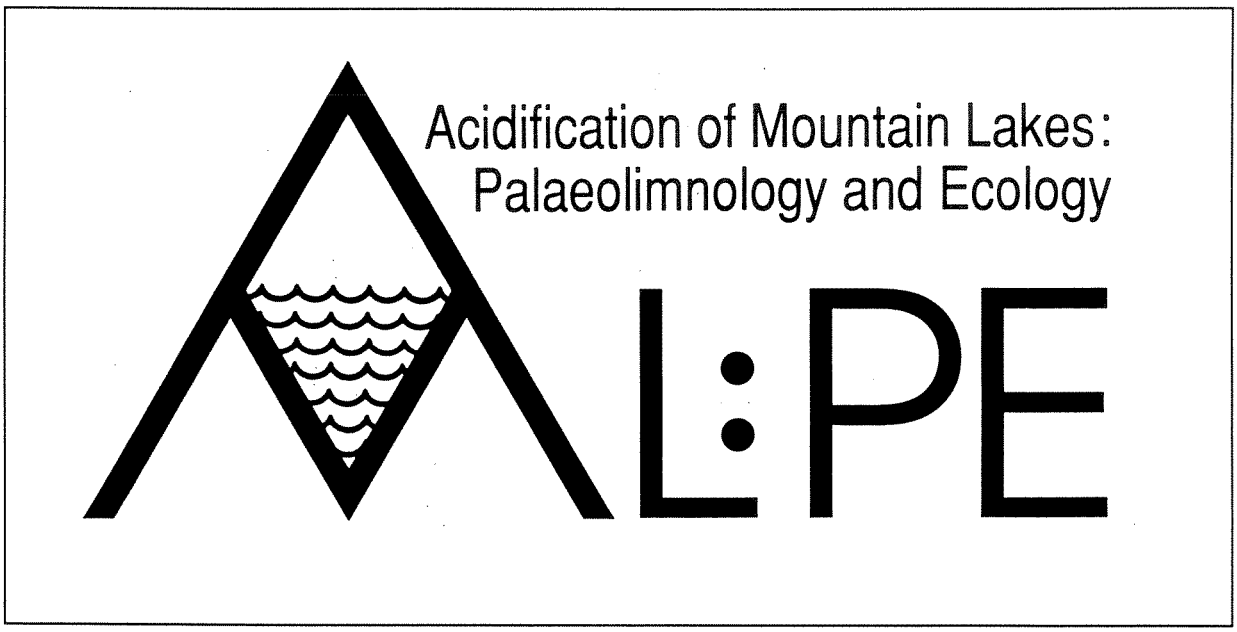

Site Information and Investigation Methods

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Abstract:

The main aims of the project are to improve the understanding of remote mountain lakes ecosystems and determine their use as early response indicatiors of trends in atmospheric pollution. ALPE is a joint project between 7 institutions in 4 countries. The working sites in Norway, UK, France and Italy are described together with the investigation methods for water chemistry, diatoms, sediments, invertebrates and fish. The ALPE-project started 1.04.91 and the working period will be two years.

4 keywords, Norwegian

1. Forsuring
2. Høyfjellssjøer
3. Økologi
4. Palaeolimnologi

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ALPE - Acidification of Mountain Lakes: Palaeolimnology and Ecology

The ALPE project has its official start date 1st April 1991, and the working period for the project will be two years. This presentation will therefore be of the agreed programme and of the background material from the investigation areas or sites for the project.

PROJECT AIMS

The main aims of this project are to establish an understanding of the ecosystems of high mountain lakes, and to use a relevant subgroup of these lakes from various regions as early response indicators of increasing or decreasing atmospheric pollution. Additional aims are to:

- establish links between existing lake chemistry databases of remote mountain lakes from EC countries, Austria, Switzerland, and Norway.

- establish contact with countries in Eastern Europe (Czechoslovakia and Poland for the Tatra mountains) aiming at future cooperation in this field

- use biological data to establish guidelines for good monitoring management, and guidance practices.

- identify critical S and N loads and recommend target loads for remote mountain lakes.

- establish baseline conditions for the long-term evaluation of climatic change and its effects.

- develop statistical methods for analysing fish and invertebrate data in relation to environmental data to provide a basis for predicting future biological responses to modelled chemical changes.

GEOGRAPHICAL LOCATION AND SITE DESCRIPTION

The sites chosen for this project are in montain areas in Norway and Scotland, the Alps (Italy, Switzerland, Austria, France) and the

Pyrenees (France). They are all remote and not affected by local pollution sources. For some of these lakes there exist data from earlier investigation projects. These earlier investigations and their results are valuable information to take into the project, and have been used for selection of sites and project planning. Some of the lakes have never been investigated before, and little information have been available in the planning period. The sites are shown on the map in Figure 2 at page 15, and a summary of the programme and the water chemistry of the lakes is given in Table 10 and 11.

Norway

In Norway two lakes are chosen as major sites, Stavsvatn and Øvre Neådalsvatn. Both lakes are situated above the timberline, and snow covers the cathments generally from October/November until May/June. Øvre Neådalsvatn, in the Todalen area in north west Norway, lies at an altitude of 728 m and is a lake in an unpolluted sensitive area. This lake will serve as a reference lake for the whole study. The catchment around Øvre Neådalsvatn is steep morene, dominated by bare rock. Near this main site the Norwegian Institute for Air Research (NILU) also has an atmospheric deposition sampling station running. This station has been in operation from 1979 (The Norwegian State Pollution Control Authrity, 1990). Øvre Neådalsvatn was part of the SNSF project (1972 - 1980), (Overrein et al. 1981)

The other main site, Stavsvatn, lies at an altitude of 1053 m, and is situated in the southern part of Norway. Stavsvatn is an acidified lake, and was part of the "Thousand Lake Survey" (The Norwegian State Pollution Control Authority, 1988). Around Stavsvatn the catchment is dominated by bare granitic bedrock and grassland.

In addition to the two main sites an even more affected and acidified lake is also chosen, Lille Hovvatn in the southernmost part of Norway. Lille Hovvatn and the neighbouring lake Store Hovvatn have been followed in several studies through the last 10 years (Wright, 1984 and 1985, Raddum et al. 1986, Barlaup et al. 1989). Lille Hovvatn is also close to the mountain area (south east direction) used for comparison of chemical characteristics between mountain lakes in Norway and Italy (Wathne et al. 1990). The catchment for Lille Hovvatn is of granitic bedrock with thin to nonexisting, poorly developed podzolic and mor soils. This lake lies at an altitude of 600 m, just below the timberline. Open forest of spruce (Picea abies), pine (Pinus sylvestris), and birch (Betula verrucosa) are interspersed with peaty areas. This lake will be sampled for biology and chemistry. Chemistry and site information for the Norwegian lakes are shown in Table 1.

Table 1. Water chemistry and site information for Norwegian lakes.

	Øvre Neådalsvatn	Stavs-vatn	Lille Hovvatn
H.a.s.l. (m)	728	1053	600
pH	6.05	5.63-5.85	4.22-4.78
Cond (mS/m)	0.6	1.00-1.33	2.30-5.16
Ca (mg/l)	0.51	0.78-1.10	0.03-0.64
Mg "	0.13	0.11-0.14	0.01-0.24
Na "	0.71	0.34-0.68	0.66-1.61
K "	0.17	0.03-0.08	0.02-0.19
Cl "	0.4	0.4-1.0	0.6-3.3
Sulph. "	0.9	2.0-2.4	0.9-4.4
ESO_4 (µeq/l)		40.5-48.2	18.7-91.6
NO_3N (µg/l)	10	47-71	130-360
RAL "	25**	101-135	144-302
ILAL "		15-37	10-63
LAL "		86-100	106-259
NH_4N "		18-25	95-180
Tot N "		123	320-620
F "		248-300	
TOC (mg C/l)		0.92-1.91	0.95-4.4
ALK-E (µeq HCO_3^-/l)		5.3-9.8	-
Map nr.	1420.1	1514.2	1312.2
Lake area (Hectare)	50	40	20
Watershed area (km^2)	16	2.43	0.8
Watershed geology	morene	granite	granite
Runoff (l/s km^2)	50	31	35
Bottom area			
depth < 5 m	6/10		7/10
depth 5-10 m	3/10		2/10
depth > 10 m	1/10		1/10

** as total Al.

The sites are marked on the map in Figure 1, also showing isolines for weighted yearly pH in precipitation in Norway from 1980 to 1984 (The Norwegian State Pollution Control Authority, 1986) also illustrates that there is a gradient of decreasing acid loadings going from Lille Hovvatn in the southernmost part of the country to Øvre Neådalsvatn in the norht west.

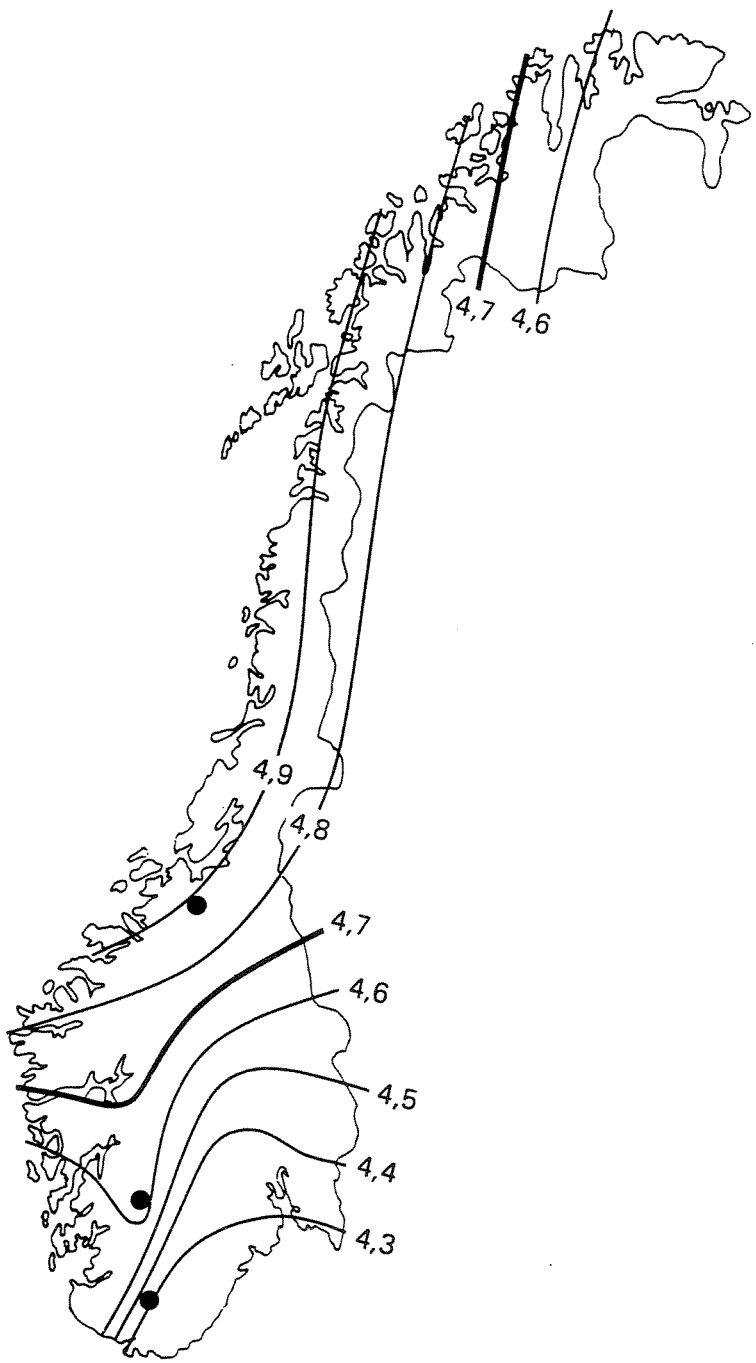

Figure 1. Isolines for weighted yearly pH in precipitation in Norway from 1980 to 1984.

Earlier measurements for the Norwegian sites are listed in Table 2.

Table 2. Earlier investigations at the Norwegian sites. (Reference to reports are given in the text).

	Chemistry	Invertebr.	Fish	Diatomees	Coring
Ø. Neådalsvatn	1978	1978	1978		
Stavsvatn	1986-90	1990			
Lille Hovvatn	1982-	1982-	*	*	*

* = Data are present from the neighbouring lake Store Hovvatn.

The geographical data for Lille Hovvatn are not based on accurate measurements, but anticipated from map material. The runoff value for Øvre Neådalsvatn is taken from the mean value for the Western part of the country.

United Kingdom

In Scotland one lake in the Cairngorms, Lochnagar, is chosen as a major site, and two lakes in the nearby region, Sandy Loch and Loch Nan Eun, will be sampled after a reduced programme.

Lochnagar lies at an altitude of 785 m in the center of the granitic massif which comprices much of Balmoral Forest in Aberdeenshire. The geology is composed of biotite granite overlain in places by blanket peat. The loch is pear-shaped and lies below a north-east facing steep backwall which rises to the summit of the same name. Snow generally occupies the catchment to a varying extent between November and May, and a significant snow field accumulates in the winter periode. The loch is acid with clear water and palaeolimnological studies (Patrick et al. 1989) have shown that the loch acidified in the mid-nineteenth century. Site characteristics and water chemistry (Juggins et al. 1989) are shown in Table 3 and 4. More details are given in Appendix A.

Both Sandy Loch and Loch Nan Eun have granitic catchments, but at this stage we do not have the same detailed information about these lakes. More information will be gathered during the ALPE - project. The water chemistry for Sandy Loch and Loch Nan Eun is shown in Table 4.

Table 3. Site characteristics for the Scottish main site.

	Lochnagar.
Altitude m a.s.l.	785
Max. depth m	24
Mean depth m	8.4
Volume m^3	820 x 10^3
Lake area ha	9.8
Catchment	
geology	granite
soils	peat
vegetation	moreland 100%
area	91.9 (excl. lake)
Catchment/lake	9.37
Net relief	370
Mean ann. rainfall	c. 1400 mm (1988)
Wet deposited acidity	0.48 kg H+/ha yr (1988)
Wet deposited non-marine Sulphate	7.33 kg S/ha yr (1988)

For Lochnagar both epilithic diatoms and benthic macroinvertebrates have been investigated. Epilithic diatoms are dominated by acidophilous species, notably Achnanhes marginulata and Tabellaria flocculosa. The species-poor macrophyte flora largely comprises submerged liverworts (eg. Scapania undulata) and Sphagnum auriculatum which extend to 6 m depth. The only non-bryophyte taxa, Isoetes lacustris and Juncus bulbosus var. fluitans are sporadic in their distribution.

Benthic macroinvertebrates are characterised by detritivorous stoneflies, predatory stoneflies and the acid-tolerant mayfly Leptophlebia vespertina, in low numbers. Trout were reported in the loch in 1940 (Hardie 1940), but a thorough gill net survey of the fishery status in 1983 yielded only 13 trout, all mature specimens (Morrison pers. comm.). However electrofishing in the outflow stream in October 1989 revealed a good population of trout.

Table 4. Water chemistry for the Scottish lakes.

	Lochnagar	Nan Eun	Sandy Loch
pH	5.35	4.96	6.32
Cond. 20^0 µS/cm	20	22	2
Alk µeq/l	0.0	0	28
Ca mg/l	0.58	0.59	0.88
Mg "	0.40	0.32	0.32
Na "	2.08	1.89	2.37
K "	<0.75	0.22	0.31
Ba "	0.02		
Sr "	0.01		
SO_4 "	2.83	2.99	3.31
TOTN "	<0.05		
PO_4 "	<0.005		
Cl "	3.13	2.65	2.56
Br "	<0.01		
F "	0.02		
Sol mon-Al µg/l	21.25		
Sol NL-mon-Al "	13.75		
Slo L-mon-Al "	7.50	128	
Si mg/l	1.03	1.1	0.9
DOC "	0.93	0.4	1.4
Excess SO_4 "	2.38	2.5	1.8

The Italian Alps

In the Alpine areas where earlier programmes have given sufficient data (Italy, Switzerland, Austria) two major site lakes are chosen. One lake, Paione Superiore, in the western Alpes (Italy), and one lake, Lago Lungo, in the eastern Alps, in South Tirol (Italy). Close to Paione Superiore, another lake, Paione Inferiore will be investigated with a reduced programme.

The Paione lakes are situated in the Bognanco Vally, a lateral of the Ossola vally, in the Pennine Alps. The geology of the watershed is described as clear banded orthogneisses and grey gneisses with potassium feldspar and epidote; trace of limb of marbles, calcareous schists and paragneisses. Paione Superiore lies at an altitude of 2269 m and Paione Inferiore at an altitude of 2002 m. Both lakes have been investigated earlier through scientific programmes (Mosello et al. 1980,1981,1985,1986,1988), and samples for water chemistry have

The land is mainly constituted by rocks which however are to a great extent covered by a thin layer of vegetation. Investigations and sampling have been made once a year in 1984, 86, 87 88, 89, 90 (Thaler et al. 1990), and the work is described in more detail in Appendix C. The main chemical parametres of Lago Lungo are shown in Table 7.

Phytoplankton and zooplankton were also sampled in 1984 and 1988. A fish population study was carried out in 1985 (Steiner 1985). This investigation showed that the fish population was constituted by three species: Salvelinus alpinus, Salmo trutta and Salvelinus fontinalis. The only species which showed natural reproduction was Salvelinus alpinus. On the basis of the study the lake was totally fished out, and following this, the only introduced species was Salvelinus alpinus. From 1985 - 89 fishing in the lake was forbidden. An athmospheric deposition sampling station is situated in the nearby region in South Tyrol.

Table 7. Main chemical parametres of Lago Lungo (1984-90 5 samplings).

	Lago Lungo	
pH	5.99-6.83	
Cond. 20°C	12-19 µS/cm	
ANC	20-37 µeq/l	
SO_4	52-66 µeq/l	2.8-3.2 mg/l
NO_3	13-17 µeq/l	175-241 µg/l
Ca	59-84 µeq/l	1.16-1.69 mg/l
Mg	7-18 µeq/l	0.09-0.22 mg/l
Tot P		5 µg/l
Transparency	5-6 m	
$(Ca + Mg)/(SO_4 + NO_3)$	1.23	
Estmated acid. value	51-55 µeq/l	

The French Alps

In the French part of the Alps the programme will cover a reduced programme for two lakes in Brianconnais in the area of Massif des Ecrins (Parc National des Ecrins), Lac Rond and Combeynod. Rond is an acid lake situated in the Valleé of Clareé at the altitude of 2446 m. The geology in the watershed is schist, and the lake has sand sediments.

been taken regularely since 1979. The main morphometric characteristics of Lakes Paione are shown in Table 5, and the chemical characteristics in Table 6. More details are given in Appendix B.

