terianske

ICP ..... sampling for the ICP programme included

### 6. Activities in the Work Package 1 ( sub-package pelagic food webs) and Work Package 3

#### A. Project Manual

Sampling protocols for site operators and protocols for laboratory analyses were written and published in the Project Manual (Draft of September 1996), which is also available on the Internet ( <http://www.natur.cuni.cz/~pah/molar/> ):

Straskrabova V., Macek M., Simek K and Fott J.: Microbial Pelagic Food Webs - 1<sup>st</sup> level (Work Package 1), p. 56-61

Fott J.: Zooplankton (Work Package 1), p. 86-89

Fott J.: Sampling Recent Zooplankton (Work Package 3), p. 90-92

Fott J., Hofman W.: Sediment Cladocera (Work Package 3), p. 103-105

#### B. Analysis of samples sent to the Prague laboratory

Phytoplankton samples were analysed in order to determine cell numbers (cells/ml) and biovolumes ( $\text{mm}^3/\text{m}^3$ ) of individual species or taxonomic groups. The data will be used for WP1, sub-package Pelagic food webs.



Samples from the following lakes were received and analysed in the Prague laboratory:

1 Ovre Neadalsvatn, 2 Stavsvatn, 4.1 Lochnagar, 11.2 Gossenköllesee, 15.1 Starolesnianske Pleso, 15.2 Terianske pleso, 15.3 Dlugi Staw.

The lakes were sampled from at least three depths on each sampling day; most of the analyses have been completed by now.

Zooplankton samples were analysed in order to determine species abundances (individuals/ m<sup>3</sup> and individuals/ m<sup>2</sup>) and biomass (estimates from biovolumes or determinations of dry weight). These analyses are still in progress.

Preserved zooplankton samples were received from the following lakes: 1 O. Neadalsvatn, 2 Stavsvatn, 4.1 Lochnagar, 11.2 Gossenköllesee, 15.1 Starolesnianske Pleso, 15.2 Terianske pleso, 15.3 Dlugi Staw, 17 Chuna, 22 Hagelsee (WP3 lake, abundance only), 23 Jorisee.

Samples for determination zooplankton dry weight were received and weighed from the following lakes:

Site	Date (1996)	z(m)	dry weight mg/m <sup>2</sup>	dry weight mg/m <sup>3</sup>
1 O. Neadalsvatn	8. September	15	118	8
2 Stavsvatn	25. July	15	1132	75
	12. August	15	624	42
	26. September	15	741	49
5.1 L. Paione S.	16. July	11	19	2
	20. August	10.5	254	24
	9. September	11	2034	185
11.2 Gossenköllesee	6. August	8.5	65	8
	16. August	8.5	258	30
	3. September	8.5	556	65
15.1 Starolesnianske	21. August	2.8	17	6
	18. September	1.5	13	9
15.2 Terianske	22. August	40.3	629	16
	20. September	39.3	257	7
	17. October	40.3	165	4
15.3 Dlugi Staw	10. August	8	0	0
	5. October	8	0	0
23 Jörisee	26. July	15	412	27
	8. August	15	976	65
	11. September	15	297	20

Samples from 13 La Caldera arrived additionally.

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### **C. Sediment Cladocera (WP3)**

Cladoceran remains - intercalibration exercise:

A large sample of sediment from the AL:PE lake 15.4 (Zielony Staw) was subsampled into portions of 1 - 3 g.

Three subsamples were analysed for cladoceran remains (numbers per g wet weight) in order to evaluate suitability of the test material and the among - subsample variation. The material fits well for the purpose and the variation is satisfactory. Other groups of three subsamples will be sent to the respective analysts and the inter - laboratory variation will be evaluated. More test material from other lakes will be mailed off this spring.

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## Partner 18

Report on activities of Hydrobiological Institute, Academy of Sciences CR  
March 1996 - February 1997

### WORK PACKAGE 3

Chemical analyses from Nižné Terianské pleso:

(i) 4 times per year surface and bottom layers: total P, total dissolved P, soluble reactive P, total and soluble organic N, nitrate and ammonia N, total and soluble organic C, Si

(ii) 4 times per year plus 8 other layers: total P, soluble reactive P, total organic N, ammonia N, total C, silica.

Results of chemical analyses were sent to E. Stuchlík.

### WORK PACKAGE 1

#### 1. Chemical analyses

\* Participation in intercomparisons of chemical analyses

(i) in July organized by NIVA

(ii) in December of AQUACON 1/96, organized by Istituto Italiano di Idrobiologia v Pallanze, Itálie.

\* Chemical analyses from Starolesnianské pleso:

(i) 1 profile in the lake

- weekly: total P, total organic N, nitrate and ammonia N, chemical oxygen demand

- 3x per year total dissolved P, soluble reactive P, soluble organic N, total and soluble organic C

(ii) bulk precipitation weekly and since December 1996 also "wet-only" weekly: total and soluble reactive P, total, nitrate and ammonia N, chemical oxygen demand, total C.

Results of chemical analyses were sent to E. Stuchlík.

#### 2. Microbiology

\* Sampling protocols and laboratory protocols for microbiology 1st level and laboratory and field protocols for experienced labs for microbiology 2nd level were elaborated.

\* Microbial workshop was organized in May in È. Budijovice (14 participants from 7 institutions from 6 countries). Training of methods was performed and methods were discussed for the final elaboration of sampling and laboratory protocols.

\* Microbiology 1st level in 1996 was investigated in 12 lakes. HBI elaborated samples from the following lakes: Starolesnianské (2x 1 layer), Nižné Terianské (3x 3 layers), Stavsvatn (3x 3 layers), Øvre Neådalsvatn (2x 3 layers, 2x 5 layers), Chuna (2x 3 layers), Lochnagar (2x 3 layers) - numbers and biomasses of bacteria, picocyanobacteria, flagellates and ciliates, Dlugi Staw (2x 3 layers) all except of ciliates,

Paione Superiore (4x 2 layers, 1x 1 layer) all except of ciliates and picocyanobacteria

\* HBI measured microbiology 2nd level in the lakes of Sumava - the measurement was carried on as a training for field "expedition" type of measurement.

\* HBI measured microbiology 2nd level in Norway - lake Øvre Neådalsvatn. Results were presented in February 1997 at the Conference of American Society for Limnology and Oceanography (accepted as oral contribution). Measurements of 2nd level microbiology were performed in September in Tatra Mts, however, they could not be fully realized because of sudden weather change and freezing up of

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the upper lakes. Measurement was done in Popradské pleso for comparison (this lower lake was accessible).

### **3. Conferences, workshops, etc**

\* February - steering committee in London (1)

\* in March - conference MOLAR in Prague (5)

\* in May organization and participation of 5 people - microbial methods workshop in È. Budjovice

\* in October participation and poster presentation on conference of American Geophysical Union, Sunriver, Oregon, "Nitrogen cycling in forested catchments" (1)

### **4. Summary of results**

Samples from all lakes for microbiology 1st level, phytoplankton and zooplankton, are gathered from all respective labs, as soon as they are elaborated. Final elaboration and suggestions for next season will be prepared for MOLAR meeting in Barcelona.

Table of sampling and abstract of ASLO meeting are attached.

**Microbiology 1st level  
Sampling in 1996 (dates and depths)**

lake	July	August	September	October	November	December
Starol esmia depth		21 1	18 1			
Nizne Teria depth		22 1, 17, 38.5	20 1, 17, 39	17 1, 17, 39		17 1, 17, 39
Dlugi Staw depth		09 1, 4, 8		05 1, 4, 8		05 1, 4, 8
Paion Super depth	16 1, 11	20 1, 10	09 1, 10	22 1		17 1, 9
Stavs vatn depth	24 1, 5, 15	11 1, 5, 15	23 1, 5, 15			
Ovre Nead a depth	18 1, 8, 15	19, 21 0.5, 4, 7, 11, 15	07 1, 7, 15			
Chun a depth		14 1, 7.5, 15	07 1, 7.5, 15			
Loch nagar depth		15 1, 10, 20			12 1, 10, 20	
Redo depth	06 0,9,18,27,36, 45, 54, 63	07 0,9,18,27,36, 45, 54, 63	10 0,9,18,27,36, 45, 54, 63	09 0,9,18,27,36, 45, 54, 63	09 0,9,18,27,36, 45, 54, 63	17 0,9,18,27,36, 45, 54, 63
La Calde depth	24 1, 4, 8, 13	20 1, 5, 9, 13	20 1, 5, 9, 12	09 1, 5, 7, 10		
Gosse koell depth	23 1, 4.5, 8.5	6, 16 1, 4.5, 8.5	03 1, 4.5, 8.5			
Jorise e depth	26 1, 4, 19	08 1, 4, 19	11 1, 4, 18	03 1, 4, 16		03 1, 4, 16

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Microbiology 1st level analyzed in the labs of Hydrobiological Institute CAS, C. Budejovice from the following lakes (from samples sent by site operators):

Starolesnianske - BAC, PICY, HNF, CIL

Nizne Terianske - BAC, PICY, HNF, CIL

Dlugi Staw - BAC, PICY, HNF

Paione Superiore - BAC, HNF

Stasvatn - BAC, PICY, HNF, CIL

Øvre Neådalsvatn - BAC, PICY, HNF, CIL

Chuna - BAC, PICY, HNF, CIL

Lochnagar - BAC, PICY, HNF, CIL

### **Presentations**

\* Kopáček, J., Stuchlík, E., Fott, J., Veselý, J., Hejzlar, J., 1996: Reversibility of acidification of mountain lakes after reduction of nitrogen and sulfur emissions in Central Europe. Poster at the conference of American Geophysical Union, Sunriver, Oregon, "Nitrogen cycling in forested catchments"

\* Straškrabová, V., Hartman, P., Macek, M., Nedoma, J., Šimek, K., Vrba, J., Kopáček, J., Lien, L., Fott, J., 1997 : Low-alkalinity clear-water mountain lakes: a domain for microbial loop. Lecture and abstract: ASLO 97 Aquatic sciences meeting, Santa Fe N.M., Program and abstracts, 314

Abstract - ASLO meeting

### **LOW-ALKALINITY NON-HUMIC MOUNTAIN LAKES: A DOMAIN FOR MICROBIAL LOOP**

Straskrabova, V., Hydrobiological Inst., Acad.of Sci. CR, C. Budejovice, Czech Republic CZ 37005, P. Hartman, M. Macek, J. Nedoma, K. Simek, J. Vrba, J. Kopacek, L. Lien, Norwegian Inst.for Water Research, Oslo, Norway, N 0411, J. Fott, Departm. of Hydrobiology, Charles Univ., Prague, CZ 12844

Mountain lakes on crystalline bedrock, with no other but the atmospheric pollution, are extremely oligotrophic. Metazoic zooplankton developing slowly during ice-free season, is scarce. The prevailing biota in pelagic region are unicellular microbes, both eucaryotic and procaryotic. The top trophic link is represented by protists. Data on biomass and activities of microbial loop from several lakes in European mountains (Norway-Trollheimen, Slovak Rep.-Tatra, Czech Rep. Sumava, latitude 49-62°N, elevation 700-2000 m a.s.l., alpine and forested watersheds) documented that: (1) both the biomass and cell specific activity (thymidine, leucine) of pelagic bacteria is considerable, (2) from total phytoplankton production, more than 50% are exudates, 50 - 70% of which being readily utilized by bacteria, (3) elimination of bacteria by grazing is low and mixotrophs may comprise for more than 50%.

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## Partner 19

Site: Terianske Pleso

Site operator: Ferdinand Sporka

### Work Package 3

#### Activities:

##### Organisation and field activity:

13.8-15.8.96 Help for Simon Patrick and his group at taking core from lake,

14.8 Core sampling from NTER

16.8.96 getting out boat and automatic weather station by helicopter  
installation weather station on NTER

22.8.96 installation sediment trap on NTER

help with water column profiling for Prague group (E. Stuchlik)

#### Field activity

##### Invertebrates and Chironomids sampling:

6.6.96            3.8.96            26.9.96

##### Diatoms sampling

6.6.96            3.8.96            26.9.96

##### Sediment trapping

First sample                            22.8-15.10.96

Ice cover trapping                    15.10.96-?(28.6.97)

##### Climatology and meteorology

22.8.96 start of measuring meteorological variables from NTER

15.10.96 stop of measuring meteorological variables from NTER

Data sets was send by e-mail David Livingstone

(for problems with battery measuring was interrupted from 30.8-19.9.96, from measure meteorological variables we obtain bad value of wind direction, air pressure and precipitation)

##### Water column profiling on lake

22.8    29.9    3.10    17.10    19.12 (winter sampling)

##### Zooplankton sampling

22.8    20.9    17.10

##### Microbial food webs: (*Microbiology 1st level sampling*)

22.8    20.9    17.10

#### Summary of field activity:

The main factor influencing our field activity was the weather. For example on 5th Sept. fell snow (in place, where was installed weather station was 2m layer of snow). But we took samples regularly, except 6th. Sept. for extremely bad weather (snow storm). Samples for water column profiling were taken together with colleagues from Prague.

## Partner 20

**MOLAR report** for the period: March 1996 - February 1997

Associate contractor: **Institute of freshwater Biology, Polish Academy of Sciences**

Joanna Galas, Elzbieta Dumnicka, Barbara Kawecka, Andrzej Kownacki,  
Krzysztof Wickowski, Anna Jachner

The lake **Długi Staw** (Tatra Mts, **Poland**) lies above timber line, at an altitude of 1783 m. It has max. depth 10.6 m and its bottom is covered by bare rocks, stones and partly by moss *Warnstorfia exannulata*. Ice covers the surface of the lake from September/October until May/June. The catchment around lake is of granite bedrock with primitive and podsollic soils.

### Deposition

The precipitation station is situated close to the site, but at the lower altitude of 1507 m. The mean results for the 30.05.1996-6.01.1997 are shown in the Table 1.

Table 1. Precipitation Chemistry in Długi Staw

Deposition												
DLUGI STAW												
	volume	pH	Conductivity	Cl	N-NO <sub>3</sub>	S-SO <sub>4</sub>	SO <sub>4</sub>	N-NH <sub>4</sub>	Na	K	Ca	Mg
	mm		μS.cm <sup>-1</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>
<b>mean</b>	<b>45,33</b>	<b>4,56</b>	<b>33,48</b>	<b>2,15</b>	<b>0,40</b>	<b>1,09</b>	<b>3,258</b>	<b>0,41</b>	<b>0,22</b>	<b>0,96</b>	<b>0,55</b>	<b>0,06</b>
<b>min</b>	2,1	3,79	12,8	0,05	0,1	0,15	0,449	0,03	0,02	0,01	0,07	0,01
<b>max</b>	251,3	5,75	90,6	15,54	1,72	3,09	9,258	1,14	3,83	13,76	4,65	0,17
<b>SD</b>	47,16	0,45	20,27	4,15	0,33	0,61	1,833	0,29	0,66	2,49	0,83	0,04

Mean precipitation quantity and pH for Długi Staw was 45 mm and 4.56 respectively. The value of Cl was 2.15 mg/l while SO<sub>4</sub> was 3.25 mg/l.