Table 5. Main morphometric characteristics of Italian Alpine lakes.

		Paione Inferiore	Paione Superiore	Lago Lungo
Altitude	m a.s.l.	2002	2269	2384
Longitude	East	8°11'23"	8°11'27"	11°5'0"
Latitude	North	46°10'1"	46°10'26"	46°43'36"
Lake surface	km^2	0.014	0.014	0.2005
Watershed area (lake included)	km^2	1.14	0.55	2.07
Max. depth	m	13.5	11.7	45
Mean depth	m	7.35	5.12	

Table 6. Chemical characteristics of Lakes Paione.

	Paione Inferiore	Paione Superiore
pH	6.50	5.32
Tot. alk µeq/l	25	0
SO_4 mg/l	2.98	3.79
Cl "	0.11	0.21
NH_4 "	0	0.06
Ca "	1.8	1.3
Mg "	0.19	0.19
Na "	0.39	0.30
K "	0.39	0.31
NO_3 µg/l	406	392
RAL "	28	28
Cond. µS/cm	13.4	12.5
Reac Si mg Si/l	0.6-0.9	0.3-0.6
Total P µg P/l	<10	<10

The other main site, Lago Lungo, is situated in the eastern Alpes in South Tyrol, in the Natural Park of Tessa at 2384 m altitude. The main morphometric parametres of the lake and its watershed are shown in Table 5. Gneiss and paragneiss are composing 80% of the watershed.

The land is mainly constituted by rocks which however are to a great extent covered by a thin layer of vegetation. Investgations and sampling have been made once a year in 1984, 86, 87 88, 89, 90 (Thaler et al.1990), and the work is described in more detail in Appendix C. The main chemical parametres of Lago Lungo are shown in Table 7.

Phytoplankton and zooplankton were also sampled in 1984 and 1988. A fish population study was carried out in 1985 (Steiner 1985). This investigation showed that the fish population was constituted by three species: Salvelinus alpinus, Salmo trutta and Salvelinus fontinalis. The only species which showed natural reproduction was Salvelinus alpinus. On the basis of the study the lake was totally fished out, and following this, the only introduced species was Salvelinus alpinus. From 1985 - 89 fishing in the lake was forbidden. An athmospheric deposition sampling station is situated in the nearby region in South Tyrol.

Table 7. Main chemical parametres of Lago Lungo (1984-90 5 samplings).

	Lago Lungo	
pH	5.99-6.83	
Cond. 20°C	12-19 µS/cm	
ANC	20-37 µeq/l	
SO_4	52-66 µeq/l	2.8-3.2 mg/l
NO_3	13-17 µeq/l	175-241 µg/l
Ca	59-84 µeq/l	1.16-1.69 mg/l
Mg	7-18 µeq/l	0.09-0.22 mg/l
Tot P		5 µg/l
Transparency	5-6 m	
$(Ca + Mg)/(SO_4 + NO_3)$	1.23	
Estmated acid. value	51-55 µeq/l	

The French Alps

In the French part of the Alps the programme will cover a reduced programme for two lakes in Brianconnais in the area of Massif des Ecrins (Parc National des Ecrins), Lac Rond and Combeynod. Rond is an acid lake situated in the Valleé of Clareé at the altitude of 2446 m. The geology in the watershed is schist, and the lake has sand sediments.

The altitude for Combeynod is 2550 m and the geology in the watershed is granite. Sediments are coarse, and it can lose a lot of water in summer by evaporation.

These lakes are frozen from November to end of June. Surface temperature rises from 7°C in July to 13°C in August. There are probably no fish in the lakes, but benthic fauna and zooplancton data are available. Some measurements of pH and conductivity are made, and the results are shown in Table 8.

Table 8. pH and conductivity from the French Alpine lakes.

	Rond	Combeynod
ph	6.6-7.3	6.8-7.6
Cond. µS/cm	60*	50

* Sometimes higher than 60 µS/cm.

Also in the French Pyrenees sufficient data for the lakes were lacking, and an initial baseline survey of sites and water chemistry was required. This survey was made during the summer 1990. One lake, Aubé, has been chosen as a major site for a full study. The lake is situated at 2240 m a.s.l. and the catchment is granitic bedrock. Lake area are anticipated close to 1 ha. Water chemistry is shown in Table 9, and more information is given in Appendix D.

Table 9. Water chemistry for Aubé in the French Pyrenees.

	Aubé
pH	6.09
Cond. µS/cm	8.21
NH_4 mg/l	<0.018
Na "	0.37
K "	0.12
Mg "	0.10
Ca "	0.72
Cl "	0.32
NO_3 "	0.62
SO_4 "	1.44

An overview over the sites and the measuring programme is given on page 15.

INVESTIGATION PROGRAMME

The six major sites will be investigated through an extensive programme covering water chemistry, fish, invertebrates and diatomees. The detailed programme is shown below:

- water chemistry
- fish, invertebrate and diatom communities using harmonised techniques
- sediment cores and statistical analysis to assess the degree of athmospheric contamination and the acidification status using diatoms, chironomid head capsules and carbonaceous particle analysis.
- a special study on comparisons between invertebrate and fish communities in Norway and the Alps.

Water chemistry programme

Water chemistry from earlier sampling have been one of the criteria for selecting the remote mountain lakes for this project. Sampling and analyzing for water chemistry will also be needed in the monitoring programme of the lakes. More details for the water chemistry programme are given in Appendix E.

Methods

The samples will be taken from the outlet of the lake at the same time as the samples for benthic invertebrates are collected. The samples will be analyzed by standard procedures for analysis of low ionic strength waters. The analytical program will include the following components: pH, conductivity, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), sulphate (SO_4), nitrate (NO_3), fluoride (F), alkalinity, total organic carbon (TOC), reactive aluminium (RAL) and non-labile aluminium (ILAL).

The analytical work will be done at national laboratories in co-operation with the chemical centres in Italy and Norway. Due to

earlier cooperative work, intercalibration data exist for Scotland and Norway and Italy and Norway. The Norwegian laboratory (NIVA) will do the Al-speciation in the samples from the Alps.

Results

The analytical results will be gathered and processed in databases in Italy and Norway. These countries will also report the results.

Fish status programme

In Norway information from different regional surveys of water chemistry and fish status forms the basis for selecting the remote mountain lakes for this project. The fish status programme is described in more detail in Appendix F.

Methods

Information on fish status will be sampled using the interview method and test fishing. The interview method has been used in several regional studies in Norway with good results. Yearly test fishing in autumn will be performed by standardized gillnet series covering the fish sizes from 10 to 50 cm in length. Electrofishing in spawning areas will be performed. Standard procedures for determining size, sex, age, maturation, etc. will be used. The test fishing and invertebrate studies will be coordinated.

The same program on fish will be followed in the other European sites. Field assistance will be given in the Italian Alps and the Pyrenees.

The analytical work will be done at national laboratories in cooperation with NIVA.

Diatom programme

Epilithic diatoms will be sampled from each study site. A standard method will be used which involves the amalgamation of scrapes from stones in the littoral zone. The samples will be examined in the laboratory using high magnification light microscopy, and the composition of each sample will be determined from a count of 500 valves. Multivariate statistical analysis will be used to compare diatom samples between sites. All sampling and analytical work will be performed by the PRU.

Sediment programme

At six sites (2 in Norway, 1 in Scotland, 1 in the Pyrenees and 2 in the Alps) short sediment cores will be taken using a Kajak or Mackereth sampler. Cores will be sectioned in the field into 0.5 cm slices. In the laboratory, the dry weight, wet density and loss-on-ignition values of each slice will be determined. Sub-samples will be sent to the University of Liverpool for ^{210}Pb dating, and the University of Bergen for analysis of chironomid head capsules. At University College London samples will be prepared for diatom analysis (light microscopy), and for carbonaceous particle analysis (light and scanning electron microscopy and EDS) using standard techniques. The carbonaceous particle analysis will be used to show the degree of contamination at each site by fossil fuel burning and the diatom analysis will be used to reconstruct the pH history of each lake. The diatom results will also be used by Professor Birks at the University of Bergen to reconstruct other chemical variables using analogue matching and other statistical techniques.

PRU/ENSIS will be responsible for sediment sampling at all sites.

Invertebrate programme

Invertebrates will be sampled at the same time as data on water chemistry and fish are collected. Samples will be taken from the profundal zone using a "Kajak sampler" and from the lake littoral and outlet stream using "kick samples". The samples will later be sorted and the different animals identified to species/groups. The fauna will be ranged according to tolerance, which will make it possible to apply the data in model work.

The sorting and identification will be done by taxonomic specialists in the participating countries in cooperation with University of Bergen, Dept. of Animal Ecology (UIB-ZM). Chironomids will be identified by UIB-ZM. The data from the different participating countries will be generated and processed in the database in Norway, and the results will be treated with statistical help from Professor John Birks, University of Bergen, Botanical Institute.

More details for the invertebrate programme are given in Appendix G.

SITE OVERVIEW AND SAMPLING PROGRAMME

In Table 10, an overview over the sites and the sampling programme is given. Also marked in Table 10 is which sites have a precipitation station in the watershed.

Table 10. Site overview and sampling programme for ALPE.

	Precip.	Chemistry	Inverteb.	Fish	Diatom.	Coring
UK						
Lochnagar	X	X	X	X	X	X
Sandy Loch	X	X			X	
Loch Nan Eun	X	X			X	
Italy						
Paione Superiore	X[1]	X	X	X	X	X
Paione Inferiore	X[1]	X	X	X	X	
Lago Lungo		X	X	X	X	X
Norway						
Øvre Neådalsvatn	X	X	X	X	X	X
Stavsvatn	(X)	X	X	X	X	X
Lille Hovvatn	(X)	X	X		X	
French Alps						
Rond	(X)	X	X		X	?
a	(X)	X	X	X	X	
French Pyrenees						
Aubé	X	X	X	X	X	X

X[1] = Only winter values
(X) = Precipitation station fairly close, but not in the watershed

Table 11 on page 16 gives a summary of the water chemistry of the lakes.

Table 11. A summary of the chemical and morphometric characteristics of the lakes in the different sites in the ALPE - project.

	Ø. Neå-dalsvatn	Stavs-vatn	Lille Hovvatn	Loch-nagar	Lac Rond	Combey-nod	Paione Super.	Paione Infer.	Lago Lungo	Étang d'Aubé	Loch Nan Eun	Sandy Loch
H.a.s.l.(m)	728	1053	600	785	2416	2550	2269	2002	2384	2091		
pH	6.05	5.70	4.47	5.41	7.0	7.2	5.32	6.50	5.99-6.83	6.09	4.96	6.32
Cond (µS/cm)	6.0	11.1	30	22.7	60	50	12.5	13.4	12-19	8.21	22	20
Ca (mg/l)	0.51	0.90	0.41	0.7			1.3	1.8	1.16-1.69	0.72	0.59	0.88
Mg "	0.13	0.12	0.07	0.4			0.19	0.19	0.09-0.22	0.10	0.32	0.32
Na "	0.71	0.47	0.78	2.4			0.30	0.39		0.37	1.89	2.37
K "	0.17	0.06	0.05	<0.75			0.31	0.39		0.12	0.22	0.31
Cl "	0.4	0.60	1.02	3.2			0.21	0.11		0.32	2.65	2.56
Sulph. "	0.9	2.2	1.86	3.1			3.79	2.98	2.8-3.2	1.44	2.99	3.31
NO_3N (µg/l)	10	56	160				392	406	175-241	140	378	168
RAL "	25**	119	220	21			28	28			128	
ILAL "		25	33	14								
LAL "		94	187	8								
NH_4N "		22	96				60	0		>14		
Tot N "		123	426	<50						140		
F "		274										
TOC/DOC (mg C/l)		1.46	2.88	1.1							0.4	1.4
ALK-E (µeq HCO_3^-/l)		7.6	-				0	20-30		11		
Lake area (Hectare)	50	40	20	9.8			0.136	0.140	20.05	8.60		
Watershed area (km^2)	16	2.43	0.8	0.919			0.55	1.14	2.07	0.8		
Watershed geology	morene	granite	granite	granite	schist	granite	gneiss	gneiss	morene	granite	granite	granite
Runoff (l/s km^2)	50	31	35									
Max. depth (m)				24			11.5	13.5	45	45		

** as total Al.

Figure 2. Location of the ALPE sites: (1) Øvre Neådalsvatn, (2) Stavsvatn, (3) Lille Hovatn, (4) Lochnagar, Sandy Loch and Loch Nan Eun, (5) Paione Lakes,(6) Lago Lungo (7) Rond and Combeynod, (8) Aubé.

PARTICIPATING INSTITUTIONS AND ORGANIZATION

Seven instiutions from four countries are now directly participating in the project.These instituitons are:

- University College of London — UK
  Dep. of Geography, Paleoecology Research Unit

- Consiglio Nazionale delle Ricerche — Italy
  Istituto Italiano di Idrobiologia

- Norwegian Institute for Water Reseach — Norway

- University of Bergen, Museum of Zoology — Norway
  Dep. of animal ecology

- Provincia Autonoma di Bolzano — Italy
  Laboratorio Biologico Privinciale

- Centre National de la Recherche Scientifique — France
  Lab. de Neurobiologie et Physiologie Comparee.

- Universite de Savoie, Esigeo — France
  Laboratoire Biologie Appliquee CI.E

Some of the directly participating institutions collaborates with other institutions on special objectives, but are still the main responsible participant in the project for their area.

Before starting the practical work of the project, all participants will meet in Pallanza at CNR III the 14th of March 1991 to go through the details of the work. Background data for the remote mountain lakes will then be presented.

The project is funded through the the ECE STEP - programme and the working periode is two years. United Kingdom has taken the administrative responsibility, while the scientific coordinating country for the project will be Norway. Together with the responible persons for each of four subject areas the project coordinators are forming a steering committee for the project, as shown in the following text. This steering committee will be responsible also for quality assurance and necessary intercalibrations between the participants. In each region/country there will be a contact person for each subject area. This is shown in Table 12.

PROGRAMME COORDINATION

Administrative Programme Center: United Kingdom/Rick Battarbee and Simon Patrick

Scientific Programme Center : Norway/ Merete Johannessen and Bente M. Wathne

Subject area	Coordinated by
- Lake sediments and diatoms	United Kingdom/Rick Battarbee
- Fish	Norway/Bjørn Rosseland
- Invertebrates	Norway/Gunnar Raddum
- Water Chemistry	Italy and Norway/ Rosario Mosello and Bente M. Wathne

Table 12. Contact persons for each subject area in each country.

Area	Country	Diatoms and lake sediments	Fish	Invertebrates	Water chemistry
Norwegian Mountains	Norway	John Birks	Bjørn Rosseland	Gunnar Raddum	Bente M. Wathne
Cairngorms, Scotland	United Kingdom	Rick Battarbee	Brian Morrison	Alan Hildrew	Ron Harriman
The Alps	Italy	A. Lami	G. Giussani	M. Manca	R. Mosello
	Switzerland	M. Simona	B. Polli	B. Polli	A.Barbieri
	Austria	R. Schmidt			R. Psenner
	France	G. Blake		G. Blake	Masclet
The Pyrenees	France	Jean-Ch. Massabuau	Charles Roqueplo	Jean-Ch. Massabuau	Anne Probst

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APPENDIX A

UK - Site information for Lochnagar

Lochnagar

Grid Reference NO 252859

Loch

Lochnagar (Figure 6, Table 8) lies at an altitude of 785 m in the centre of the granitic massif which comprises much of Balmoral Forest in Aberdeenshire. Lochnagar is a corrie loch and lies below a north-east facing steep backwall which rises to the summit of the same name. The loch is pear-shaped and occupies an area of 9.8 ha. No distinguishable inflow feeds the loch and drainage is primarily from small seepage channels. The loch drains to the north-east through a series of small pools to the Lochnagar Burn which feeds the Gelder Burn, a south-bank tributary of the River Dee. Snow generally occupies the catchment to a varying extent between November and May and a significant snow field accumulates in the main winter period. Snow-melt therefore comprises a major input to the loch. Unlike other sites in the Network Lochnagar regularly freezes each winter. Partial ice cover may last from November to June in many years, with a complete ice cover between January and April.

The bathymetric map (Figure 7) shows that the loch floor slopes quite sharply to a deep basin. The deepest point (24 m) is offset from the centre of the loch towards the backwall. The loch is deep for its area with a mean depth of 8.4 m.

The loch is acid (mean pH 5.41) and alkalinity (mean 0.1 mg l^{-1}) and calcium levels (mean 0.7 mg l^{-1}) are both low (Table 9). Despite the existence of some localised peat erosion in the catchment the loch water is very clear. Palaeolimnological studies (Patrick *et al.* 1989a) have shown that the loch acidified in the mid-nineteenth century and that prior to acidification loch water pH was about 5.7.

Epilithic diatoms are dominated by acidophilous species, notably *Achnanthes marginulata* and *Tabellaria flocculosa.* The species-poor macrophyte flora largely comprises submerged liverworts (eg. *Scapania undulata*) and *Sphagnum auriculatum* which extend to 6 m depth. The only non-bryophyte taxa, *Isoetes lacustris* and *Juncus bulbosus* var. *fluitans* are sporadic in their distribution.

Benthic macroinvertebrates are characterised by detritivorous stoneflies, predatory stoneflies and the acid-tolerant mayfly *Leptophlebia vespertina*, in low numbers. The loch is remote and relatively inaccessible. Consequently very little is known of its fishery history. Trout were reported in the loch in 1940 (Hardie 1940), but a thorough gill net survey of the fishery status in 1983 yielded only 13 trout, all mature specimens (Morrison pers. comm.). However, electrofishing of the outflow stream in October 1989 revealed a good population of trout with a density of combined reaches of 0.644 ± 0.016 m^{-2} and ages of up to five years.

Catchment

The loch drains a precipitous catchment of 91.9 ha which reaches a maximum altitude of 1155 m at the summit of Lochnagar to the west of the loch (Figure 6). The geology is composed of biotite granite overlain in places by blanket peat. The catchment is

Figure 6
Lochnagar: Catcment

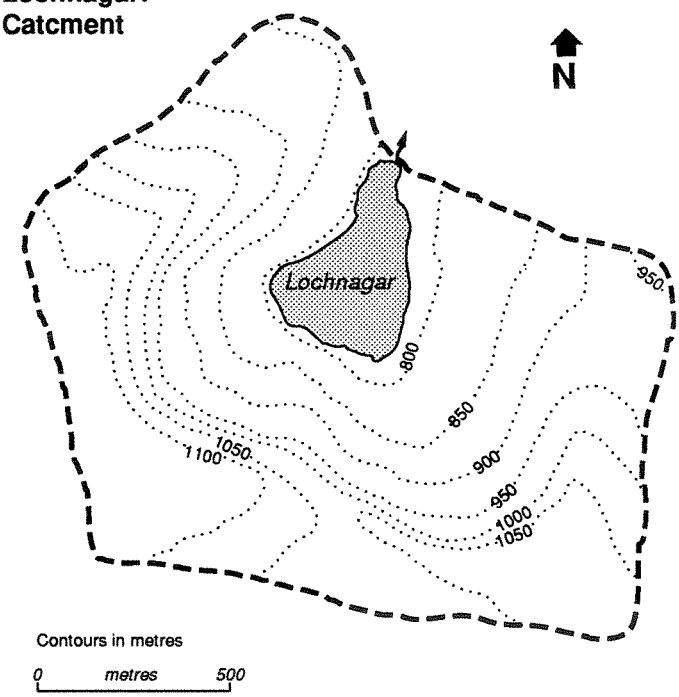
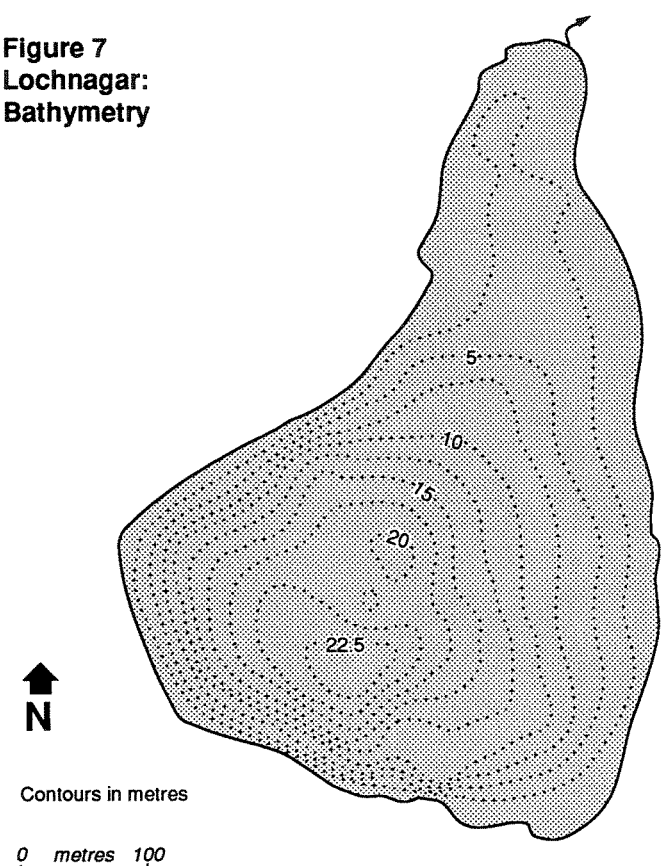


Figure 7
Lochnagar: Bathymetry



dominated by bare rock, both on the steep backwall and the extensive fields of large boulders and coarse screes that have developed between the corrie ridge and the loch.

The loch and its catchment receive an annual rainfall of c. 1400 mm (1988) and lie in an area with wet deposited acidity of 0.48 kg H^+ ha^{-1} yr^{-1} and wet deposited non-marine sulphate of 7.33 kg S ha^{-1} yr^{-1} (Table 8).

The catchment is unafforested and the sparse vegetation is dominated by a community of stunted *Calluna* and *Vaccinium*, interspersed in places with *Scirpus*. Lichens and mosses are abundant on the boulders and screes that characterise the catchment. Of the localised areas of peat in the catchment, certain areas, notably along the eastern shore, are severely eroded. Pine stumps are revealed in peat exposures adjacent to the outflow and further down the Lochnagar Burn.

This area represents some of the most harsh environmental conditions to be found in the British Isles. At over 700 m the catchment lies above the limit of summer sheep grazing in the region and there is no evidence for, nor rational expectation of, any land-use change or active land-management within the catchment. Red deer range across the catchment when food is available, but stalking in the area, once popular (Clark 1981), is now rare and strictly controlled. The catchment comprises part of a nature reserve administered by the Scottish Wildlife Trust.

Table 8
Lochnagar:
Site characteristics

Lake altitude	785 m
Maximum depth	24 m
Mean depth	8.4 m
Volume	0.82 x 10^{-6} m^3
Lake area	9.8 ha
Catchment geology	granite
Catchment soils	peat
Catchment vegetation	moorland - 100%
Catchment area	91.9 ha (excluding lake)
Catchment:lake ratio	9.37
Net relief	370 m
Mean annual rainfall	c. 1400 mm (1988)
Wet deposited acidity	0.48 kg H^+ ha^{-1} yr^{-1} (1988)
Wet deposited non-marine sulphate	7.33 kg S ha^{-1} yr^{-1} (1988)

Table 9
Lochnagar:
Water chemistry (1988-1989) (Juggins *et al.* 1989)

Determinand		Mean	Max	Min
Temperature	°C	3.4	9.5	0.3
pH		5.41	5.52	5.30
H^+	µeq l^{-1}	4.0	5.0	3.0
Alkalinity ($CaCO_3$)	mg l^{-1}	0.1	0.2	0.0
Conductivity	µS cm^{-1}	22.7	35.0	15.0
Ca	mg l^{-1}	0.7	1.0	0.5
Mg	mg l^{-1}	0.4	0.7	0.3
Na	mg l^{-1}	2.4	4.0	1.6
K	mg l^{-1}	<0.75	<0.75	<0.75
Ba	mg l^{-1}	0.02	0.03	0.02
Sr	mg l^{-1}	0.01	0.01	0.01
SO_4	mg l^{-1}	3.1	4.1	2.5
TON	mg l^{-1}	0.2	0.31	0.11
PO_4	mg l^{-1}	<0.005	0.01	<0.005
Cl	mg l^{-1}	3.2	5.9	1.8
Br	mg l^{-1}	<0.01	<0.01	<0.01
F	mg l^{-1}	0.01	0.02	<0.01
Sol mon Al	µg l^{-1}	38.0	48.0	25.0
Sol NL mon Al	µg l^{-1}	17.0	35.0	<5.0
Sol L mon Al	µg l^{-1}	21.0	39.0	11.0
Cu	mg l^{-1}	<0.02	<0.02	<0.02
Zn	mg l^{-1}	0.01	0.03	<0.02
Fe	mg l^{-1}	<0.015	<0.015	<0.015
Mn	mg l^{-1}	0.01	0.01	0.01
Si	mg l^{-1}	1.2	1.5	1.0
B	mg l^{-1}	<0.05	<0.05	<0.05
DOC	mg l^{-1}	1.1	2.1	0.4
Excess SO_4	mg l^{-1}	2.8	3.7	2.2

APPENDIX B

Italy - Site information for Paione Lakes

C.N.R. Istituto Italiano di Idrobiologia, Pallanza

LAKES PAIONE

OSSOLA VALLEY, LEPONTINE ALPS

NW ITALY

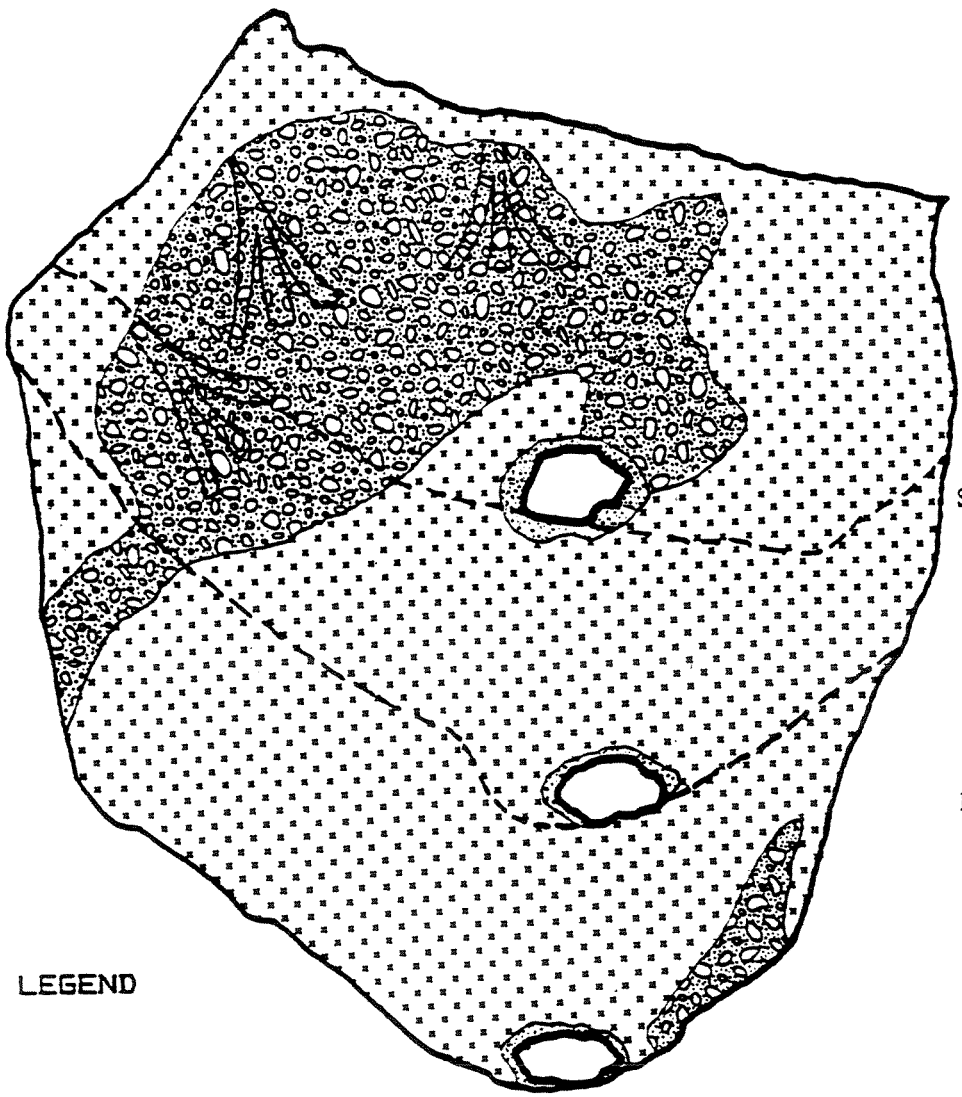
Tab. 1 - Main morphometric characteristics of Lakes Paione.

		Paione Inferiore	Paione Superiore
Altitude	m a.s.l.	2002	2269
Longitude	East	8°11'23"	8°11'27"
Latitude	North	46°10'1"	46°10'26"
Lake surface	km^2	0.014	0.014
Watershed area (lake included)	km^2	1.14	0.55
Max. depth	m	13.5	11.7
Mean depth	m	7.35	5.12
Lake volume	10^6 m^3	103	69

Laghi dei PAIONI SUP.RE, MEDIO, INF.RE
Valle Bognanco

SCALA:
0 100 200 300 mt

LITHOLOGICAL MAP



LEGEND

Talus

Bog-lake deposit

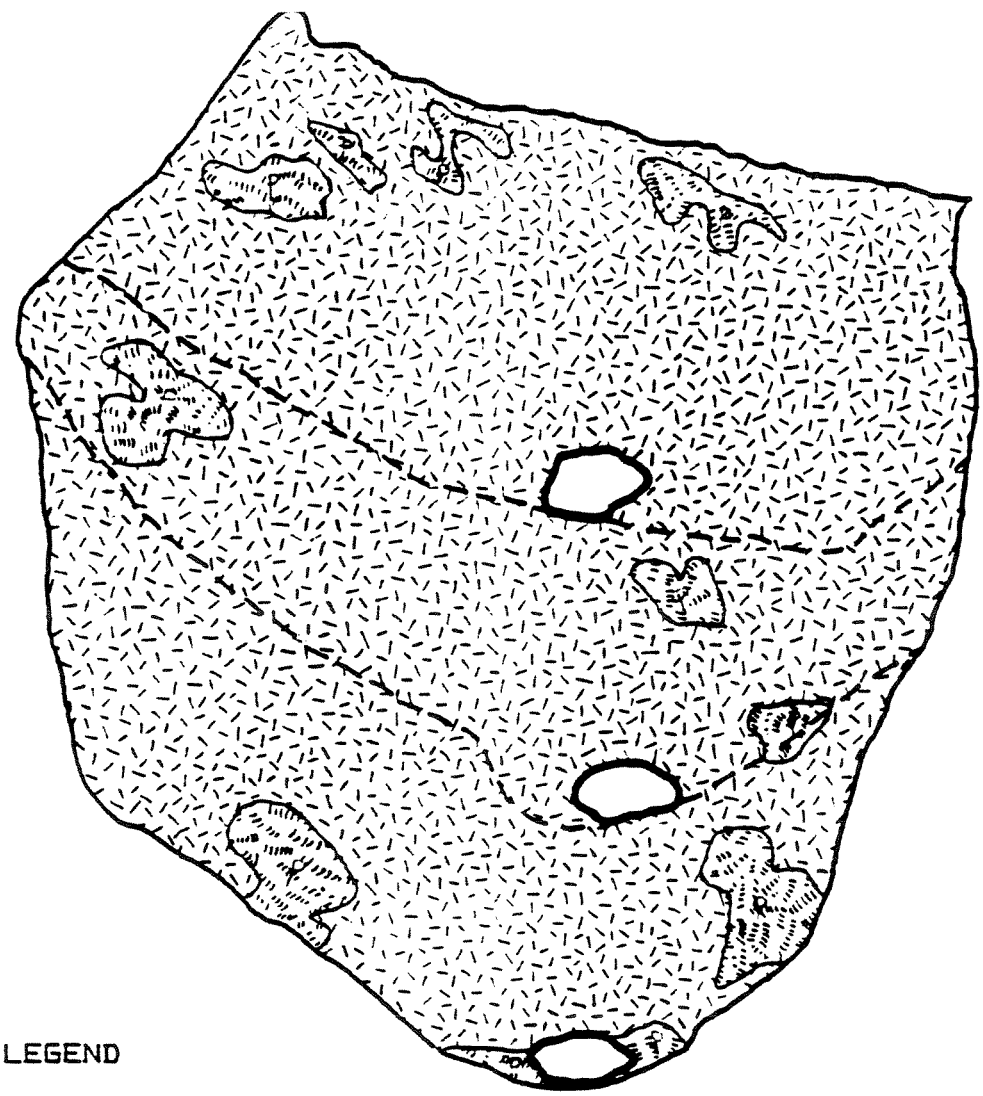
Orthogneiss

N

Laghi dei PAIONI SUP.RE, MEDIO, INF.RE
Valle Bognanco

SCALA:
0 100 200 300 mt

LAND COVER



LEGEND

Rocks and debris

Hay meadows

N

Tab. 2 - Chemical characteristics of Lakes Paione.

		Paione Inferiore	Paione Superiore
pH		6.4	5.4
Total alkalinity	μeq l^{-1}	25	0
Sulphate	"	60	60
Nitrate	"	29	28
Chloride	"	5	6
Ammonium	"	0	1
Calcium	"	84	58
Magnesium	"	16	13
Sodium	"	13	12
Potassium	"	9	8
Anions	"	119	94
Cations	"	123	97
Conductivity	μS cm^{-1}	12.6	11.5
Reactive silica	mg Si l^{-1}	0.6-0.9	0.3-0.6
Total phosphorus	μg P l^{-1}	< 10	< 10

* H^+ included (4 μeq l^{-1})