### Water chemistry

The mean major ion concentrations in 8 samples for the period 05.1996-01.1997 are shown in the Table 2.

The pH varied from 4.36 to 5.8. The conductivity values was 23.41 μS/cm, Ca and Mg values were 1.52 and 0.08 mg/l respectively. Cl value was 0.34 mg/l while SO<sub>4</sub> value was 3.40 mg/l.

### Epilithic diatom

The samples of epilithic diatoms were taken two times in 1996: in summer (08.08) and in autumn (19.10). Diatom communities was very scarce. The epilithic flora was dominated by *Achnanthes marginulata* Grun., the species which is mostly found in low ionic and acidified water. The other diatom species found in summer sample *Achnanthes helvetica* (Hust.) Lange Bertalot, and *Eunotia exigua* (Bréb.) Rabenh., mostly found in acidic water. *Achnanthes curtissima* Carter and *A. subatomoides* (Hust.) Lange-Bertalot were more frequently found in autumn. The other common epilithic species were *Cymbella minuta* Hilse and *Achnanthes minutissima* Kütz. var. *minutissima*.



Table 2. Water Chemistry in Dlugi Staw

Water chemistry												
DLUGI STAW												
	alkalinity	pH	Conductivity	Cl	N-NO <sub>3</sub>	S-SO <sub>4</sub>	SO <sub>4</sub>	N-NH <sub>4</sub>	Na	K	Ca	Mg
	meq.dm <sup>-3</sup>		μS.cm <sup>-1</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>	mg.dm <sup>-3</sup>
<b>mean</b>	<b>0,01</b>	<b>5,38</b>	<b>23,41</b>	<b>0,34</b>	<b>0,63</b>	<b>1,14</b>	<b>3,4</b>	<b>0,08</b>	<b>0,40</b>	<b>0,11</b>	<b>1,52</b>	<b>0,08</b>
<b>min</b>	0,001	4,36	15,4	0,01	0,45	0,73	2,2	0,01	0,22	0,09	1,03	0,04
<b>max</b>	0,049	5,88	43,1	1,42	0,88	2,95	8,8	0,21	0,77	0,15	2,08	0,14
<b>SD</b>	0,02	0,58	8,69	0,47	0,16	0,74	2,22	0,078	0,232	0,021	0,347	0,037

### 1st level of microbiology

The samples for microbiology study were taken in August and October 1996. The mean number of bacteria was 0.297 mill./ml in August while in October there was found 0.079 mill./ml. PICY were absent in all samples from Dlugi Staw. HNF were very scarce. Ciliates were not found in August, only few were found in the October.

### Zooplankton

Very low number of zooplankton species was found in the samples from August and October (Table 3).

Table 3. Zooplankton in Dlugi Staw

Dlugi Staw	9.08		5.10	
	ind/m2	qualitysam.	ind/m2	qualitysam.
<i>Alonella excisa</i>	49		23	1,7
<i>Chydorus sphaericus</i>	46	0,3	26	2,7
<i>Notholca acuminata</i>		0,3		
<i>Polyartchra dolichoptera</i>		0,3		
<i>Polyartchra vulgaris</i>		0,3		
<i>Diacyclops bicuspidatus</i>			3	

Only two species were observed in high number: *Alonella excisa* and *Chydorus sphaericus*, while the other were very scarce.

### Macroinvertebrates

In the lake Dlugi Staw 10 taxonomic groups were found (Table 4). They were mainly Nematoda Chironomidae and Oligochaeta. In the profundal zone macroinvertebrates diversity was very low, represented only by Nematoda, Chironomidae, Crustacea (Copepoda and Ostracoda) and one Oligochaeta genus (*Cernosvitoviella*). In the littoral zone the diversity was higher. Except above mentioned groups, there were Turbellaria, Plecoptera, Trichoptera and five Oligochaeta taxa. The higher water level in October resulted in the presence of amphibiotic or even soil species in kick samples. The higher profundal density (12938 ind. m<sup>-2</sup>) was found in October.

**Fish status**

The studied lake is fishless.

Table 4. Macroinvertebrates in Dlugi Staw

DLUGI STAW	10.08.1996			DLUGI STAW	19.10.1996	
	profundal N m2	ejector	kick		profundal N m2	kick
<b>TURBELLARIA</b>						
Crenobia alpina			1			
<b>NEMATODA</b>	4578		5	6967	+	
<b>OLIGOCHAETA</b>				<b>OLIGOCHAETA</b>		
Cernosvitoviella tatrensis			3	Cernosvitoviella tatrensis		
- sp.			7	- sp.	597	
Cognettia sphagnetorum				Cognettia sphagnetorum		
- glandulosa				- glandulosa		
- sp			13	- sp		37
Marionina sp.			1	Marionina sp.		
Eiseniella tetraedra		+		Eiseniella tetraedra		
<b>CRUSTACEA</b>				<b>CRUSTACEA</b>		
Copepoda	796		6	Copepoda	398	32
Ostracoda			1	Ostracoda	199	
<b>COLLEMBOLA</b>				<b>COLLEMBOLA</b>		2
<b>PLECOPTERA</b>				<b>PLECOPTERA</b>		
Nemuridae juv.				Nemuridae juv.		
			7			
<b>TRICHOPTERA</b>				<b>TRICHOPTERA</b>		
Limnephilus coenosus			1	Limnephilus coenosus		
<b>DIPTERA</b>				<b>DIPTERA non. det.</b>		1
Chironomidae	1791	127	84	Chironomidae	4777	7
<b>COLEOPTERA</b>	199		2	<b>COLEOPTERA</b>		+
<b>MYRIAPODA</b>				<b>MYRIAPODA</b>		+















Recording of above mentioned parameters started on Sept. 11. Till now we collected data from Sept. 11 to Nov. 5. Data have already been transferred to D. Livingstone, responsible for meteorological data within MOLAR project. Next data-collecting is planned at the beginning of March.

O<sub>2</sub>, TEMPERATURE, pH and MAJOR WATER CHEMISTRY PROFILES (*nitrogen, phosphorus, dissolved silica, calcium, magnesium, sodium, chloride, potassium, alkalinity, and sulphate*)

All above listed parameters were measured or were taken samples for analyses at the deepest point of the lake (i.e. 14 m). Samples were taken with Friedinger's bottle with 2.5 m intervals from the surface to the bottom and temperature was measured with 1 m interval.

Sampling dates for profiles were: May 29, Jul. 9, Aug. 1, Aug. 19, Sept. 10, Oct. 1 and Nov. 5. Ice cover started in the middle of November.

Surface-water samples were taken at the outlet of the lake. Outlet is a sink hole due to carstic surrounding of the lake. Sampling dates for surface-water samples were: Jul. 1, Jul. 25, Aug. 15., Sept. 4, Sept. 16, Oct. 21

#### SEDIMENT TRAPS

Four sediment traps were put parallel into the lake on May 29 at the depth of 12 m. They are constructed from 0.5 long PVC tubes with diameter of 7.5 cm and they are 10 cm apart. We emptied them each time when vertical profile for water chemistry was taken, too. Analyses for Cladoceran remains will be done in March.

#### CONTEMPORARY PHYTOPLANKTON AND ZOOPLANKTON

Parallel with samples for vertical profile of major water chemistry qualitative and quantitative samples for phytoplankton and zooplankton were collected, too. Qualitative zooplankton samples were analysed, except for November as well as quantitative (expressed as dry weight/ m<sup>2</sup>). Qualitative phytoplankton samples will be analysed later. Samples for Chrysophytes will be delivered to coordinator. Quantitative phytoplankton samples were taken at the same depth as chemicals were.

#### LITTORAL DIATOMS and CLADOCERA

Spring, summer and fall samples of diatoms and Cladocera were collected from the littoral zone. They will be analysed later.

#### DEPTH DISTRIBUTION PROFILES OF CLADOCERA, CHIRONOMIDS and DIATOMS

On Sept. 4 a diver collected samples of bottom-dwelling fauna and flora. He took samples from the depths of 2.5, 5, 7.5, 10, 12.5 and 14 m. Due to the fact, that structure of the lake bowl is uniform, we made only one profile. Cladocera community has been analysed and subsamples for Chironomids' community were delivered to the specialist.

## CORRING AND SEDIMENT ANALYSES FOR SUBFOSSIL CLADOCERA AND DIATOMS

On Aug. 18 - 20 a coring for the sediment analyses was done by NIB and ECRC-UCL stuff. All the material was sliced on-site into 2 mm thin slices and transported to ECRC for further analyses. Material for Diatom analyses has been already delivered to NIB. For Cladocera samples will be delivered later.

### CONCLUSIONS FOR 1996-ACTIVITIES:

All field activities planned for 1996 were executed. The only disagreement with schedule was a timetable. Intervals between two sampling dates were somewhat longer. The reason was windy and rainy weather that made sampling danger or impossible.

Most of laboratory analyses were done and most of samples were delivered to specialists. At the same time we run intercalibration on diatoms from different lakes.

### PLANS for 1997

#### Field work:

In 1997 we will follow the plan which includes regular sampling for water chemistry and biota /phytoplankton, zooplankton/ and on-site measurements /profiles of temperature, oxygen and pH/. Content of the sediment traps will be collected with monthly intervals. Measurements of the meteorological parameters will be recorded over the whole year. At the beginning of March we are planning to make some snow sampling, if weather conditions will be favourable. Benthic communities from the littoral zone will be sampled 4 times. The first one will be when the littoral zone will be free of the ice and the last one in October/November.

The first sampling in 1997 we are planning for the beginning of March; next one will be at the beginning of May (the end of the ice-cover period). After that the frequency of sampling water column will increase up to two samplings per month in summer/autumn period.

#### Laboratory work:

In the period between February and end of April we are planning to finish all analyses of the recent communities of Diatoms and Cladocera from 1996 which we are obligated to do. In 1997 we are planning to finish with the analyses of the sediment cores for diatoms (lake Jezero v Ledvici) and for Cladocera remains (lake Jezero v Ledvici, Lake Redo and Lake Cimera), too. Parallel we will run analyses of benthic communities, collected during 1997, too.

Chemical analyses for samples from the vertical profile of the lake will run immediately after field work.

**Partner 22**

**MEASURING AND MODELLING THE DYNAMIC RESPONSE OF  
REMOTE MOUNTAIN LAKE ECOSYSTEMS TO ENVIRONMENTAL  
CHANGE**

**MOLAR**

**Site 17 Chuna**

Status WP 1

**Progress report-2/1997**

Institute of the North Industrial Ecology Problems  
(INEP)

Apatity, Murmansk region, Russia

## Site description:

<b>Country: Russia</b> <b>Site code: 17</b> <b>Site longitude (E/W): E0322900</b> <b>River (R) / Lake (L): L</b>	<b>District/County: Murmansk region</b> <b>Site name: Chuna</b> <b>Site latitude (N/S): N675700</b> <b>Head lake</b>
<b>Catchment data:</b> <b>Required data:</b> Catchment area, km <sup>2</sup> : 2.05 Lake area, km <sup>2</sup> : 0.125 Elevation at site, m: 475.3	
Average precipitation, mm.yr <sup>-1</sup> : 900 Average runoff, mm.yr <sup>-1</sup> : 570 Average depth, m: 10.0 Maximum depth, m: 15.5	
<b>Optional data:</b> Main type of bedrock: Gabbro Forest cover (total), %: 0 Wetlands / Bogs, %: 0 Heather/tundra/grassland, %: 90	
Average soil depth, cm: 10-20 Deciduous, %: 0      Coniferous, %: 0 Lakes, %: 0 Rocks, %: 10	

## INTRODUCTION

The progress report summarizes the results of the Chuna lake study carried out in the framework of MOLAR project in 1996. The lake has been investigated through an extensive programme, covering climatology and meteorology, water chemistry, lake sediments coring and diatom analysis, phytoplankton, zooplankton, invertebrates and fish.

The data collected in 1996 suggest that it is needs in more precise definition to programme for next year, particularly estimations of deposition.

A joint scientific group of INEP (Russia) has prepared the report. Climate, meteorology, precipitation, water chemistry - T. Moiseenko, S. Sandimirov; Lake sediments - V. Dauvalter; Phytoplankton - A. Sharov; Zooplankton - O. Vandysh; Invertebrates - V. Yakovlev; Fish - A. Lukin.

Responsible Scientist - T. Moiseenko

## MATERIAL AND METHODS

Field and laboratory methods of study were performed according to the Project Manual for WP 1 level (NIVA -Report 0-96061).

**Chemistry of precipitation.** The snow sampling was conducted at April, 13th. Five snow samples were taken around Chuna lake.

**Water chemistry.** The water samples was taken in April under ice condition from depths 0.5 - 7.5 - 15 m. From 10 July after snow melting time in mountain the water samples was taken biweekly. The analytical components water samples and precipitation samples agree with standard procedures for analysing low ionic strength waters.

**Sediments.** In April 1996 two sediment cores were collected from the deepest part (accumulation area, 16.5 m) of the lake: the first long core (about 3 m length) for studies of pre-industrial pollution trends and global climatic changes at University of Umeå, Sweden, and Geography

College, University of London; the second short core (20 cm length) for studies of recent pollution trends at INEP. The short sediment core was vertically extruded and sectioned in of 1 cm layers for analyses. Values of water content (H<sub>2</sub>O), loss of ignition as indirect index of organic content (LOI) were determined, as well as metals' (Ni, Cu, Co, Zn, Cd, Pb, Sr, Mn, Fe, Ca, Mg, Na, K, Al) concentrations with atomic-absorption spectrophotometry.

**Microbial (Pelagic) Food Webs (WP1).** The bacteria, heterotrophic nanoflagellates, ciliates and picocyanobacteria samples were taken August 14th and September 7th, in accordance with a programme of MOLAR (WP1). The samples were send to coordinator at Hydrobiological Institute, Academy of Sciences of the Czech Republic, Ceske Budejovice. The samples of phytoplankton were collected from Chuna lake April 13 under ice and every month (from July) in the ice-free period. The phytoplankton samples were taken and elaborated in accordance with a programme of MOLAR (WP1) at INEP. Large zooplankton samples were taken in April 13th, July 24th, August 10th, September 7th 1996. Zooplankton biomass was calculated as mg wet weight and number of individuals in sample and m<sup>-3</sup> at INEP. Some samples of phytoplankton and zooplankton were also mailed to coordinator at Charles University Prague, Faculty of Science, Department of Hydrobiology.