Lake: PAIONE SUPERIORE

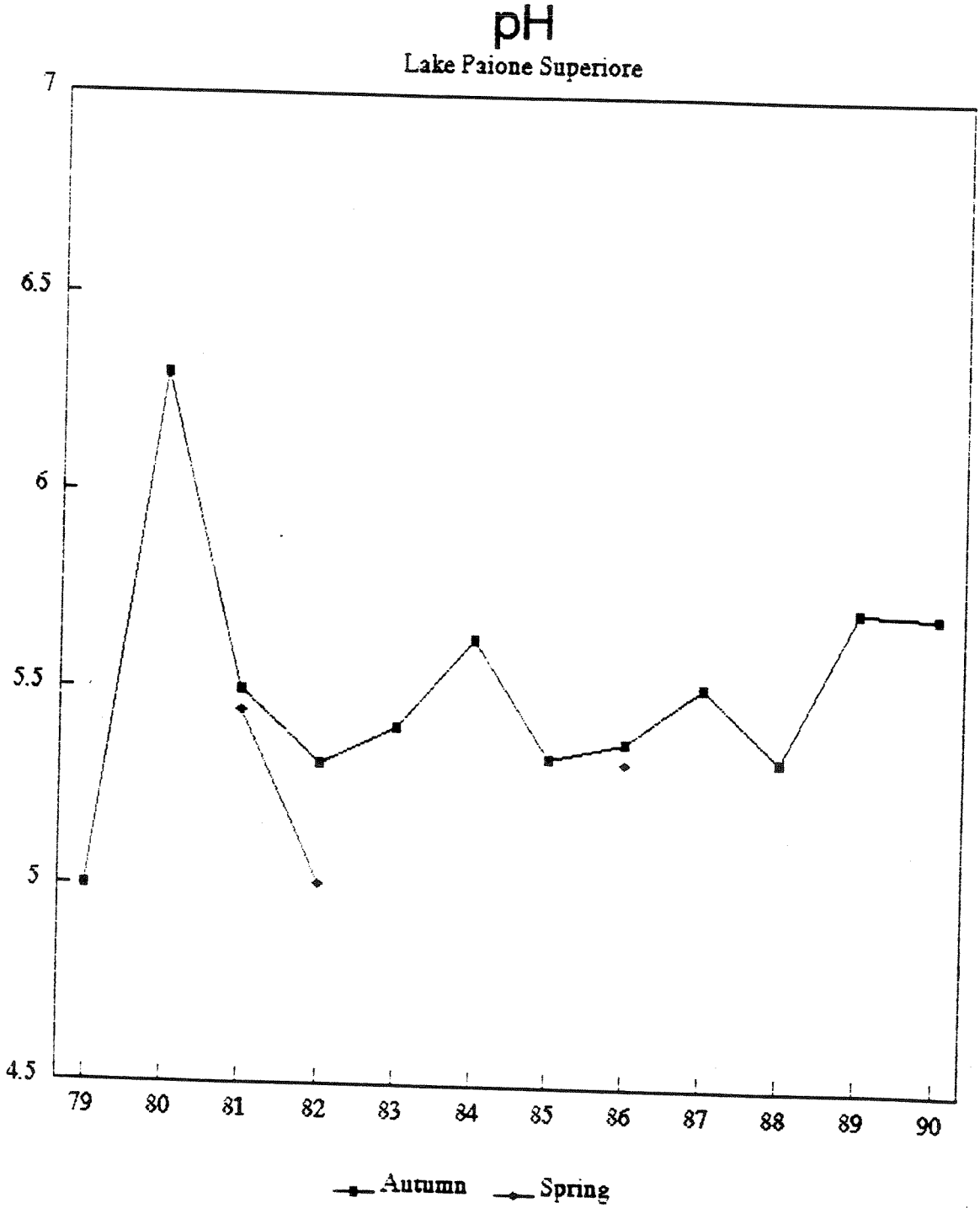
List of chemical analyses

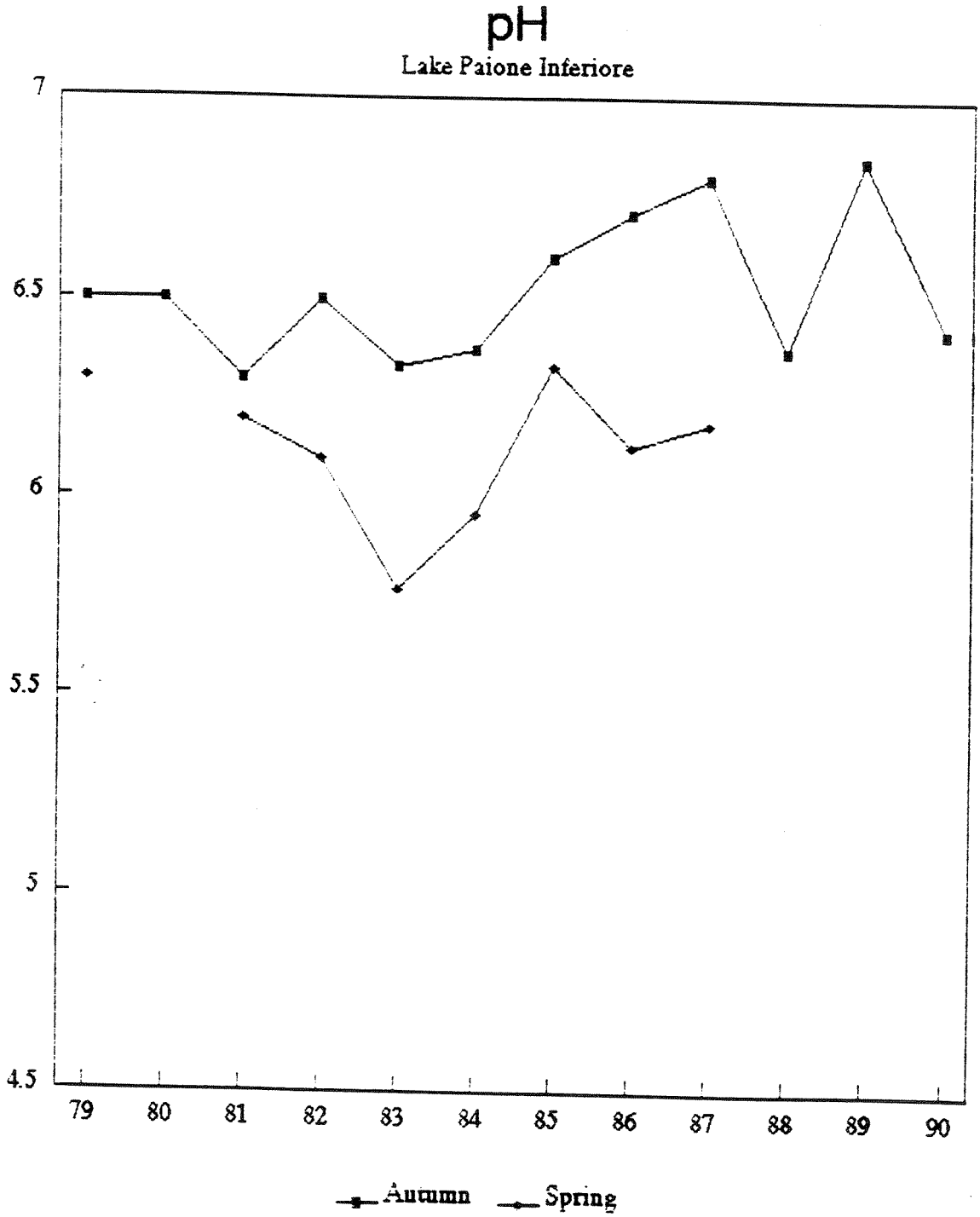
06/11/79	10/02/79	08/18/80	08/24/80	06/13/81	06/13/81
10/09/81	05/26/82	06/10/82	07/01/82	07/01/82	09/22/82
07/26/83	09/29/83	08/14/84	10/25/84	08/07/85	09/25/85
10/23/85	07/30/86	10/14/86	09/23/87	11/02/88	10/17/89
10/24/90					

Lake: PAIONE INFERIORE

List of chemical analyses

06/11/79	10/02/79	08/18/80	08/24/80	06/13/81	10/09/81
04/22/82	05/26/82	06/10/82	06/10/82	09/22/82	05/04/83
06/01/83	06/29/83	06/29/83	07/26/83	09/29/83	05/31/84
06/26/84	06/26/84	06/26/84	07/19/84	08/14/84	10/10/84
10/25/84	06/13/85	06/27/85	08/07/85	09/25/85	10/23/85
06/17/86	07/07/86	07/30/86	10/14/86	06/09/87	09/23/87
11/02/88	10/17/89	10/24/90			


pH
Lake Paione Superiore
7
6.5
6
5.5
5
4.5
79
80
81
82
83
84
85
86
87
88
89
90
Autumn
Spring


pH
Lake Paione Inferiore
7
6.5
6
5.5
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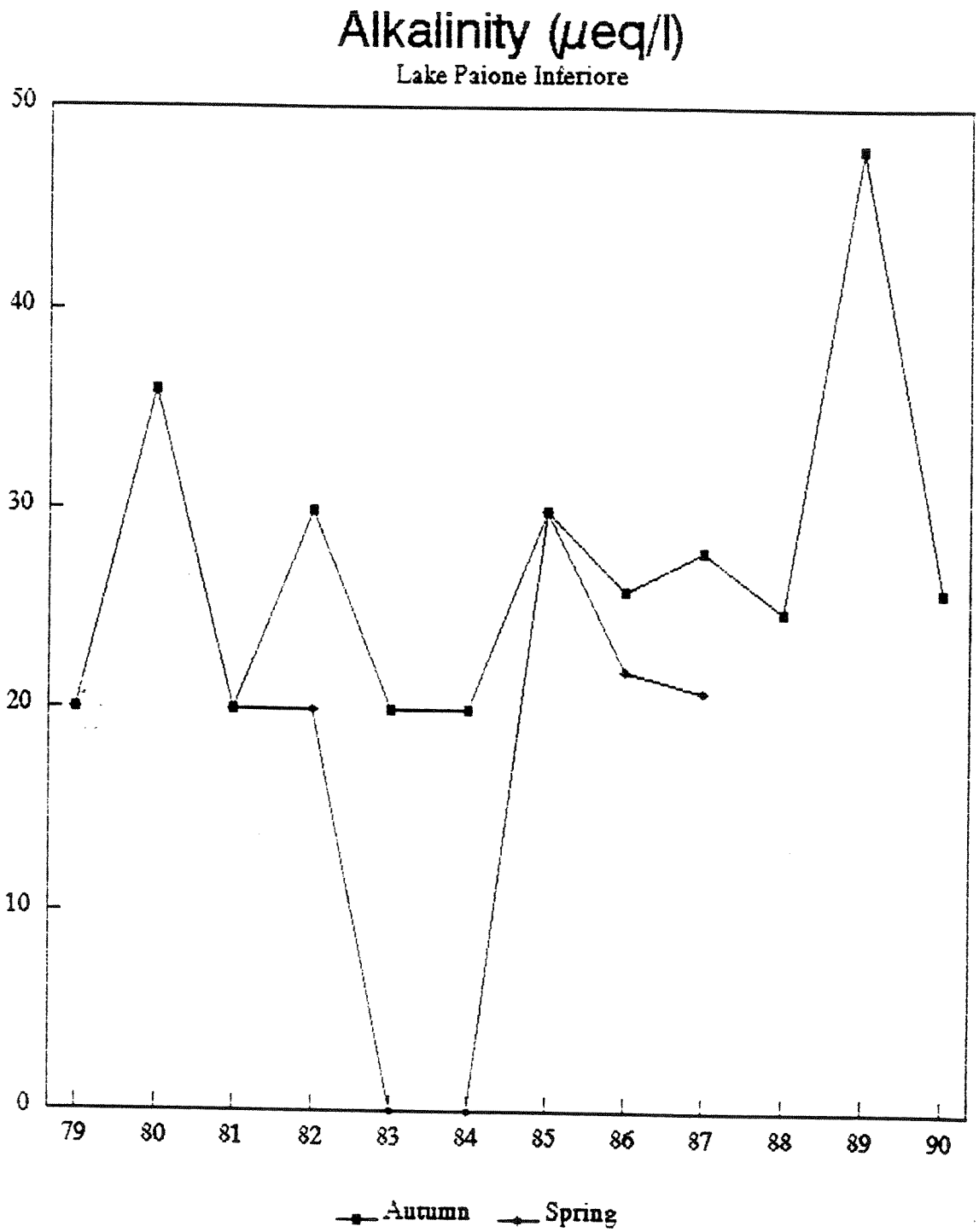
4.5
79
80
81
82
83
84
85
86
87
88
89
90
Autumn
Spring


Alkalinity (μeq/l)
Lake Paione Inferiore
50
40
30
20
10
0
79
80
81
82
83
84
85
86
87
88
89
90
Autumn
Spring

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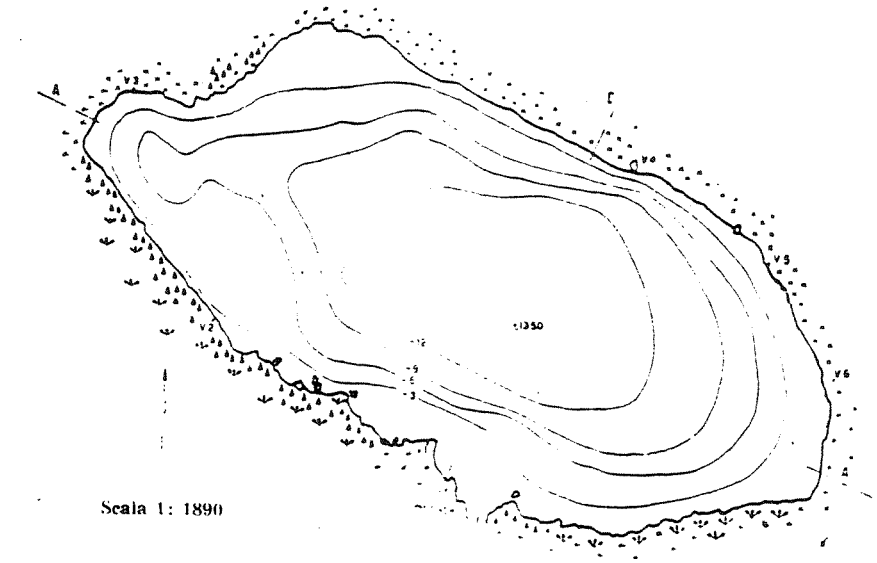
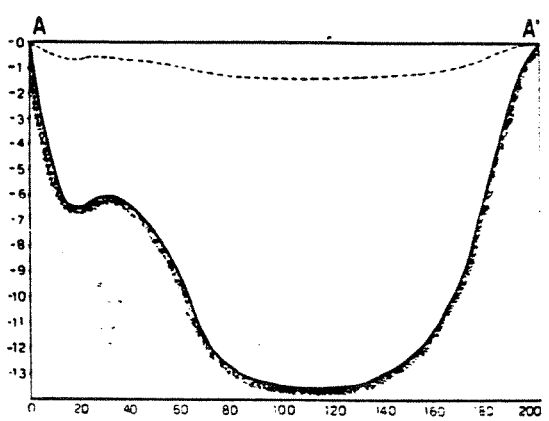
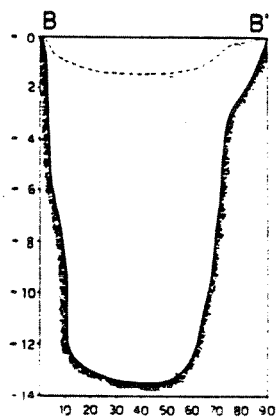
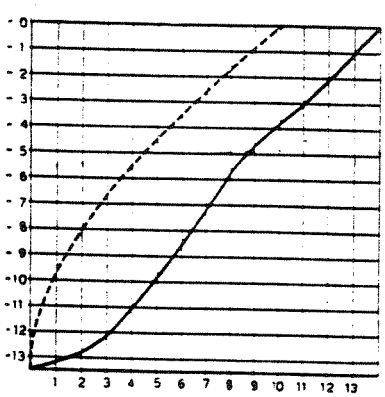
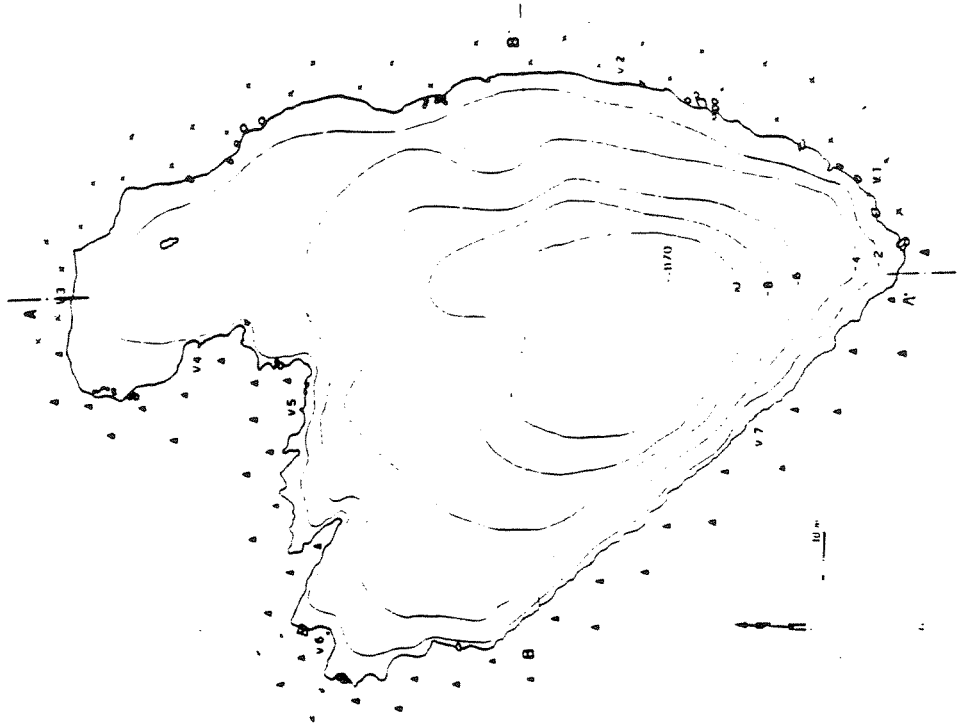


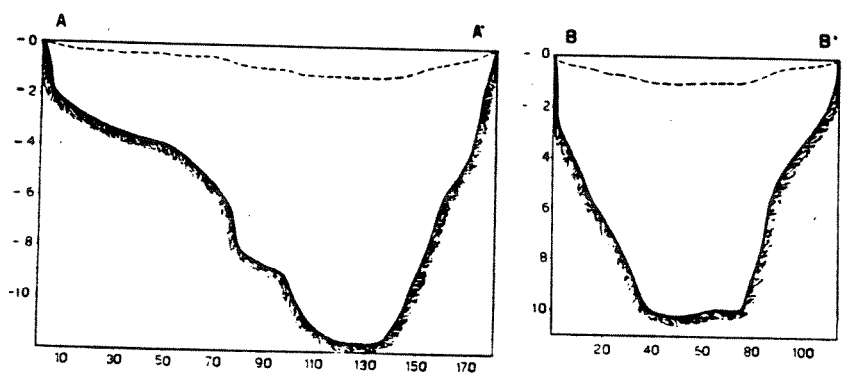


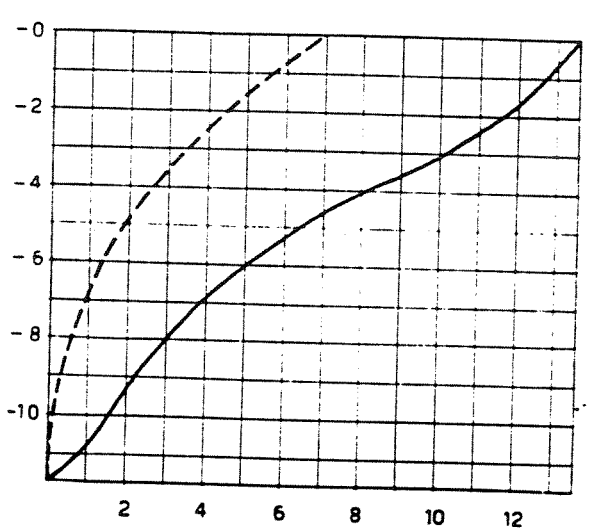




Batimetric map and ipsografic curve of lake Paione Inferiore







Batimetric map and ipsographic curve of Lake Paione Superiore

APPENDIX C

Italy - Site information for Lago Lungo

LIMNOLOGICAL CHARACTERISTICS OF LAKE LUNGO

(Tessa Group - South Tyrol - Italy)

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1. Study area

The Lake Lungo (Langsee) lies in the Natural Park of Tessa (Province of Bolzano) at 2384 m altitude at coordinates 46°43'36" northern latitude, and 11°05'00" eastern longitude in the international system (Fig.1). The main morphometric parameters of the lake and its watershed are shown in tab. I and the bathimetric map is shown in fig. 4.

A lithological map of the watershed is shown in fig. 2. 80% of the watershed is composed by gneiss and paragneiss. Other two lakes are present within the watershed and make up 12% of its surface. A land cover map of the watershed is shown in fig. 3. The land is mainly constituted by rocks which however are to a great extent covered by a thin layer of vegetation.