**Invertebrates.** Samples of invertebrates were taken two times - 24 July and 07 September. A total of 12 quantitative Ekman grab samples have been taken from the profundal zone: - 16 m depth (maximum depth) and 5 m during each sampling. Qualitative samples were taken using a kick net from two lake littoral habitat (Littoral A - stony bottom; Littoral B - macrophytes and soft silt). Kick samples were also taken from inlet stream, lake outlet, and outlet stream.

**Fish.** The study of fish community was carried out between 23-24 September 1996. Fish were caught with standard gillnets series, consisting of eight individual bottom gillnets of different mesh sizes: 10, 12.5, 16.5, 21, 25, 30, 38. 45 mm. Gillnets have been put in littoral zones on the depths from 1,5 to 5 m. All fish samples were analyzed for body length and weight, sex, gonad maturity, intestine fat content and stomach fullness. Scales and otoliths were collected for age determination according to standard methods.

## RESULTS

### 1 Climate and meteorology

Chuna lake is relatively small lake with a surface area of 12.5 km<sup>2</sup>, laying above the tree line at an altitude of 475 m at height in Chuna-tundra mountains.

The Kola peninsula is in a Atlantic-Arctic zone of a moderate climate with prevalence of warm air flows from Atlantic and cold from Arctic regions. The increase of repeatability of cyclones in winter and anticyclones in summer is characteristic for Kola peninsula. The cyclones bring strong winds and precipitation, and consequently the weather there can be rapidly changed. The affinity warm of Golfstream ocean current causes rather high winter air temperature. However, weather in this area are more stable due to significant distance from lake up to the see coast. In winter, the north wind directions prevail. In summer, the repeatability of anticyclones is increased, and the direction of the winds becomes less steady. But it is possible to allocate prevalence directions E.

The meteorological station is located 56 km south-east of Chuna.

#### 1.1 Solar radiation

The monthly meanings of direct solar radiation are in a range from 0 up to 490.1 MJ/m<sup>2</sup> (Fig. 1.1).

The maximum of radiation was observed in May (490.1 MJ/m<sup>2</sup>), and the lowest - in December, during the polar night.

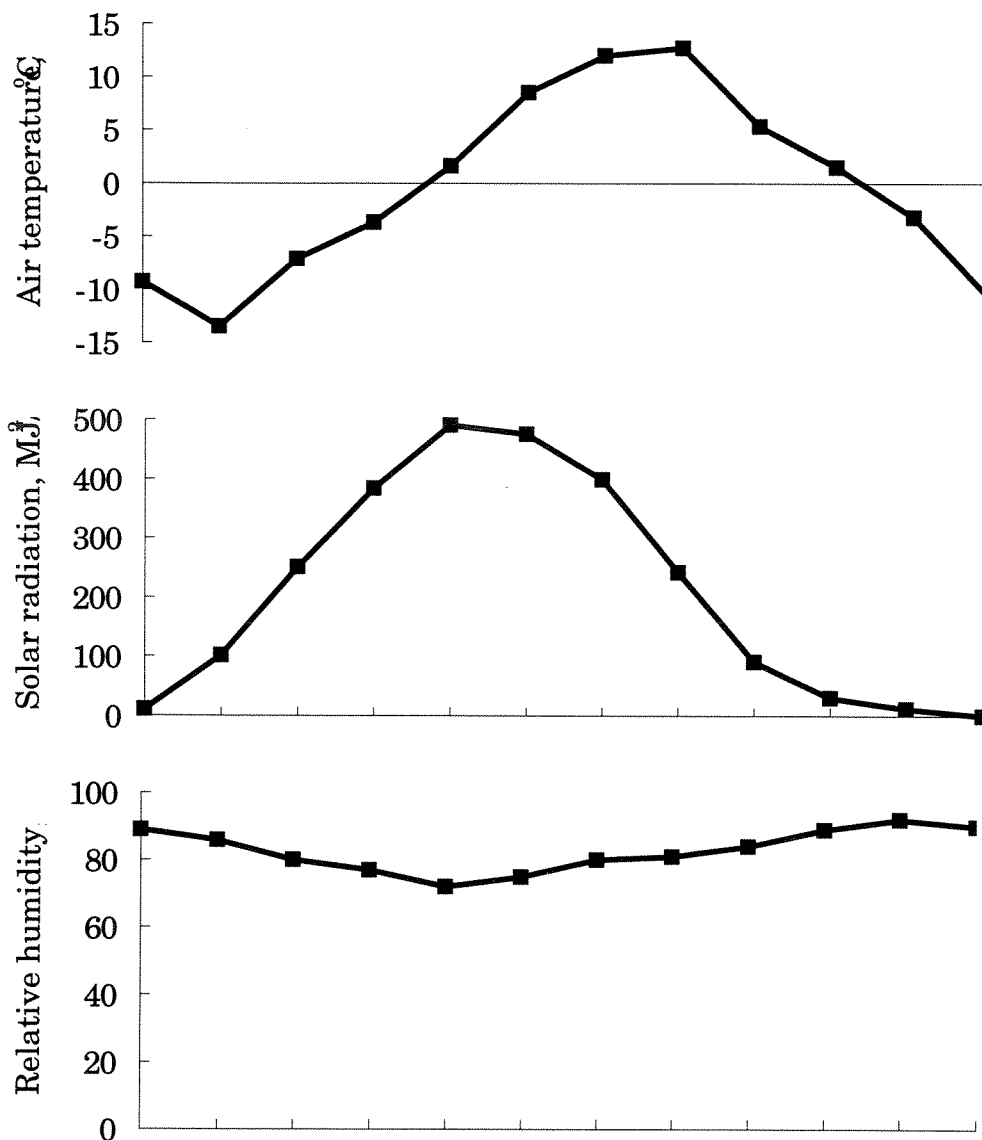
### 1.2 Air temperature

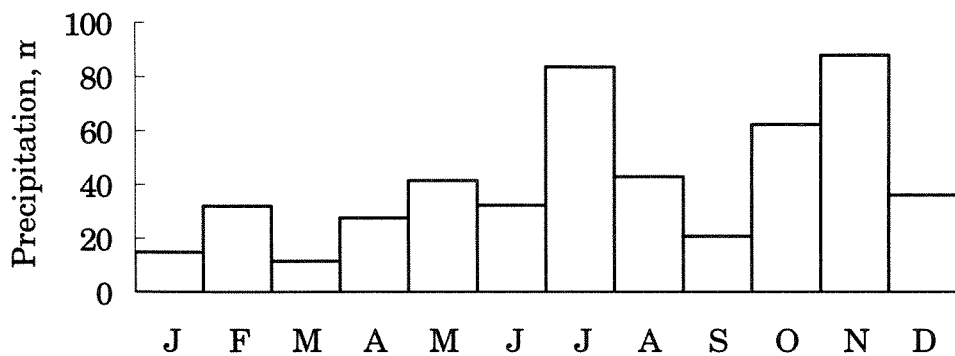
Month average temperatures in lake area are quite variable, especially in winter (Appendix 1). It was connected with often passes of cyclones. Annual average temperature ( $-0.51^{\circ}\text{C}$ ) was in lake area. The range of the month average temperatures was  $-3.5^{\circ}\text{C}$  -  $+12.7^{\circ}\text{C}$  in 1996. The most cold month was February, and the warmest - August. The unfrosted period was very short (about 60 days). It is necessary to note, that the meteorological conditions were abnormal in 1996. It was relatively cold and long spring.

### 1.3 Wind

The north-west direction of a wind most frequently occur in Chuna lake valley. Winds from WSW, W, ENE and NE are rare. The monthly speeds of a wind are in an interval 2.5 - 4.1 m/sec, which are measured at height 5 m above a level of ground.

Fig. 1.1. Climatic conditions of the Chuna lake area.





#### 1.4 Precipitation

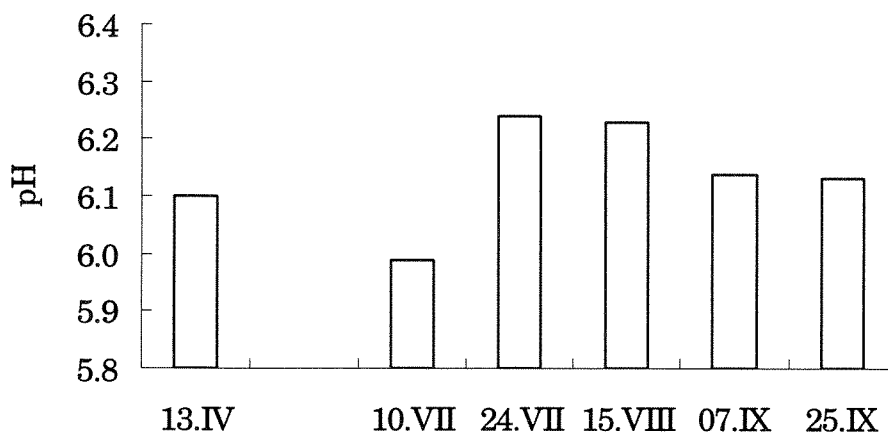
The Murmansk region completely concerns to area of superfluous humidifying. The annual quantity of precipitation can reach 1000 mm and more, that largely depends on topographical conditions in Chuna-mauntais. The large part of precipitation drops out with winds, which prevail in cyclones arriving from north-west. The greatest quantity of precipitation was observed in summer and autumn, and least - in spring. The 1996 was also characterized by rather low summer precipitation in comparison with last years.

The height of snow cover on lake catchment was generally ranged from 25 to 35 cm. The concentration of sulphur were varied from 1.2 to 1.8 mg/l, nitrate - 177 to 317 µgN/l, and pH - 4.44 to 4.79, respectively. According to our approximately assessment the deposition of anthropogenic sulphur on Chuna catchment was 0.3 gS/m<sup>2</sup>/year, total nitrogen less than 0.1 gN/m<sup>2</sup>/year.

#### 2 Water chemistry

The water chemistry of Chuna lake is shown in Appendix 2. The pH was ranged 5.7 and 6.29 in 1996 (Fig. 2.1), alkalinity - 15-29 µeq/l, except one sample from bottom layer in April, were alkalinity was higher - 48 µeq/l. The lowest level of alkalinity was observed just after snow melt period in mountains (July, 10). The sulphate content (after correction on see salt) was ranged from 36 to 48 µeq/l. Chuna lake is slightly acidified lake.

Fig. 2.1. Seasonal dynamic of water pH in Chuna



The concentrations of main cations in lake water were relatively low (mg/l): Ca - 0.9 - 1.2; Mg - 0.13 - 0.19; Na - 0.52 - 0.62; K - 0.04 - 0.08.

The vertical stratification of water chemistry was pronounced under ice (April, 13; Fig. 2.2). The extremely low oxygen saturation (almost equal to zero) was indicated in the deepest part of profundal zone (Fig. 2.3).

The concentration of nutrient elements is low, typical of mountain oligotrophic lakes. The phosphorus was 0 - 2  $\mu\text{g/l}$  in surface layers and 8 - 9  $\mu\text{g/l}$  - near bottom.

Fig. 2.2 Seasonal vertical variations in temperature, 1996

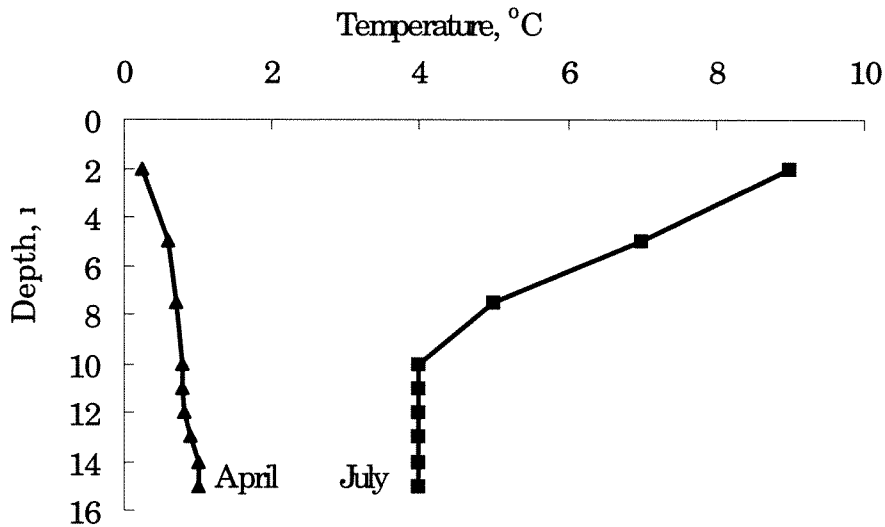
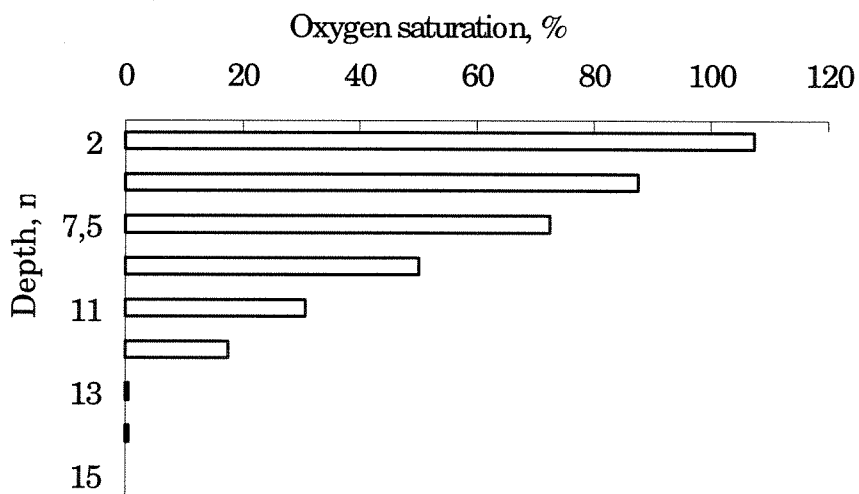


Fig. 2.3. Vertical distributions in oxygen saturation (April, 1996)

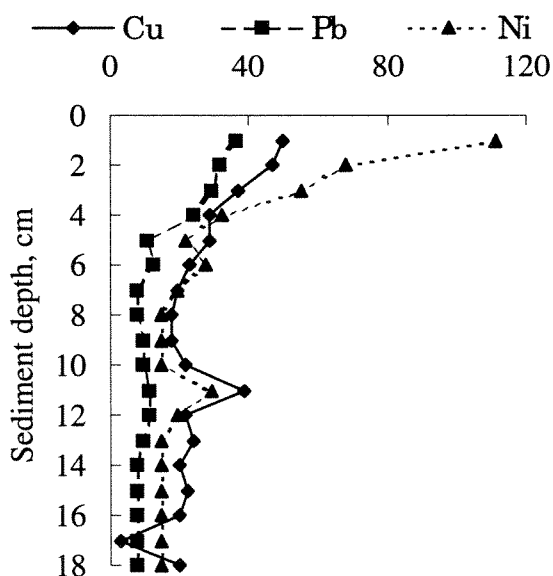




### 3 Sediments

Sediments of the Chuna are characterized by exceeded concentrations of heavy metals (Ni, Cu and Pb) in the upper of 4-5 cm core (Fig. 3.1, Appendix 3). Factors of contamination, i.e. a quotient of concentrations from the uppermost to the lowermost layers, for Ni, Pb and Cu are 7.5, 4.6 and 2.5, respectively. Side by side with increasing of the above-mentioned heavy metals, in the same layers there is decreasing of concentrations of metals leached to water column during reducing of pH values- Zn, Cd, Al and Na. Increasing the Fe and Mn concentrations is also observed in the upper 5-6 layers.