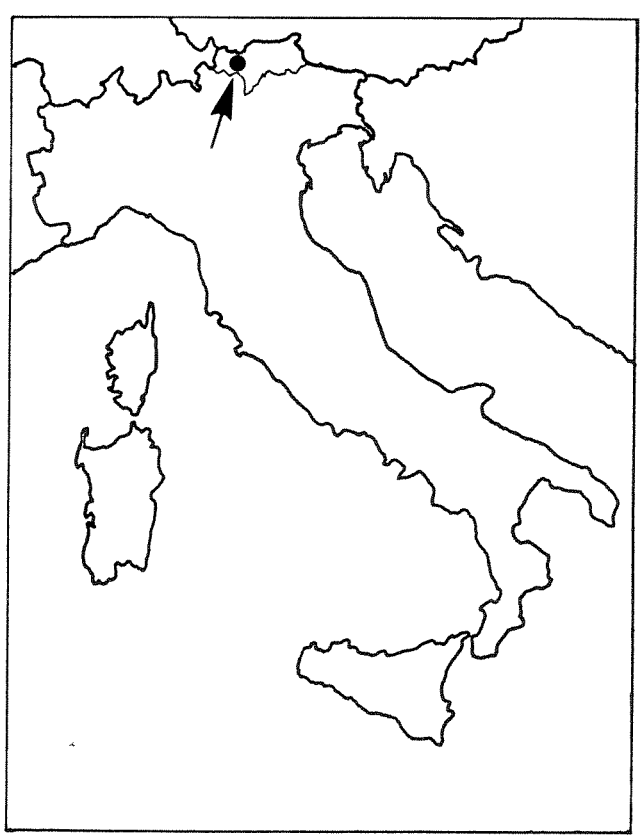


Fig. 1: Geographic location of Lake Lungo (Tessa).

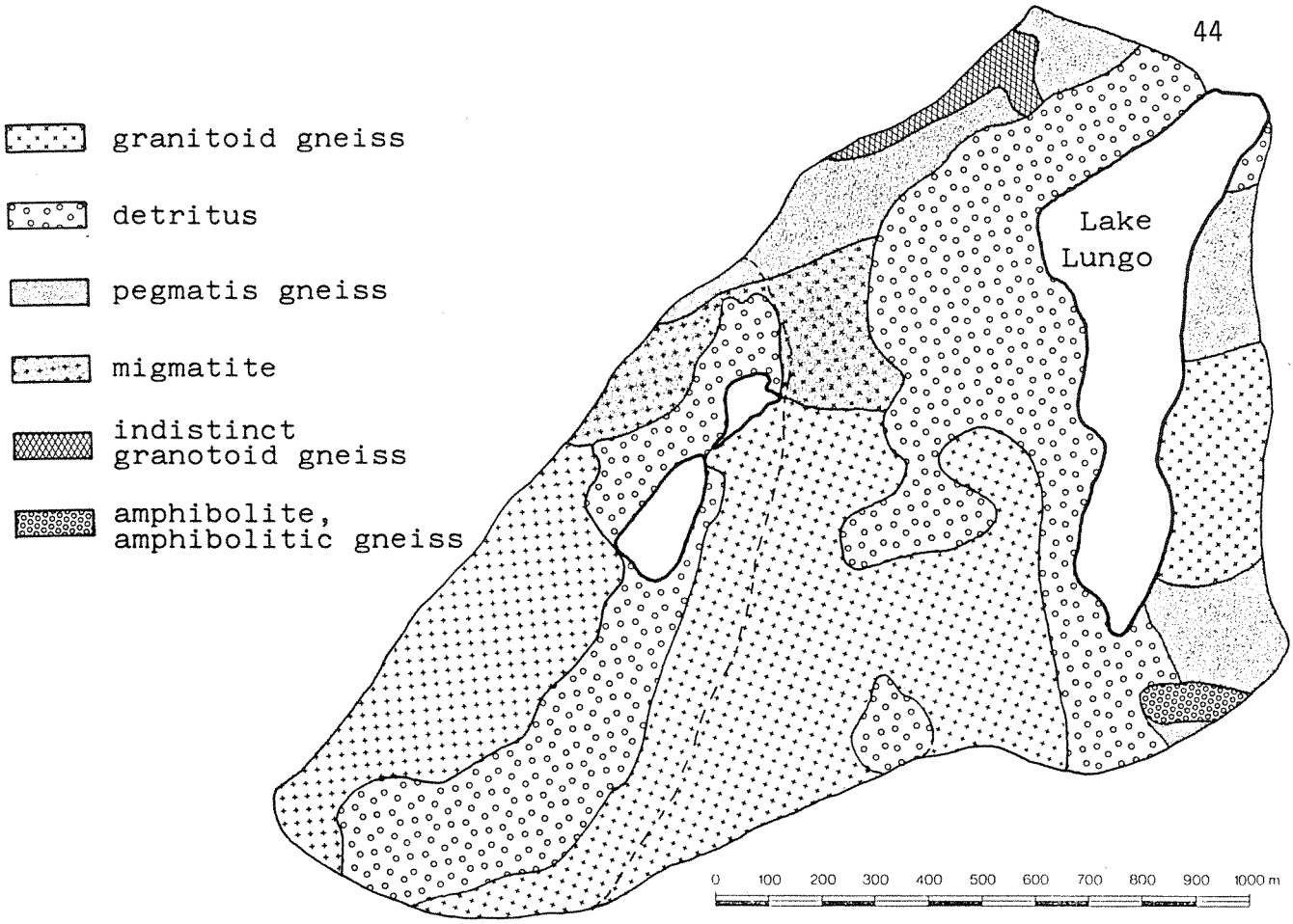


Fig. 2: Lake Lungo (Texel). Lithological map.

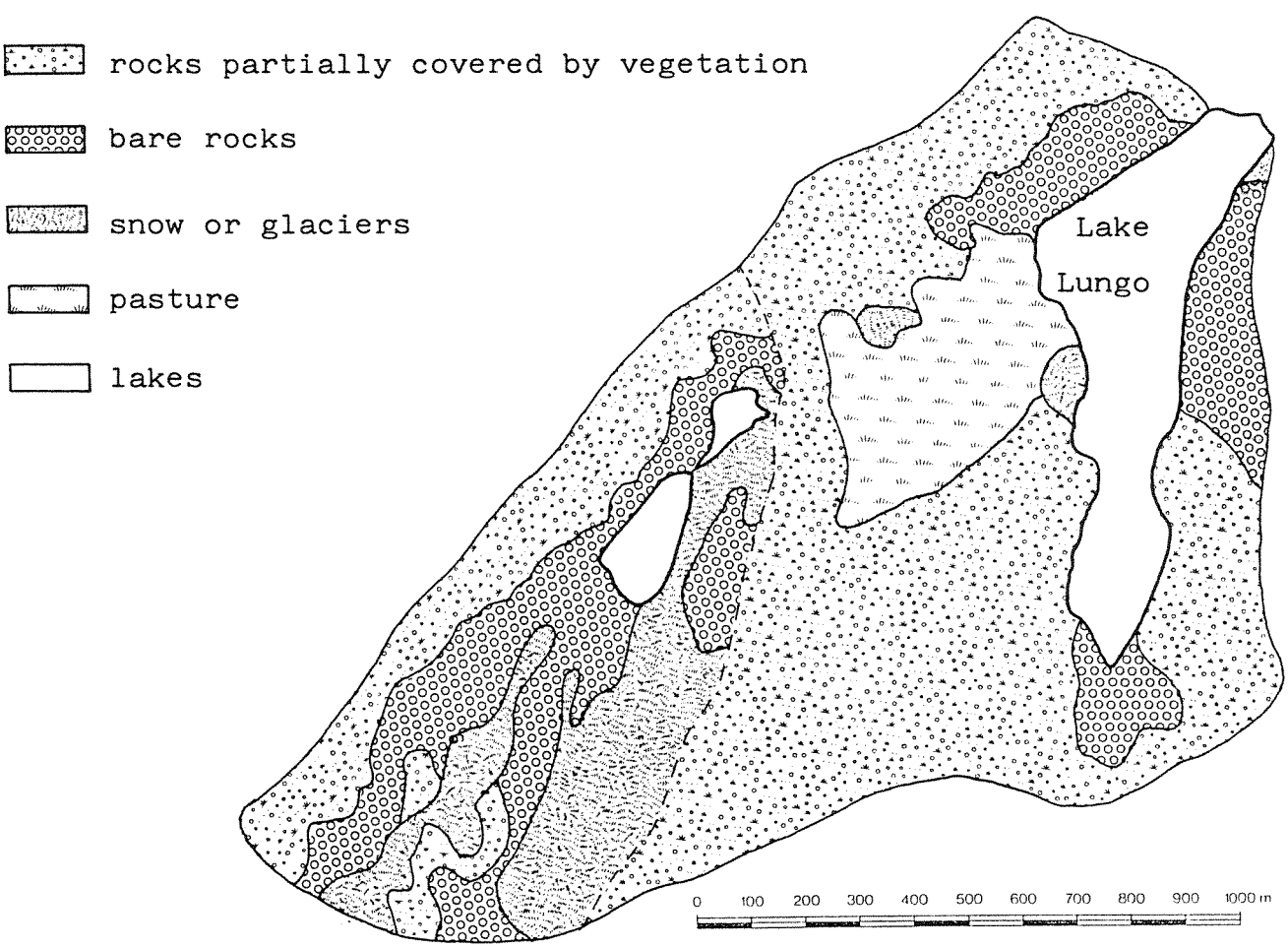


Fig. 3: Lake Lungo (Texel). Land cover map.

Table I

Record: 253 Ch. rec.: 6

Lake: LAGO LUNGO - LANGSEE
Comune : TIROLO

Max length (m): 1091 1:25000 Map : 4 III S.E. MERANO
Max width (m) : 310 Aerial phot. : 8-74
Altitude : 2384 ORTHOPHOT. 1:10000 : 013 05
Max depth (m): 45,0 Coord. NORTH : 46°43 '36''
Lake area ha : 20,05 EST : 11° 5 ' 0''
Volume m3X1000 : 2583
Basin area kmq.:2,070
Tributaries : 2 Outlets : 1
Geology : MOERAENENRESTE IM AUSRINNBEREI
Lithological groups: paragneiss, gneiss granitoidi
Lithological class : 1
Vegetal cover. of the bacin: rocks, prairie

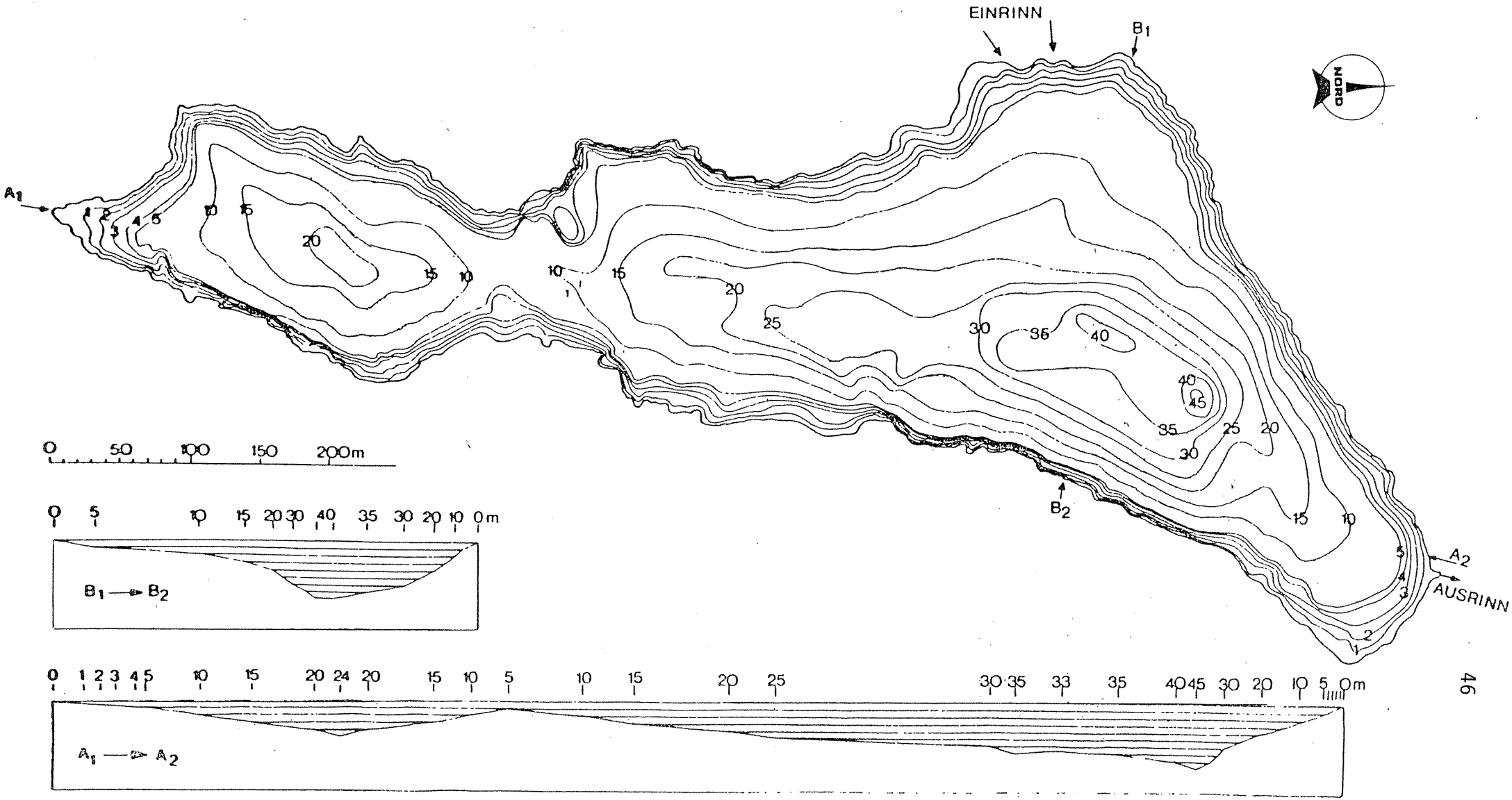
Macrophytes:

Chemical samplings :	25-07-84	06-11-86	03-11-88
	25-10-89	16-10-90	- -
	- -	- -	- -
	- -	- -	- -
	- -	- -	- -
	- -	- -	- -
	- -	- -	- -
	- -	- -	- -
Fitoplankton samplings :	25-07-84	03-11-88	- -
	- -	- -	- -
Zooplankton samplings :	25-07-84	03-11-88	- -
	- -	- -	- -

Notes: Oulet toward Lago Verde. Bathimetric map 1985
TEXEL GROUP

Fig.4: LANGSEE TEXELGRUPPE

LAGO LUNGO GRUPPO DEL TESSA



2. MATERIALS AND METHODS

Water samples have been taken five times. In July 1984 during snowmelt, once a year in 1986, 87, 88, 89, 90 during the period Summer-late Autumn usually between 10.00 A.M. and 2.00 P.M. Temperature, pH, conductivity and dissolved oxygen were measured in the field by means of a combined instrument (Hydropolytester ZÜLLIG HPT - 77) and major ions, oxygen, algal nutrients and chlorophyll a) were determined. Biological samples for quantitative determinations were taken twice (1984 and 1988).

Water samples for chemical analyses were taken using a 5 liter SCHINDLER sampler made entirely of Plexiglas and stored in 1 liter polyethylene bottles. For the analyses of the dissolved components water samples were filtered a few hours after sampling using a MILLIPORE filtering unit (0.45 µ).

According to the analytical methods listed the following chemical parameters have been measured:

Alkalinity	by GRAN titration with HCl 0,02 N
pH	determined in the laboratory on METTLER DL40 or METROHM E603 using combined glass-reference electrode. Since 1989 an INGOLD combined electrode for poorly ionized media has been used. Standard buffers for pH 7.00 and pH 4.00 were used to calibrate the electrodes and checks with HCl 0.0001 M were made. Reading after 10-15 min. in unstirred samples.
Conductivity	with instrument WTW LF 39 at room temperature corrected for 20°C;
Sulphate	until 1987 turbidimetric according to METODI ANALITICI PER LE ACQUE, CNR Roma (1972) since 1988 with flow injection using a FIASTAR 5023 analyzer; since 1990 with ionic chromatograph DIONEX 2000/i;
Chloride	automatic titration with AgNO3 0,01N (Memotitrator METTLER DL 40) after addition of a known amount; since 1990 with ionic chromatograph DIONEX 2000/i;

Nitrate nitrogen	sodium salycylate method according to MÜLLER & WIDEMANN (1955); since 1990 with ionic chromatograph DIONEX 2000/i;
Ammonia nitrogen	according to WAGNER (1969);
Total and dissolved iron	according to GANTHALER (1977);
Total (TP), dissolved (TDP)	and reactive phosphorus (MRP) were determined according to VOGLER (1965);
Dissolved reactive silica (DRSi)	according to GOLTERMANN (1971);
Ca, Mg, K, Na	atomic absorption spectrophotometry (PERKIN-ELMER 370), for Ca e Mg after addition of HCl e La

Trasparency was measured with a 30 cm Secchi disk. Samples for phytoplankton, zooplankton and chlorophyll analyses were taken with SCHINDLER sampler. Phytoplankton samples were preserved with LUGOL solution, zooplankton samples with 90% ethanol. Chlorophyll was determined after extraction in 90% acetone and evaluation of the spectrophotometric readings according to GOLTERMANN (1969).

3. Atmospheric depositions

The bulk deposition of sulfate ranges in South Tyrol from 9.6 kg/ha.yr to 30.6 kg/ha.yr with a mean value of 20 kg/ha.yr.

Tab. II: Average bulk values in precipitation in South Tyrol measured at Ritten (1780 m).

Ritten		SO4 µeq/l	NO3 µeq/l	NH4 µeq/l	Cl µeq/l	SO4/Cl
('85-88)	Bulk	42.7	26.1	35.2	7.9	5.4
1988	Bulk	50.0	26.8	39.7	8.5	5.9
1990	Bulk	43.7	30.7	59.3	12.1	4.9
1990	Wet	41.8	27.1	57.1	6.5	8.8

The bulk deposition of nitrate ranges from 9.3 kg/ha.yr to 23.9 kg/ha.yr with a mean value of 15 kg/ha.yr. On equivalent

basis nitrate levels are between 64 and 70% of sulfate levels. Tab. II shows the average bulk values in precipitation in South Tyrol measured at Ritten, a site located at 1780 m altitude and tab. III the corresponding deposition valued of sulphate and nitrate.