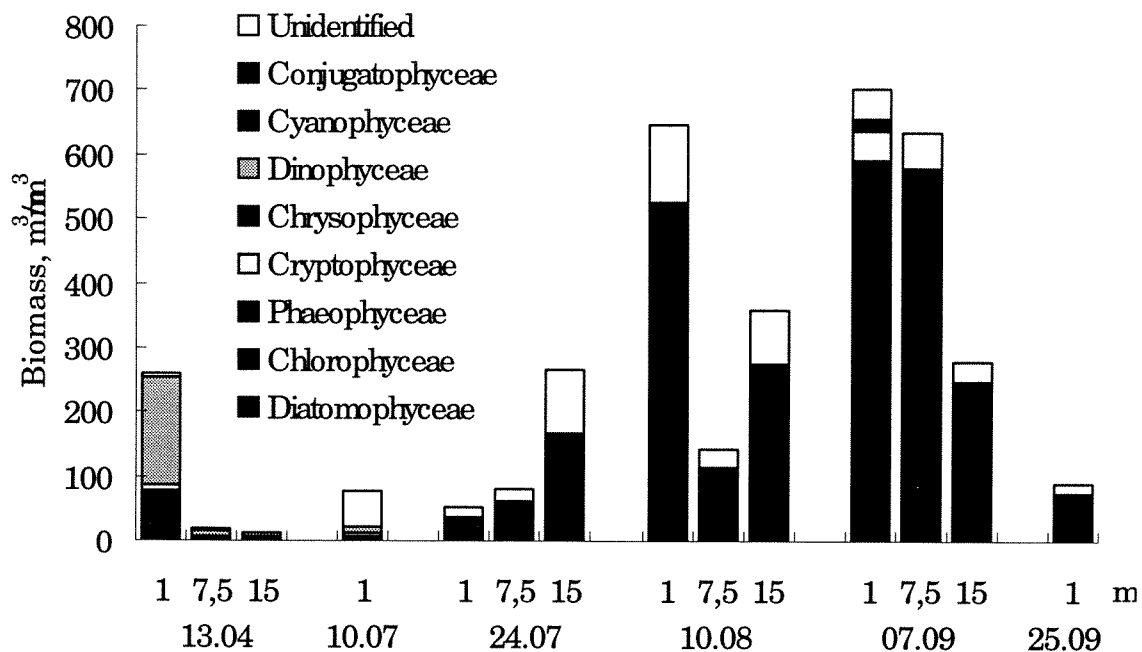
Fig. 3.1. Vertical distributions of concentrations of Cu, Ni, Pb ( $\mu\text{g/g}$  dry weight) in sediment cores of Chuna lake.



### 4 Phytoplankton

38 species, forms and varieties were detected in the phytoplankton composition: Cyanophyceae - 2, Chlorophyceae - 9, Chrysophyceae - 5, Bacillariophyceae - 16, Cryptophyceae - 2, Dinophyceae - 2, Conjugatophyceae - 2 (Appendix 4). The maximum value of phytoplankton was registered in September 7 in the upper part of water column. In this time the green algae *Elakatothrix* sp. composed about 50% of total phytoplankton biomass (Fig. 4.1). *Peridinium pygmaeum*, *P. pusillum*, were dominant species in winter-early spring. Diatoms diversity was also high under ice. *Isthmochloron trispinatum* (Phaeophyceae) was abundant, and *Oocystis solirata* (Chlorophyceae) was common in the hypolimnion early summer. There were numerous unidentified cysts ( $d = 12 \mu\text{m}$ ). Chlorophycean *Elakatothrix* sp. became dominant species in water column, and diatom *Tabellaria flocculosa* was subdominant in the epilimnion in late summer. In early autumn, the chlorophycean *Elakatothrix* sp. was present in high number, in whole water column. While, *Oocystis solirata*, *Dictyoshaerium pulchellum*, *D.subsolitarium* and diatom *Tabellaria flocculosa* were dominants in the epilimnion. The maximum value of phytoplankton biomass was observed on September 7 in the upper layers of water column. Green algae *Elakatothrix* sp. composed about 50% of the total biomass.

Fig. 4.1. Biomass of phytoplankton in Chuna lake in 1996



## 5 Zooplankton

A total of 1 species of Rotatoria, 3 species of Cladocera and 5 species of Copepoda were recorded in Chuna lake. The highest numbers of ind. m<sup>-3</sup> (16.752) were recorded in September, the low numbers (4.843) - in April, in July and August- 9.217 and 9.604, respectively (Appendix 5). Cladocera *Bosmina obtusirostris*, the most frequently occurring species, was found in all samples. Other common species were *Holopedium gibberum*, *Acanthocyclops* sp., *Eudiaptomus gracilis*. Dominant species were: in April - *Bosmina obtusirostris*, in July - *Holopedium gibberum*, *Eudiaptomus gracilis*, in August and September - *Bosmina obtusirostris*, *Eudiaptomus gracilis*. Biomass (wet weight mg m<sup>-3</sup>) showed differences between months. High level of biomass (622.4) was recorded in September, low (129.6) - in April. The differences in biomass are probably caused by relative abundance of large-sized cladocerans and copepods (*Bosmina obtusirostris*, *Eudiaptomus gracilis*) in September.

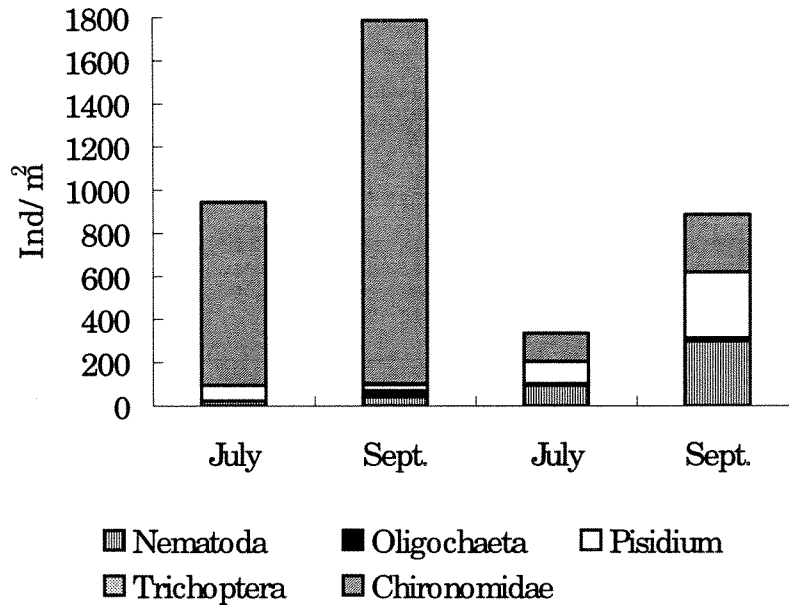
## 6 Invertebrates

A total of 44 taxa were recorded in Chuna from kick and grab samples (Appendix 6). The highest species richness was found in lake littoral (Littoral B) with muddy bottom and reach macrophyte vegetation. In contrast, stony shore (Littoral B) was inhabited by low number invertebrate species.

Two species of mayflies, *Ameletus inopinatus*, *Siphonurus aestivalis* were found in lake littoral zone. Three stonefly species were collected from the littoral (*Diura nanseni*), outlet and down stream (*Arcynopteryx compacta* and *Nemoura avicularis*). Chironomids are the most important taxa at depth 5 (Fig. 6.1). Small mussels (*Pisidium* sp.), chironomids and nematoda worms were an abundant invertebrates in the deepest area of profundal zone (16 m). Inlet stream and littoral with reach macrophyte vegetation were also distinguished by the high relative abundance of oligochaeta worms, and simuliids in outlet stream. Most part of chironomid species collected from profundal zone are widely distributed at all elevations on arctic sites, and they frequently occur in deep oligotrophic subalpine/alpine lakes. However, the most abundant in Chuna lake chironomids, *Micropsectra* spp., *Tanytarsus* spp., *Patatanytarsus* spp., *Psectrocladius* spp. and *Cricotopus* spp. are common in shallow, relatively warm arctic small lakes. No typical of deep ultraoligotrophic/oligotrophic lakes species, such as *Heterotrissocladius subpilosus*, *Paracladius* and *Parakiefferiella* species were found in our study.

The moderate sensitive to acidification species with acidification score 0.5 were mayflies *A. inopinatus*, *S. aestivalis*, stonefly *A. compacta* and *D. nanseni*, and possible some chironomids - *Micropsectra* spp. and *Zavreliomyia* spp. No snails and mayfly species with score 1.0 was recorded in samples. Stonefly, *N. avicularis* found in outlet stream assumed to be tolerant to low pH (score 0).

Fig. 6.1. Abundance and composition of invertebrates in grab samples from depth 5 and 16 m.



### 7 Fish

The total number of fish was 30 representatives (Appendix 7). Young age fish were absent from samples in 1996. Fish of 5 (4+) age were predominated in population of 1996 (Fig. 7.1, 7.2). Spawning has finished, when we began our investigation, nevertheless, two male with gonads on VI stage of maturity (with dropping sperms) have been caught. Ratio between male and female in population was 1,6:1. Spawning conditions were to be fair in 1996. Change in age structure of population Brown trout in Chuna has been noted in comparison with last year what can be connected with migration of small fish to downstream or deep-lake.

Pathological and morphological analysis were conducted for appraisal of fish organism. Brown trout from the lake Chuna showed not so much visual indications of anomalies. Connective tissue expansions of kidney (4 fish) and anemic rings on gills (2 fish) have been recorded in 1996, but this results must be verified by histological analysis.

Fig. 7.1. Length distribution (%) of Brown trout (*Salmo trutta* L.) in Chuna, 1996

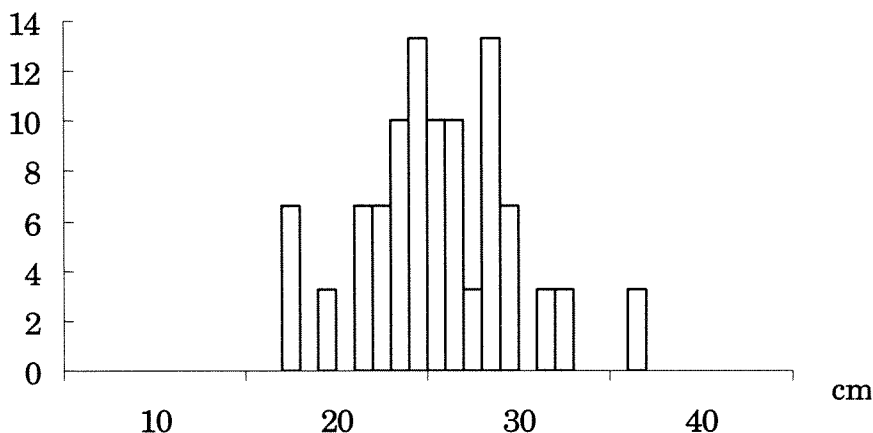
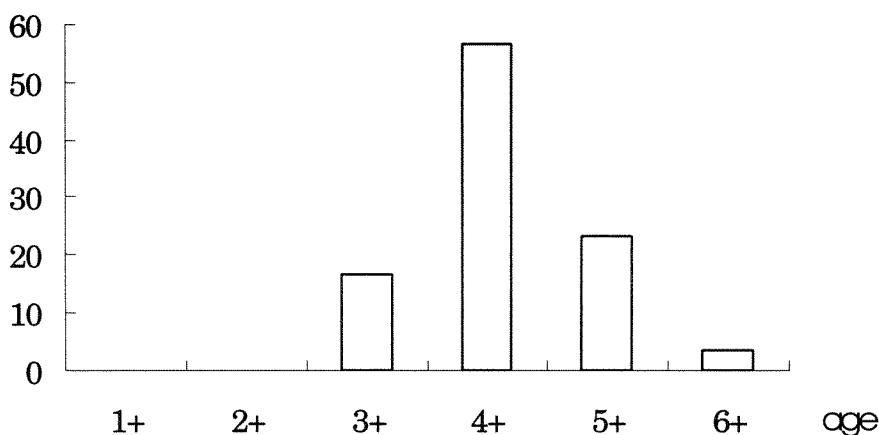


Fig. 7.2. Age distribution (%) of Brown trout (*Salmo trutta* L.) in Chuna Lake in 1996.



## CONCLUSIONS

Chuna Lake is situated in the northern Europe, laying above the tree line. Severe climate at high latitudes and relative high altitude 475 m created extremely conditions which similar to the typical alpine lakes. The chemical composition of precipitation corresponded to background for the northern Europe: pH precipitation, 4.4. - 4.7. The sulphur deposition is low, 0.3 gS/m<sup>2</sup>/year. It may reflect that emission from local sources does not exert significant influence on acid deposition. The water quality of Chuna also corresponded to background - sulphate < 50 µeqv/l, Ni < 1 µg/l. The calcium was dominated in water composition, pH was ranged between 5.7 - 6.3, with the lowest pH values (5.9) registered after snow-melt period. The oxygen deficit observed in deepest part of profundal zone in late winter-early spring period may reflect the headwater type of Chuna, and low water discharge in freeze-up period. According to chemical parameters Chuna seems to be oligotrophic (except deepest parts in winter), slightly acidified lake.

The exceeding Ni, Cu and Pb concentrations in the upper 4-5 cm layers of the lake sediment core is accounted by atmospheric emissions. Reduced concentrations of Al, Na, Zn and Cd in the upper sediment layers may testify to the changing in the lake water chemistry directed to pH decrease. Increase in Fe concentrations in the upper layers of sediments is accounted either by the flux of Fe to

the lake from watershed, or Fe retention during acidification period. The similar increasing of Fe concentrations recorded in other investigated lakes showed a tendency to acidification.

In phytoplankton, diatom species, *Tabellaria flocculosa* and *T. fenestrata* are typical of light acidophilous species. Peridinean species are common both acid and circumneutral lake in a spring. The zooplankton species are typical for mountain oligotrophic lakes of the Kola North. The predominance of species frequently occurring at low water pH (*Holopedium gibberum*, *Bosmina obtusirostris*, *Eudiaptomus gracilis*) may suggest that the Chuna light-moderate acidic lake.

The simultaneous absence of acid-sensitive invertebrates, such as snails, Baetidae mayflies, and occurrence moderate sensitive species of mayflies and stoneflies may also indicate that Chuna seems to be the moderate acidified. Species composition, relatively low abundance of invertebrates in profundal zone with prevailing of Tanytarsini and Tanypodinae chironomids is typical of north oligotrophic subalpine/alpine lakes.

## **Appendix E. MOLAR Sites. Status, operators and Steering Group Responsible persons**

## MOLAR sites

status, operators and steering group representative.

Site nr.	Site name	Status	Site operator	Steering Group Repr.
1	Ø. Neådalsvatn	WP 1, 2, 3	L.Lien	B.O. Rosseland
2	Stavsvatn	WP 1	L.Lien	B. Wathne
4.1	Lochnagar	WP 1, 2	N. Rose	S. Patrick
5.1	Lago Paione Superiore	WP 1	R. Mosello	R. Mosello
11.2	Gossenköllesee	WP 1, 2, 3	R. Psenner	R. Psenner
12.2	Lago Redo	WP 1, 2, 3	J. Catalan	J. Catalan
13	La Caldera	WP 1	L. Cruz-Pizarro	J. Catalan
15.1	Starolesnianske Pleso	WP 1, 2	E. Stuchlik	J. Fott
15.2	Terianske Pleso	WP 3	F. Sporcka	J. Fott
15.3	Dlugi Staw	WP 1	J. Galas	J. Fott
17	Chuna	WP 1	T. Moisenko	B. Wathne
19.2	Jezero Ledvicah	WP 3	A. Brancelj	S. Patrick
21	Saanajävi	WP 3	A. Korhola	S. Patrick
22	Hagelsee	WP 3	A. Lotter	R. Psenner
23	Jorisee	WP 1, 2	K. Hanselmann	R. Psenner
24	Laghetto Inferiore	WP 1	O. Gianora	R. Mosello
Site nr.	Site name	Status	Site operator	Steering Group Repr.
6.2	Lago di Latte	Secondary	D. Tait	R. Mosello
8	Etang d'Aube	Secondary	J.-C. Massabuau	J. Catalan
9	Arresjøen	Secondary	S. Rognerud	B. Wathne
11.1	Schwarzsee ob Sölden	Secondary	R. Schmidt	R. Psenner
16	Laguna Cimera	Secondary	M. Toro	J. Catalan
20	Limgambergjtjern	Secondary	S. Rogenrud	B. Wathne

## AL:PE sites where data is kept in the database

Site nr.	Site name	Status/Data	Site operator	Steering Group Repr.
3	Lille Hovvatn	AL:PE 1, 2	L.Lien	B. Wathne
4.2	Sandy Loch	AL:PE 1, 2	N. Rose	S. Patrick
4.3	Loch nan Eun	AL:PE 1, 2	N. Rose	S. Patrick
5.2	Lago Paione Inferiore.	AL:PE 1, 2	R. Mosello	R. Mosello
6.1	Lago Lungo	AL:PE 1, 2	D. Tait	R. Mosello
7.1	Lac Rond	AL:PE 1	G. Blake	R. Mosello
7.2	Lac Combeynod	AL:PE 1	G. Blake	R. Mosello
7.3	Lac Blanc	AL:PE 1, 2	G. Blake	R. Mosello
7.4	Lac Noir	AL:PE 1, 2	G. Blake	R. Mosello
10	Lough Maam	AL:PE 2	N. Rose	S. Patrick
14	Lago Escura	AL:PE 2	J. Catalan	H.J.B. Birks
12.1	Lago Aguilo	AL:PE 2	J. Catalan	J. Catalan
15.4	Zieloni Staw	AL:PE 2	J. Galas	J. Fott
18	Chibini	AL:PE 2	T. Moisenko	B. Wathne
19.1	Zgornje krisko jezero	AL:PE 2	A. Brancelj	S. Patrick

# **Appendix F. MOLAR Methodological Responsibilities**



**Molar: methodological responsibilities**

<b>Method</b>	<b>Steering Group Repr.</b>	<b>Associated responsible scientists</b>
Meteorology	R. Psenner	D. Livingstone
Deposition	R. Mosello	
Major water/snow chemistry	B. Wathne/R. Mosello	
Chemical AQC	R. Mosello	
Water column profiling	J. Catalan	
Organic micropollutants	J. Grimalt	
Metals	B. Wathne	S. Rognerud
1st level microbiology	V. Straskabova	
2nd level microbiology	V. Straskabova	
Invertebrates	G. Raddum	
Zooplankton	J. Fott	
Diatoms	R. Battarbee	N. Cameron
Chironomids	G. Raddum	S. Brooks
Chrysophytes	R. Battarbee	R. Schmidt/N. Cameron
Cladocera	J. Fott	A. Brancelj
Biological transects	R. Battarbee/J. Catalan	
Sediment coring	R. Battarbee	N. Rose/N. Cameron
Sediment core dating	R. Battarbee	P. Appleby
Sediment core analyses	R. Battarbee	N. Rose/N. Cameron/P. Appleby/R. Schmidt/ G. Raddum/A. Brancelj/A. Lami
Sediment trap sampling	R. Psenner/J. Catalan	N. Rose
Sediment trap analyses	R. Psenner/J. Catalan	N. Rose/N. Cameron
Soil coring	R. Psenner	P. Appleby
Soil core analyses	R. Psenner	P. Appleby
Fishing	B-O Rosseland	
Fish analyses	B-O Rosseland	R. Hofer/J-C Massabuau
Climate data collation	R. Battarbee	R. Thompson
Modelling	J. Catalan	R. Wright/L. Hakanson/V. Straskabova/ H.J.B. Birks/R. Battarbee/P. Appleby
Database	H.J.B. Birks	
Statistics	H.J.B. Birks	
Reports & Publications	B. Wathne/S. Patrick	
Administration	S. Patrick	

## **Appendix G. Detailed Sampling Programme for the MOLAR sites**

**Site Name and number: Øvre Neådalsvatn, 1**

Site operator: Leif Lien

Site Steering Group representative: B.O. Rosseland

Site status (WP1, WP2, WP3, secondary)

WP1,2,3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	NILU	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition	CSIC												
Meteorology	NIVA												
Snow chemistry deposite	NILU				4	4	4	4	4	4	4	4	
Snow pack chemistry	NIVA										1		
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV										1		
Major water chemistry	NIVA	4	5	5	4	2	2	4	4	4	4	4	4
Water column profiling	NIVA	1	1	1					1		1		
Organic water chemistry	CSIC												
Metal water chemistry	NIVA	1		1					1		1		
1st level microbiology	NIVA	1	1	1									
2nd level microbiology	HBI-ASCR		1										
Invertebrates	UiB ZI	1	1	1									
Contemporary chironomids	UiB ZI	1	1	1									
Contemporary zooplankton	FSCU	1	1	1									
Contemporary diatoms	ECRC	1	1	1									
Contemporary chrysophytes	ECRC	1	1	1									
Contemporary cladocera	FSCU	1	1	1									
Biological transects	ECRC			1									
Fishing	NIVA												
Fish metals	NIVA												
Fish organics	CSIC												
Fish histology	CNRS/UIBK												
Fish physiol & histopathol	CNRS/UIBK												
Sediment coring	ECRC			1									
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	ECRC												
Sediment core magnetics	ULIV												
Sediment core diatoms	ECRC												
Sediment core pigments	CNR												
Sediment core chironomids	UiB ZI												
Sediment core chrysophytes	UCL												
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval				1									
Small sediment trap SCP				1									
Small sediment trap biota				1									
Soil core retrieval	NIVA												
Soil core analyses	ULIV												
Climate data collation	UEDIN/EAWAG												
Metal speciation	ULIV												
Water Pb210	ULIV												
Water SCP	ECRC	1	1	1									
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

Site Name and number: Øvre Neådalsvatn, 1

Site operator: Leif Lien

Site Steering Group representative: B.O. Rosseland

Site status (WP1, WP2, WP3, secondary)

WP1,2,3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	NIVA	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition	CSIC		1	1	1	1	1	1	1	1	1		
Meteorology	NILU												
Snow chemistry	NIVA				4	4	4	4	4	4	4		
Snow pack chemistry	NIVA										1		
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV										1		
Major water chemistry	NIVA	4	4	4	4	4	4	4	4	4	4		
Water column profiling	NIVA	1	1	1					1		1		
Organic water chemistry	CSIC			1									
Metal water chemistry	NIVA	1		1					1		1		
1st level microbiology	NIVA	1	1	1									
2nd level microbiology	HBI-ASCR	1											
Invertebrates	UiB ZI	1	1	1									
Contemporary chironomids	UiB ZI	1	1	1									
Contemporary zooplankton	FSCU	1	1	1									
Contemporary diatoms	ECRC	1	1	1									
Contemporary chrysophytes	ECRC	1	1	1									
Contemporary cladocera	? FSCU	1	1	1									
Biological transects													
Fishing	NIVA		1										
Fish metals	NIVA												
Fish organics	CSIC												
Fish histology	CNRS/UIBK												
Fish physiol & histopathol	CNRS/UIBK												
Sediment coring													
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	ECRC												
Sediment core magnetics	ULIV												
Sediment core diatoms	ECRC												
Sediment core pigments	CNR												
Sediment core chironomids	UiB ZI												
Sediment core chrysophytes	UCL												
Sediment core cladocera	FSCU												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval		1		1									
Small sediment trap SCP		1		1									
Small sediment trap biota		1		1									
Soil core retrieval	NIVA	1											
Soil core analyses	ULIV	1											
Climate data collation	UEDIN/EAWAG												
Metal speciation	ULIV		1										
Water SCP	ECRC	1	1	1									
Water Pb210	ULIV	1	1	1									
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

Site Name and number: Stavsvatn, 2

Site operator: L.Lien

Site Steering Group representative: B.M. Wathne

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

Sampling/analytical frequency

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	NILU	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology	NILU												
Snow chemistry	NIVA												
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	NIVA	1	1	1	1		1			1	1	3	3
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA	1		1						1			
1st level microbiology	NIVA	1	1	1									
2nd level microbiology													
Invertebrates	UiB ZI	1		1									
Contemporary chironomids	UiB ZI	1		1									
Contemporary zooplankton	FSCU	1	1	1									
Contemporary diatoms	ECRC	1	1	1									
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing	NIVA			1									
Fish metals	NIVA												
Fish organics													
Fish histology	CNRS/UIBK												
Fish physiol & histopathol	CNRS/UIBK												
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

Site Name and number: Stavsvatn, 2

Site operator: L.Lien

Site Steering Group representative: B.M. Wathne

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	NILU	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology	NILU												
Snow chemistry	NIVA												
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	NIVA	1	1	1	1		1			1	3	3	3
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA	1		1						1			
1st level microbiology	NIVA	1	1	1									
2nd level microbiology													
Invertebrates	UiB ZI	1		1									
Contemporary chironomids	UiB ZI	1		1									
Contemporary zooplankton	FSCU	1	1	1									
Contemporary diatoms	ECRC	1	1	1									
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing	NIVA	(1)											
Fish metals	NIVA												
Fish organics													
Fish histology	CNRS/UIBK												
Fish physiol & histopathol	CNRS/UIBK												
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Lochnagar, 4.1**

Site operator: N. Rose

Site Steering Group representative: S. Patrick

Site status (WP1, WP2, WP3, secondary)

WP1,2

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	ECRC (SOAFD)	4	4	4	4	4	2	2	2	2	4	4	4
PCB, PAH deposition													
Meteorology	ECRC (SOAFD)												
Snow chemistry	ECRC (SOAFD)												
Snow pack chemistry	ECRC (SOAFD)												
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV												
Major water chemistry	ECRC (SOAFD)	4	4	4	4	4	2	2	2	2	4	4	4
Water column profiling					1							1	
Organic water chemistry													
Metal water chemistry													
1st level microbiology	ECRC		1		1							1	
2nd level microbiology													
Invertebrates	ECRC (SOAFD)			1							1		1
Contemporary chironomids													
Contemporary zooplankton	ECRC (SOAFD)		1		1							1	
Contemporary diatoms	ECRC		1		1							1	
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring	ECRC	1											
Sediment core dating	ULIV	1											
Sediment core SCP	ECRC	1											
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval	ECRC		1										1
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval	ECRC		1										1
Soil core analyses	ULIV												
Climate data collation													
Metal speciation													
Water SCP													1
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Lochnagar, 4.1**

Site operator: N. Rose

Site Steering Group representative: S. patrick

Site status (WP1, WP2, WP3, secondary)

WP1,2

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition	ECRC (SOAFD)	4	4	4	4	4	2	2	2	2	4	4	4	
PCB, PAH deposition														
Meteorology	ECRC (SOAFD)													
Snow chemistry	ECRC (SOAFD)									1				
Snow pack chemistry	ECRC (SOAFD)									1				
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV									1				
Major water chemistry	ECRC (SOAFD)	4	4	4	4	4	2	2	2	2	4	4	4	
Water column profiling			1		1								1	
Organic water chemistry														
Metal water chemistry	NIVA			1			1			1				1
1st level microbiology	ECRC		1		1									
2nd level microbiology														
Invertebrates	ECRC (SOAFD)			1							1			1
Contemporary chironomids														
Contemporary zooplankton	ECRC (SOAFD)		1		1									
Contemporary diatoms	ECRC		1		1								1	
Contemporary chrysophytes														
Contemporary cladocera														
Biological transects														
Fishing														
Fish metals														
Fish organics														
Fish histology														
Fish physiol & histopathol														
Sediment coring														
Sediment core dating														
Sediment core SCP														
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval	ECRC													1
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval	ECRC													
Soil core analyses	ULIV													
Climate data collation														
Metal speciation														
Water SCP					1								1	
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	



**Site Name and number: Lago Paione Superiore, 5.1**

Site operator: Andrea Lami

Site Steering Group representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	CNR	4	4	4	4	4	4	4	4	4	4	4	4
Bulk deposition													
PCB, PAH deposition													
Meteorology	CNR	1											
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	CNR	1	1	1	1		1		1	1	1	1	1
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA			1			1				1		1
1st level microbiology	CNR	1	1	1	1		1		1	1	1		
2nd level microbiology													
Invertebrates													
Contemporary chironomids	CNR	1	1	1	1								
Contemporary zooplankton	CNR	1	1	1	1		1		1	1	1		
Contemporary diatoms													
Contemporary chrysophytes	CNR	1	1	1	1		1		1	1	1		
Contemporary cladocera	CNR	1	1	1	1		1		1	1	1		
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Lago Paione Superiore, 5.1**

Site operator: Andrea Lami

Site Steering Group representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

WP1, WP2

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	CNR	4	4	4	4	4	4	4	4	4	4	4	4
Bulk deposition													
PCB, PAH deposition													
Meteorology	CNR												
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	CNR	1	1	1	1	1	1	1	1	2	4	2	
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA			1			1				1		1
1st level microbiology	CNR	1	1	1	1								
2nd level microbiology													
Invertebrates	CNR		1		1							1	
Contemporary chironomids	CNR		1		1							1	
Contemporary zooplankton	CNR	1	1	1	1								
Contemporary diatoms	CNR	1	1	1	1							1	
Contemporary chrysophytes	CNR	1	1	1	1								
Contemporary cladocera	CNR	1	1	1	1								
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Lago Paione Inferiore, 5.2**

Site operator: Andrea Lami

Site Steering Group representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	CNR	1	1	1	1	1	1		1		1	1	1
Water column profiling													
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids													
Contemporary zooplankton													
Contemporary diatoms													
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Lago Paione Inferiore, 5.2**

Site operator: Andrea Lami

Site Steering Group representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	CNR	1	1	1	1	1	1		1		1	1	1
Water column profiling													
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids													
Contemporary zooplankton													
Contemporary diatoms													
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Lago Lungo, 6.**

Site operator: D. Tait

Site Steering Group representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	BIOLAB	4	4	4	4	4	4	4	4	4	4	4	4
Bulk deposition	BIOLAB	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	BIOLAB	1		1							1		
Water column profiling	BIOLAB	1		1							1		
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids													
Contemporary zooplankton	BIOLAB	1		1							1		
Contemporary diatoms	BIOLAB			1							1		
Contemporary chrysophytes	BIOLAB	1		1							1		
Contemporary cladocera	BIOLAB	1		1							1		
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

Site Name and number: Lago Lungo, 6.