Tab. III: Bulk deposition values of sulphate and nitrate (Kg/ha y). For 1990 also wet values.

sampling site Ritten (1780 m)		SO4 kg/ha.y	NO3 kg/ha.y
Bulk	1985	22.5	16.4
Bulk	1986	17.7	17.3
Bulk	1987	21.0	16.8
Bulk	1988	22.5	15.9
Bulk	1990	22.2	19.9
Wet	1990	19.8	16.4

4. RESULTS

4.1 Chemical characteristics of Lake Lungo (Tessa).

Among the 67 high altitude lakes sampled in South Tyrol 29% have alkalinity lower than 50 µeq/l and low ionic concentrations (<=20 µS 20°C). Fig. 5 shows the frequency distribution of calcium, magnesium and sulphate of the lakes showing low buffering capacity. The values measured for Lake Lungo are marked in the figure by an arrow. Although lakes with lower calcium content exist in the study area they have been discharged because shallow or free from fish population. The lowest SO4 value measured in South Tyrol is 35 µeq/l and only three lakes show a sulphate concentration lower than the value of 43 µeq/l measured in precipitation. The main chemical parameters measured for Lake Lungo are listed in tab. IV. The pH autumnal values ranged during the 1986-1990 period between 6.56 and 6.83 while the value measured during snowmelt was

Tab. IV: Main chemical parameters of Lake Lungo (Langsee) (1984-90 5 samplings).

pH	5.99 - 6.83	
Conductivity	12 - 19 µS/cm 20 °C	
ANC	20 - 37 µeq/l	
SO4	52 - 66 µeq/l	2.8 - 3.2 mg/l
NO3	13 - 17 µeq/l	175 - 241 µg/l
Ca	59 - 84 µeq/l	1.16 - 1.69 mg/l
Mg	7 - 18 µeq/l	0.09 - 0.22 mg/l
TP		5 µg/l
Transparency	5 - 6 m	
(Ca*+Mg*)/(SO4*+NO3) = 1.23		
Estimated acidification value:		51 - 55 µeq/l

5.99. Alkalinity ranged in the same period between 30 and 37. LEUTELT-KIPKE found in September 1936 a pH value of 8.4 and an alkalinity of 270 µeq/l.

4.2 Phytoplankton

According to the two biological samplings the phytoplankton biovolume of Lake Lungo ranges between 1.0 to 1.7 mm^3/l and the number of species between 11 and 18. The phytoplankton spectrum is dominated by surprisingly high fractions of Zygnemaphyceae (63%-92%) (Cosmarium), but also Dinophyceae are important (Peridinium).

4.3 Zooplankton

The composition of zooplankton was sparse and abundancies low. The total number of species amounted to 6 in 1984 and to

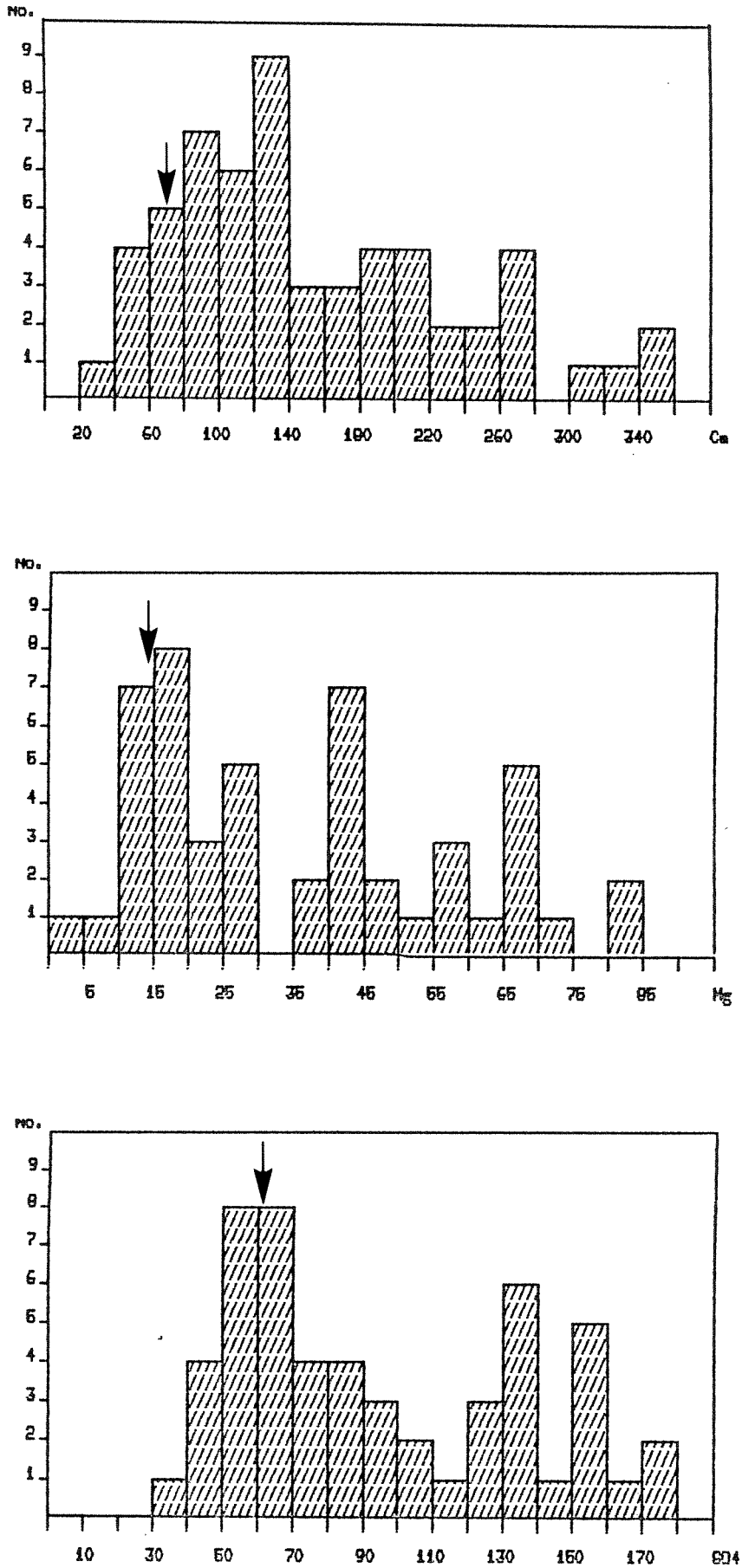


Fig.5: Frequency distribution of calcium, magnesium and sulphate in the lakes of South Tyrol with low buffering capacity.

3 in 1988; the number of species of rotifers was 4 and 2 respectively with abundancies of 44180 ind./m³ and 28840 ind./m³. The found species were Keratella hiemalis, Polyarthra sp., K. cochlearis, Filinia sp.. No Cladocers were found in both samplings. The abundancies of copepods were sparse, some Calanoids were found only in 1988 just in young stages (85 ind./m³) and the only Cyclopid was Cyclops abyssorum tatricus with abundancies of 5460 ind./m³. STEINER (1985) found 5 g Crustaceans in 1000 m³.

4.4 Fish Population

A research was carried out in 1985 (STEINER 1985). The objectives were to study population structures, reproduction, and growth. According to the study the fish population was constituted by three species: Salvelinus alpinus, Salmo trutta and Salvelinus fontinalis. The only species which showed a natural reproduction was Salvelinus alpinus. Mean condition factor and total lenghth of each species are shown in tab. V.

Tab. V: Lake Lungo. Fish population status (1985).

	KF	TL
Salvelinus alpinus	0.87	14-31
Salmo trutta	1.0	22-51
Salvelinus fontinalis	0.9	

On the basis of the study recomendations the lake was totally fished out and following this, the only introduced species was Salvelinus alpinus. The introduced quantities are

Tab. VI:Langsee. Fish introductions. From 1985 Salvelinus alpinus is the only introducted species.

1985	30 kg	(9-10 cm)
1986	0 kg	
1987	10 kg	(9-10 cm)
1988	10 kg	(9-10 cm)
1989	10 kg	(9-10 cm)
1990	20 kg	(10-15 cm)

listed in tab. VI. From 1985 - 1989 fishing in the lake was forbidden.

According to the stomach fillings the nourishment of the fishes is mainly composed by Diptera (Tipulidae, adults).

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APPENDIX D

France - Site information for the French Alps

State of studies of the remote lakes in the Alps of the STEP program

Selected region: Briançonnais (Parc National des Ecrins)

reasons: remote region far from air source pollutions

Presence of Air data collection station (Casset)

Number of studied lakes in 1990 (summer) : 15

Lacs	Altitude	Tourism	Cattle	Depth	Geol	Area	Chemist
Clarée							
Rouge	2585	1	0	8	Calc., So4	0,28	Ca ,
Béraudes	2504	2	0	3,04	Calc.	2,9	Ca-
Long	2387	3	1		Schist	3,6	Fe,Ca
Rond	2416	2	1	?	Schist	1,8	Fe
mare	2380	3	1				
Guisane							
Combeynod	2550	2	0	16,4	Granit	3,3	0
Blanc	2650	1	2		Dolomics	1,6	Ca,Mg
Ponsonnière	2565	3	3	2,4	Schist	0,6	Fe
Grand Lac	2282	3	3	14	Dolom	4,6	Ca,Mg
Romanche							
Lérié	2378	3	3+	3,8	Dolom	0,7	Mg
Orceyrette	1930	4	3	5	Schistes	4,6	Ca

Lacs	pH
Clarée	
Rouge	7,8-8,2
Béraudes	7,9-8,2
Long	6,8-7,4
Rond	6,6-7,3
mare	6,2-6,5
Guisane	
Combeynod	6,8 7,6
Blanc	7,8-8
Ponsonnière	7,8-8,2
Grand Lac	7,8-8,5
Romanche	
Lerié	7-7,5
Orceyrette	7,3

Temperatures of the lakes :

The lakes are frozen from November to end of June . The temperature of the surface rises from 7°C in July to 13°C in August. Temperature of deep strates are often the same or sometimes lower.

Selected areas and lakes for the study:

The choice has been made to retain the less visited by tourist and the less alcalin geologic environement situation.

Sediments caracteristics:

Study of the lakes of Vallée de la Clarée:
48 sp. (50% Dipteres):
exemple of repartition of benthic fauna for 4 lakes of Vallée of Clarée:

Molluscs	6 (Pisidium)
Oligoch.	4
Planaria	1
Hydracariens	1
Trichopter.	2
Megalopter.	1
Coleopter.	8
Dipter.	25

Zooplancton:

2 to 6 sp. of Cladocera: D. Hyalina, Acroperus harpae, Alona affinis...
1 to 5 sp of Ostracodes : C. ovum...
2 to 3 sp. of Copepodes: C. strenuus, Artodiaptomus

Fishes:

No fishes in the selected lakes (but we are not really sure for the moment)

(in Lakes Serpent , which is neared the selected lakes , we can find :

Salvelinus alpinus
Salvelinus fontinalis
Salmo trutta
Salmo gairdneri
Phoxinus phoxinus)

Conclusion

So we have selected the Lake Rond in the Vallée of Clarée and the lake of Combeynod in the vallée of Guisane:

The **lake Rond** , situated in the Vallée of Clarée has sand sediments . It is quite easy to get to (so in summer, it can be visited by tourists !) . It is one of the lower pH of the lakes of this Vallée but its conductivity is sometime higher than 60µS/cm .

The **lake of Combeynod** (Vallée de la Guisane) is more a real remote lake but can lose a lot of water in summer by evaporation ; its sediments are coarse and it is difficult to get invertebrates larvae.
(conductivity : 50µScm^{-1};).

These lakes are now covered with ice , they will be visited in july .

APPENDIX E

Water chemistry programme

WATER CHEMISTRY PROGRAMME

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Italy

ALPE - Acidificaiton of Mountain Lakes: Paleolimnology and Ecology

Water Chemistry Programme;

Background

The six major sites chosen for the ALPE project will be investigated through an extensive programme covering water chemistry, fish, invertebrates and diatomees. The detailed programme is shown below:

- water chemistry
- fish, invertebrate and diatom communities using harmonised techniques
- sediment cores and statistical analysis to assess the degree of athmospheric contamination and the acidification status using diatoms, chironomid head capsules and carbonaceous particle analysis.
- a special study on comparisons between invertebrate and fish communities in Norway and the Alps.

According to the programme for the ALPE project, Italy and Norway together are responsible for the water chemistry part. The responible persons are Dr. Rosario Mosello at the CNR Istituto Italiano di Idrobiologia and Bente M. Wathne at NIVA, cooperating as coordinators for this area. In the following some details for the chemistry programme are described. The chemistry programme will be discussed at the first ALPE project meeting in Pallanza 14th of March 1991.

Documentation of the sampling site

Documentation of the sampling site will be needed for interpretation of the chemistry data as for all the other samples and information gathered. Caracteristics for the lake and the watershed must be included as necessary information in the data base for the whole project. It is sugested that site documentation shall be given according to the Programme Manual for the ECE programme "International Co-opreative programme on Assessment and Monitoring of Acidification of Rivers and Lakes" (NIVA,1987).

Lake sampling

The samples will be taken as surface grab samples from the outlet of the lake, and one sample shall be taken at the same time as the samples for benthic invertebrates are collected. We will prefer that more than one sample for water chemistry is taken each year (but we demand only one). Variability in lake properties has an annual cycle. The prefered sampling times are normally in the spring and the autumn when homogenous mixing takes place. For this project we have already chosen the periode August - September as preferred sampling time (Informal project meeting in Glasgow, September 19th, 1990).

Prevention of sample contaminaiton or sample changes while storage may be critical in obtaining accurate measurements for these water samples of very low total ionic strength. All containers used for sample collection or storage must be free of any important quantity of the determinands in relation to the lowest concentration to be measured. The containers must also be of a material that will neither absorb nor release measurable quantities of the determinand.

Analytical methods

The samples will be analyzed by standard procedures for analysis of low ionic strength waters. The analytical program will include the following components: pH, conductivity, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), chloride (Cl), sulphate (SO_4), nitrate (NO_3), ammonia (NH_4),(also total nitrogen, Tot N, when possible), fluoride (F), alkalinity, total organic carbon (TOC), reactive aluminium (RAL) and non-labile aluminium (ILAL).

The analytical work will be done at national laboratories in co-operation with the chemical centres in Italy and Norway. The Norwegian laboratory (NIVA) will do the Al-speciation in the samples from the Alps. Al-speciation is done on unfiltered samples by a photometric method (pyrocatechol violet)(Røgeberg and Henriksen,1985).

Data handling and quality assurence

Due to earlier cooperative work, intercalibration data exist for Scotland and Norway (Wright and Henriksen, SNSF IR 72/80). Within the ECE project "International Co-operative Programme on Assessment and Monitoring of Acidification of Rivers and Lakes" now running, there have so far been four intercalibration exercises. Three of them with both CNR-III (Italy) and NIVA (Norway) as participants. These

intercalibration exercises are covering all componenets in the analytical programme for the ALPE project, and will be arranged also in the future. CNR - III arrange in addition yearly intercalibrations, and we sugest that all participating laboratories attend at least one of these intercalibrating exercises every year. The ECE programme has its own manual for chemical and biological monitoring (NIVA, 1987) describing sampling and analytical methods both for chemistry and biology. This manual is sugested as basis also for ALPE. In table 1 information about the major analytical methods used in Italy and Norway are shown.

The analytical results will be gathered and processed in databases in Italy and Norway. Data control shall be performed by the national laboratories analyzing the water samples. But the responsible laboratories in Italy and Norway will also do data quality controle based on:

1. looking for outliers
2. looking for continuity in time series (where they exist)
3. ionic balance

Italy and Norway will report the results.

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Table 1. Major analytical methods used in Italy and Norway.

	Italy	Norway
pH, electrometry	x	x
Conductivity, electrometry	x	x
Alkalinity, electrometric	x	x
Gran.t.tration		
Nitrate, ion chromatography	x	
photom., autoanal.		x
Ammonia, photom., autoanal.		x
Total nitrogen, photom.,autoa.		x
Chloride, ion chrom.	x	x
photom., autoanal.		
Sulfate, ion chrom.	x	x
autoanal.		
Calcium, FAAS	x	x
ICP-OES		
Magnesium, FAAS	x	x
ICP-OES		
Sodium, FAAS	x	x
ICP-OES		
Atomic emission spectr		
Potassium FAAS	x	x
ICP-OES		
Fluoride, ion selec. electr.		x
Aluminium GFAAS	x	x
Aluminium speciation		x
Total/Dissolved organic carbon		
$Na_2S_2O_8$/UV oxidation		x

APPENDIX F

Fish status programme

ALPE - ACIDIFICATION OF MOUNTAIN LAKES: PALEOLIMNOLOGY AND ECOLOGY.

ROS 13/3-91

FISH POPULATIONS - INVESTIGATION PROGRAMME

by

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INTRODUCTION

Since 1976, Norwegian studies have used a standard investigation programme to describe the fish population status/changes in acidified lakes. Two methods have been used :

1) Interview-method, information given by local lake-owners etc. having first hand information of fish population status.

2) Test fishing-method, using standard gill net series and sampling procedures to describe fish population size, age composition, growth pattern, food organisms etc.

In the ALPE program, both methods should be used.

PROGRAMME

Interview - method.

The interview-method has been used in several regional surveys in Norway since the mid 1970s (Sevaldrud *et al.* 1980, Sevaldrud and Muniz 1980, Sevaldrud and Skogheim 1986, Henriksen *et al.* 1988, 1989). By standardized questionnaires, informations are collected from local lake owners, fishery advisors, fishing unions etc. having first hand information about the status and changes in status in each lake. Based on these data and the result from water samples taken in connection to

the interviews, follow-up investigations in a 5 - 10 year cycle will enable important trend-analyses.

The questionnaires used in the Norwegian investigations are shown in Appendix 1. Based on a large number of testfishing results (Rosseland *et al.* 1980), the use of interviews have proven to be a reliable source as for fish population status and changes.

Test fishing.

Gillnet series

In 1976, a gillnet series containing eight individual bottom gillnets of different mesh sizes was constructed (Rosseland *et al.* 1979). Based on the individual catch efficiency of each mesh size (Jensen 1972), the series was design to give a best theoretically uniform catchability of brown trout (Condition-factor = 1) over a range of fish lengths from 10 to 45 cm (Fig. 1). The mesh size (knot to knot) and nylon monofilament thread thickness is given in Table 1. Each individual gillnet is 26 m long, 1.5 m deep, and have a dark red colour.

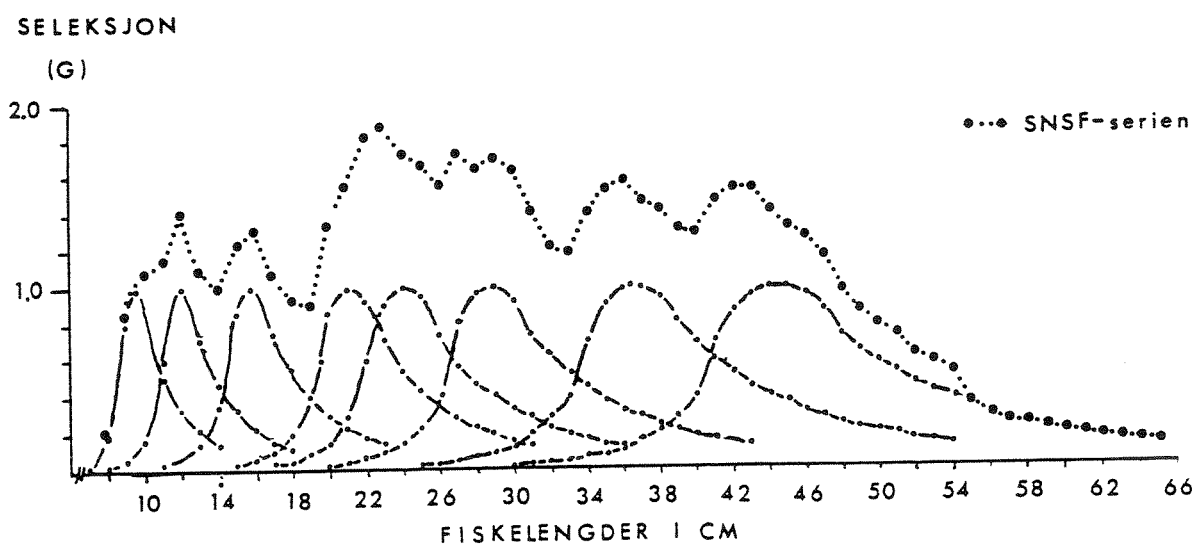

Figure 1. The catch-probability (G) of the eight individual gillnets and the series (SNSF-series) as a function of fish length in cm. (After : Rosseland *et al.* 1979).

In 1980, an alternative series was designed. The same eight mesh sizes were used in 4 m lengths and put into one single gillnet of 32 m length. Three different combinations of mesh-size as a function of location from the shore were used, giving a new series of three gillnets having a total catchability of 0.46 compared to the "old" series. Today, both series are used in the national monitoring programs. Lundgrens Fiskredskapsfabrik AB, Stocholm, Sweden, has manufactured the gillnets.

Table 1. The standardized gillnet series, containing 8 gillnets of given mesh size and thread thickness. (After: Rosseland *et al.* 1979). The gillnets are produced by Lundgrens Fiskredskapsfabrik AB, Stocholm, Sweden.

Mesh size mm.	10	12.5	16.5	22	25	30	38	46
Thread thickness mm.	.15	.15	.15	.15	.15	.15	.15	.17

Gillnet-setting.

The gillnets are set perpendicular to the shore, avoiding steep-slope shore to bottom areas. Gillnets in the "old" series are set at random as for mesh size, whereas the "new" series always will have all eight mesh sizes represented at a certain point.

Time of testfishing.

In Norway, the period between August 15 to October 15 have been selected for testfishing, because of:

1) The recruits from brooks or other spawning areas have entered the lake. In brooks, the fry has reach a catchable size for electro fishing,

2) Dark nights and lower water temperatures ensures a higher swimming activity and hence a higher catch pr. effort.

3) The period represents the end of the growing season, giving data for the last summers growth and a better probability for catching the youngest recruits to the lake.

4) The period represents the time of the year where the different year-classes are most uniformed distributed. Testfishing in t his period gives thus the best year-class representation in the catches.

5) The gonadal development will clearly separate sex and status for the coming spawning season.

6) The spawners are still in the lake, and have not yet started migration to running waters.

If all or most of these factors are identical in all areas, the period 15/8 - 15/10 should be chosen as a sampling period for fish within the ALPE-project.

Analytical program

Each fish should be given a specific number which will follow all subsamples to be analyzed. Due to exchange of data, country codes should be used as prefix.

For each individual fish, the following parametres should be noted: lake, date, gillnet type, mesh size, species, length, weight, sex, gonadal maturation, flesh colour, stomach fullness, stomach content, scale samples (salmonids) or opercular bone samples (perch) and otolith samples. Data from the different analyses should be filled into the schemes in Appendix 2. All schemes should be sent to NIVA for processing and presentation. The different parametres should be taken as follows:

- Length, in mm, measured from tip of snout to lower tip of tail.

- Weight, in gram.

- Gonadal development, from stage I - VII

  I - II juveniles

  III - V recruit spawners

VI spawning

VII/.. postspawners

- Flesh colour, white, pink or red.

- Stomach fullness, classified from 0 - 4.

- Stomach content, conserved in 70% alcohol and classified in main invertebrate groups.

- Age determination by:

  - Scales (salmonids), taken from the area between the sideline organ and dorsal and pectorial fin.

  - Otoliths (all species), using the "burning technique" described by Christensen (1964).

  - Opercular bone, removal of skin, drying and age determined as describes by Le Cren (1947).

  !!!! If age differ when determined by otolith and scales or opercular bone, otolith age is considered as the true age.

- Growth, determined by:

  - Length at catch as a function of true age.

  - Back calculation of growth, using the methods of Dahl (1910) and Lee (1920).

Data

All data should be filled into schemes as shown in Appendix 2, and sent to NIVA for computation. Special data programs will give tables as shown in Appendix 3, which can be used directly for figure generation.

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APPENDIX F 1

I'm the one that got away. The stress was killing me! pH news describes a negative trend in my river.

Petter Wang, mNGD

1000 LAKE SURVEY

QUESTIONNAIRE FOR THE DETERMINATION OF FISH STATUS

County: Municipality:

Lake: Elevation above sea level: meters

Answer given by: Adress: Date:

DETAILS OF CONDITIONS FOR FISH

Does the lake contain fish? Yes ☐ No ☐ If no - has it contained fish earlier? Yes ☐ No ☐

NB! If the lake contain/has contained fish, complete the rest of the questionnaire.
Write any additional comments under the heading "Comments" on the last page,
or on a separate sheet. NB!

1 SPECIES OF FISH

Any other species?

What species are/were present in the lake?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

2 POPULATIONS

Comments:

What is the population density of this/these species at present?

2.1 Present density

	1	2	3	4	5
a) Sparcely populated	☐	☐	☐	☐	☐
b) Well/over populated	☐	☐	☐	☐	☐
c) Barren	☐	☐	☐	☐	☐

2.2 Changes in populations

Comments:

	1	2	3	4	5
a) Increased	☐	☐	☐	☐	☐
b) Unchanged	☐	☐	☐	☐	☐
c) Diminished	☐	☐	☐	☐	☐
d) Lost	☐	☐	☐	☐	☐

How did these changes occur?
- when did they occur (within 10 years)?
- are there variations between the species?

2.3 Changes according to time and species

Time code:
A: Before 1940
B: 1940 - 1950
C: 1950 - 1960
D: 1960 - 1970
E: 1970 - 1980
F: After 1980

	1	2	3	4	5
a) Increased populations	☐	☐	☐	☐	☐
b) Decline in populations	☐	☐	☐	☐	☐
c) Loss of populations	☐	☐	☐	☐	☐

3 REPRODUCTION Comments:

Has natural reproduction changed from the 1970s to the present?

	1	2	3	4	5
a) Increased	☐	☐	☐	☐	☐
b) Unchanged	☐	☐	☐	☐	☐
c) Decreased	☐	☐	☐	☐	☐
d) Unknown	☐	☐	☐	☐	☐

4 FISH MANAGEMENT Comments:

Has there been any fish management- such as stocking, liming,? etc.?

4.1 Fish stocking

What species? _____

When? _____

Quantity? _____

Result? _____

4.2 Other types of management

When, how and with what result? _____

_____

_____

_____

5 EARLIER DATA Comments:

	Yes	No	Do not know
Has there been test fishing in the lake?	☐	☐	☐

If so, by whom and when? _____

6 RESPONDENTS OWN AND OTHER COMMENTS:

APPENDIX F 2

PRØVEFISKE I FERSKVANN

(Bruk av EDB-programmet DATAFISK-SNSF-77)

Utfylling av skjemaene.

1. Skriv tydelig og bruk bare store bokstaver til tekst.
   Bokstaven "O" skrives "Ø", mens tallet "null" skrives "0".
2. De fleste opplysningene (unntatt på Skjema 1 og 7) fylles ut som tallkoder. Det må bare nyttes koder som er angitt på kodelister utarbeidet for de enkelte skjemaer. Mangler opplysninger, lar en tilsvarende felter på skjemaene stå blanke.
3. I felter som fylles ut med tall (koder, mål, areal, etc.), skrives tallene så langt til høyre i feltene som plassen tillater.
   Eks.: Vekt 263 g (kol.29-33 på Skjema 5) skrives | | | 2 | 6 | 3 |

SKJEMA nr	1
VASSDRAG nr	1 3 0 (2–4)
ELV/VANN nr. og navn	2 6 SAULANDSVN (5–17)
FYLKE	VESTAGDER (18–26)
KOMMUNE	FARSUND (27–35)
KARTBLAD	1 3 1 1 2 (36–40)
KARTREFERANSE, utløpsosen (UTM-syst.)	6 8 9 5 3 5 (41–46)
HØYDE over havet	9 0 (47–50) m
VANNAREAL, naturlig	1 5 (51–55) ha
REGULERINGSHØYDE, total	0 (56–59) m
AREAL, HRV	0 (60–64) ha
AREAL, LRV	0 (65–69) ha
NEDSLAGSFELT	4 (70–74) km²
AVLØP, gjennomsnittlig	(75–77) m³/sek.
VANNTYPE	3 (78)
Næringsrik =1 Myrvann =4 Mid.næringsrik =2 Brevann =5 Næringsfattig =3	
AVSTAND til bilvei	0 (79–80) km

Skjema nr. 2 Vassdrag nr. 1,3,0 *Farsund* Vann/Elv nr. ,2,6 *Saulandsvn* Dato 1,1 0,9 7,7

Navn / Navn (1, 2, 5, 8, 10, 12)

	Nedslagsfelt		Bergrunn						Løsav			
	Areal	Belter	Kvartsitt, sandstein	Granitt/lys/mørk gneis	Amfibolitt	Gabbro, Dioritt	Fyllitt, Gl. skifer	Kalknoldig	Morene	Smeltev. avsetning	Vannavsett	Bart fjell
	14	18				21			25			
	4	2							1	4		2

Nedslagsfelt Vegetasjon	Dyrket mark	Beitemark	Løvskog	Granskog	Furuskog	Barbl. skog	Fjellbjørkeskog	Snaufjell	Lyngmark	Husstilater	Næringsrik myr	Næringsfattig myr
	29						35					
	3	3	2	4	4				2			4

Nærområde Vegetasjon	Dyrket mark	Beitemark	Løvskog	Granskog	Furuskog	Barbl. skog	Fjellbjørkeskog	Snaufjell	Lyngmark	Husstilater	Næringsrik myr	Næringsfattig myr
	41					46				50		
	3	3	1									4

Menneskel. påvirk.	Gruvedrift	Industri	Jordbruk	Boligkloakk
	53			
	4	4	2	

Bunnforhold	Area: Grunnere enn 5m	5-15 m	> 15 m	Type: Slamjord	Leire	Sand / Grus	Stein	Levende planter	Organisk materiale	Omsetningsstad
	57			60					65	
	5	4	1	3	4	2	2	2	3	1

VANNVEGETASJON	[illegible]	Annen elvevegetasjon	Kransalger (Characeae)	Botnegras (Lobelia)	Brasmegras (Isoetes)	Tjønnaks (Potamogeton)	Tusenblad (Myriophyllum)	Andemat (Lemna)	Mose / Sphagnum	"Grønne" alger	"Brune" alger	Andre	
	64			70					75				80
	3		3	2	3					4			

St.jema nr. [3] Vassdrag nr. [1,3,0] Tarsund (Navn) Vann/Elv nr. [2,6] Saulandsvn (Navn) Dato [1,1|0,9|7,7]

1 — 2 — 5 — 8 10 12

FYSISK / KJEMISKE FORHOLD

Vannføring (19)	Vannstand (15)	Vanntemperatur (17)	Siktedyp (19)	Vannfarge (22)	pH (24)	Ledningsevne µS/cm (27)
2	2		1,1	4	5,21 (,)	4,80 (,)

FISK — VIKTIGSTE ARTER

Antall arter (31)	Art (33)	Forekomst (35)	Bestandsforandring	År	Gytemuligheter	Art (39)	Forekomst	Bestandsforandring (42)	År	Gytemuligheter	Art (45)	Forekomst	Bestandsforandring (48)	År	Gytemuligheter	Art (51)	Forekomst	Bestandsforandring (54)	År	Gytemuligheter
2	5	1	2		1	38	2													

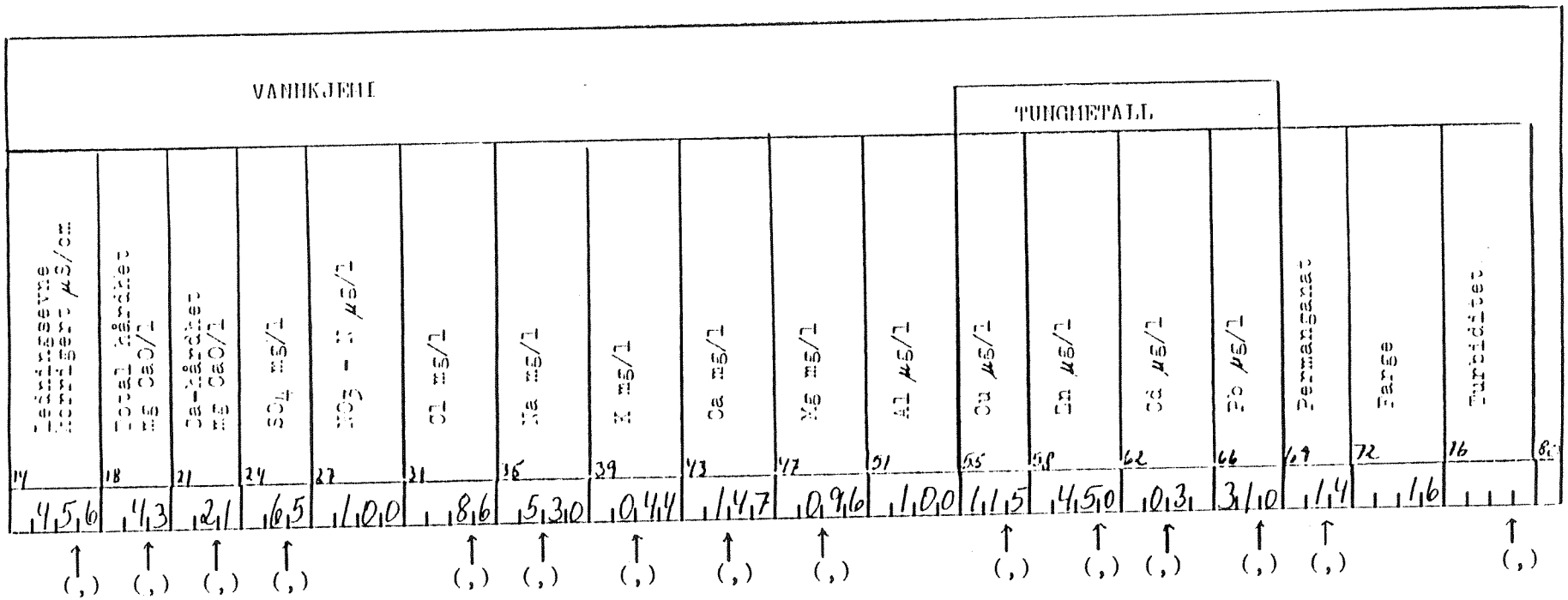
BESKATNING

[illegible] (57)	TYPE: [illegible]	TYPE: Husholdningsfiske	TYPE: Sportsfiske	REDSKAP: Garn (61)	REDSKAP: Not (63)	REDSKAP: Ruse / teine	REDSKAP: Oter / dorg	REDSKAP: Stang (66)	REDSKAP: Isfiske	REDSKAP: Dominerende maskevidde, omfang (68)	Total avkastning kg pr. år (71)	[illegible] (76)
1		1		1						24		3

UNDERSØKELS

Sist undersøkt (78)	Av hvem (80)

Skjema nr. 7 (1) Vassdrag nr. 1,3,0 (2) Farsund Navn Vann/Elv nr. 1,2,6 (5) Saulandsvn Navn Dato 1/1 0 9 7 7 (8 10 12)



SKJEMA NR. 4 (1) VASSDRAG NR. 130 (2) Farsund (Navn) VANN/ELV NR. 26 (5) Saulandsraun (Navn)

Dato			Værforhold	Vind	Garn																				Annen redskap				Prøvefisket utført av:
					Standard serier		Tillegg til standard serie eller garnsammensetning når st. serie ikke benyttes																						
Dag (8)	Mnd. (10)	År (12)	(14)	(16)	Garntype (18)	Antall (20)	Garntype (22)	Omfar (24)	Antall	Omfar (27)	Antall	Omfar (30)	Antall	Omfar (33)	Antall	Omfar (36)	Antall	Omfar (39)	Antall	Omfar (42)	Antall	Omfar (45)	Antall	Omfar (48)	Antall	Omfar (51)	Antall	Type (54)	Innsats	Type (58)	Innsats	(62)
1.1	09	77	1.2	1			3	6,3	1	5,0	1	3,8	1	2,9	1	2,5	1	2,1	1	1,7	1	1,4	1									RIOSS BRÉM SNSF

ARK 1 AV 3

SKJEMA NR. 5 (1) VASSDRAG NR. 130 (2) Farsund Navn VANN/ELV NR. 26 (5) Saulandsvann Navn DATO 12 09 77 (8 Dag, 10 Mnd, 12 År)

Art (14)	Løpenr. (16)	Identifikasjon (19)	Redskap (21)	Maskevidde (23)	Lengde i mm (25)	Vekt i g (29)	Kjønn (34)	Stadium (36)	Kjøttfarge (38)	Parasitter (40)	Prøver: Skjell, otolitter mv. (42)	Prøver: Parasitter	Prøver: Mageprøver	Mageinnhold: Fyllingsgrad (45)	1. Overflateins.	2. Flomdrift	3. Fisk	4. Insekter i vann	5. Marflo	6. Skjoldkreps	7. Linsekreps	8. Plankton	9. Snegler og musl.	10. Annet og ubest. (65)	Tilleggsopplysninger: Fangststed Sone nr. (67)	Fangststed Hol nr.	Antall fisk (se kodeskjema) (71)	Dødsmåneden (74)	Merket	Gjenfange
5	6 4 5		3	1 7	2 1 2	8 5	2	5	1		3			0																
5	6 4 6		3	1 7	2 0 0	7 0	2	2	1		3		2	3																
5	6 4 7		3	1 7	2 2 0	1 0 4	1	7 4	1		3		2	4																
5	6 4 8		3	1 7	2 3 0	9 8	1	7 4	1		3		2	3																
5	6 4 9		3	1 7	2 2 5	8 8	2	4	1		3		2	4																
5	6 5 0		3	1 7	2 0 5	8 5	2	7 4	1		3		2	3																
5	6 5 1		3	2 1	2 0 5	7 4	1	7 4	1		3		2	3																
5	6 5 2		3	2 1	2 2 0	1 0 6	1	2	1		3		2	3															i	
5	6 5 3		3	2 1	2 0 5	8 0	1	7 5	1		3		2	4																
5	6 5 4		3	2 1	2 0 5	8 5	1	2	2		3		2	3																
5	6 5 5		3	2 1	2 0 5	7 6	2	2	1		3		2	1																
5	6 5 6		3	2 1	2 1 5	8 0	2	4	1		3			0																
5	6 5 7		3	2 5	2 3 5	1 2 2	1	4	2		3		2	1																
5	6 5 8		3	2 5	2 3 5	1 2 4	1	4	1		3		2	3																
5	6 5 9		3	2 5	2 3 5	1 2 2	1	7 4	1		3			0																
5	6 6 0		3	2 5	2 2 0	1 1 0	2	7 5	1		3		2	4																
5	6 6 1		3	2 5	2 1 0	9 2	2	4	1		3			0																
5	6 6 2		3	2 5	2 1 0	8 8	1	2	1		3		2	2																
5	6 6 3		3	2 5	1 9 0	7 0	2	7 2	1		3		2	4																
5	6 6 4		3	2 5	2 1 0	8 6	1	7 4	1		3		2	1																

ARK 1 AV 3

SKJEMA NR. 6 (1) VASSDRAG NR. 1.30 (2) Navn Farsund VANN/ELV NR. 2.26 (5) Navn Sauslandsvann DATO Dag 12 (8) Mnd 09 (10) År 77 (12)

Art (14)	Løpenr. (18)	Identifikasjon (19)	Lengde i mm (21)	Kjønn (25)	Alder: Totalt Skjell (27)	Alder: Totalt Otolitter (29)	Alder: Ved urvandring (31)	Alder: Ved gytemerke (33)	Skjellradius (35)	Avstand fra skjellsentrum til vintersone – 1 (38)	2 (44)	3	4	5 (50)	6 (56)	7	8 (62)	9	10	11 (68)	12	Skjellkant * (74)	Merknader (75–80)
5	6.4.5	1	2.1.2	2	3	3	1	1	1	6.9	1.4.5	1.8.5											
5	6.4.6	1	2.0.0	2	3		1	1	1	4.8	7.8	1.6.9											
5	6.4.7	1	2.2.0	1	3	4	1	1	1														
5	6.4.8	1	2.3.0	1	4	4	1	1	1	5.4	9.0	1.5.9	1.9.2										
5	6.4.9	1	2.2.5	2	2	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
5	6.5.0	1	2.0.5	2	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	
5	6.5.1	1	2.0.5	1	2	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
5	6.5.2	1	2.2.0	1	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	
5	6.5.3	1	2.0.5	1	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	
5	6.5.4	1	2.0.5	1	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	
5	6.5.5	1	2.0.5	2	3	3	1	1	1	6.3	1.2.6	1.8.6	1	1	1	1	1	1	1	1	1	2	
5	6.5.6	1	2.1.5	2	3	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
5	6.5.7	1	2.3.5	1	4	4	1	1	1	8.6	1.4.7	1.8.4	2.1.6	1	1	1	1	1	1	1	1	2	
5	6.5.8	1	2.3.5	1	4	4	1	1	1	6.8	9.2	1.9.0	2.2.0	1	1	1	1	1	1	1	1	2	
5	6.5.9	1	2.3.5	1	4	4	1	1	1	6.4	1.1.5	1.9.4	2.1.6	1	1	1	1	1	1	1	1	2	
5	6.6.0	1	2.2.0	2	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	
5	6.6.1	1	2.1.0	2	2		1	1	1	5.8	1.6.1	1	1	1	1	1	1	1	1	1	1		
5	6.6.2	1	2.1.0	1	3	3	1	1	1	7.8	1.5.9	1.9.7	1	1	1	1	1	1	1	1	1		
5	6.6.3	1	1.9.0	2	4	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	
5	6.6.4	1	2.1.0	1	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	

★ Viser normal vekst = 1 Viser stagnert vekst = 2

Skjema nr. 8 (1) Vassdrag nr. 130 (2) _____ navn

Vann/Elv nr. 26 (5) Saulandsvann navn Dato 12 09 77 (8 10 12)

Art nr. 5 (14) Løpenr. 649 (16) Fyllingsgrad 4 (19)

Dyregruppe	Antall	F %	Volum verdi	Volum	Volum % * 1	2
Copepoda						(20)
Cladocera	30	19	1/4	7,5	13.57	1.4
Gastropoda						(27)
Bivalvia						
Oligochaeta						(28)
Ephemeroptera l.						
- " - im.						(32)
Plecoptera l.						
- " - im.						(36)
Trichoptera l.	22	14	1	22	39,82	4.0
- " - p.						(40)
- " - im.						
Chironomidae l.	2	1	1/5	0.4	0.72	(44) .1
- " - p.	98	64	1/4	24.5	44,34	4.4
- " - im.						(48)
Simulidae l.						
- " - p.						(52)
- " - im.						
Corixidae						(56)
Coleoptera						
Skjoldkreps						(60)
Gammarus						
Asellus						(64)
Fisk						
Annet Diverse	2	1	0,42	0,85	1.54	(68) .1

* Volum % : 1 - Tall med desimaler
2 - Tall opphøyd, blank = 0, 00 = 100%

APPENDIX F 3

VEDLEGG 3

UTSKRIFT AV RESULTATENE FRA DATAFISK-SNSF-77

SNSF - PROSJEKTET
PRØVEFISKE I FERSKVANN

VASSDRAG NR. .....:	130
ELV/VANN NR. OG NAVN .....:	26 SAULANDSVN.
FYLKE .....:	VESTAGDER
KOMMUNE .....:	FARSUND
KARTBLAD .....:	1311.2
KARTREFERANSE. UTLØPSOSEN (UTM-SYST.)...:	689535
HØYDE OVER HAVET .....:	90 M
VANNAREAL. NATURLIG .....:	15 HA
REGULERINGSHØYDE. TOTAL .....:	0 M
AREAL. HRV .....:	0 HA
AREAL. LRV .....:	0 HA
NEDSLAGSFELT .....:	4 KVAD.KM
AVLØP. GJENNOMSNITTLIG .....:	INGEN OPPLYSN.
VANNTYPE .....:	NÆRINGSFATTIG
AVSTAND TIL BILVEI .....:	0 KM

PRØVEFISKE I SAULANDSVN. I FARSUND
VASSDRAG Nr. 130. VANN/ELV NR. 26

DATO: 11.9.77

NEDSLAGSFELT/GEOLOGI

AREAL	: 4 KVAD.KM
RELIEFF	: MARKERT
MORENE	: FULL DOMINANS
SMELTEV. AVSETNING	: UBETYDELIG
BART FJELL	: ALM. FOREKOMMENDE

NEDSLAGSFELT/VEGETASJON

DYRKET MARK	: SPREDT
BEITEMARK	: SPREDT
LØVSKOG	: ALM. FOREKOMMENDE
GRANSKOG	: UBETYDELIG
FURUSKOG	: UBETYDELIG
LYNGMARK	: ALM. FOREKOMMENDE
NÆRINGSFATTIG MYR	: UBETYDELIG

VEGETASJON/NÆROMRÅDE

DYRKET MARK	: SPREDT
BEITEMARK	: SPREDT
LØVSKOG	: FULL DOMINANS
NÆRINGSFATTIG MYR	: UBETYDELIG

MENNESKELIG PÅVIRKNING

GRUVEDRIFT	: INGEN PÅVIRKNING
INDUSTRI	: INGEN PÅVIRKNING
JORDBRUK	: MODERAT PÅVIRKNING

BUNNAREAL

GRUNNERE ENN 5M	: 5/10
5M - 15M	: 4/10
DYPERE ENN 15M	: 1/10

BUNNFORHOLD

BLØTBUNN	: SPREDT
LEIRE	: UBETYDELIG
SAND/GRUS	: ALM. FOREKOMMENDE
STEIN	: ALM. FOREKOMMENDE
LEVENDE PLANTER	: ALM. FOREKOMMENDE
ORGANISK MATERIALE	: SPREDT
OMSETNINGSGRAD	: NORMAL

VANNVEGETASJON

TAKRØR (PHRAGMITES)	: SPREDT
NØKKEROSE (NYMPHAEA)	: SPREDT
BOTNEGRAS (LOBELIA)	: ALM. FOREKOMMENDE
BRASMEGRAS (ISOETES)	: SPREDT
"GRØNNE" ALGER	: UBETYDELIG

PRØVEFISKE I SAULANDSVN. I FARSUND

VASSDRAG NR. 130. VANN/ELV NR. 26

DATO: 11.9.77

FYSISK/KJEMISKE FORHOLD

VANNFØRING	: NORMAL	
VANNSTAND	: MIDDELS	
SIKTEDYP	: 11 METER	
VANNFARGE	: BLÅLIG GRØNN	
PH	: 5.21	
LEDNINGSEVNE	: 48.0	MICROMHO/CM
LED.EVNE KORR	: 45.6	MICROMHO/CM
TOTAL HARDHET	: 4.3	MG CAO/LITER
CA-HARDHET	: 2.1	MG CAO/LITER
SO4	: 6.5	MG/LITER
NO3 - N	: 100	MICROGRAM/LITER
CL	: 8.6	MG/LITER
NA	: 5.30	MG/LITER
K	: 0.44	MG/LITER
CA	: 1.47	MG/LITER
MG	: 0.96	MG/LITER
AL	: 100	MICROGRAM/LITER
CU	: 11.5	MICROGRAM/LITER
ZN	: 45.0	MICROGRAM/LITER
CD	: 0.30	MICROGRAM/LITER
PB	: 31.0	MICROGRAM/LITER
PERMANGANAT	: 1.4	MG O/LITER
FARGE	: 16	GRADER H

FISK

ANTALL ARTER TOTALT: 2

HOVED-ARTER	FOREKOMST	GYTEMULIGHET	BESTANDSFORANDRING	NÅR
ØRRET	OVERBEFOLKET	MEGET GOD	UFORANDRET	
ÅL	GOD			

EIENDOMSFORHOLD

PRIVAT

BESKATNING

TYPE: HUSHOLDNINGSFISKE - FULL DOMINANS

REDSKAP: GARN - FULL DOMINANS

DOMINERENDE MASKEVIDDE: 24 OMFAR (26 MM)

FISKEINTENSITET: LITEN

PRØVEFISKE I SAJLANDSVN I FARSUND

VASSDRAG NR. 130. VANN/ELV NR. 26

* * FANGSTFORHOLD OG FANGSTINNSATS * *

DATO : 11. 9.77

VÆRFORHOLD: KLART/LETTSKYET
OVERSKYET

VIND : STILLE

ANTALL STANDARD GARNSERIER(HVER SERIE 8 GARN): INGEN

ANDRE GARN: 1X53 OMFAR 1X50 OMFAR 1X38 OMFAR

1X29 OMFAR 1X25 OMFAR 1X21 OMFAR

1X17 OMFAR 1X14 OMFAR

GARNTYPE :BUNNGARN, MONOFILAMENT, 1.5 M DYP

PRØVEFISKET ER UTFØRT AV: ROSS BREM SNSF

PRØVEFISKE I SAULANDSVN. I FARSUND KOMMUNE (VASSDRAG NR. 130. VANN/ELV NR. 26)

DATO: 13.9.77 - 12.9.77

FANGSTFORDELING PÅ MASKEVIDDE

ART	ANTALL GARN / OMFAR	1 / 63	1 / 50	1 / 38	1 / 29	1 / 25	1 / 21	1 / 17	1 / 14	ANT/SERIE / GR./SERIE
ØRRET	ANTALL/GARN	0.0	3.0	14.0	17.0	11.0	6.0	6.0	0.0	57.0
	GRAM/GARN	0.0	78.0	892.0	1254.0	1017.0	501.0	530.0	0.0	4272.0

PRØVEFISKE I SAULANDSVN. I FARSUND KOMMUNE (VASSDRAG NR. 130. VANN/ELV NR. 26)

RESULTATER AV PRØVEFISKET

DATO	ART	FANGST				SAMLET VEKT	GJ.SN. VEKT
		HANNER	HUNNER	UBESTEMT	TOTALT		
12.9.77	ØRRET	28	29	0	57	4272	74
I ALT	ØRRET	28	29	0	57	4272	74

PRØVEFISKE I SAULANDSVN. 1 FARSUND KOMMUNE

PRØVEFISKE I SAULANDSVN. I FARSUND KOMMUNE (VASSDRAG NR. 130. VANN/ELV NR. 26)

DATO: 13.9.77 - 12.9.77

ART: ØRRET

LENGDE (MM)	ANTALL	%	K-FAKTOR	KJØNN HAN	KJØNN HUN	% GYTEFISK HAN	% GYTEFISK HUN	TIDL. GYTERE HAN	TIDL. GYTERE HUN	KJØTTFARGE H	KJØTTFARGE LR	KJØTTFARGE R	PARASITTER SPOR	PARASITTER LITE	PARASITTER MYE	PARASITTER S.MYE	DEFORITETER TYPE/ANTALL	DEFORITETER %	MERKET TYPE/ANTALL	MERKET %
100																				
101-130	1	1.8	1.18	0	1	0.0	0.0	0	0	1	0	0	0	0	0	0	0/ 0	0.0	0/ 0	0.0
131-160	4	7.0	1.01	3	1	66.7	0.0	0.	0	4	0	0	0	0	0	0	0/ 0	0.0	0/ 0	0.0
161-190	16	28.1	1.02	8	8	87.5	37.5	1	1	15	1	0	0	0	0	0	0/ 0	0.0	0/ 0	0.0
191-220	81	54.4	0.93	13	18	46.2	72.2	4	2	28	3	0	0	0	0	0	0/ 0	0.0	0/ 0	0.0
221-250	5	8.8	0.88	4	1	100.0	100.0	2	0	4	1	0	0	0	0	0	0/ 0	0.0	0/ 0	0.0
251-280																				
281-310																				
311-340																				
341-370																				
371-400																				
401-430																				
431-460																				
461																				
ALL FISK	57	100.1	0.96	28	29	67.9	58.6	7	3	52	5	0	0	0	0	0	0	0.0	0	0.0

PRØVEFISKE I SAULANDSVN I FARSUND KOMMUNE (VASSDRAG NR. 130, VANN/ELV NR. 26)

FANGSTDAGER: 12. 9.77

ART: ørret

ALDER		ANTALL	%	LENGDE GJ.SN.	STANDARD AVVIK	VEKST SISTE HELE ÅR	TILBAKEBEREGNET LENGDE VED ÅR: 1	2	3	4	5	6	7	8	9	10	11	12	ANTALL FISK MED STAGNERT VEKST
1+	I	0	0.0	0	0.0														
	II	3	8.1	133	12.6	75	63												0
2+	I	0	0.0	0	0.0														
	II	11	29.7	131	15.4	40	66	141											0
3+	I	3	15.0	203	8.7														
	II	15	43.2	197	13.1	17	66	133	179										7
4+	I	13	65.0	206	11.9														
	II	7	13.9	222	14.7	17	64	117	179	205									14
5+	I	4	20.0	209	14.9														
	II	0	0.0	0	0.0	0													2
6+																			
7+																			
8+																			
9+																			
10+																			
11+																			
12+																			
ALL FISK	I	20	100.0	206	12.0														
	II	37	100.0	192	13.0	22	65	132	179	205									23

MERKNADER:
****

ALLE LENGDER I MM. UNDER ANTALL ER: GRUPPE I FISK MED FORSKJELLIG ALDER PÅ SKJELL OG OTOLITT,
GRUPPE II FISK MED SAMMENFALLENDE ALDER PÅ SKJELL OG OTOLITT.
VEKST OG TILBAKEBEREGNET LENGDE KUN FOR DENNE KATEGORI.

PRØVEFISKE I SAULANDSVN. I FARSUND KOMMUNE (VASSDRAG NR. 130 VANN/ELV NR. 26)

*** MAGEINNHOLD - BESTEMT I LABORATORIUM ***

ART :	ØRRET				
ANT. MAGER UNDERSØKT:	42				
FYLLINGS GRAD: TYPE	0	1	2	3	4
ANTALL	0	9	2	14	14
PROSENT	0	21	4	33	33

MAGEINNHOLD DYREGRUPPE	VOLUM PROSENT	FREKVENS PROSENT
COPEPODA	7.0	16.6
CLADOCERA	19.3	59.5
PLECOPTERA 1.	0.1	2.3
TRICHOPTERA 1.	8.0	23.8
CHIRONOMIDAE 1.	5.6	54.7
CHIRONOMIDAE P.	42.3	73.8
COLEOPTERA	0.6	7.1
ANNET	16.8	50.0

APPENDIX G

Invertebrate programme

INVERTEBRATE SAMPLING PROGRAMME

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Museum of Zoology, University of Bergen.
N-5007 Bergen, Norway.

General

Benthic invertebrate sampling should take place at the same time as water chemistry and fish are collected. Samples must be taken from the lake profundal, lake littoral and outlet stream. The samples should preferably be collected in a net with mesh size 250 µm. All samples should be conserved in ethanol; alcohol concentration of the sample being approximately 70%.

Lake profundal sampling

The samples should be taken at the deepest part of the lake. If diatom coring is taken from the same locality, benthic invertebrate sampling should take place near this site. Six parallel quantitative samples should be collected using a Kajak sampler (Kajak 1971) or modified versions of this sampler.

Lake littoral sampling

The lake littoral should be sampled qualitatively using the "kick method" (Frost et al. 1971). If the littoral is heterogeneous, for example stones and macrophytes, samples should be taken from different habitats.

Outlet stream sampling

Qualitative "kick samples" should be taken from two sites: one at the outlet of the lake and one 200 - 300 m downstreams of the lake.

If possible we also recommend to place a partly submerged drift sampler at the outlet during the sampling period. The purpose is to collect hatching insects and exuvia which can be helpful in the taxonomic work.

Sorting and identification

Each participating institution is responsible for the sorting and identification of the collected material. University of Bergen, Dept. of Animal Ecology can, if wanted, assist in the determination of the chironomids.

Taxonomic lists and site data should be sent to University of Bergen, Dept. of Animal Ecology, preferably in ASCII files. Ecological data on the acid-tolerance of different animal taxa are also welcomed. All data will be generated and processed in a database in Bergen.

Literature

Frost, S., Huni, A. & Kershaw, W.E. 1971. Evaluation of a kicking technique for sampling stream bottom fauna. - Can. J. Zool. 49: 167-173.
Kajak, Z. 1971. Benthos of standing water. In: Edmondson, W.T. and Winberg, G.G. (eds.) A manual on methods for the assessment of secondary productivity in fresh waters. IBP Handbook no. 17. pp 25-65. Blackwell Scientific Publications, Oxford.

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