Site operator: D. Tait

Site Steering Group representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	BIOLAB	4	4	4	4	4	4	4	4	4	4	4	4
Bulk deposition	BIOLAB	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	BIOLAB	1		1		1			1		1		
Water column profiling	BIOLAB	1		1		1			1		1		
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids													
Contemporary zooplankton	BIOLAB	1		1		1			1		1		
Contemporary diatoms	BIOLAB	1		1		1			1		1		
Contemporary chrysophytes	BIOLAB	1		1		1			1		1		
Contemporary cladocera	BIOLAB	1		1		1			1		1		
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Lago di Latte, 6.2**

Site operator: D. Tait

Site Steering Group representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	BIOLAB	4	4	4	4	4	4	4	4	4	4	4	4
Bulk deposition	BIOLAB	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	BIOLAB	1	1	1		1			1		1		1
Water column profiling	BIOLAB	1	1	1		1			1		1		1
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids													
Contemporary zooplankton	BIOLAB	1	1	1		1			1		1		1
Contemporary diatoms	BIOLAB	1	1	1		1			1		1		1
Contemporary chrysophytes	BIOLAB	1	1	1		1			1		1		1
Contemporary cladocera	BIOLAB	1	1	1		1			1		1		1
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Lago di Latte, 6.2**

Site operator: D. Tait

Site Steering Group representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	BIOLAB	4	4	4	4	4	4	4	4	4	4	4	4
Bulk deposition	BIOLAB	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	BIOLAB	1	1	1		1		1		1		1	1
Water column profiling	BIOLAB	1	1	1		1		1		1		1	1
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids													
Contemporary zooplankton	BIOLAB	1	1	1		1		1		1		1	1
Contemporary diatoms	BIOLAB	1	1	1		1		1		1		1	1
Contemporary chrysophytes	BIOLAB	1	1	1		1		1		1		1	1
Contemporary cladocera	BIOLAB	1	1	1		1		1		1		1	1
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun



**Site Name and number: Étang d'Aubé, 8**

Site operator: J.-C. Massabuau

Site Steering Group representative: J. Catalan

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition														
PCB, PAH deposition														
Meteorology														
Snow chemistry														
Snow pack chemistry														
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry	CGS			1										
Water column profiling	CNRS			1										
Organic water chemistry														
Metal water chemistry	NIVA			1										
1st level microbiology	NIVA ?													
2nd level microbiology														
Invertebrates														
Contemporary chironomids	CEMAGREF													
Contemporary zooplankton														
Contemporary diatoms														
Contemporary chrysophytes														
Contemporary cladocera														
Biological transects														
Fishing	CEMAGREF/CNRS			1										
Fish metals	NIVA			1										
Fish organics	CID-CSIC			1										
Fish histology	CNRS			1										
Fish physiol & histopathol	CNRS			1										
Sediment coring														
Sediment core dating														
Sediment core SCP														
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval														
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval														
Soil core analyses														
Climate data collation														
Metal speciation														
Water SCP/Pb210														
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	



**Site Name and number: Étang d'Aubé, 8**

Site operator: J.-C. Massabuau

Site Steering Group representative: J. Catalan

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition														
PCB, PAH deposition														
Meteorology														
Snow chemistry														
Snow pack chemistry														
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry														
Water column profiling														
Organic water chemistry														
Metal water chemistry														
1st level microbiology														
2nd level microbiology														
Invertebrates														
Contemporary chironomids														
Contemporary zooplankton														
Contemporary diatoms														
Contemporary chrysophytes														
Contemporary cladocera														
Biological transects														
Fishing														
Fish metals														
Fish organics														
Fish histology														
Fish physiol & histopathol														
Sediment coring														
Sediment core dating														
Sediment core SCP														
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval														
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval														
Soil core analyses														
Climate data collation														
Metal speciation														
Water SCP/Pb210														
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	

**Site Name and number: Arresjøen, 9**

Site operator: S. Rognerud

Site Steering Group representative: B.M. Wathne

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition														
PCB, PAH deposition														
Meteorology														
Snow chemistry														
Snow pack chemistry														
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry	NIVA		1											
Water column profiling														
Organic water chemistry														
Metal water chemistry	NIVA/NILU		1											
1st level microbiology														
2nd level microbiology														
Invertebrates														
Contemporary chironomids														
Contemporary zooplankton	NIVA		1											
Contemporary diatoms	NIVA													
Contemporary chrysophytes	NIVA													
Contemporary cladocera	NIVA		1											
Biological transects														
Fishing	NIVA		1											
Fish metals	NIVA		1											
Fish organics			1											
Fish histology	UiB K		1											
Fish physiol & histopathol			1											
Sediment coring														
Sediment core dating														
Sediment core SCP														
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval														
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval														
Soil core analyses														
Climate data collation														
Metal speciation														
Water SCP/Pb210														
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	

**Site Name and number: Arresjøen, 9**

Site operator: S. Rognerud

Site Steering Group representative: B.M. Wathne

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition														
PCB, PAH deposition														
Meteorology														
Snow chemistry														
Snow pack chemistry														
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry														
Water column profiling														
Organic water chemistry														
Metal water chemistry														
1st level microbiology														
2nd level microbiology														
Invertebrates														
Contemporary chironomids														
Contemporary zooplankton														
Contemporary diatoms														
Contemporary chrysophytes														
Contemporary cladocera														
Biological transects														
Fishing														
Fish metals														
Fish organics														
Fish histology														
Fish physiol & histopathol														
Sediment coring														
Sediment core dating														
Sediment core SCP														
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval														
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval														
Soil core analyses														
Climate data collation														
Metal speciation														
Water SCP/Pb210														
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	

**Site Name and number: Schwarzsee ob Sölden, 11.1**

Site operator: R. Psenner

Site Steering Group representative: R. Psenner

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition														
PCB, PAH deposition														
Meteorology														
Snow chemistry														
Snow pack chemistry														
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry				1										
Water column profiling				1										
Organic water chemistry														
Metal water chemistry														
1st level microbiology														
2nd level microbiology														
Invertebrates														
Contemporary chironomids														
Contemporary zooplankton				1										
Contemporary diatoms														
Contemporary chrysophytes														
Contemporary cladocera				1										
Biological transects														
Fishing														
Fish metals														
Fish organics														
Fish histology														
Fish physiol & histopathol														
Sediment coring														
Sediment core dating														
Sediment core SCP														
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval														
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval														
Soil core analyses														
Climate data collation														
Metal speciation														
Water SCP/Pb210														
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	

**Site Name and number: Schwarzsee ob Sölden, 11.1**

Site operator: R. Psenner

Site Steering Group representative: R. Psenner

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition														
PCB, PAH deposition														
Meteorology														
Snow chemistry														
Snow pack chemistry														
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry				1										
Water column profiling				1										
Organic water chemistry														
Metal water chemistry														
1st level microbiology														
2nd level microbiology														
Invertebrates														
Contemporary chironomids														
Contemporary zooplankton				1										
Contemporary diatoms														
Contemporary chrysophytes														
Contemporary cladocera				1										
Biological transects														
Fishing														
Fish metals														
Fish organics														
Fish histology														
Fish physiol & histopathol														
Sediment coring														
Sediment core dating														
Sediment core SCP														
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval														
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval														
Soil core analyses														
Climate data collation														
Metal speciation														
Water SCP/Pb210														
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	

Site Name and number: Gossenköllesee 11.2

Site operator: R. Psenner

Site Steering Group representative: R. Psenner

Site status (WP1, WP2, WP3, secondary)

WP1,2,3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	UIBK	4	4	4	4	4	4	4	4	4	4	4	4
Bulk deposition	UIBK	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition	CSIC	1	1	1	1	1	1	1	1	1	1		
Meteorology	UIBK												
Snow chemistry		1	4				1	1	1	1	1	1	1
Snow pack chemistry	UIBK										1		
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV								1		1		
Major water chemistry	UIBK	1	1	1	1	1	1	1	1	1	1	1	1
Water column profiling	UIBK	1	1	1	1	1	1	1	1	1	1	1	1
Organic water chemistry	CSIC												
Metal water chemistry	UIBK			1			1			1			1
1st level microbiology	UIBK	1	1	1	1								
2nd level microbiology	UIBK	1	1	1	1								
Invertebrates	UIBK		1		1							1	
Contemporary chironomids	UIBK/ECRC	1	1	1	1								
Contemporary zooplankton	UIBK	1	1	1	1							1	1
Contemporary diatoms	ILIMNOL	1	1	1	1							1	
Contemporary chrysophytes	ILIMNOL	1	1	1	1								
Contemporary cladocera	FSCU?	1	1	1	1								
Biological transects	ILIMNOL												
Fishing	UIBK	1											
Fish metals	NIVA												
Fish organics	CSIC												
Fish histology	UIBK/CNRS	1											
Fish physiol & histopathol	UIBK/CNRS	1											
Sediment coring													
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	ILIMNOL												
Sediment core magnetics	ULIV												
Sediment core diatoms	ILIMNOL												
Sediment core pigments	CNR												
Sediment core chironomids	ECRC												
Sediment core chrysophytes	ILIMNOL												
Sediment core cladocera	FSCU												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP		1					1						
Small sediment trap biota		1	1	1	1	1							1
Soil core retrieval	UIBK		1										
Soil core analyses	UIBK/ULIV												
Climate data collation	UEDIN/EWAG/FBG												
Metal speciation	NIVA				1								
Water SCP/Pb210	ECRC/ULIV			1									
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun



Site Name and number: Gossenköllesee 11.2

Site operator: R. Psenner

Site Steering Group representative: R. Psenner

Site status (WP1, WP2, WP3, secondary) WP1,2,3

Sampling programme commences: Jul 96 Sampling programme ceases: Jun 98

Sampling/analytical frequency

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	UIBK				4	4	4	4	4	4	4	4	4
Bulk deposition	UIBK				4	4	4	4	4	4	4	4	4
PCB, PAH deposition	CSIC				1	1	1	1	1	1	1	1	1
Meteorology	UIBK												
Snow chemistry	UIBK						1	1	1	1	1	1	1
Snow pack chemistry	UIBK										1		
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV								1		1		
Major water chemistry	UIBK				1	1	1	1	1	1	1	1	1
Water column profiling	UIBK				1	1	1	1	1	1	1	1	1
Organic water chemistry	CSIC				1					1			
Metal water chemistry	UIBK				1				1				1
1st level microbiology	UIBK	1	1	1	1								
2nd level microbiology	UIBK		2	1									
Invertebrates	UIBK												
Contemporary chironomids	ECRC/UIBK												
Contemporary zooplankton	UIBK	1	1	1		1						1	
Contemporary diatoms	ILIMNOL	1	1	1	1							1	
Contemporary chrysophytes	ILIMNOL	1	1	1	1								
Contemporary cladocera	FSCU	1	1	1		1						1	
Biological transects	ILIMNOL	1											
Fishing	UIBK												
Fish metals	NIVA												
Fish organics	CSIC												
Fish histology	UIBK/CNRS												
Fish physiol & histopathol	UIBK/CNRS												
Sediment coring	ILIMNOL	1											
Sediment core dating	ULIV	1											
Sediment core SCP	ECRC	1											
Sediment core grain size	ILIMNOL	1											
Sediment core magnetics	ULIV	1											
Sediment core diatoms	ILIMNOL	1											
Sediment core pigments	CNR	1											
Sediment core chironomids	ECRC	1											
Sediment core chrysophytes	ILIMNOL	1											
Sediment core cladocera	FSCU												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval		1				1							1
Large sediment trap SCP													
Small sediment trap biota		1	1	1	1	1							
Soil core retrieval	UIBK												
Soil core analyses	ULIV												
Climate data collation	UEDIN/EWAG/FBG												
Metal speciation	NIVA ?								1	1			
Water SCP/Pb210	ECRC/ULIV					1						1	

**Site Name and number: Redo 12.2**

Site operator: J. Catalan

Site Steering Group representative: J. Catalan

Site status (WP1, WP2, WP3, secondary)

WP1,2,3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	FBG	4	4	4	4	4	4	4	4	4	4	4	4
Bulk deposition	FBG	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition	CSIC	4	4	4	4	4	4	4	4	4	4	4	4
Meteorology	FBG												
Snow chemistry	FBG	4	4	4	4	4	4	4	4	4	4		
Snow pack chemistry	FBG						1	1	1	1	1	1	
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV						1	1	1	1	1	1	
Major water chemistry	FBG	4	4	4	4	4	4	4	4	4	4	4	4
Water column profiling	FBG	1	1	1	1	1	1	1	1	1	1	1	1
Organic water chemistry	CSIC			1					1				
Metal water chemistry	FBG			1			1			1			1
1st level microbiology	FBG	1	1	1	1	1	1	1	1	1	1	1	1
2nd level microbiology	FBG		1	1									
Invertebrates	FBG		1		1								
Contemporary chironomids	FBG		1		1								
Contemporary zooplankton	FBG	1	1	1	1	1	1	1	1	1	1	1	1
Contemporary diatoms	FBG	1	1	1	1	1	1	1	1	1	1	1	1
Contemporary chrysophytes	FBG	1	1	1	1	1	1	1	1	1	1	1	1
Contemporary cladocera	FBG	1	1	1	1								
Biological transects	FBG		1										
Fishing	FBG			1									
Fish metals	NIVA												
Fish organics	CSIC												
Fish histology	CNRS/UIBK												
Fish physiol & histopathol	CNRS/UIBK												
Sediment coring	FBG												
Sediment core dating	ULIV												
Sediment core SCP	UCL												
Sediment core grain size	FBG												
Sediment core magnetics	ULIV												
Sediment core diatoms	FBG												
Sediment core pigments	CNR												
Sediment core chironomids	FBG												
Sediment core chrysophytes	FBG												
Sediment core cladocera	NIB												
Large sediment trap retrieval	FBG	1	1	1	1	1	1						1
Large trap PCB, PAH, <sup>210</sup> Pb	CSIC/ULIV	1	1	1	1	1	1						1
Small sediment trap retrieval	FBG	1	1	1	1	1	1	1	1	1	1		
Large sediment trap SCP	ECRC	1	1	1	1	1	1						1
Small sediment trap biota	FBG	1	1	1	1	1	1	1	1	1	1		
Soil core retrieval	FBG	1											
Soil core analyses	ULIV	1											
Climate data collation	UEDIM/EWAG/FBG												
Metal speciation	NIVA			1									
Water SCP/Pb210	ECRC/ULIV			1									

**Site Name and number: Redo 12.2**

Site operator: J. Catalan  
 Site status (WP1, WP2, WP3, secondary)  
 Sampling programme commences: Jul 96

Site Steering Group representative: J. Catalan  
 WP1,2,3  
 Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	FBG				1	4	4	4	4	4	4	4	4
Bulk deposition	FBG				1	4	4	4	4	4	4	4	4
PCB, PAH deposition	CSIC				2	2	2	2	2	2	2	2	2
Meteorology	FBG												
Snow chemistry	FBG												
Snow pack chemistry	FBG												
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV												
Major water chemistry	FBG	1	1	1	2	4	4	4	4	4	4	4	4
Water column profiling	FBG	1	1	1	1	1	1	1	1	1	1	1	1
Organic water chemistry	CSIC	1							1				
Metal water chemistry	FBG/NIVA/ULIV			1			1			1			1
1st level microbiology	FBG	1	1	1	1	1	1	1	1	1	1	1	1
2nd level microbiology	FBG	1	1										
Invertebrates	FBG	1	1	1	1								1
Contemporary chironomids	FBG	1	1	1	1								1
Contemporary zooplankton	FBG	1	1	1	1	1	1	1	1	1	1	1	1
Contemporary diatoms	FBG		1	1	1	1	1	1	1	1	1	1	1
Contemporary chrysophytes	FBG	1	1	1	1	1	1	1	1	1	1	1	1
Contemporary cladocera	FBG	1	1	1	1								1
Biological transects	FBG												
Fishing	FBG												
Fish metals	NIVA												
Fish organics	CSIC												
Fish histology	CNRS/UIBK												
Fish physiol & histopathol	CNRS/UIBK												
Sediment coring	FBG						1						
Sediment core dating	ULIV												
Sediment core SCP	UCL												
Sediment core grain size	FBG												
Sediment core magnetics	ULIV												
Sediment core diatoms	FBG												
Sediment core pigments	CNR												
Sediment core chironomids	FBG												
Sediment core chrysophytes	FBG												
Sediment core cladocera	NIB												
Large sediment trap retrieval	FBG												1
Large trap PCB, PAH, <sup>210</sup> Pb	CSIC/ULIV												1
Small sediment trap retrieval	FBG		1	1	1	1	1	1	1	1	1	1	1
Small sediment trap SCP	ECRC			1	1	1	1	1	1	1	1	1	1
Small sediment trap biota		1	1	1	1	1	1	1	1	1	1	1	1
Soil core retrieval	FBG												
Soil core analyses	ULIV												
Climate data collation	UEDIN/EWAG/FBG												
Metal speciation	NIVA												
Water SCP/Pb210	ECRC/ULIV												
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: La Caldera, 13**

Site operator: L. Cruz-Pizarro

Site Steering Group representative: J. Catalan

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	UGR-ES												4
PCB, PAH deposition													
Meteorology	UGR-ES												
Snow chemistry	UGR-ES	1	1	1									1
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	UGR-ES	1	1	1	1								1
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA												1
1st level microbiology	UGR-ES	1	1	1								1	1
2nd level microbiology	UGR-ES	1	1	1									1
Invertebrates	UGR-ES												1
Contemporary chironomids													
Contemporary zooplankton	UGR-ES	1	1	1	1							1	1
Contemporary diatoms	UGR-ES	1	1	1	1								1
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: La Caldera, 13**

Site operator: L. Cruz-Pizarro

Site Steering Group representative: J. Catalan

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	UGR-ES	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology	UGR-ES												
Snow chemistry	UGR-ES	1				1	1	1	1	1	1	1	
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	UGR-ES	2	2	2	2	1	1	1	1	1	1	1	1
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA			1			1			1			1
1st level microbiology	UGR-ES	1	1	1								1	1
2nd level microbiology	UGR-ES	1	1	1									
Invertebrates	UGR-ES		1									1	
Contemporary chironomids													
Contemporary zooplankton	UGR-ES	1	1	1	1							1	1
Contemporary diatoms	UGR-ES	1	1	1	1							1	
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Starolesnianske Pleso, 15.1**

Site operator: E. Stuchlik

Site Steering Group representative: J. Fott

Site status (WP1, WP2, WP3, secondary)

WP1,2

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition		4	4	4	4	4	4	4	4	4	4	4	4
Bulk deposition	FSCU	4	4	4	4	4							
PCB, PAH deposition													
Meteorology	FSCU												
Snow chemistry	FSCU				1	1	1	1	1	1	1		
Snow pack chemistry	FSCU												
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV										1		
Major water chemistry	FSCU	4	4	2	2	2	2	2	2	2	2	2	2
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA			1			1			1			1
1st level microbiology	HBI-ASER		1	1	1							1	1
2nd level microbiology	HBI-ASER		1	1									
Invertebrates	IZ SAS		1		1							1	
Contemporary chironomids													
Contemporary zooplankton	FSCU		1	1	1							1	1
Contemporary diatoms	IZ-SAS	1		1								1	
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval	FSCU	1											
Soil core analyses	ULIV	1											
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Starolesnianske Pleso, 15.1**

Site operator: E. Stuchlik

Site Steering Group representative: J. Fott

Site status (WP1, WP2, WP3, secondary)

WP1,2

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition						4	4	4	4	4	4	4	4
Bulk deposition	FSCU	4	4	4	4	4	2	2	2	2	4	4	4
PCB, PAH deposition													
Meteorology	FSCU												
Snow chemistry	FSCU					1	1	1	1	1	1		
Snow pack chemistry	FSCU										1		
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV										1		
Major water chemistry	FSCU	4	4	4	4	4	4	4	4	4	4	4	4
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA			1			1			1			1
1st level microbiology	HBI-ACER	1	1	1	1							1	1
2nd level microbiology	HBI-ACER		1	1									
Invertebrates	IZ SAS		1		1							1	
Contemporary chironomids													
Contemporary zooplankton	FSCU	1	1	1	1							1	1
Contemporary diatoms	IZ-SAS	1		1								1	
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval	FSCU	1											
Soil core analyses	ULIV	1											
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Terianske Pleso, 15.2**

Site operator: F. Sporka

Site Steering Group representative: J. Fott

Site status (WP1, WP2, WP3, secondary)

WP3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	FSCU	2	2	2	1	1	1	1	1	1	1		
Water column profiling	FSCU	2	2	2	1		1		1				
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	IZ SAS	1	1	1	1								
Contemporary zooplankton	FSCU	1	1	1	1								
Contemporary diatoms	IZ-SAS	1	1	1	1								
Contemporary chrysophytes	ILIMNOL	1	1	1	1								
Contemporary cladocera	FSCU	1	1	1	1								
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring	ECRC												
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	?												
Sediment core magnetics	ULIV												
Sediment core diatoms	IZ-SAS												
Sediment core pigments	CNR												
Sediment core chironomids	IZ SAS												
Sediment core chrysophytes	?ILIMNOL												
Sediment core cladocera	FSCU												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation	EAWAG/UEDIN												
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun



Site Name and number: Terianske Pleso, 15.2

Site operator: F. Sporka

Site Steering Group representative: J. Fott

Site status (WP1, WP2, WP3, secondary)

WP3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	FSCU				2	1	4	4	1	4	1	2	2
Water column profiling	FSCU				2	1			1		1	2	2
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	IZ SAS		1	1	1								
Contemporary zooplankton	FSCU	1	1	1	1								
Contemporary diatoms	IZ-SAS	1	1	1	1								
Contemporary chrysophytes	ILIMNOL	1	1	1	1								
Contemporary cladocera	FSCU	1	1	1	1								
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring	ECRC												
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	?												
Sediment core magnetics	ULIV												
Sediment core diatoms	IZSAS												
Sediment core pigments	CNR												
Sediment core chironomids	IZ SAS												
Sediment core chrysophytes	ILIMNOL												
Sediment core cladocera	FSCU												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation	EAWAG/UEDIN												
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Dlugi Staw, 15.3**

Site operator: J. Galas

Site Steering Group representative: J. Fott

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	IFB-PAS	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology	IFB-PAS												
Snow chemistry	IFB-PAS					1	1	1	1	1	1		
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	IFB-PAS	4	4	4	4	4	4	4	4	4	4	4	4
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA			1			1			1			1
1st level microbiology	IFB-PAS		1	1	1							1	1
2nd level microbiology	HBI-ASCR		1	1									
Invertebrates	IFB-PAS		1		1							1	
Contemporary chironomids													
Contemporary zooplankton	IFB-PAS		1	1	1							1	1
Contemporary diatoms	IFB-PAS	1		1								1	
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Dlugi Staw, 15.3**

Site operator: J. Galas

Site Steering Group representative: J. Fott

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	IFB-PAS	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology	IFB-PAS												
Snow chemistry	IFB-PAS					1	1	1	1	1	1		
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	IFB-PAS	4	4	4	4	4	4	4	4	4	4	4	4
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA			1			1			1			1
1st level microbiology	IFB-PAS	1	1	1	1							1	1
2nd level microbiology	HBI-ASCR		1	1									
Invertebrates	IFB-PAS		1		1							1	
Contemporary chironomids													
Contemporary zooplankton	IFB-PAS	1	1	1	1							1	1
Contemporary diatoms	IFB-PAS	1		1								1	
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Laguna Cibera, 16**

Site operator: M. Toro

Site Steering Group representative: J. Catalan

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry													
Water column profiling	FBG (UAM)	1		2	1	1						2	2
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	FBG (UAM)	1		2	1	1							1
Contemporary zooplankton	FBG (UAM)												
Contemporary diatoms	FBG (UAM)	1		2	1	1							1
Contemporary chrysophytes	FBG	1		2	1	1							1
Contemporary cladocera													
Biological transects	FBG (UAM)			1									
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring	FBG (UAM)												
Sediment core dating	ULIV												
Sediment core SCP	ECRC ?												
Sediment core grain size	FFBG (UAM)												
Sediment core magnetics	ULIV												
Sediment core diatoms	FBG (UAM)												
Sediment core pigments	CNR												
Sediment core chironomids	FBG (UAM)												
Sediment core chrysophytes	FBG												
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval	FBG (UAM)			1	1	1						1	1
Large sediment trap SCP													
Small sediment trap biota	FBG + UAM			1	1	1						1	1
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Laguna Cimera, 16**

Site operator: M. Toro

Site Steering Group representative: J. Catalan

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry													
Water column profiling	FBG (UAM)	2	2	2	1		1		1		1		
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	FBG (UAM)	1	1	1	1	1							1
Contemporary zooplankton	FBG (UAM)												
Contemporary diatoms	FBG (UAM)	1	1	1	1	1							1
Contemporary chrysophytes	FBG	1	1	1	1	1							1
Contemporary cladocera													
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating	ULIV												
Sediment core SCP													
Sediment core grain size	FBG (UAM)												
Sediment core magnetics	ULIV												
Sediment core diatoms	FBG (UAM)												
Sediment core pigments	CNR												
Sediment core chironomids	FBG (UAM)												
Sediment core chrysophytes	FBG												
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval	FBG (UAM)	1	1	1	1		1		1		1		1
Large sediment trap SCP													
Small sediment trap biota	FBG + UAM	1	1	1	1		1		1		1		1
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

Site Name and number: Chuna, 17

Site operator: T. Moisenko

Site Steering Group representative: B. Wathne

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

Sampling/analytical frequency

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition				1							?		
Bulk deposition	INEP			1							?	4	4
PCB, PAH deposition													
Meteorology	INEP												
Snow chemistry	INEP										4		
Snow pack chemistry											4		
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	INEP	4	4	4	4	4					4	4	4
Water column profiling													
Organic water chemistry													
Metal water chemistry	NIVA			1							?	1	1
1st level microbiology	INEP	1	1	1	1						1	1	1
2nd level microbiology		1	1	1	1						1	1	1
Invertebrates	INEP	1			1							1	1
Contemporary chironomids													
Contemporary zooplankton	INEP	1	1	1	1							1	1
Contemporary diatoms	INEP	1		1								1	1
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing	INEP			1									
Fish metals	NIVA												
Fish organics													
Fish histology	CNRS/UIBK			1									
Fish physiol & histopathol	CNRS/UIBK			1									
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Chuna, 17**

Site operator: T. Moisenko

Site Steering Group representative: B. Wathne

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition	INEP	4	4	4	4	4	4	4	4	4	4	4	4
PCB, PAH deposition													
Meteorology	INEP												
Snow chemistry	INEP					1?	1?	1?	1?	1?	1		
Snow pack chemistry											4		
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	INEP	4	4	4	4	4	4	4	4	4	4	4	4
Water column profiling													
Organic water chemistry													
Metal water chemistry	INEP			1			1?			1?			1
1st level microbiology	INEP		1	1	1							1	1
2nd level microbiology			1	1	1							1	1
Invertebrates	INEP		1		1							1 or	1
Contemporary chironomids													
Contemporary zooplankton	INEP	1		1								1	
Contemporary diatoms	INEP	1		1								1	
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing	INEP			1									
Fish metals	NIVA												
Fish organics													
Fish histology	CNRS/UIBK												
Fish physiol & histopathol	CNRS/UIBK												
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Jezero Ledvica, 19.2**

Site operator: A. Brancelj

Site Steering Group representative: S. Patrick

Site status (WP1, WP2, WP3, secondary)

WP3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	NIB				4	4	4	4	4	4	4	4	4
Water column profiling	NIB				2	1			1		1	2	2
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	?	1	1	1	1								
Contemporary zooplankton	NIB	1	1	1	1								
Contemporary diatoms	NIB	1	1	1	1								
Contemporary chrysophytes	ILIMNOL	1	1	1	1								
Contemporary cladocera	NIB	1	1	1	1								
Biological transects	NIB	1											
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring	ECRC/NIB												
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	?												
Sediment core magnetics	ULIV												
Sediment core diatoms	NIB												
Sediment core pigments	CNR												
Sediment core chironomids	?												
Sediment core chrysophytes	ILIMNOL												
Sediment core cladocera	NIB												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation	EWAG/UEDIN/FBG												
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun



**Site Name and number: Jezero Ledvica, 19.2**

Site operator: A. Brancelj

Site Steering Group representative: S. Patrick

Site status (WP1, WP2, WP3, secondary)

WP3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	NIB	4	4	4	4	4					2	4	4
Water column profiling	NIB	2	1	2	1	1	1	?	1		1	1	
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	NHM-London	1	1	1	1								
Contemporary zooplankton	NIB	1	1	1	1								
Contemporary diatoms	NIB	1	1	1	1								
Contemporary chrysophytes	ILIMNOL	1	1	1	1								
Contemporary cladocera	NIB	1	1	1	1								
Biological transects	NIB												
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	?												
Sediment core magnetics	ULIV												
Sediment core diatoms	NIB												
Sediment core pigments	CNR												
Sediment core chironomids	?												
Sediment core chrysophytes	ILIMNOL												
Sediment core cladocera	NIB												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation	EWAG/UEDIN/FBG												
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Limgambergtjern, 20**

Site operator: S. Rognerud

Site Steering Group representative: B.M. Wathne

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition														
PCB, PAH deposition														
Meteorology														
Snow chemistry														
Snow pack chemistry														
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry	NIVA		1	1										
Water column profiling														
Organic water chemistry														
Metal water chemistry														
1st level microbiology														
2nd level microbiology														
Invertebrates														
Contemporary chironomids	UiB-Z			1										
Contemporary zooplankton														
Contemporary diatoms														
Contemporary chrysophytes														
Contemporary cladocera														
Biological transects														
Fishing														
Fish metals														
Fish organics														
Fish histology														
Fish physiol & histopathol														
Sediment coring	UiB-Z			1										
Sediment core dating														
Sediment core SCP	UiB-Z													
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval														
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval														
Soil core analyses														
Climate data collation														
Metal speciation														
Water SCP/Pb210														
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	

**Site Name and number: Lingsbergstjern, 20**

Site operator: S. Rognerud

Site Steering Group representative: B.M. Wathne

Site status (WP1, WP2, WP3, secondary)

Secondary

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition														
PCB, PAH deposition														
Meteorology														
Snow chemistry														
Snow pack chemistry														
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry	NIVA			2										
Water column profiling														
Organic water chemistry														
Metal water chemistry														
1st level microbiology														
2nd level microbiology														
Invertebrates														
Contemporary chironomids	UiBZ													
Contemporary zooplankton														
Contemporary diatoms														
Contemporary chrysophytes														
Contemporary cladocera														
Biological transects														
Fishing														
Fish metals														
Fish organics														
Fish histology														
Fish physiol & histopathol														
Sediment coring														
Sediment core dating														
Sediment core SCP														
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval														
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval														
Soil core analyses														
Climate data collation														
Metal speciation														
Water SCP/Pb210														
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	

**Site Name and number: Saanajärvi, 21**

Site operator: A. Korhola

Site Steering Group representative: S. Patrick

Site status (WP1, WP2, WP3, secondary)

WP3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	UHEL	2	2	2	1		1		1		4		
Water column profiling	UHEL	2	2	2	1		1		1				
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	UHEL	2	2	2	1								
Contemporary zooplankton	UHEL	2	2	2	1								
Contemporary diatoms	UHEL	2	2	2	1		1		1				
Contemporary chrysophytes	UHEL	2	2	2	1								
Contemporary cladocera	UHEL	2	2	2	1								
Biological transects													
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	UHEL												
Sediment core magnetics	ULIV												
Sediment core diatoms	UHEL												
Sediment core pigments	CNR												
Sediment core chironomids	UHEL												
Sediment core chrysophytes	UCL												
Sediment core cladocera	UHEL												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation	UEDIN/EWAG/FBG												
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Saanajärvi, 21**

Site operator: A. Korhola

Site Steering Group representative: S. Patrick

Site status (WP1, WP2, WP3, secondary)

WP3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	UHEL	2	2	2	1		1		1		1	2	2
Water column profiling	UHEL	2	2	2	1		1		1		1	2	2
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	UHEL	1	1	1	1								
Contemporary zooplankton	UHEL	1	1	1	1								
Contemporary diatoms	UHEL	2	2	2	1								
Contemporary chrysophytes	UHEL	1	1	1	1								
Contemporary cladocera	UHEL	1	1	1	1								
Biological transects	UHEL	1											
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring	UHEL												
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	UHEL												
Sediment core magnetics	ULIV												
Sediment core diatoms	UHEL												
Sediment core pigments	CNR												
Sediment core chironomids	UHEL												
Sediment core chrysophytes	UCL												
Sediment core cladocera	UHEL												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation	UEDIN/EWAG/FBG												
Metal speciation													
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Hagelsee, 22**

Site operator: A. Lotter

Site Steering Group representative: R. Psenner

Site status (WP1, WP2, WP3, secondary)

WP3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition													
Bulk deposition													
PCB, PAH deposition													
Meteorology	EAWAG												
Snow chemistry													
Snow pack chemistry													
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	EAWAG	1	1	2	2	1		1			1	1	1
Water column profiling	EAWAG	1	1	1	1	1		1			1	1	1
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	ECRC		1										
Contemporary zooplankton	EAWAG		1										
Contemporary diatoms	EAWAG		1										
Contemporary chrysophytes	EAWAG		1										
Contemporary cladocera	ESCU		1										
Biological transects			1										
Fishing													
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring	May 1996												
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size	EAWAG												
Sediment core magnetics	ULIV												
Sediment core diatoms	EAWAG												
Sediment core pigments	CNR												
Sediment core chironomids	Hoffmann Plön									+			
Sediment core chrysophytes	ILIMNOL									+			
Sediment core cladocera	FSCU												
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval				1	2								
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation	UEDIN/EAWAG												
Metal speciation													
Water SCP/Pb210													

Site Name and number: Hagelsee, 22

Site operator: A. Lotter

Site Steering Group representative: R. Psenner

Site status (WP1, WP2, WP3, secondary)

WP3

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1997						1998						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition														
Bulk deposition														
PCB, PAH deposition														
Meteorology	EAWAG													
Snow chemistry														
Snow pack chemistry														
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry	EAWAG	1	1	1	1									
Water column profiling	EAWAG	1	1	1	1				1		1	2	2	
Organic water chemistry														
Metal water chemistry														
1st level microbiology														
2nd level microbiology														
Invertebrates														
Contemporary chironomids	ECRC	1	1	1	1									
Contemporary zooplankton	FSCU?													
Contemporary diatoms	EAWAG	1	1	1	1									
Contemporary chrysophytes	EAWAG	1	1	1	1									
Contemporary cladocera	FSCU	1	1	1	1									
Biological transects	EAWAG		1											
Fishing														
Fish metals														
Fish organics														
Fish histology														
Fish physiol & histopathol														
Sediment coring	EAWAG													
Sediment core dating	ULIV													
Sediment core SCP	ECRC													
Sediment core grain size	EAWAG													
Sediment core magnetics	ULIV													
Sediment core diatoms	EAWAG				1									
Sediment core pigments	CNR													
Sediment core chironomids	W.Hofmann, Plön													
Sediment core chrysophytes	ILIMNOL													
Sediment core cladocera	FSCU													
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval		1	1	1	1									
Large sediment trap SCP														
Small sediment trap biota		1	1	1	1									
Soil core retrieval														
Soil core analyses														
Climate data collation	UEDIN/EAWAG													
Metal speciation														
Water SCP/Pb210														
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	

Site Name and number: Jörisee, 23

Site operator: K. Hanselmann

Site Steering Group representative: R. Psenner

Site status (WP1, WP2, WP3, secondary)

WP1,2

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

Measurements	Analytical Lab.	1996						1997					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition		4	4	4	4		1		1		4		2
Bulk deposition		4	4	4	4		1		1		1		2
PCB, PAH deposition													
Meteorology		All parameters with no heating											
Snow chemistry													
Snow pack chemistry									1		1		1
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry		4	4	4	4		1		1		1		2
Water column profiling		4	4	4	4		1		1		1		2
Organic water chemistry													
Metal water chemistry				1					1				
1st level microbiology		1	1	1	1							1	1
2nd level microbiology			1	1									1
Invertebrates													
Contemporary chironomids			1										
Contemporary zooplankton		1	1	1	1								1
Contemporary diatoms			1	1									1
Contemporary chrysophytes			1	1									1
Contemporary cladocera			1	1									1
Biological transects													
Fishing				1									
Fish metals	NIVA												
Fish organics	CSIC												
Fish histology	UIB/CNRS												
Fish physiol & histopathol	UIB/CNRS												
Sediment coring											1		
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval			1			1							1
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Metal speciation			1										
Water SCP/Pb210													
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun



Site Name and number: Jörisee, 23

Site operator: K. Hanselmann

Site Steering Group representative: R. Psenner

Site status (WP1, WP2, WP3, secondary)

WP1,2

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

Sampling/analytical frequency

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	U. Zurich	4	4	4	4		1		1		1		2
Bulk deposition	U. Zurich	4	4	4	4	4	1		1		1		2
PCB, PAH deposition	CSIC												
Meteorology	U. Zurich												
Snow chemistry	U. Zurich								1		1		1
Snow pack chemistry	U. Zurich								1		1		1
Snow pack SCP, <sup>210</sup> Pb	ECRC/ULIV												
Major water chemistry	U. Zurich	4	4	4	4		1		1		1		2
Water column profiling		4	4	4	4		1		1		1		2
Organic water chemistry	CSIC												
Metal water chemistry	NIVA			1			?		1				1
1st level microbiology	U. Zurich	1	1	1	1							1	1
2nd level microbiology	UIBK		1	1									1
Invertebrates	U. Zurich												
Contemporary chironomids			1										
Contemporary zooplankton	U. Zurich		1	1	1								1
Contemporary diatoms	ILIMNOL	1		1									1
Contemporary chrysophytes													
Contemporary cladocera													
Biological transects													
Fishing	U. Zurich	1											
Fish metals	NIVA												
Fish organics	CSIC												
Fish histology	UIBK/CNRS												
Fish physiol & histopathol	UIBK/CNRS												
Sediment coring	U. Zurich												
Sediment core dating	ULIV												
Sediment core SCP	ECRC												
Sediment core grain size													
Sediment core magnetics	CSIC?												
Sediment core diatoms	ULIV?												
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval				1		1							1
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval	U. Zurich		1										
Soil core analyses	ULIV												
Climate data collation													
Metal speciation	NIVA			1									
Water SCP/Pb210	ECRC/ULIV			1									
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Laghetto Inferiore, 24**

Site operator: A. Barbieri

Site Steering Group representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

**LSA = Laboratorio studi Ambientali**

Measurements	Analytical Lab.	1996						1997						
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Wet only deposition	LSA	4	4	3	2							2	4	
Bulk deposition														
PCB, PAH deposition														
Meteorology														
Snow chemistry														
Snow pack chemistry	LSA									1	1			
Snow pack SCP, <sup>210</sup> Pb														
Major water chemistry	LSA	1	1	1	1					1			1	
Water column profiling	LSA	4	1	1	1					1				
Organic water chemistry														
Metal water chemistry														
1st level microbiology														
2nd level microbiology														
Invertebrates	LSA		3	2	2									
Contemporary chironomids														
Contemporary zooplankton	LSA	1	1	1	1									
Contemporary diatoms	LSA	1	1	1	1									
Contemporary chrysophytes	LSA	1	1	1	1									
Contemporary cladocera	LSA	1	1	1	1									
Biological transects														
Fishing	LSA		1											
Fish metals														
Fish organics														
Fish histology														
Fish physiol & histopathol														
Sediment coring														
Sediment core dating														
Sediment core SCP														
Sediment core grain size														
Sediment core magnetics														
Sediment core diatoms														
Sediment core pigments														
Sediment core chironomids														
Sediment core chrysophytes														
Sediment core cladocera														
Large sediment trap retrieval														
Large trap PCB, PAH, <sup>210</sup> Pb														
Small sediment trap retrieval														
Large sediment trap SCP														
Small sediment trap biota														
Soil core retrieval														
Soil core analyses														
Climate data collation														
		June												
Inflow chemistry	LSA	3	4	4	3	2						1	2	
Outflow chemistry	LSA	3	4	4	3	2				1		1	2	
			Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun

**Site Name and number: Laghetto Inferiore, 24**

Site operator: A. Barbieri

Site Seering Group Representative: R. Mosello

Site status (WP1, WP2, WP3, secondary)

WP1

Sampling programme commences: Jul 96

Sampling programme ceases: Jun 98

**Sampling/analytical frequency**

**LSA = Laboratorio studi Ambientali**

Measurements	Analytical Lab.	1997						1998					
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Wet only deposition	LSA	4	4	4	2							2	4
Bulk deposition													
PCB, PAH deposition													
Meteorology													
Snow chemistry													
Snow pack chemistry	LSA									1	1		
Snow pack SCP, <sup>210</sup> Pb													
Major water chemistry	LSA	1	1	1	1					1			
Water column profiling	LSA	1	1	1	1					1			
Organic water chemistry													
Metal water chemistry													
1st level microbiology													
2nd level microbiology													
Invertebrates													
Contemporary chironomids	LSA	1	1	1	1								
Contemporary zooplankton	LSA	1	1	1	1								
Contemporary diatoms	LSA	1	1	1	1								
Contemporary chrysophytes	LSA	1	1	1	1								
Contemporary cladocera	LSA												
Biological transects													
Fishing	LSA/UCP												
Fish metals													
Fish organics													
Fish histology													
Fish physiol & histopathol													
Sediment coring													
Sediment core dating													
Sediment core SCP													
Sediment core grain size													
Sediment core magnetics													
Sediment core diatoms													
Sediment core pigments													
Sediment core chironomids													
Sediment core chrysophytes													
Sediment core cladocera													
Large sediment trap retrieval													
Large trap PCB, PAH, <sup>210</sup> Pb													
Small sediment trap retrieval													
Large sediment trap SCP													
Small sediment trap biota													
Soil core retrieval													
Soil core analyses													
Climate data collation													
Inflow chemistry		1	1	1	1								
Outflow chemistry		1	1	1	1					1			
		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun