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CURRENT LIMNOLOGICAL CONDITION OF A GROUP OF THE WEST MIDLAND MERES THAT BEAR SSSI STATUS

FINAL REPORT OF ENGLISH NATURE RESEARCH CONTRACT
NUMBER F72-06-14

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SUMMARY

1. The meres lie aggregated in discrete groups across the Shropshire/Cheshire/Staffordshire plain and constitute one of the few lake districts in England. Compared with other such districts as those in Cumbria and the Norfolk Broadland their limnology is not well known. They have been considered to be a naturally eutrophic set of lakes with records of blue-green algal blooms extending back into the nineteenth century.

2. Surface water blooms, however, are not necessarily diagnostic of highly fertile conditions and early existence of them does not preclude intense anthropogenic eutrophication in recent decades. This survey investigated the state of twenty-three discrete sites, each accorded SSSI status from among the more than 60 water bodies conventionally included in the meres group. The sites included are Berrington Pool, Betley Mere, Betton Pool, Bomere, Chapel Mere, Cole Mere, Comber Mere, Cop Mere, Crose Mere, Fenemere, Hatch Mere, Little Mere, Oss Mere, Petty Pool, Quoisley Big and Little Meres, Rostherne Mere, Tabley Mere, Tabley Moat, White Mere, Mere Mere, and Oakmere.

3. Water from the lakes themselves and from available inflows and outflows was analysed for conductivity, alkalinity,pH, chloride, soluble reactive and total phosphorus, ammonium, nitrate, silicate, chlorophyll a, phytoplankton and zooplankton communities on a three-weekly basis during 1991/92. Aquatic plant communities were recorded in late summer 1991. Streams were gauged where possible.

4. Original data are given in tabular form and the sites are considered individually and collectively. For individual meres an assessment of their current status is given with recommendations for management where appropriate. The meres are then considered as a group and the approach of regression modelling is taken to draw conclusions about what controls phytoplankton development in them and what general lessons this may give for their conservation.

5. Land use data drawn from 1931 and 1987 suggest that there is likely to have been some increase in nutrient loading on all of the meres since before the Second World War. The common pattern of change in the catchments has been an increase in cattle keeping and in the overall potential load of nutrients from stock keeping, and adrift from pastureland to arable. Beyond this some meres have suffered further increased loads due to pollution of the

streams entering them,usually by farm wastes. In only two instances (the Little Mere/Rostherne Mere system and Chapel Mere) are human effluents likely to have been important.

6. The following are considered to be in a reasonable state and for which any nutrient control would be unneccessary or impracticable in the present state of legislation: Berrington Pool, Betton Pool, Bomere, Cole Mere, Crose Mere, Hatch Mere, Oss Mere, Tatton Mere, White Mere, Mere Mere, and Oakmere.

7. There is an urgent need for nutrient control (which should include nitrogen control) at Betley Mere, Chapel Mere, Comber Mere, Cop Mere, Petty Pool, Tabley Mere and Tabley Moat. Such control is in progress already at Little Mere and Rostherne Mere. Additionally, because zooplankton grazing is an important control of algal crops in some of the meres, reduction of the existing fish stock to discourage zooplanktivorous fish may be necessary at Betley Mere, Cop Mere, and Petty Pool. Carp should be removed from Fenemere and fish stocking should be avoided at Chapel Mere, Comber Mere, and the Quoisley Meres.

8. Synoptic plots of key variables reveal no simple systematic pattern among the meres and regression models using the entire group suggest only a weak influence of grazing as a control on the algal crops. Chemical factors including nutrients explained none of the variance in chlorophyll a. However when the meres were considered in two groups based on maximum depth, very strong patterns emerged. Shallow meres were those with depth <3m and deep meres with depth>3m. The criterion was ultimately linked with actual or potential dominance by aquatic plants in the shallow group and dominance by plankton in the deep group.

9. Shallow meres were significantly smaller,had higher conductivities and alkalinities, higher nitrogen concentrations and greater zooplankton grazing potential than deep meres. There were no differences in chlorophyll a, soluble reactive or total phosphorus concentrations between the groups. Overall phosphorus concentrations were very high and nitrogen concentrations rather low. The former is ascribed to naturally occuring phosphorus minerals dissolving in the largely groundwater supply to the deep meres and farm effluents polluting the streams feeding the shallow meres which are largely surface-water supplied. Low nitrogen concentrations are attributed to denitrification in the wet meadows and wetlands which fringe many of the sites, for surface water nitrate concentrations are not especially low and reflect the agricultural nature of the area.

10. Control of algal crops was largely independent of water chemistry in the shallow group but greatly dependent on

zooplankton grazing. Large populations of grazers are fostered by the refuges, provided by the structure of the aquatic weed beds, against fish predation.

11. Control of algal crops in the deep group was largely independent of grazing but very strongly linked with nitrogen loading as reflected in the winter available nitrogen concentrations. Phosphorus exerted little control.

12. For conservation of aquatic plant communities and relatively clear water , emphasis thus needs to be given to maintenance of the zooplankton grazer populations in the shallow meres. This means attention to factors, extraneous to nutrients, which can decimate these communities or their refuges(e.g. fish, pesticides, water level changes, herbicides, exotic grazing birds). A paper is given in the Appendix which explains current theory concerning losses of aquatic plants from eutrophicated lakes and the mechanisms by which this may occur. There is an urgent need for data on fish stocks in these shallow meres.

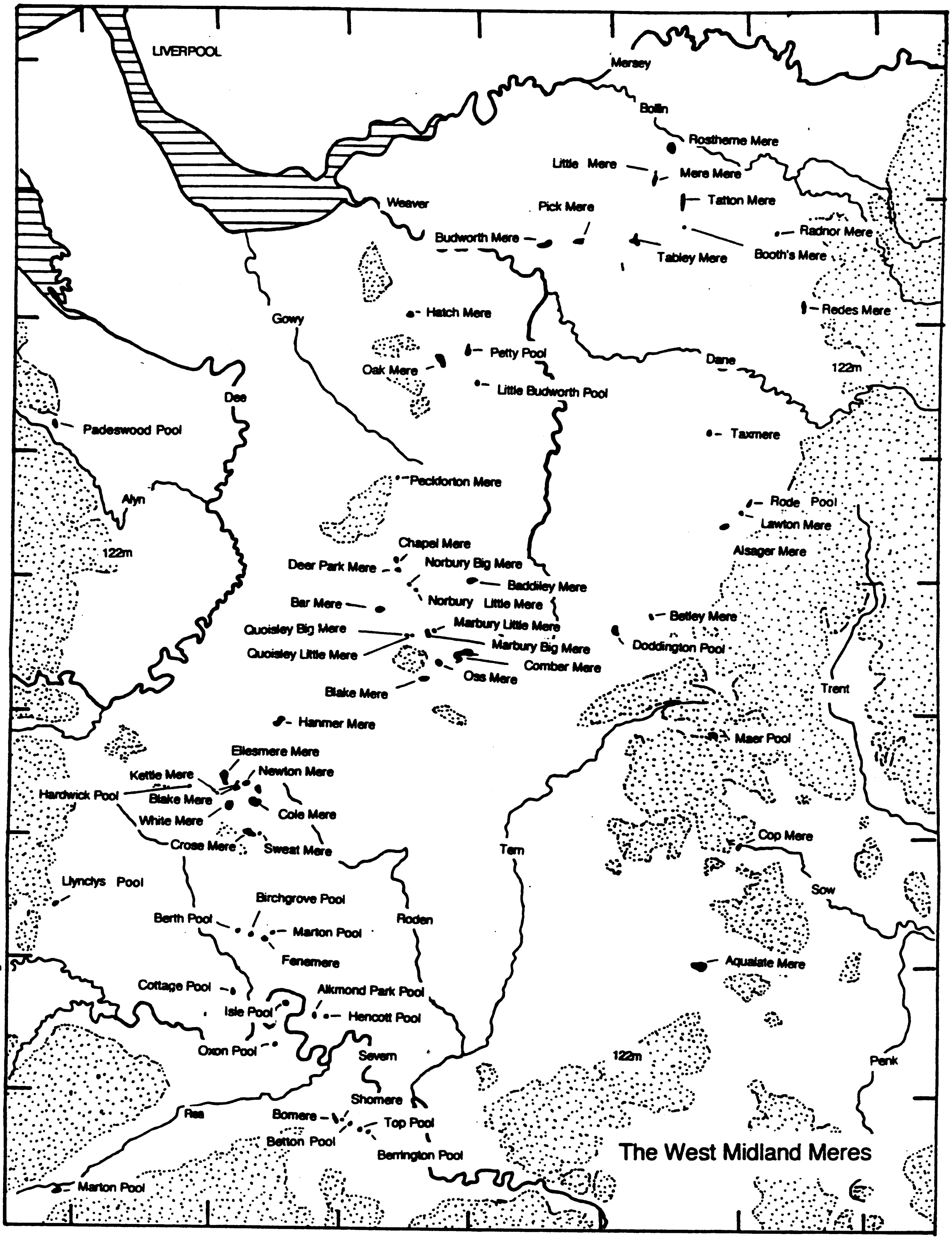
13. For similar conservation of the deep meres, there must be strict control on nitrogen inputs. This may be difficult as nitrogen sources are often diffuse. Phosphorus is generally so abundant that conventional control measures would in most cases be insufficient to make it limiting and hence reduce the size of the algal populations. Only very severe control could do this and may be impossible as there is evidence that much of the phosphorus may be naturally derived.

Introduction

1. Great Britain has some 81000 bodies of water greater than about 1 hectare in area. Most are scattered over the landscape, not randomly but reflecting the complex interplay of geology, geomorphology and past human aspiration that characterises the British landscape. There are, however, a few distinctive lake districts where particular groups of lakes occur. Best known are the Cumbrian Lakes, the Snowdonian Lakes and the Scottish Lochs in the upland regions. Large amounts of intensive work have been carried out on the Cumbrian lakes during a period of over half a century and a reasonable scientific base exists for at least a few of the Welsh and Scottish lakes. In the lowlands the man-made shallow broads in the Norfolk Broadland have come under intensive limnological scrutiny in the last twenty-five years and some isolated lakes such as Slapton Ley, the Loo Pool, and Rutland Water, have been intensively investigated.

2. There is one distinctive lake district, however, that has not received anything like the attention that it might have considering its particularly interesting combination of features. These lakes are the West Midland meres and the infilled hydrosere basins that began their ecological life as lakes after the last glaciation but are now wetlands (Sinker 1962). The meres lie in a great plain which was left from washout of glacial drift and uncovered from the ice a little more than thirteen thousand years ago and which is now contained in the counties of Cheshire, Shropshire and Staffordshire. Left on the plain were moraines and buried in the drift were icebergs often several kilometres in length. In Triassic times the northern part of the plain had itself been a region of internally drained or endorheic lakes, which had left deposits of salt. Progressive dissolution of these deposits led to sinking of the land surface. Through the backing up of melt water by the moraines, the melting in situ of the icebergs and the collection of water in the sunken depressions, and possibly through other means, the antecedents of the present- day meres were born.

3.The meres are not randomly scattered over the plain; they occur in distinctive groups which may sometimes be linked with moraine areas, though not always. Some are relatively deep, others very shallow. Nor are they at all uniform in water chemistry. A few, set in sandy basins, have very low concentrations of major ions, whilst the remnant basins of nearly completed hydroseres are both ion-poor and heavily humic-stained. Others have ionic levels that are probably the highest in Britain with total phosphorus concentrations from apparently natural sources that would elsewhere indicate gross contamination with sewage effluent. The



The West Midland Meres

meres have been claimed to be Britain's naturally eutrophic lakes with anecdotal evidence of blue-green algal blooms dating to at least the last century.

4. What most of the meres do share, is a relative obscurity in the public perception. The upland lakes are large and highly visible; the Broads have a profile generated by generations of holidaymakers. But the meres are small, usually hidden on private estates in a lowland in which they are little apparent from the public roads. Their wetland edges make them generally inaccessible to all but the professionally concerned and their often ground- rather than surface- water supply isolates them from otherwise accessible river corridors with their ancient public pathways.

5. The meres lie deep in agricultural land of high enough quality not to have avoided some of the intensification that has been a feature of post-war farming and which has contributed to the problems of eutrophication that beset many British lakes. Their ecology was last reviewed by Reynolds in 1979 and Reynolds & Sinker (1976) . There have been some surveys of the submerged plant populations (Wigginton & Palmer 1987) since then and a series of papers on the corixids has been published by Savage(1990) and savage & Pratt (1976). The phytoplankton of Rostherne mere has been monitored over a long period (Reynolds & Bellinger 1992) and there have been a few intensive palaeolimnological studies (Twigger & Haslam 1991). There has, however, been no recent systematic attempt to assess the state of even a subset of the more than 60 meres. It was possible that, if naturally eutrophic, they had changed little. It was also possible that with changes in stocking rates, those fed by surface water might be showing eutrophication from cattle yard wastes or that those fed by ground water might be showing enhanced nitrate concentrations from nearby or even more distant intensive arablisation.

6. The present survey,carried out largely between July 1991 and June 1992, set out with two objectives. The first was to characterise the water chemistry, phytoplankton, zooplankton and plant populations of a series of twenty-three meres, chosen by English Nature because they are Sites of Special Scientific Interest. Often these are the only intensive limnological data available for the sites and interpretation has had to be based on judgement and experience for lack of comparative data. The second was to see what general model might emerge to explain the major features controlling phytoplankton crop size in the meres. The ultimate intentions of this were both fundamental understanding in a system which might be unusual among lakes in not being phosphorus-limited or even nutrient-limited at all and of

recommending workable restoration strategies should resroration be found to be necessary.

7.The report is thus organised into two main sections. The first takes each site in turn and presents the available information in a common format. The second attempts an overview of the whole data set.

Methods

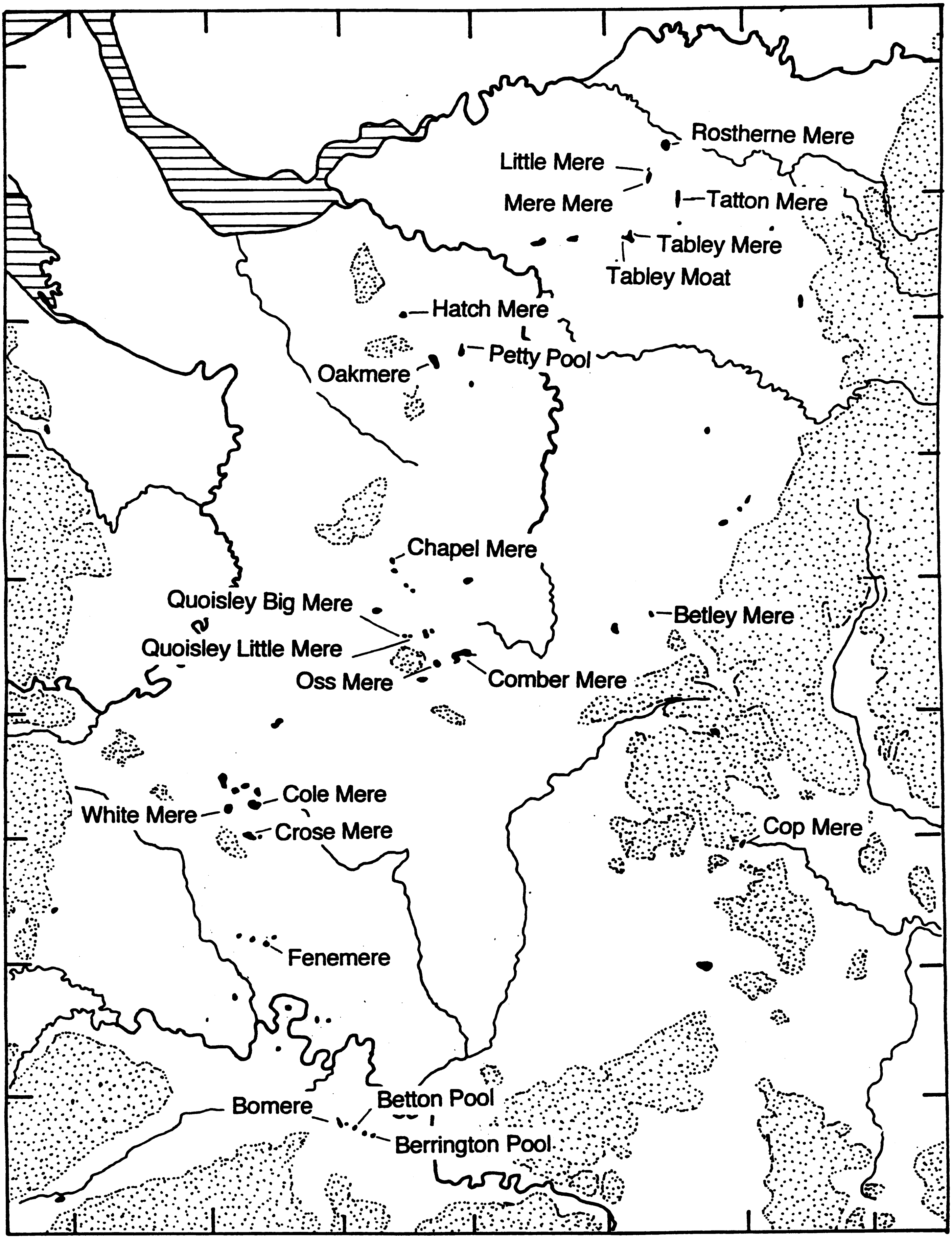
8. The meres included in this survey were:
Berrington Pool; Betley Mere; Betton Pool; Bomere; Chapel Mere; Cole Mere; Comber Mere; Cop Mere; Crose Mere; Fenemere; Hatch Mere; Little Mere; Mere Mere; Oakmere; Oss Mere; Petty Pool; Quoisely Little Mere; Quoisely Big Mere; Rostherne Mere; Tabley Mere; Tabley Moat; Tatton Mere; White Mere.

9.Each site was visited about once every three weeks over an entire year and sampled at the surface from the middle where this was logistically possible. Where it was not, samples were taken from the ends of jetties or from fishing platforms protruding into the lake. Samples were also taken of major surface inflows and outflows so that nutrient budgets could be approximated for these sites. Such flows were gauged with a current meter. The exact location and sample code for each sampling site is given with the data on each lake. All water samples were analysed for: conductivity (uS per cm); phenolphthalein and total alkalinity (mequivalents per l, using titration with standard hydrochloric acid to pH 8.4 and 4.5 respectively using phenolphthalein and BDH 4.5 indicators); chloride(mg per l, using thr Mohr titration with silver nitrate); pH; soluble reactive-,total soluble-, particulate-, and total-phosphorus(ug per l, using the molybdenum blue reaction following digestion with acid persulphate where necessary); nitrate-nitrogen (mg per l, using reduction on spongy cadmium followed by azo dye formation and spectrophotometric measurement); ammonium-nitrogen (ug per l, using the Chaney-Morbach phenol-hypochlorite reaction); and silicate(mg per l, using reaction with acid molybdate).

10.For inflows, the N:P ratios have been calculated from the ratios of nitrate-N + ammonium-N to total P. The calculations are thus underestimates of the true N:P ratio as organic forms of nitrogen are not included.

11.Chlorophyll a and carotenoid concentrations were measured in the lake samples and phytoplankton in whole water samples was counted using an inverted microscope. Zooplankters were sampled using a 67 um mesh net drawn up the water column at the sampling site and counted in preserved subsamples using a stereo

The West Midland Meres . Detailed Survey 1991/92



microscope. Aquatic plants were sampled on a single occasion in summer and scored using the DAFOR system used in previous surveys of the meres by Wigginton and Palmer (). Maps are provided of the plant distributions. A common key to symbols is given at the eend of the introduction.

12.For comparison, full tables of chemical and phytoplankton data are provided together with means and standard deviations calculated for the whole year, for the winter (Nov-Feb inclusive) and for the main phytoplankton growth season (March-October). Data are given in the Tables for the numbers of ***Daphnia***, the main zooplankton grazer genus in almost all of the meres. For Oakmere, where ***Daphnia*** is replaced in some years by the companion genus ***Diaphanosoma***, numbers of both are given.

13.Some data are given concerning stocking and land usage in the parishes which contain the catchments of the lakes. These data have been taken from the Agricultural Census returns, held at the Public Records Office at Kew. Data are given for 1931, a year which predates the major changes that have taken place in British agriculture since world War II and for 1987. For stock headage, an index of potential relative nutrient supply from excreta has been derived from the annual average amounts of nitrogen and phosphorus excreted per head. The amounts excreted of N and of P have been summed and normalised relative to a value of 1 for humans. The index has then been multiplied by the headage to give an indication of change in nutrient load for each catchment. Values are relative and can be compared only between years and not between catchments as the areas of these vary. Values used in calculating the index were(in kg per year): cattle,N 70.2, P 7.7; pigs,N 18.8, P 5.6;sheep,N 7, P 1.5; poultry,N 0.3, P 0.2; humans,N 4, P 1.16. These values give overall ratios for P+N of cattle 12.1: pigs 4.8: sheep 1.5:poultry 0.14;humans 1.0. Human populations have been assumed to have remained constant though in fact there is likely to have been a slight decline between 1931 and 1987 in most of these rural areas.

14.The data given in the Agricultural censuses for cereal, root crop, field vegetable and oilseed rape hectarages have been combined here under the single heading of arable.

15.Reference is made in the text to different phases of change in shallow lakes. A manuscript reviewing recent thinking in this area and describing the phases is given as an Appendix at the end of the Report.

Key to Vegetation Maps

Ec	*Elodea canadensis*	Nl	*Nuphar lutea*
Lt	*Lemna trisulca*	Na	*Nymphaea alba*
Ch	*Callitriche hermaphroditica*	Np	*Nuphar pumila*
Lu	*Littorella uniflora*	Pa	*Polygonum amphibium*
Rc	*Ranunculus circinatus*	Nx	Cultivated Nymphaeid
Pp	*Potamogeton pectinatus*	Cl	*Cladophora* spp
Ppf	*Potamogeton perfoliatus*	Nt	*Nitella* spp
Pb	*Potamogeton berchtoldii*	Cv	*Chara vulgaris*
Ea	*Eleocharis acicularis*	Ep	*Eleocharis palustris*
Ms	*Myriophyllum spicatum*	Cd	*Ceratophyllum demersum*
Eh	*Elatine hexandra*	Em	*Enteromorpha* spp
Po	*Potamogeton obtusifolius*	Hd	*Hydrodictyon* spp
Zp	*Zannichellia palustris*	Fa	*Fontinalis antipyretica*
Lm	*Lemna minor*	Df	*Drepanocladius fluitans*
Pcs	*Potamogeton crispus*	Pc	*Phragmites communis*
Rna	*Rorippa nasturtium aquatica*	Ta	*Typha angustifolia*
Cs	*Callitriche stagnalis*	Tl	*Typha latifolia*
Cha	*Callitriche hamulata*	Ser	*Sparganium erectum*
Pn	*Potamogeton natans*	Ip	*Iris pseudacorus*
Chi	*Crassula helmsii*	J	*Juncus* spp
Pbs	*Polygonum bistorta*	Ac	*Acorus calamus*
Se	*Sparganium emersum*	C	*Carex* spp
	Mixed emergent vegetation		*Equisetum fluviatile*

SECTION 1 THE MERE SITES

(a) BERRINGTON POOL

(i) Morphometry and water budget

Berrington Pool is a small lake situated south of Shrewsbury, with an area of 2.5 ha and a maximum depth of about 12m. It lies in cup shaped basin and there is evidence of past major changes in water level(Farr et al 1990). Its water supply appears to be largely of ground water though there will be some surface run off after heavy rain.

(ii) Land use changes

The catchment of the lake includes parts of the parishes of Berrington and Atcham. Agricultural changes in these have been as follows:

	1931	1987
Cattle(head)	1819	1733
nutrient units	22000	20963
Pigs(head)	872	21
nutrient units	4190	101
Sheep(head)	3661	2337
nutrient units	5492	3510
Poultry(head)	8759	237
nutrient units	1226	33
Total nutrient units	32908	24607
Permanent grazing(ha)	1599	796
Temporary grazing(ha)	237	158
Arable(ha)	586	1685
Woodland(ha)	4	20
Rough grazing(ha)	2	21
Total hectarage	2428	2680

There has been an overall decrease in the biomass of stock kept and therefore a likely decrease in the supplies of nutrients from these sources, particularly from pigs and poultry. Losses of grazing land to arable have been considerable and since cattle numbers have fallen only marginally there may be more intensive feeding with consequent production of more liquid yard waste. The increased arablization may have meant an increased nitrate load to the lake.

(iii)Major ion water chemistry and nutrient loads

Berrington Pool has a relatively low conductivity for the meres, a modest alkalinity and a high chloride concentration. Its total and soluble phosphorus concentrations are moderate for the meres, high relative to other lakes and, because they are higher in winter than in summer likely to be determined by external sources than internal sediment-derived loading. Nitrate and ammonium concentrations are low for an agricultural area

(iv)Phytoplankton and zooplankton.

Phytoplankton crops are moderately high, in the conventional eutrophic range, and have strong representations of blue green algae in them. Green algae are numerically most abundant overall but diatoms dominate in winter. Cladocera are scarce in the zooplankton and grazing impact is likely to be minimal.

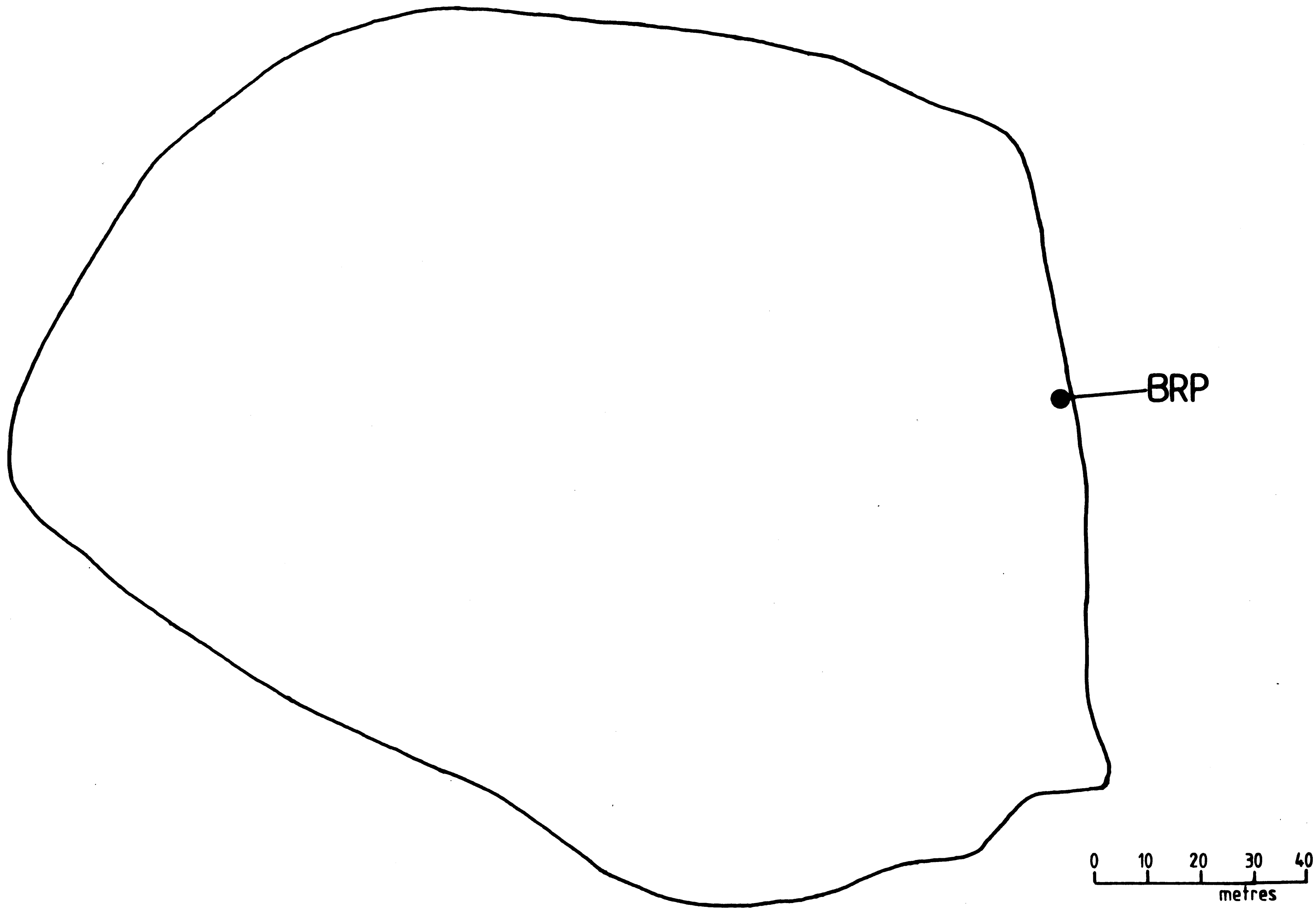
(v)Aquatic plants

The pool is relatively deep and steep sided. The potentiality for submerged plant colonisation is therefore low. However no completely submerged species were found. Patches of ***Nuphar lutea*** and ***Polygonum amphibium*** which have some submerged leaves were present with ***Nymphaea alba*** also. One submerged species was found by NCC in 1979 but not in 1987. The trophic score for aquatic plants has changed little between 1979 (8.3) and 1991 (8.1).

(vi)Overall assessment

Berrington Pool is clearly eutrophic and fed mostly by ground water. It is likely that its trophic state has increased over the past sixty years because of agricultural changes (mostly through arable increases leading to increased nitrogen loading) but these have been less important than in other meres. Nitrogen is probably limiting algal growth for phosphorus is abundant and probably from mostly natural sources. The algal crops probably lie at the potential set by the nitrogen supply and there is little grazing by zooplankton.

Other than modifications in arable farming in the catchment, the best way of reducing the algal crops would be reduction in fish stock to allow increase in the ***Daphnia*** but in such a steep sided basin it is unlikely that large enough littoral plant beds could develop to provide enough refuges to make this a stable state. Fish removal would thus have to be annual and overall there is little to be gained by such measures.


N
BRP
0 10 20 30 40
metres

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.09	54.0	0.18	6.2	18.7	3.29	1.18	0.35	0.24
2	0.00	242.0	0.00	6.4	13.0	2.05	1.26	>	0.00
3	0.00	51.0	0.34	5.4	13.0	2.44	1.16	>	0.00
4	0.00	131.0		8.4	12.7	1.52	1.08	>	0.00
5	0.03	387.0	0.51	11.1	14.3	1.30	1.02	>	0.55
6	0.19	546.0	0.61	9.2	8.3	2.08	0.93	>	0.00
7	0.07	666.0	0.89	8.8	16.0	2.00	1.01	>	0.13
8	0.62	131.0	0.45	5.5	11.0	2.20	0.93	>	0.00
9	0.55	89.0	0.75	4.8	7.3	1.69	0.96	>	0.00
10	0.70	37.0	0.43	18.7	25.0	1.47	1.15	>	0.15
11	0.58	39.0	0.14	19.4	22.7	1.28	1.17	>	0.00
12	0.03	31.0	0.01	28.9	37.8	1.44	1.10	>	0.00
13	0.00	19.0	0.41	44.4	80.3	1.99	1.35	1.25	0.10
14	0.02	7.0	0.56	54.6	83.5	1.68	1.33	0.75	0.15
15									
16	0.36	358.0	0.68	7.1					0.03
17	0.27	291.0	0.19	2.2					0.07
18	0.15	100.0	0.29	20.4					0.12
19	0.26	123.0	0.21	17.2					0.17
20	0.21	174.0	0.41	16.6					0.09
21	0.27	211.0	0.27	15.7					0.15

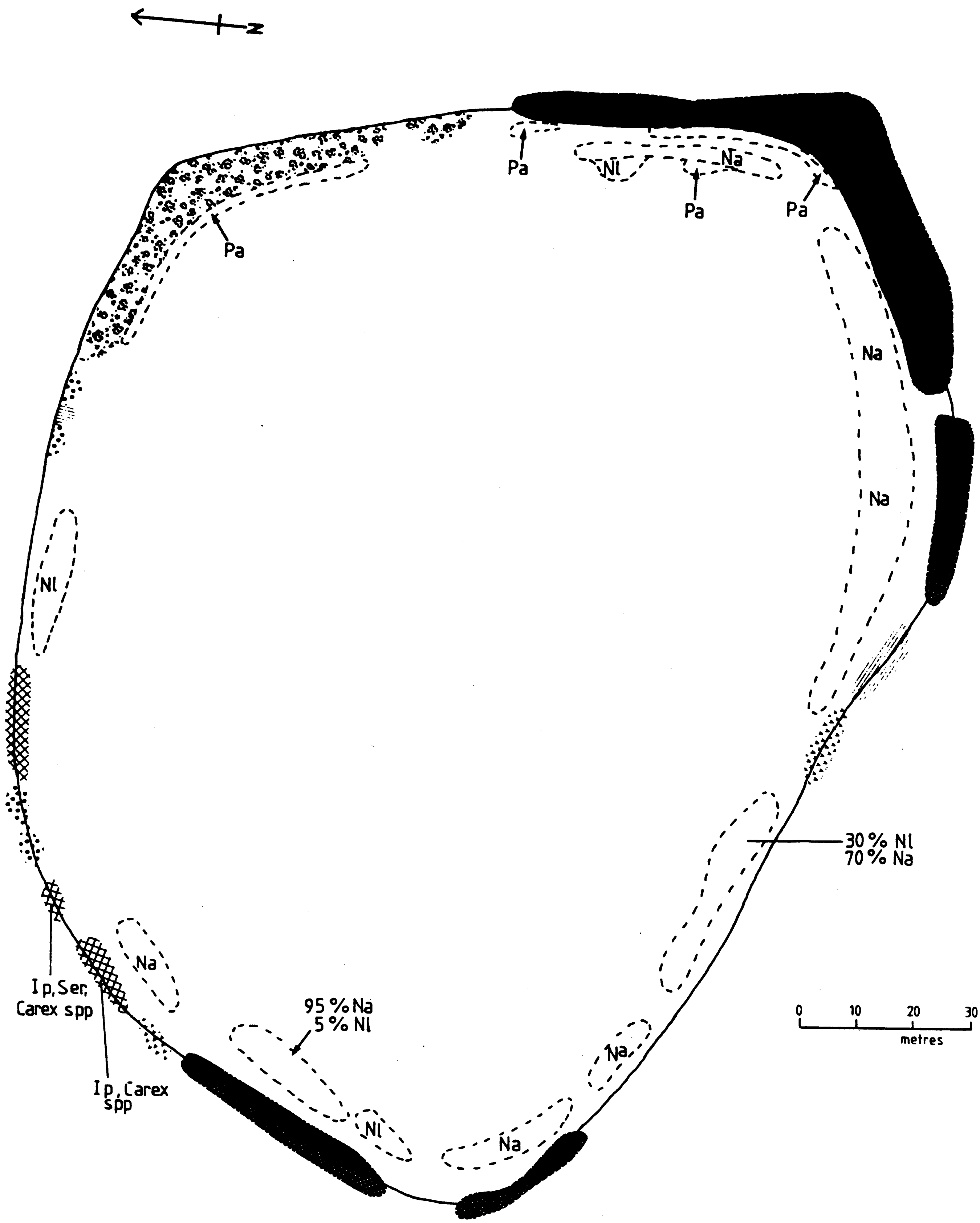
	Date	Conductivity	Phenolph alk	Total alk	pH	Chloride	Sol React P	Total Sol P	Partic P	Total P
1	Jul 24 1991	393	0.00	1.80	8.25	59.2	8.0	28	31	59.0
2	Aug 14 1991	406	0.10	1.80	8.30	69.4	4.0	23	0.0	23.0
3	Sept 4 1991	411	0.08	1.16	8.33	57.1	1.0	28	8	36.0
4	Oct 9 1991	406	0.10	1.90	7.79	65.2	20.0	-	-	91.0
5	Oct 30 1991	411	0.10	0.75	7.69	50.5	75.0	94	28	122.0
6	Nov 20 1991	384	0.10	2.15	7.85	58.0	120.0	135	13	149.0
7	Dec 18 1991	402	0.10	2.20	7.79	38.4	135.0	195	30	225.0
8	Jan 22 1992	399	0.00	1.80	7.93	59.6	131.0	191	0	191.0
9	Feb 19 1992	403	0.20	1.90	8.08	64.7	117.0	142	24	166.0
10	Mar 11 1992	393	0.15	1.95	8.37	90.3	94.0	94	0	94.0
11	April 1 1992	391	0.30	2.20	8.52	58.8	69.0	82	89	171.0
12	April 29 1992	355	0.50	2.00	9.20	60.0	0.8	23	49	72.0
13	May 20 1992	377	0.25	1.85	9.28	60.0	0.0	17	58	75.0
14	June 10 1992	368	0.35	1.75	9.39	60.8	4.0	4	-	
15										
16	Winter mean	379	0.10	2.00	7.90	55.2	126.0			183.0
17	SD	9	0.08	0.19	0.12	11.5	9.0			33.0
18	Growth mean	391	0.19	1.72	8.51	63.1	27.6			82.6
19	SD	19	0.15	0.43	0.60	10.7	36.7			44.7
20	All year mean	392	0.17	1.80	8.34	60.9	55.6			113.3
21	SD	17	0.14	0.40	0.57	11.1	55.4			62.6

Berrington Pool Phytopl 1991/2

Organism	Jul 24 1991	Aug 14 91	Sept 4 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 221991	Feb 19 1992	March	April 1 1992	April 28 1992	May 20 1992	June 10 1992
1 Aster form	-	-	-	-	-	-	-	-	-	-	-	67	-	-
2 Cyclotella sp	-	-	-	302	54	784	295	1112	2260	-	643	1340	-	-
3 Denticula sp	-	-	-	34	80	-	-	-	-	-	-	-	-	-
4 Fragilaria sp	-	-	-	335	-	-	-	-	-	-	161	-	-	-
5 Frag. constr	-	13	-	-	-	-	-	-	-	-	-	-	-	-
6 Navicula	-	13	-	34	26	-	-	-	-	-	-	-	-	-
7 Pinnularia sp	-	-	22	-	-	-	-	-	-	-	-	-	-	-
8 Rhoicosphenia	-	-	-	-	-	-	-	13	-	-	-	-	-	-
9 Synedra ulna	-	-	-	-	-	-	-	-	20	-	-	-	-	-
10 Synedra sp	-	-	-	-	13	-	-	-	-	-	80	-	-	-
11 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12 Scened bij	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13 Closteriops lo	-	-	-	-	-	-	-	-	-	-	-	-	-	13
14 Pandorina mor	-	-	-	-	-	-	-	-	-	-	-	-	-	13
15 Actinastrum	-	-	-	101	-	-	-	-	-	-	-	-	-	-
16 Ankist conv	-	80	-	1776	348	60	-	375	360	-	3780	1005	-	13
17 Ankist falc	4189	-	-	603	-	60	107	-	-	-	442	67	13	-
18 Carteria cord	-	-	-	-	-	-	-	-	-	-	-	67	-	-
19 Chlamydo ep	-	2224	-	-	-	-	-	-	-	-	-	-	107	-
20 Chlamydo glob	235	121	-	-	-	-	-	-	-	-	40	-	-	-
21 Chlamydo sp	101	-	827	369	134	-	844	40	40	-	281	134	-	-
22 Closterium ac	-	-	22	-	-	-	-	-	-	-	-	-	-	-
23 Clost cynth	-	27	-	-	-	-	54	40	80	-	-	-	13	-
24 Clost sp	-	-	-	34	27	-	-	-	-	-	-	-	-	-
25 Crucigenia quad	-	-	-	-	-	-	-	40	60	-	-	-	27	-
26 Crucig fen	-	-	-	-	-	-	27	-	-	-	-	-	-	-
27 Dictyo pulch	-	-	-	-	27	-	-	-	-	-	-	-	-	-
28 Lagerheim qua	-	-	-	-	-	-	-	40	-	-	282	268	-	-
29 Micract pusil	-	-	-	-	-	-	-	-	-	-	-	268	-	-
30 Pedinopera	-	-	-	34	-	-	-	-	-	-	-	-	-	-
31 Scened bij	101	27	22	201	121	201	174	-	-	-	4584	2815	13	40
32 Scened quad	-	-	-	-	-	20	-	-	-	-	-	134	27	-
33 Schroed setig	-	13	-	-	-	-	-	-	-	-	-	-	-	-
34 Selenast west	335	-	-	-	-	-	-	54	-	-	201	-	-	-
35 Selenast min	-	-	89	101	27	40	94	255	320	-	40	134	147	-
36 Staurast sp	-	-	-	-	27	-	-	-	-	-	-	-	-	27
37 Tetrast staur	-	-	-	-	-	-	-	-	-	-	402	2413	-	-
38 Chlamyd sphg	-	-	-	-	-	-	-	-	-	-	-	-	482	-
39 Quadrig lac	-	-	-	-	-	-	-	-	-	-	-	-	40	-
40 Oocystis erem	-	-	-	-	-	-	-	-	-	-	-	-	40	-
41 Carteria glob	-	-	-	-	-	-	-	-	-	-	-	-	80	-
42 Scened obliq	-	-	-	-	-	-	-	-	-	-	-	-	13	-
43 Chlorella	-	-	-	-	-	-	-	-	-	-	-	-	-	13
44 Euglena polym	-	-	245	-	-	-	-	-	-	-	-	-	-	-
45 Euglena sang	-	-	-	-	-	-	-	-	100	-	-	-	-	-
46 Euglena sp	-	-	-	-	-	-	27	-	-	-	-	268	27	-
47 Trachelo sp	-	-	89	34	13	-	-	-	20	-	-	-	13	54
48 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50 Crypto ac	-	-	-	-	-	-	13	67	-	-	-	-	-	-
51 Crypto ovat	100	67	22	268	107	101	54	-	20	-	1890	402	-	188
52 Rhodo min	905	-	178	871	107	121	188	241	1080	-	563	1139	54	938
53 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-
54 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55 Dinobryon sp	-	-	45	-	-	-	-	-	-	-	-	-	-	-
56 Mallomonas sp	-	-	-	-	13	20	-	-	-	-	-	-	54	13
57 Chroomonas	-	-	-	-	-	-	-	-	-	-	-	-	107	-
58 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60 Unident flag	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61 Gymnodinium	-	-	-	-	-	-	-	-	-	-	-	-	-	27
62 Glenodinium sp	-	-	-	-	-	-	-	-	-	-	40	-	-	-
63 Ceratium hir	-	-	-	-	-	-	-	-	-	-	-	-	-	40
64 Anab circ	-	-	-	-	-	-	-	-	-	-	-	-	1407	308
65 Anabaena aff	-	-	-	-	-	20	-	-	-	-	-	-	-	844
66 Anabaena spir	-	-	-	-	-	20	-	-	-	-	-	-	-	858
67 Anabaena sp	269	40	-	-	777	-	1059	-	-	-	-	-	-	-
68 Aphanizom fl a	-	-	246	804	1072	2512	1461	-	-	-	80	469	-	-
69 Aphanocapsa	-	-	-	-	-	362	-	13	-	-	-	-	-	-
70 Dact acic	-	-	22	-	-	-	-	-	-	-	-	-	-	-
71 Dact fac	-	-	201	-	-	-	-	-	-	-	-	-	-	-
			-	570	228	-	-	-	-	-	161	-	-	-

	Organism	Jul 24 1991	Aug 14 91	Sept 4 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 221991	Feb 19 1992	March	April 1 1992	April 28 1992	May 20 1992	June 10 1992
74	Coelosphaer	-	-	-	-	214	-	-	13	-	-	-	-	-	-
75	Gloeocapsa sp	34	-	-	-	-	-	-	-	-	-	-	-	-	-
76	Merismop pu	-	-	-	3418	657	-	-	27	-	-	684	-	-	-
77	Oscill ten	235	-	-	-	-	-	-	-	-	-	-	-	-	-
78	Phormidium sp	67	-	-	-	-	-	-	-	-	-	-	-	-	-
79	Spirulina sp	-	-	-	-	-	40	-	-	-	-	-	-	-	-
80	Stigonema sp	-	-	-	-	-	40	-	-	-	-	-	-	-	-
81	Chroococcus	34	-	-	-	-	-	-	-	-	-	-	-	-	-
82	Gomphosph.	-	13	-	-	-	-	-	-	-	-	-	-	-	-
83	Anab flos aq	-	-	-	-	-	543	-	-	-	-	-	-	-	-
84	Gloeocaps rup	-	-	-	-	-	-	-	-	-	-	201	-	-	-
85	Osclat sp	-	-	-	-	-	-	-	-	-	-	-	-	134	27
86	Coelos naeg	-	-	-	-	-	-	-	-	-	-	-	-	-	13
87															
88	Total diatoms	0	26	22	705	173	784	322	1125	2280		884	1407	0	0
89	Total greens	4860	2492	960	3219	711	381	1300	844	860		10052	7305	1012	119
90	Total other	1005	67	579	1173	240	242	282	308	1220		1493	1809	251	1220
91	Total bga	673	53	469	4792	2948	3537	2520	53	0		1126	469	1541	2090
92	Total	6538	2638	2030	9889	4072	4944	4424	2330	4360		13555	10990	2804	3429
93															
94	Diatoms%	0	0.98	1.1	1.75	4.3	15.9	7.3	48.3	52.3		6.5	12.8	0	0
95	Greens%	74.3	94.5	47.2	32.6	17.4	7.7	29.4	36.2	19.7		74.2	66.5	36.1	3.5
96	Others%	15.4	2.5	28.5	11.9	5.9	4.9	6.4	13.2	28		11	16.5	9	35.6
97	Bga %	10.3	2	23.1	48.5	72.4	71.5	57	2.3	0		8.3	4.3	55	61
98															
99		Diatoms %	Greens%	Other%	Blue greens %										
00	Winter mean%	31	23.3	13.1	32.7										
01	SD	22.7	12.4	10.6	36.9										
02	Growth mean%	3.4	49.6	15.1	31.7										
03	SD	4.4	30	10.7	27.5										
04	Allyear mean%	12.6	41.5	14.5	32										
05	SD	18.3	28.2	10.2	29.1										

Berrington Pool



(b) BETLEY MERE

(i) Morphometry and water budget

Betley Mere is 9.3 ha in area, and very shallow (max 1.8m). It has several small surface inflows and a distinct outflow. The two main inflows carried a total of 1.14 million cubic metres of water per year, which was much greater than the gauged outflow (0.02 million metre cubed). This suggests that much of the water may have been lost by seepage (or undetected surface outflows) to the wetland areas to the west of the mere, that the average retention time was at most 0.07 yr and that the mere is flushed about 13.6 times per year. There may also be some ground water sources which would tend to increase further the flushing rate. Most of the flow is in winter and the retention time is thus much longer in summer (about 0.97 yr) with a flushing rate equivalent to 1.03 per yr. The picture is thus one of rapid winter flush-out followed by summer stagnation.

(ii) Land use changes

Betley Mere's catchment lies entirely in Betley Parish, whose land usage since 1931 has changed in the following way:

	1931	1987
Cattle(head)	473	1036
nutrient units	5723	12540
Pigs(head)	149	169
nutrient units	715	811
Sheep(head)	515	904
nutrient units	773	1356
Poultry(head)	4720	164
nutrient units	661	23
Total nutrient units	7872	14730
Permanent grass(ha)	383	329
Temporary grass(ha)	51	84
Arable(ha)	90	105
Woodland(ha)	1	12
Rough grazing	4	4
Total hectarage	529	534

This pattern is one of little change in field crops but a major increase in stocking of cattle with some increase also in sheep and a switch of some land from permanent to temporary, and thus more heavily fertilised, grazing.

(iii) Major ion water chemistry and nutrient loads

The two inflows (BLIE and BLIF) differ with the former having a consistently lower conductivity and major ion content compared with the former. The mere itself has a conductivity between the two but a higher total alkalinity and a lower chloride concentration. Because the former is largely soil derived and the latter rain derived this suggests a small but significant source of ground water to the mere. Values overall are relatively high. Both inflows carry large concentrations of soluble and total phosphorus which are larger in summer than in winter. This suggests an effect of reduced dilution of a point source or sources in the lesser flows of summer. Moderately high concentrations of ammonium suggest that these sources may lie in a local farm as the former sewage treatment works to the south of the mere appears to be no longer functional. Nitrate concentrations in the inflows are also high and highest in the farm inflow (BLIF). High nitrate values usually come from arable sources or fertilised grazing; in this instance there may be a substantial element of well oxidised farm effluent. The N:P ratios in the inflows (BLIF, 21 by weight,47.4 by atoms; BLIE, 5.6 by weight,12.6 by atoms) suggest that despite the high phosphorus values nitrogen is still in excess relative to algal growth needs.

The mere itself also shows high phosphorus concentrations, which can be explained by the inflows, so that major internal sediment release is unlikely. Nitrogen concentrations are lower in the mere and available nitrogen is scarce in summer falling sometimes to negligible concentrations. This suggests a loss of nitrogen through processes like denitrification as the inflows enter the mere and pass through the reedswamp as well as algal uptake. But the high N:P ratios in the inflow waters relative to algal need suggest that the latter is not the dominant process. The high chlorophyll a values in the mere coupled with the degree of sediment resuspension that is inevitable in such a shallow water body, suggest that the phytoplankton may not be strongly limited by nutrient supply and that light availability may be most important in summer.

(iv) Phytoplankton and zooplankton

Chlorophyll a concentrations were high even in January. However blue green algae were only relatively minor components of the community. Green algae and diatoms dominated it in both winter and summer. Such a community has frequently been described from heavily eutrophicated lakes, particularly where organic inputs accompany the nutrients. The organic matter provides both energy sources to many of the small green algae that can use them as well as creating relatively high carbon dioxide concentrations through bacterial decomposition. Consistent with this are the relatively low (for the meres) values of pH and phenolphthalein alkalinity in Betley Mere.

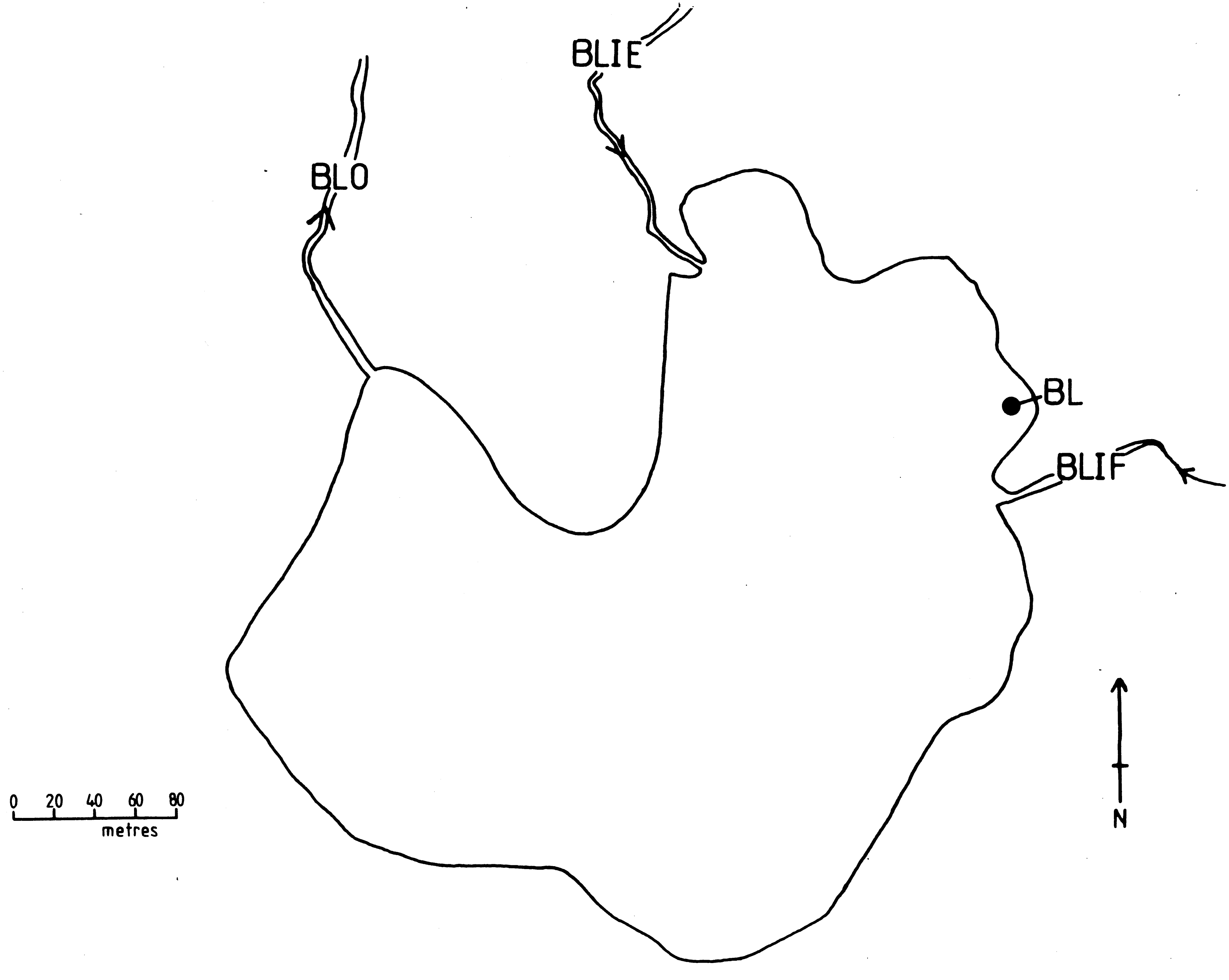
Zooplankton was scarce for such a fertile lake and very few large cladoceran grazers were found. The picture is one of probably intense fish predation.

(v) Aquatic Plants

Rather surprisingly on account of the high nutrient loading, Betley Mere is in no way devoid of submerged plants and has well developed marginal reedbeds. The dominant species are the more tolerant ones (***Potamogeton pectinatus, Ceratophyllum demersum***) but it has a reasonable diversity. Undoubtedly this is partly due to its shallowness which allows light penetration to the bottom despite the sometimes large algal crops.

(vi) Overall assessment

Betley Mere is in a threatened state. It is clearly heavily eutrophicated by stock wastes and the situation has undoubtedly deteriorated in the last sixty years. Phytoplankton crops are high, submerged plants are still vigorous but , on the basis of experience elsewhere could precipitously disappear. The mere is in a Phase 2 state where normally algal crops are kept low by zooplankton grazing.The situation is threatened here by probably heavy fish predation on the zooplankton. Elsewhere Phase 2 states have been moved into completely algal dominated Phase 3 states by mechanisms such as changes in the fish community, changes in water level or bird grazing of the plants. Protective measures would need to include fairly severe control of the farm effluents. The flushing rate in summer is low but the winter flush would help a speedy restoration. Desirable follow up measures would include biomanipulation of the fish community to restore grazing by zooplankters for the lake would almost certainly remain fertile even after practicable nutrient control measures had been established.


BLO
BLIE
BL
BLIF
N
0 20 40 60 80
metres

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Total Sol P	Partic P	Total P
1	Aug 7	*	*	*	*	*	*	*	*	*
2	Aug 28	*	*	*	*	*	*	*	*	*
3	Sept 18	*	*	*	*	*	*	*	*	*
4	Oct 23	957	0	3.2	7.26	88	3516	3516	490	4006
5	Nov 12	699	0.3	3.65	7.77	47	164	189	24	214
6	Dec 12 1991	715	0.35	4.15	8.02	46	175	202	0	202
7	Jan 15 1992	594	0.2	3.6	7.71	48	176	176	56	233
8	Feb 4 1992	884	0.25	3.0	8.39	68	152	195	102	298
9	Mar 3 1992	587	0.35	3.15	7.96	46.2	64.7	80.8	86	167
10	Mar 24 1992	574	0.3	3.1	8.18	44	26.9	26.9	0	27
11	April 15 1992	583	0.35	3.05	8.14	39.2	36	66	155	221
12	May 13 1992	594	0.3	3.4	8.57	44	22	62	329	390
13	June 3 1992	276	0	1.6	7.8	19.6	447	460	1502	1962
14	June 22 1992	633	0	3.8	8.11	45.1	135	275	0	275
15										
16	Winter mean	723(120)	0.28 (0.07)	3.6 (0.47)	7.97 (0.31)	52.3 (10.5)	167 (11)			237 (43)
17	Growth mean	601 (198)	0.19 (0.18)	3.04 (0.7)	8.0 (0.4)	46.6 (20.5)	607 (1292)			1007 (1478)
18	Allyear mean	645 (178)	0.22 (0.15)	3.25 (0.65)	7.99 (0.36)	48.6 (17.1)	447 (1025)			727 (1209)

Betley Inflow East BLIE

Nitrate N	Ammonium N	Silicate Si	Discharge	SD Discharge	P load/week	P load/year	N load/week	N load/year
*	*	*	0.000		0.000		0.000	
*	*	*	0.000		0.000		0.000	
*	*	*	0.000		0.000		0.000	
8.09	2853		0.002		4.850		12.300	
1.39	84	6.57	0.005		0.650		4.460	
2.61	132	5.5	0.007		0.860		11.600	
2.00	121	5.77	0.002		0.280		2.570	
6.04	192	4.9	0.037		6.670		139.500	
3.35	83	4.21	0.002		0.200		4.150	
3.62	98	2.76	0.001		0.016		2.250	
2.95	51	1.42	0.002		0.267		3.630	
1.79	0	1.18	0.005		1.180		5.410	
1.69	752	2.55	0.020		23.730		29.540	
1.88	66	2.29	0.004		0.670	146.000	4.730	817.000
3.01 (2.08)	132 (45)	5.7 (0.69)	0.013	0.016				
3.34 (2.23)	558 (1045)	2.4 (1.09)	0.004	0.006				
3.22 (2.08)	403 (838)	3.72 (1.92)	0.006	0.010				

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7	*	*	*	*	*	*	*	*	*
2	Aug 28	*	*	*	*	*	*	*	*	*
3	Sept 18	*	*	*	*	*	*	*	*	*
4	Oct 23	*	*	*	*	*	*	*	*	*
5	Nov 12	873	0.45	4.2	7.87	38.4	189	196	113	308
6	Dec 5 1991	884	0	5.05	7.94	46	218	218	0	218
7	Jan 15 1992	845	0.2	3.5	7.69	60	225	251	*	*
8	Feb 4 1992	834	0.15	2.55	8.45	56	300	340	159	500
9	Mar 3 1992	801	0.5	3.1	7.95	58	159	232	158	390
10	Mar 24 1992	728	0.3	2.9	8.05	52	217	238	241	479
11	April 15 1992	789	0.4	3.9	8.12	52.9	151	200	285	485
12	May 13 1992	672	0.1	3.0	8.06	46	7	34	219	253
13	June 3 1992	728	0	2.2	7.67	80.4	737	867	139	1006
14	June 22 1992	790	0	3.9	8.01	65.7	153	153	16	169
15										
16	Winter mean	859 (23)	0.2 (0.19)	3.83 (1.06)	7.99 (0.33)	50.1 (9.8)	233 (47)			342 (144)
17	Growth mean	751 (51)	0.22 (0.21)	3.17 (0.65)	7.98 (0.16)	59.2 (12.3)	237 (254)			464 (294)
18	Allyear mean	794 (68)	0.21 (0.19)	3.43 (0.85)	7.98 (0.22)	55.5 (11.80	236 (192)			423 (251)

Betley Inflow Farm BLIF

	Nitrate N	Ammonium N	Silicate Si	Discharge	SD Discharge	N kg/week	N kg/year	P kg/week	P kg/year
1	*	*	*	0.0000		0.000		0.000	
2	*	*	*	0.0000		0.000		0.000	
3	*	*	*	0.0000		0.000		0.000	
4	*	*	*	0.0000		0.000		0.000	
5	2.1	171	5.3	0.0030		4.120		0.560	
6	4.34	279	4.8	0.0040		11.200		0.530	
7	5.73	696	4.5	0.0080		31.090			
8	10.28	883	4.62	0.0120		84.400		3.630	
9	1.31	585	4.14	0.0010		1.150		0.240	
10	15.6	482	4.08	0.0002		1.950		0.060	
11	8.88	249	3.96	0.0110		60.700		3.230	
12	6.21	32	0.74	0.0030		11.850		0.460	
13	6.04	2130	3.14	0.0030		14.820		1.830	
14	5.04	54	4.6	0.0010		3.080	833.000	0.100	39.500
15									
16	5.61 (3.5)	507 (338)	4.81 (0.35)	0.0070	0.004				
17	7.18 (4.8)	589 (787)	3.44 (1.4)	0.0020	0.003				
18	6.55 (4.20	556 (620)	3.99 (1.29)	0.0030	0.004				

Betley Outflow N

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol react P	Tot Sol P	Partic P	Total P
1	Aug 7	*	*	*	*	*	*	*	*	*
2	Aug 28	680	0.25	3.4	7.86	43	204	225	52.4	278
3	Sept 18	691	0.4	3.8	8.12	49	221	252	133	386
4	Oct 23	730	0.4	3.65	7.91	47	149	157	29	186
5	Nov 12	942	0.1	3.85	7.36	95	2737	2737	664	3401
6	Dec 12 1991	*	*	*	*	*	*	*	*	*
7	Jan 15 1992	657	0.2	3.6	7.59	50	163	166	*	*
8	Feb 4 1992	*	*	*	*	*	*	*	*	*
9	Mar 3 1992	672	0.35	3.15	7.96	58	159	232	158	390
10	Mar 24 1992	637	0.25	3.35	8.16	48	29	29	229	258
11	April 15 1992	536	0.45	2.55	9.32	47.1	5	35	268	304
12	May 13 1992	No flow								
13	June 3 1992	No flow								
14	June 221992	No flow								
15										
16	Winter mean	780 (202)	0.15 (0.07)	3.73 (0.18)	7.48 (0.16)	72.5 (32)	1450 (1820)			3401
17	Growth mean	658 (67)	0.35 (0.08)	3.32 (0.44)	8.22 (0.55)	48.7 (5)	128 (90)			300 (78)
18	Allyear mean	693 (115)	0.3 (0.12)	3.42 (0.42)	8.04 (0.58)	44.6 (17)	446 (929)			743 (1174)

Betley Mere BL

Sun, Aug 30, 1992 7:15 am

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	*	*	*	*	*	*	*	*	*
2	Aug 28 1991	700	1.0	5.4	8.52	49	773	1056	200	1256
3	Sept 18 1991	726	1.3	6.0	8.53	51	610	422	626	1048
4	Oct 23 1991	752	0.3	5.1	7.81	45	286	286	101	386
5	Nov 12 1991	721	0.35	4.45	7.87	48.5	275	291	62	353
6	Dec 12 1991	740	0.4	4.85	7.91	50	218	218	85	303
7	Jan 15 1992	649	0.2	3.3	7.66	44	169	169	31	200
8	Feb 4 1992	678	0.25	3.45	8.43	52	127	127	114	241
9	Mar 3 1992	667	0.35	2.55	8.46	50	49	76	141	217
0	Mar 24 1992	625	0.3	2.4	8.3	48	30	30	12	42
1	April 15 1992	524	0.6	2.5	9.45	43.1	11	39	253	292
2	May 13 1992	559	0.5	3.4	9.12	44	283	342	238	580
3	June 3 1992	594	0.2	3.8	8.26	45.1	645	648	433	1081
4	June 22 1992	629	0	3.9	8.15	49.0	552	552	24	576
5										
6	Winter mean	697 (41)	0.3 (0.09)	4.0 (0.76)	7.97 (0.33)	48.6 (3.4)	197 (64)			274 (67)
7	Growth mean	642 (76)	0.51 (0.41)	3.89 (1.3)	8.51 (0.5)	47.1 (2.9)	360 (294)			609 (427)
18	Allyear mean	659 (71)	0.44 (0.35)	3.93 (1.16)	8.34 (0.51)	47.6 (3)	310 (254)			506 (386)

	Nitrate N	Ammonium N	Silicate Si	Discharge
1	*	*	*	*
2	2.07	24	2.4	0.001
3	2.86	197	3.26	0.002
4	3.7	165		0.004
5	4.75	4486	3.18	0.002
6	*	*	*	*
7	1.65	70	5.76	+
8	*	*	*	*
9	1.31	585	4.14	0.001
10	1.54	60	2.41	+
11	0.27	11	0.38	+
12				
13				
14				
15				
16	3.2 (2.2)	2278 (3123)	4.47 (1.82)	0.0005(0.001)
17	1.96 (1.2)	174 (215)	2.52 (1.390	0.0008(0.001)
18	2.27 (1.44)	700 (154)	3.08 (1.66)	0.0007(0.001)

Betley Mere Phytoplankton / ml

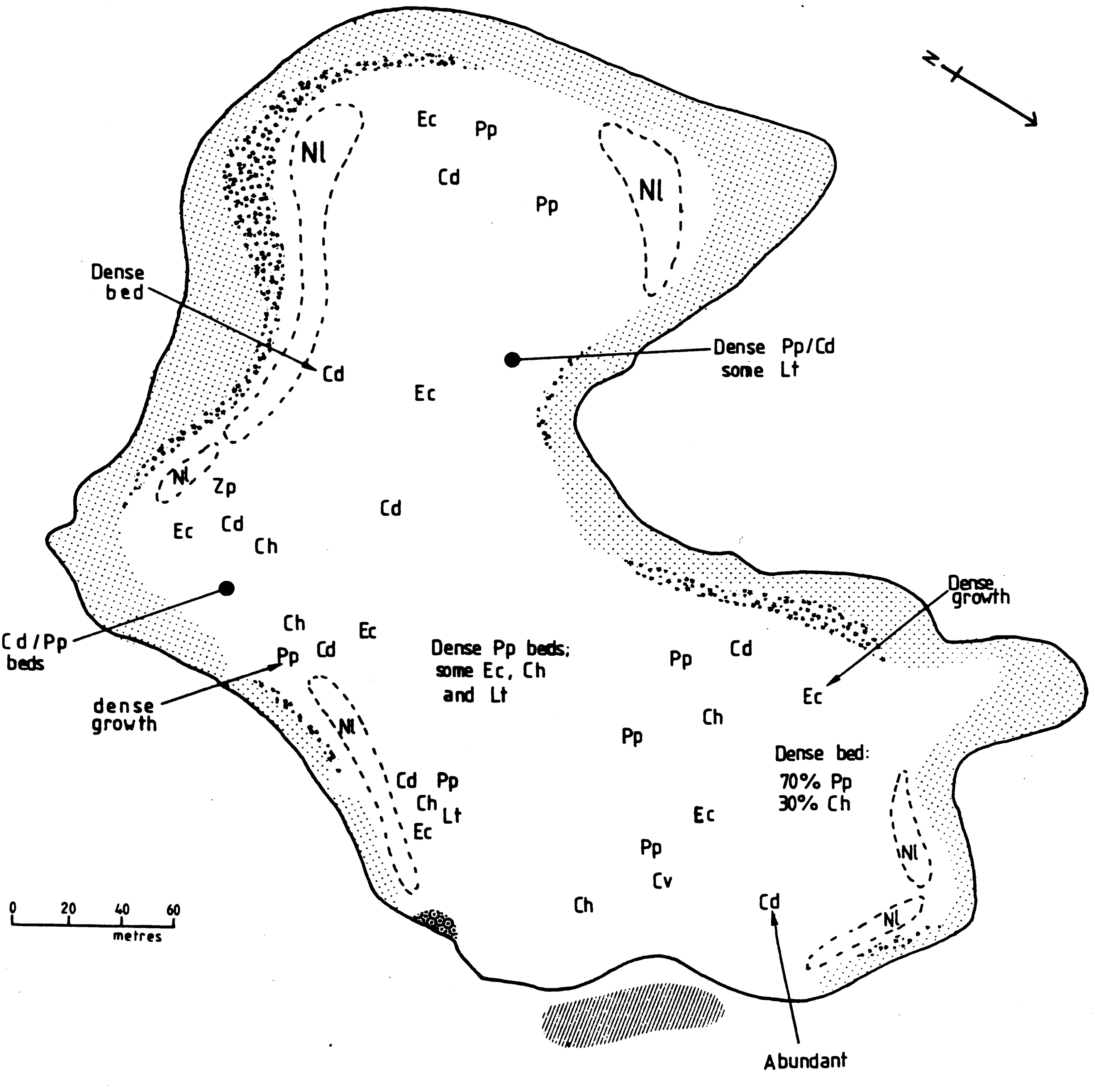
	Organism	Aug 28 91	Sep 18 91	Oct 23 91	Nov 12 91	Dec 4 91	Jan 15 92	Feb 4 92	Mar 3 92	Mar 24 92	Apr 15 92	May 13 1992	June 3 1992	June 22 1992
1	Cyclotella oc	11900	251	268	657	750	-	-	-	-	-	-	11159	-
2	Cyclotella men	3940	-	-	-	-	122	80	14400	31570	57311	46050	-	375
3	Synedra ulna	603	120	936	-	54	-	-	-	402	605	-	-	67
4	Nitzschia sp	282	-	67	-	40	-	-	-	-	-	-	101	-
5	Cocconeis sp	40	-	268	94	54	-	-	-	201	-	-	-	-
6	Surirella sp	40	-	-	-	-	-	-	-	-	-	-	-	-
7	Navicula sp	80	-	737	134	107	40	-	-	-	404	201	-	201
8	Fragilaria crot	-	3418	-	-	-	-	-	-	-	-	201	-	-
9	Amphora sp	-	120	-	-	-	40	40	-	-	-	-	-	-
10	Nitzsch. sigm.	-	40	-	-	-	-	-	-	-	-	-	-	-
11	Frag. constr.	-	40	-	-	-	-	-	-	-	-	-	-	-
12	Gomphon. sp	-	-	268	40	54	-	-	-	-	-	-	-	-
13	Cymbella vent	-	-	67	-	-	-	-	-	201	-	-	-	-
14	Synedra sp	-	-	-	67	-	-	-	-	-	-	-	-	-
15	Melosira gran	-	-	-	40	-	-	-	-	-	-	-	-	-
16	Rhoicosphenia	-	-	-	13	27	-	-	-	-	-	-	-	-
17	Neidium sp	-	-	-	13	-	-	-	-	-	-	-	-	-
18	Stephanodis sp	-	-	-	67	-	-	-	-	-	-	-	-	-
19	Fragillaria sp	- -	-	-	27	-	-	-	-	-	-	-	201	27
20	Pinnularia vir	-	-	-	13	-	-	-	-	-	-	-	-	13
21	Synedra u. v a	-	-	-	27	-	-	-	-	-	-	-	201	-
22	Amphora ov	-	-	-	-	27	-	-	-	-	-	-	101	54
23	Gompho ventr	-	-	-	-	-	-	-	-	-	-	-	-	13
24	Caloneis sp	-	-	-	13	-	-	-	-	-	-	-	-	-
25	Achnanthes	-	-	-	-	-	-	-	-	201	-	-	-	-
26	Stephan ast	-	-	-	-	-	-	-	-	-	-	201	-	-
27	Scened acum	-	-	-	-	-	-	-	-	-	-	-	101	-
28	Chlamydomo.	1649	40	67	77	27	563	920	7800	2212	2825	7641	5932	-
29	Actinast hant	2131	-	-	-	-	-	-	-	-	-	-	-	-
30	Ankistr conv	24130	2252	1273	67	-	282	-	2200	804	1009	-	11964	817
31	Scened bijug	241	-	1474	-	13	40	-	201	201	-	-	704	-
32	Tetraedron	241	-	-	-	-	-	-	-	-	-	-	-	-
33	Treubaria set	402	-	-	-	-	-	-	-	-	-	402	-	-
34	Selenast min	322	-	67	-	-	-	-	-	-	807	2212	403	-
35	Oocystis pus	80	-	-	13	-	-	-	-	-	-	-	-	-
36	Chlamyd polyp	321	-	-	-	-	-	-	-	-	-	-	-	-
37	Scened quad	1005	1126	335	67	40	-	-	-	-	-	3821	3117	255
38	Crucigenia	120	-	67	-	-	-	-	-	-	-	-	-	-
39	Selenast west	362	523	6367	147	54	80	-	-	201	-	-	302	13
40	Shroederia set	40	-	-	-	-	-	-	-	201	-	201	-	-
41	Pediast duplex	40	-	-	-	-	-	-	-	-	-	-	-	-
42	Scened otter	40	-	-	-	-	-	-	-	-	-	-	-	-
43	Dictyosph pulc	-	-	-	-	-	-	-	-	-	-	201	-	80
44	Ankist falc	-	80	-	13	40	-	40	-	-	-	-	905	-
45	Closterium cy	-	523	-	-	-	-	-	-	-	-	-	-	-
46	Crucigenia fen	-	40	-	-	-	-	-	-	-	-	-	-	-
47	Crucig tetrap	-	40	-	-	-	-	-	-	-	-	-	-	-
48	Chlorella	-	-	-	107	-	-	-	-	402	-	-	101	161
49	Carteria cord	-	-	-	13	-	-	-	-	-	-	-	-	147
50	Pediastr bory	-	-	-	-	-	40	-	-	-	-	-	-	-
51	Chlamydo spha	-	-	-	-	-	-	40	8400	-	-	-	302	-
52	Closteriopsis l	-	-	-	-	-	-	-	-	603	-	-	-	-
53	Racib urog	-	-	-	-	-	-	-	-	402	-	-	-	-
54	Oocystis cras	-	-	-	-	-	-	-	-	201	-	-	-	-
55	Tetrast staur	-	-	-	-	-	-	-	-	-	404	-	704	27
56	Lagerheimia q	-	-	-	-	-	-	-	-	-	404	1005	101	13
57	Crucig quad	-	-	-	-	-	-	40	-	-	-	-	-	-
58	Chlorogonium	-	-	-	-	-	-	320	-	-	-	-	-	-
59	Lobomonas sp	-	-	-	-	-	-	-	-	-	-	201	-	-
60	Micractin pus	-	-	-	-	-	-	-	-	-	-	1810		-
61	Xanthidium	-	-	-	-	-	-	-	-	-	-	402	-	-
62	Staurastrum	-	-	-	-	-	-	-	-	-	-	603	-	-
63	Trachelomonas	80	281	-	13	-	-	40	200	-	404	201	3016	161
64	Euglena virid	522	-	-	-	-	-	-	-	-	-	-	-	-
65	Euglena grac	201	-	-	-	-	-	-	-	-	-	-	-	134
66	Phacus sp	201	40	-	-	-	-	-	-	-	-	-	101	
67	Euglena min	-	160	-	-	-	-	-	800	-	-	-	-	-
68	Euglena sp	-	-	-	27	13	-	-	-	-	-	402	-	-
69	Lepocinclis sp	-	-	-	-	-	-	-	20800	201	-	-	-	-13
70	Euglena conv	-	-	-	-	-	-	-	-	-	-	-	-	-
71	Trachelo hisp	-	-	-	-	-	-	-	-	-	-	-	-	27
72	Phacus long	-	-	-	-	-	-	-	-	-	-	-	-	13
73	*	-					-	-	-	-	-	-	-	-

Betley Mere BL

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	*	*	*	*	*	*	*	*	*
2	0.009	0	1.95	64.3	76.3	1.2	1.22	0.6	0
3	0.032	14	1.96	74.7	112.7	1.52	1.08	0.4	1.2
4	1.18	221		6.1	8.3	1.39	0.72	>	0.26
5	0.46	234	5.63	6.4	14.3	2.26	0.75	>	2.9
6	0.64	275	5.45	6.2	16.7	3.24	0.87	>	1.8
7	2.24	112	5.59	25.3	25.7	1.12	0.97	>	0.14
8	3.4	26.5	5.91	58.3	40	0.75	0.86	0.5	0.4
9	2.31	54	5.27	63	42	0.73	0.67	0.35	0
10	2.0	83	2.5	80	89	1.22	1.16	>	0.13
11	0.3	67	0.44	213	261	0.22	1.29	0.6	0.16
12	0	74	0.56	109.3	129.3	1.3	1.27	>	0.76
13	0	0	6.52	84.7	82.7	1.07	1.13	>	7.77
14	0.05	14	6.5	26.0	30.0	1.27	1.12	>	7.8
15									
16	1.69 (1.4)	162 (114)	5.65 (0.190	24.1 (24.5)					1.3 (1.29)
17	0.65 (0.93)	59 (69)	3.21 (2.5)	80.1 (58.6)					2.01 (3.3)
18	0.97 (1.15)	90 (94)	4.02 (2.34)	62.9 (56.3)					1.79 (2.8)

Betley Mere Phytoplankton / ml

	Organism	Aug 28 91	Sep 18 91	Oct 23 91	Nov 12 91	Dec 4 91	Jan 15 92	Feb 4 92	Mar 3 92	Mar 24 92	Apr 15 92	May 13 1992	June 3 1992	June 22 1992
74	Myrmecia sp	-	-	-	-	-	-	-	-	-	-	201	-	-
75	Unid flag	-	-	-	-	-	-	-	-	-	3834	-	-	-
76	Monomastix	-	-	-	-	-	13830	17480	-	-	-	-	-	-
77	*	-	-	-	-	-	-	-	-	-	-	-	-	-
78	Rhodomonas m	442	483	201	13	-	643	1480	1800	402	5247	1207	1508	1018
79	Crypto erosa	241	-	-	-	-	-	-	-	201	-	-	-	-
80	Crypto ovata	-	-	-	-	-	40	200	600	-	1816	-	402	415
81	Crypto acuta	-	-	-	-	-	-	-	-	-	-	-	1810	-
82	*	-	-	-	-	-	-	-	-	-	-	-	-	-
83	Ceratium hir	40	-	-	-	-	-	-	-	-	-	-	-	-
84	Glenodinium	-	-	-	-	-	-		84	-	-	-	-	-
85	*	-	-	-	-	-	-	-	-	-	-	-	-	-
86	Ochromonas	-	-	-	-	-	-	-	-	-	-	-	-	107
87	Ophiocyt cap	-	322	-	-	-	-	-	-	-	-	-	-	40
88	Mallomonas sp	-	-	-	-	-	-		-	-	201	201	-	54
89	Chroomonas	-	-	-	-	-	-	-	-	-	-	-	302	-
90	*	-	-	-	-	-	-	-	-	-	-	-	-	-
91	Anabaena circ	-	-	-	-	-	-	-	-	-	-	603	-	-
92	Microcystis a	121	-	-	-	-	-	-	-	-	-	-	-	-
93	Aphanocap el	121	-	-	-	-	-	-	-	-	-	603	-	-
94	Gloeocystis m	201	-	-	-	-	-	-	-	-	-	-	-	804
95	Anabaena sp	-	-	-	-	-	-	-	600	-	-	-	-	-
96	Dactyloc raph	241	-	-	-	-	-	-	-	-	-	-	1810	94
97	Oscillatoria	-	-	67	-	-	-	-	-	-	-	-	-	13
98	Microc incerta	-	-	67	-	-	-	-	-	-	-	-	-	-
99	Stigonema	-	-	-	-	-	-	40	-	-	-	-	-	-
100	Aphanocapsa	-	-	-	-	-	-	-	-	-	-	-	201	134
101	Gloeothece lin	-	-	-	-	-	-	-	-	-	-	-	101	-
102	Dact acic	-	-	-	-	-	-	-	-	-	-	-	-	40
103	*	-	-	-	-	-	-	-	-	-	-	-	-	-
104	*	-	-	-	-	-	-	-	-	-	-	-	-	-
105	*	-	-	-	-	-	-	-	-	-	-	-	-	-
106	*	-	-	-	-	-	-	-	-	-	-	-	-	-
107	Chlamydo glob	-	-	-	-	-	-	-	-	-	-	-	-	134
108	Chlamydo sp	-	-	-	-	-	-	-	-	-	-	-	-	161
109	Selenast min	-	-	-	-	-	-	-	-	-	-	-	-	94
110	Closterium	-	-	-	-	-	-	-	-	-	-	-	-	13
111	Crucigenia api	-	-	-	-	-	-	-	-	-	-	-	-	94
112	Pandor morum	-	-	-	-	-	-	-	-	-	-	-	-	13
113	Quadrig lac	-	-	-	-	-	-	-	-	-	-	-	-	13
114	Nephrocytium	-	-	-	-	-	-	-	-	-	-	-	-	13
115	Tetraed trig	-	-	-	-	-	-	-	-	-	-	-	-	27
116	Coelast sphaer	-	-	-	-	-	-	-	-	-	-	-	-	13
117														
118	Total diatoms	16885	3989	2611	1205	1113	202	120	14400	32374	58320	46653	11363	750
119	Total greens	31124	4624	9650	504	174	1005	1360	18601	5227	5449	18499	24636	1513
120	Total others	1727	1286	201	53	13	14513	19200	24284	804	11502	2212	7139	1982
121	Total bl greens	584	0	134	0	0	0	40	600	0	0	1206	2112	1660
122	Total	50320	9899	12596	1762	1300	15720	20720	57885	38405	75271	68570	45250	5905
123														
124	% diatoms	33.6	40.3	20.7	68.3	85.6	1.3	0.6	24.9	84.3	77.5	68	25.1	12.7
125	%greens	61.9	46.7	76.6	28.6	13.4	6.4	6.6	32.1	13.6	7.2	27	54.4	25.6
126	%others	3.4	13.0	1.6	3.0	1.0	92.3	92.6	42.0	2.1	15.3	3.2	15.8	33.6
127	% bga	1.2	0	1.1	0	0	0	0.2	1.0	0	0	1.8	4.7	28.1
128														
129		Diatoms	Greens	Others	Blue greens									
130	Winter mean %	39(44)	13.7(10.4)	47.2(52.3)	0.05(0.1)									
131	Growth mean%	43(26.6)	38.3(23)	14.4(14.6)	4.2(9.1)									
132	Allyear mean%	41.8(31)	30.8(23)	24.5(33)	2.9(7.7)									



N
Ec
Pp
Cd
Pp
Nl
Nl
Dense
bed
Cd
Dense Pp/Cd
some Lt
Ec
Nl
Zp
Cd
Ec
Cd
Ch
Cd/Pp
beds
Ch
Ec
Pp
Cd
Dense Pp beds;
some Ec, Ch
and Lt
Pp
Cd
Dense
growth
Ec
dense
growth
Nl
Ch
Pp
Dense bed:
70% Pp
30% Ch
Cd
Pp
Ch
Lt
Ec
Ec
Pp
Nl
Cv
Ch
Cd
Nl
0
20
40
60
metres
Abundant

Betley Mere

(c) BETTON POOL

(i) Morphometry and water budget

Betton Pool is a fairly deep lake (10.9m) of modest area (6.4ha). It appears to be fed entirely by ground water apart from a little surface run-off after rain and it is not possible to make any sensible estimate of retention time of water in it. It stratifies in summer and the hypolimnion becomes deoxygenated to a severe extent.

(ii) Land use changes

Betton Pool has a probable catchment in Berrington Parish whose land usage since 1931 has changed as follows:

	1931	1987
Cattle(head)	956	1181
nutrient units	11568	14290
Pigs(head)	473	21
nutrient units	2270	101
Sheep(head)	2250	773
nutrient units	3375	1160
Poultry(head)	2951	237
nutrient units	413	33
Total nutrient units	17626	15584
Permanent grass(ha)	942	409
Temporary grass(ha)	184	120
Arable(ha)	370	757
Woodland(ha)	2	20
Rough grazing(ha)	1	7
Total hectarage	1499	1313

There has thus been some decline in stock-keeping overall despite an increase in cattle which has been a common feature in the region, and much conversion of grassland to arable and to other (non-agricultural) uses.

(iii) Major ion chemistry and nutrient loads

Conductivities and alkalinities are modest for the area and chloride relatively high. Total and soluble phosphorus are relatively high but modest in the mere's context, whilst nitrate and ammonium concentrations are low even in winter. when the main supplies arrive. Nitrate is frequently undetectable in summer.

(iv) Phytoplankton and zooplankton

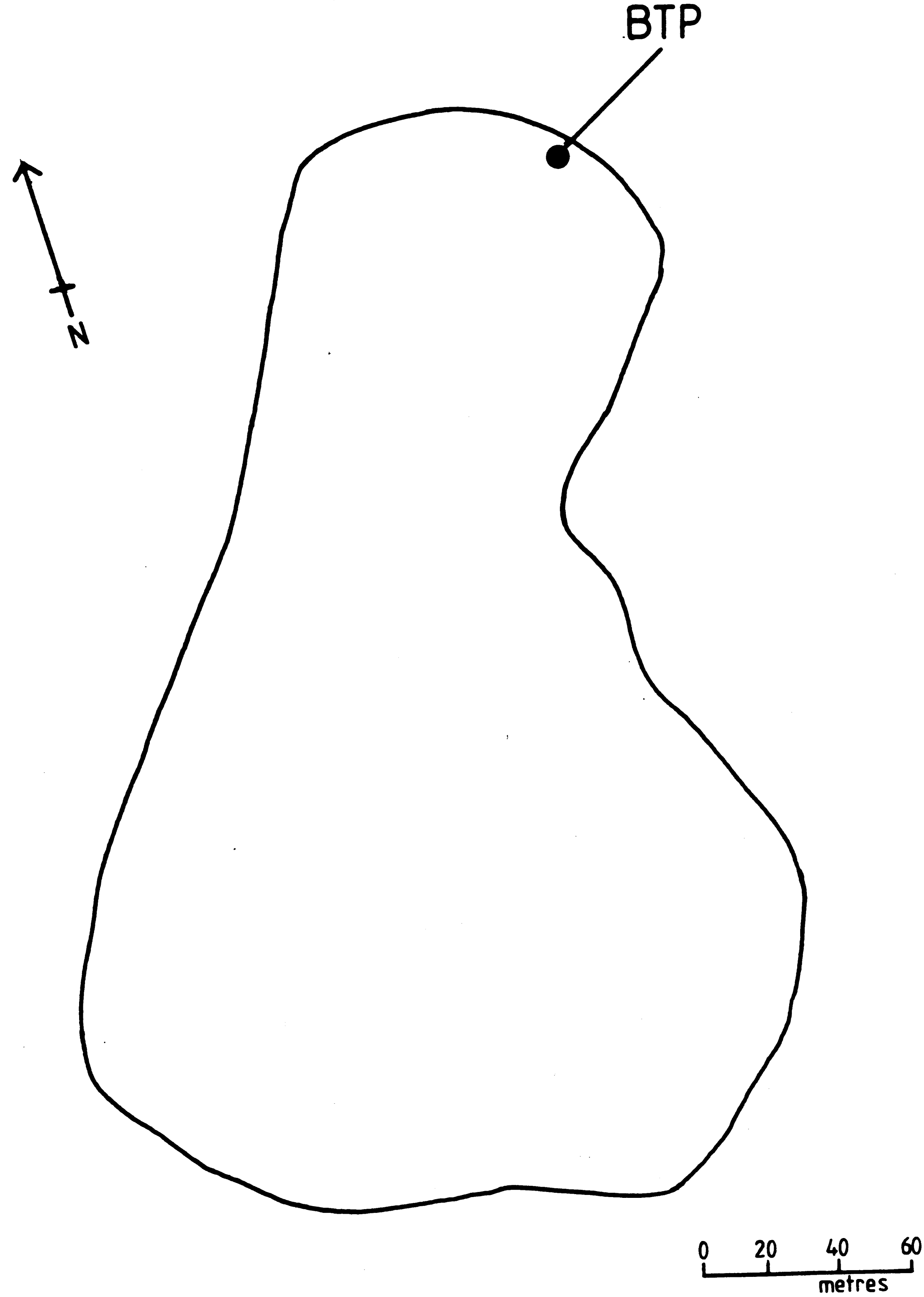
Chlorophyll a concentration reaches modest peaks in mid summer but is, on average not very high. The algal crops are probably controlled largely by nitrogen availability for zooplankton grazers are scarce. The phytoplankton is dominated by diatoms and flagellates in winter whilst flagellates, green algae and to a rather lesser extent. blue-green algae become more abundant in summer.

(v) Aquatic plants

The pool has a relatively well developed aquatic plant community in the narrow littoral zone where the morphometry would permit growth. The trophic score has remained steady since 1979 (8.3) and the small drop to 8.1 in 1991 is probably not significant. There has been a reduction in DAFOR score for the submerged plants from 13.5 in 1979 to 9.5 in 1987 and 10 in 1991. This may be as much due to different observer perceptions as real change.

(vi) Overall assessment

Betton Pool does not appear to be suffering from eutrophication problems that are any greater than the probable regional change that has occurred in the post-war period as a result of the intensification of agriculture. There are no restoration measures that are immediately practicable.



BTP
N
0 20 40 60
metres

Betton Pool BTP

Mon, Aug 31, 1992 5:23 am

	Date	Conductivity	Phenolph Alk	Total alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	366	0.00	2.00	8.19	40.8	8.0	8.0	17.0	25.0
2	Aug 14 1991	354	0.10	2.00	8.33	42.9	5.8	18.8	21.9	40.7
3	Sep 4 1991	364	0.10	1.62	8.02	40.8	0.0	23.0	30.0	53.6
4	Oct 9 1991	363	0.20	2.20	7.50	41.3	97.7	-	-	134.0
5	Oct 30 1991	370	0.20	2.40	7.68	44.4	149.5	132.8	66.6	199.4
6	Nov 20 1991	337	0.05	2.25	7.82	44.0	142.0	152	18	169.0
7	Dec 18 1991	365	0.00	2.20	7.79	61.0	157.0	157	26	183.0
8	Jan 22 1992	362	0.15	2.00	8.14	40.4	156.0	184	0	184.0
9	Feb 19 1992	356	0.20	2.10	8.18	43.1	118.0	134	40	175.0
10	Mar 11 1992	363	0.15	2.05	8.20	43.5	100.4	31	131	131.0
11	April 1 1992	351	0.30	2.10	8.13	43.1	91.0	91	82	173.0
12	April 29 1992	351	0.20	2.10	8.31	40.0	39.0	60	6	66.0
13	May 20 1992	349	0.05	2.00	8.30	44.0	21.0	43	2	45.0
14	June 10 1992	332	0.35	2.05	9.18	39.2	7.0	8	0.2	8.0
15										
16	Winter mean	355	0.10	2.14	7.98	47.1	143.0			178.0
17	SD	13	0.10	0.11	0.20	9.4	18.0			7.0
18	Growth mean	356	0.17	2.05	8.18	42.0	52.0			88.0
19	SD	11	0.11	0.20	0.45	1.8	53.0			66.0
20	Allyear mean	356	0.15	2.08	8.13	43.5	78.0			113.0
21	SD	11	0.10	0.18	0.40	5.3	62.0			70.0

Betton Pool BTP

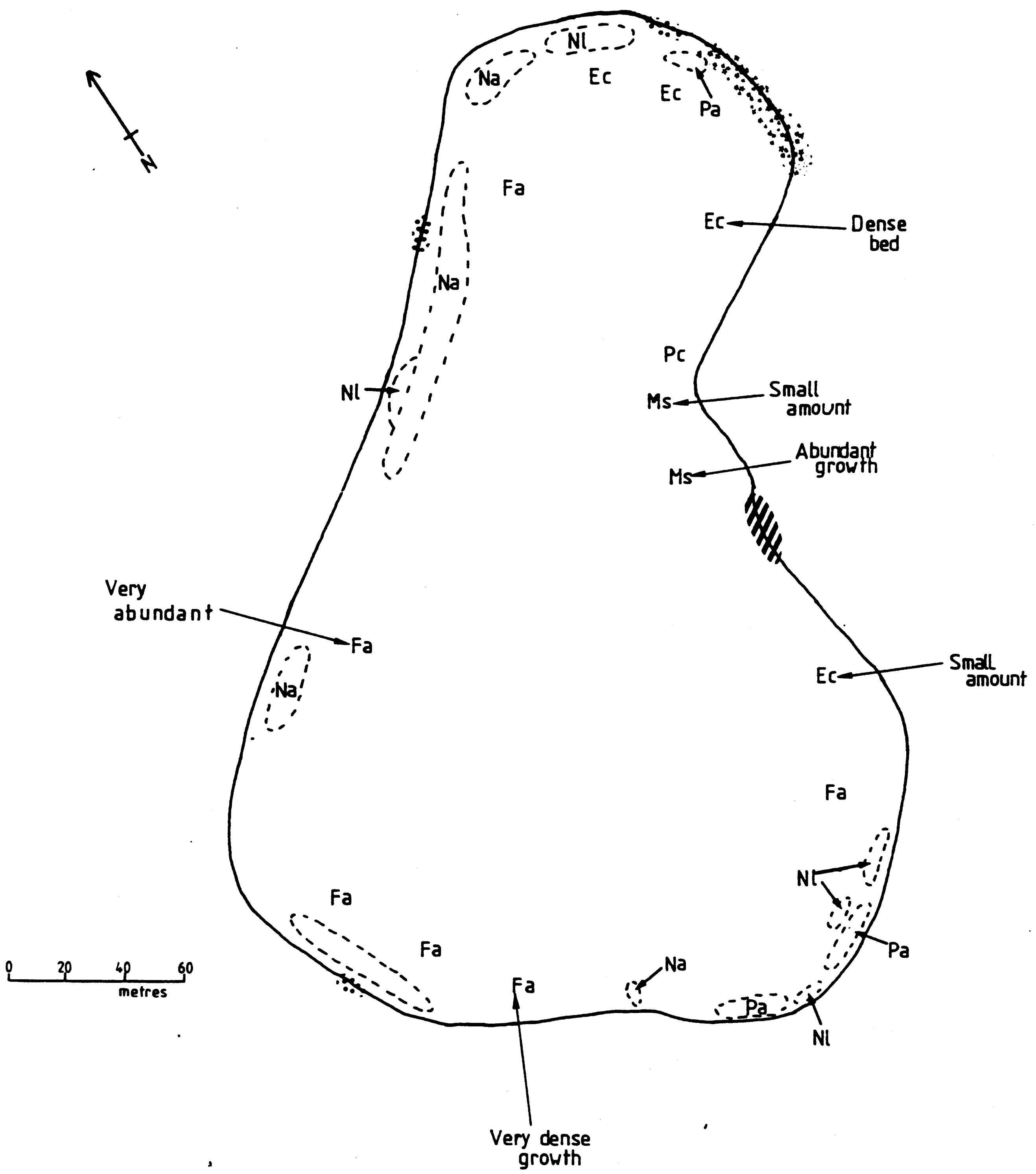
	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.00	32.0	0.05	7.3	11.7	1.75	1.04	-	0.00
2	0.00	151.0	0.00	32.0	33.3	1.05	1.25	0.95	0.39
3	0.00	27.0	0.27	18.9	34.0	1.82	1.22	>	0.07
4	0.00	153.0		5.4	11.7	2.19	1.06	>	0.00
5	0.11	336.0	0.50	7.4	13.3	1.82	0.99	>	0.00
6	0.43	219.0	0.51	5.2	12.3	2.64	0.89	>	0.07
7	0.34	184.0	0.59	3.7	8.0	2.40	0.96	>	0.00
8	0.64	94.0	0.59	3.7	6.0	1.80	1.00	>	0.00
9	0.56	82.5	7.74	7.3	11.3	1.70	1.17	>	0.00
10	0.75	48.0	0.20	3.7	12.3	3.70	1.06	>	0.18
11	0.93	42.0	0.21	3.7	4.3	1.30	1.06	>	0.36
12	0.36	61.0	0.13	3.7	6.0	1.80	1.06	>	4.10
13	0.12	117.0	0.31	1.9	3.9	2.20	1.07	>	7.63
14	0.11	188.0	0.54	53.5	51.0	1.05	1.31	>	1.96
15									
16	0.49	145.0	0.56	5.0					0.18
17	0.13	67.0	0.05	1.7					0.04
18	0.24	116.0	0.25	13.8					1.47
19	0.33	97.0	0.18	16.8					2.53
20	0.31	124.0	0.33	11.2					1.05
21	0.31	88.0	0.21	14.6					2.20

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	March	April 1 1992	April 28 1992	May 20 1992	June 10 1992
1	Ast form	-	-	134	-	13	54	134	637	-	-	-	-	-
2	Cocconeis	-	-	-	-	-	13	-	-	-	-	-	-	-
3	Cyclot meneg	-	-	13	-	-	-	-	-	-	-	-	-	-
4	Cyclot sp	44	-	-	415	375	80	27	650	-	27	-	-	-
5	Frag crot	-	-	94	-	-	-	-	-	-	-	-	-	-
6	Gomph vent	-	134	-	-	-	-	-	-	-	-	-	-	-
7	Navicula	-	-	13	-	-	-	-	-	-	-	13	-	-
8	*	-	-	-	-	-	-	-	-	-	-	-	-	-
9	*	-	-	-	-	-	-	-	-	-	-	-	-	-
10	*	-	-	-	-	-	-	-	-	-	-	-	-	-
11	*	-	-	-	-	-	-	-	-	-	-	-	-	-
12	Ankist falc	-	-	13	-	-	-	-	-	-	-	-	-	-
13	Characium lim	22	-	-	-	-	-	-	-	-	-	-	-	-
14	Chlamydo ep	-	201	-	-	-	-	-	-	-	-	-	-	-
15	Chlamydo glob	67	-	-	-	-	-	-	-	-	-	-	-	-
16	Chlamydo poly	-	-	27	-	-	-	-	-	-	-	-	-	-
17	Chlamydo sp	-	536	107	161	-	27	107	134	-	27	-	-	844
18	Chlorog elong	-	-	-	-	-	-	-	-	-	-	54	-	-
19	Coelastrum sph	-	-	54	-	-	-	-	-	-	-	-	-	-
20	Closterium ac	-	-	40	-	-	-	-	-	-	-	-	-	-
21	Clost cynth	-	-	-	-	27	13	-	-	-	-	-	-	-
22	Dict pulch	-	-	27	-	-	-	-	-	-	-	-	-	27
23	Eudorina eleg	45	-	-	-	-	-	-	-	-	-	-	-	94
24	Oocystis pus	22	-	27	-	-	-	-	-	-	-	13	-	-
25	Oocystis sol	-	-	-	-	-	-	-	-	-	13	-	-	-
26	Pandor morum	22	-	40	-	-	-	-	-	-	-	-	-	898
27	Pediast duplex	-	-	-	-	-	-	-	13	-	-	-	-	-
28	Selenast min	-	-	40	40	-	-	-	-	-	-	-	-	13
29	Scened bijug	45	-	-	13	-	-	-	-	-	27	-	-	-
30	Scened quad	-	-	40	13	27	-	-	-	-	-	-	-	-
31	Schroed setig	-	134	-	-	-	-	-	-	-	-	-	27	13
32	Tetrastrum sp	-	-	-	-	-	-	-	13	-	-	-	-	-
33	Lagerheim qua	-	-	-	-	-	-	-	-	-	-	-	13	-
34	*	-	-	-	-	-	-	-	-	-	-	-	-	-
35	*	-	-	-	-	-	-	-	-	-	-	-	-	-
36	Crypto sp	-	-	-	94	-	-	-	-	-	-	-	-	-
37	Crypto ac	-	-	-	-	-	27	67	39	-	-	-	-	-
38	Crypto ov	-	-	54	-	13	-	-	78	-	134	362	214	67
39	Crypto refl	-	-	-	-	-	-	13	-	-	13	-	-	-
40	Rhodomonas m	2033	268	214	201	295	523	884	663	-	134	40	295	402
41	Trachelomonas	-	-	-	-	-	-	-	-	-	-	-	-	40
42	*	-	-	-	-	-	-	-	-	-	-	-	-	-
43	Euglena sang	-	-	-	-	-	-	-	13	-	-	-	-	-
44	Euglena sp	-	67	-	-	-	-	-	-	-	-	-	-	-
45	*	-	-	-	-	-	-	-	-	-	-	-	-	-
46	*	-	-	-	-	-	-	-	-	-	-	-	-	-
47	*	-	-	-	-	-	-	-	-	-	-	-	-	-
48	Chlorochro mi	-	335	-	-	-	-	-	-	-	-	-	-	-
49	Mallomonas	-	-	-	-	-	-	-	-	-	-	13	-	13
50	Dinobryon div	-	-	27	-	-	-	-	-	-	-	-	27	-
51	Ceratium hir	45	-	13	-	-	-	-	-	-	-	-	-	-
52	Glenodinium	-	-	-	-	-	-	-	13	-	-	-	-	-
53	*	-	-	-	-	-	-	-	-	-	-	-	-	-
54	Anabaena aff	268	268	509	-	-	-	-	-	-	-	-	-	-
55	Anab spir	-	-	13	-	-	-	-	-	-	-	-	-	-
56	Anab sp	-	67	-	-	-	-	-	-	-	-	-	13	13
57	Aphcap elac	22	469	174	-	-	-	-	-	-	-	-	-	-
58	Aphanocapsa	-	-	-	-	-	-	-	13	-	-	-	-	-
59	Aphanothece g	22	-	-	-	-	-	-	-	-	-	-	-	-
60	Aphan flos aq	-	-	13	40	-	-	-	-	-	-	-	-	-
61	Chroococ lim	670	-	-	-	-	-	-	-	-	-	-	-	-
62	Coelo sp	-	-	-	13	-	-	-	-	-	-	-	-	-
63	Coelo naeg	-	-	-	-	67	-	-	-	-	-	-	-	-
64	Gompho lac	-	-	27	-	-	-	-	-	-	-	-	-	-
65	Gompho spon	-	-	161	-	-	-	-	-	-	-	-	-	-
66	Dact fac	67	-	-	-	-	-	-	-	-	-	-	-	-
67	Microcyst aer	89	201	1005	-	13	-	-	13	-	-	-	-	-
68	Oscillat ten	-	-	-	-	-	-	-	-	-	-	-	27	-
69														
70	Total diatoms	44	134	254	415	388	147	161	1287		27	13	0	0
71	Total greens	223	671	415	227	54	40	107	160		67	67	40	1899
72	Total others	2078	670	308	295	308	550	964	806		281	415	536	522
73	Total bga	1128	1005	1902	53	70	0		26		0	0	40	13

Betton Pool Phytopl. 1991/92

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	March	April 1 1992	April 28 1992	May 20 1992	June 10 1992
74	Total	3473	2480	2879	990	820	737	1232	2279		375	495	616	2434
75														
76	Diatom %	1.3	5.4	8.8	42	47.3	19.9	13.1	56.5		7.2	2.6	0	0
77	Grenns %	6.4	27.1	14.4	23	6.6	5.4	8.7	7		17.9	13.5	6.5	78
78	Others %	59.8	27.0	10.7	29.8	37.6	74.6	78.2	35.4		74.9	83.8	87	21.4
79	Bga %	32.5	40.5	66.1	5.4	8.5	0	0	1.1		0	0	6.5	0.5
80														
81		Diatoms	Greens	Others	Blue greens									
82	Winter mean %	34.2(21)	6.9(1.4)	56.5(23.1)	2.4(4.1)									
83	Growth mean%	8.4(14)	23.4(23.2)	49.3(30.5)	18.9(24.7)									
84	Allyear mean%	17(20)	17.9(20.2)	51.7(27)	13.4(21.4)									

Betton Pool


N
Nl
Na
Ec
Ec
Pa
Fa
Ec
Dense
bed
Na
Pc
Nl
Ms
Small
amount
Abundant
growth
Ms
Very
abundant
Fa
Na
Ec
Small
amount
Fa
Nl
Pa
Fa
Fa
Fa
Na
Pa
Nl
0
20
40
60
metres
Very dense
growth

(d) BOMERE

(i) Morphometry and water budget

Bomere is an elongate lake, of 10.3ha, and with a maximum depth of 15.2 m that lies, with Betton Pool and Berrington Pool in the group of meres to the south east of Shrewsbury. It stratifies in summer and appears to be largely ground-water fed, for there are no permanent surface water inflows. No sensible estimate can be made at present of its retention time.

(ii) Land use changes

Bomere has a catchment that is probably contained in the parishes of Berrington (Bayston Hill) and Condover. The land use of these parishes has been as follows:

	1931	1987
Cattle(head)	2668	4731
nutrient units	32283	57245
Pigs	1931	236
nutrient units	9269	1133
Sheep(head)	6699	8336
nutrient units	10049	12504
Poultry(head)	14978	389
nutrient units	2097	55
Total nutrient units	53698	70937
Permanent grass(ha)	2605	1467
Temporary grass(ha)	495	874
Arable(ha)	964	2516
Woodland(ha)	4	77
Rough grazing(ha)	51	33
Total hectarage	4119	4967

There has thus been a small increase of stock-keeping with cattle and sheep replacing pigs and poultry and a change from permanent grazing to temporary grazing and arable. There have been some parish boundary changes and so the stock increase in the catchment itself may have been on a lesser scale.

(iii) Major ion water chemistry and nutrient loads

Bomere has a very low conductivity for the meres, coupled with a low alkalinity and chloride concentration. In these respects it is most comparable with Oakmere, both being considerably less ion-rich than the other meres examined. Similarly, Bomere has low soluble and total phosphorus concentrations though these are slightly higher (as is its alkalinity) than those of Oakmere. The soluble phosphorus rises to a mean of 81 ug/l in winter which is not inconsiderable but may fall to zero in summer. The total phosphorus also falls in summer to half the winter value. This may be due to uptake and delivery to the sediment in summer rather than to any great seasonality in water delivery or washout. Nitrate concentrations and ammonium concentrations are both low, even in winter and concentrations of total inorganic nitrogen are sometimes zero in summer. The data suggest a lake that is fairly severely nutrient limited in the growth season.

(iv) Phytoplankton and zooplankton

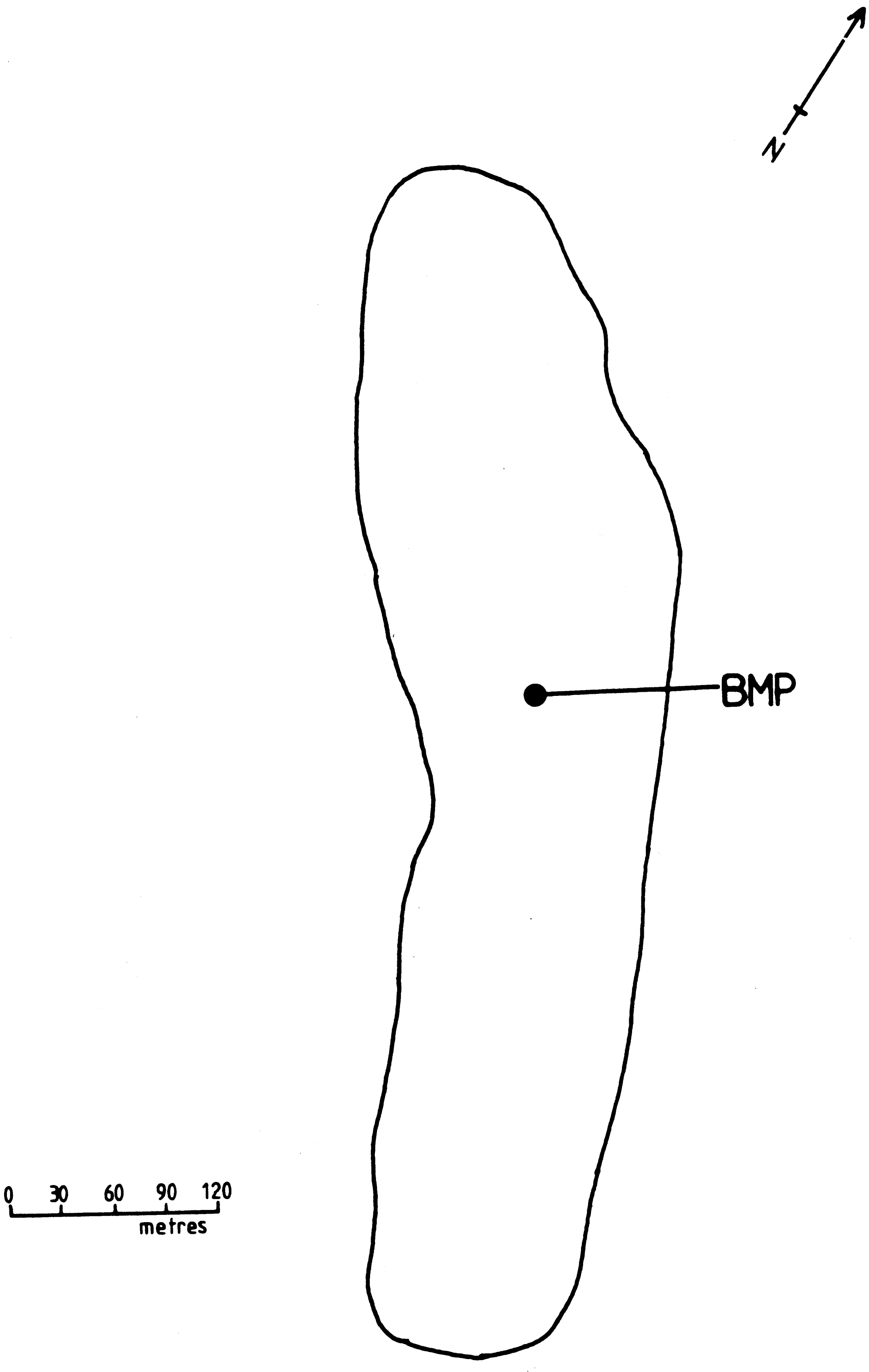
Phytoplankton crops are modest with relatively low representation of diatoms. Green algae dominate with flagellates next most abundant. Blue-green algae are present but only occasionally have much numerical significance. Although there is a late spring population of ***Daphnia***, it rapidly declines and grazing is probably a minor feature of the plankton in summer.

(v) Aquatic plants

The aquatic plant community is reasonably diverse and includes ***Elatine hexandra*** among species that are more widely distributed both in this lake and elsewhere. The trophic score has remained steady at 7.6-7.8 since 1979 and, if anything, the DAFOR score for submerged plants seems to indicate an increase in biomass.

(vi) Overall assessment

Bomere seems to have few real problems. The boating activity on it may locally disturb the plant beds but they are nonetheless thriving and the water quality is good despite post-war changes in agriculture and the proximity of Bomere Farm to the immediate north of the lake. Among the meres, Bomere may be notable in having fairly marked nutrient limitation in summer.


N
BMP
0 30 60 90 120
metres

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	161	0	0.40	8.74	26.5	5.0	14.0	14.0	28.0
2	Aug 14 1991	135	0	0.60	8.29	24.5	8.0	17.4		17.4
3	Sept 4 1991	137	0	0.30	7.48	22.5	0.0	29.0	31.0	60.0
4	Oct 9 1991	131	0	1.50	7.78	28.3	14.0			64.0
5	Oct 30 1991	142	0	1.85	7.23	24.2	61.0	78.0	31.0	109.0
6	Nov 20 1991	124	0	0.60	7.47	22.0	79.0	98.0	15.0	113.0
7	Dec 18 1991	136	0	0.55	7.79	22.2	93.0	93.0	0.0	93.0
8	Jan 22 1992	130	0	0.45	7.95	23.1	85.4	108.0	9.0	118.0
9	Feb 19 1992	127	*	*	7.49	25.5	67.7	90.0	34.5	124.5
10	Mar 11 1992	130	0	0.45	8.22	24.0	33.0	33.0	59.0	92.0
11	April 1 1992	133	0.3	0.6	9.65	21.6	16.0	16.0	0.0	16.0
12	April 29 1992	120	0	0.5	7.85	20.0	3.0	10.0	26.0	36.0
13	May 20 1992	121	0	0.45	8.57	24.0	0.0	26.0	25.0	51.0
14	June 10 1992	120	0	0.45	8.20	23.5	12.0	12.0	0.0	12.0
15										
16	Winter mean	129	0	0.53	7.67	23.2	81.0			112.0
17	SD	5		0.08	0.24	1.6	11.0			14.0
18	Growth mean	133	0.03	0.71	8.20	23.9	15.0			48.5
19	SD	12	0.09	0.57	0.70	2.3	19.0			33.0
20	Allyear mean	132	0.02	0.67	8.05	23.7	34.1			66.7
21	SD	11	0.08	0.46	0.64	2.1	35.0			41.0

Bomere Pool BMP

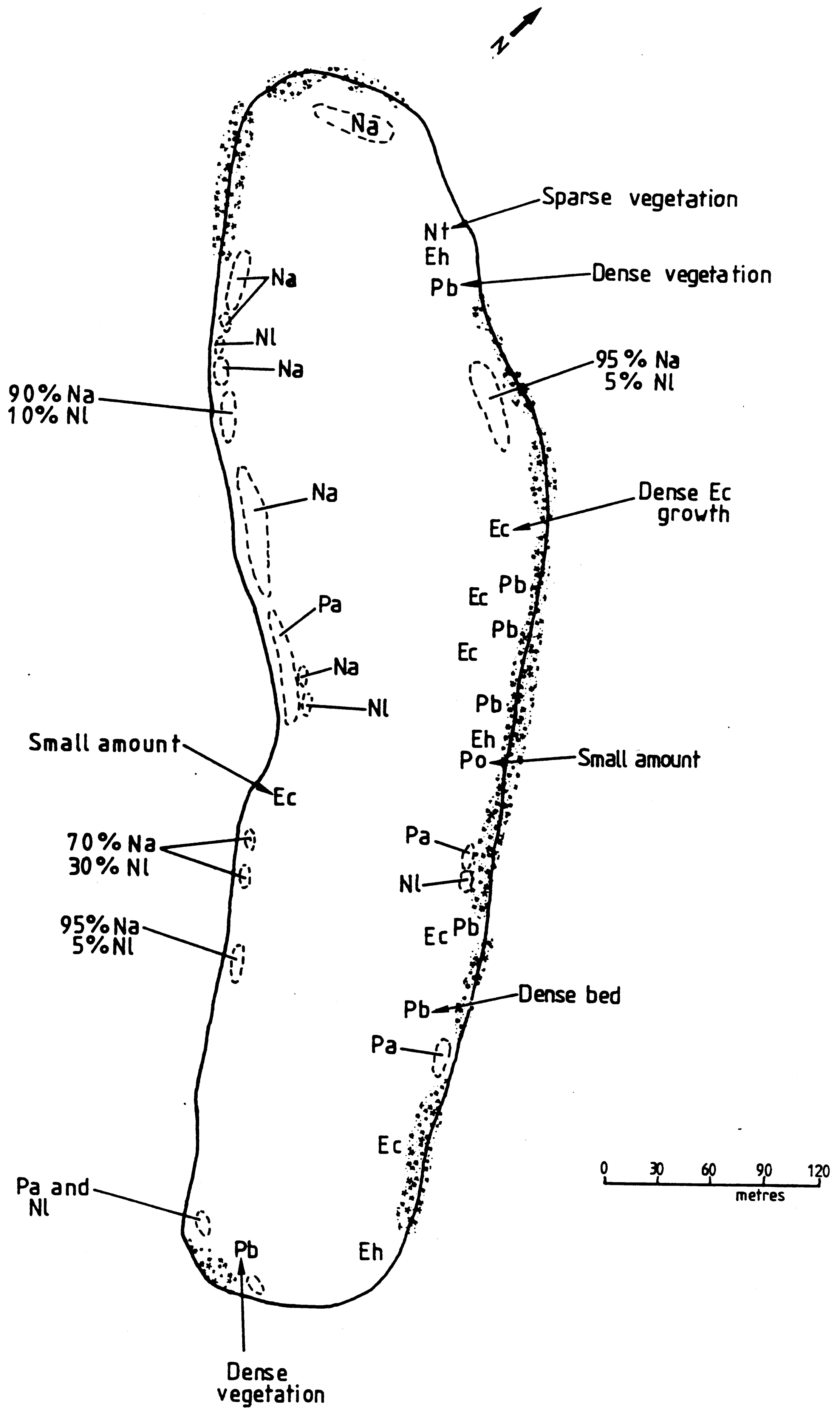
	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.100	67.0	0.44	6.9	15.3	2.56	1.09	1.45	0.60
2	0.008	329.0	0.00	2.7	8.0	3.00	1.10	2.10	0.00
3	0.000	44.0	0.28	12.1	20.0	1.67	1.13	1.85	0.00
4	0.000	116.0	0.50	23.9	30.3	1.28	1.17	1.80	0.00
5	0.020	406.0	0.28	9.4	12.3	1.32	0.95	2.65	0.08
6	0.170	306.0	0.14	4.4	8.3	2.08	0.93	2.10	0.08
7	0.120	464.0	0.74	5.9	9.3	1.75	0.93	2.90	0.00
8	0.320	309.0	0.31	2.2	6.3	3.17	0.76	2.60	0.00
9	0.470	235.0	0.20	16.5	18.3	1.22	1.18	1.70	0.15
10	0.520	16.3	0.18	15.8	24.0	1.67	1.15	-	0.21
11	0.350	17.0	0.17	28.6	33.7	1.29	1.11	-	0.12
12	0.180	34.0	0.23	6.2	11.0	1.94	0.98	1.9	55.50
13	0.100	232.0	0.23	15.8	19.0	1.33	1.18	1.5	58.90
14	0.000	0.0	0.27	17.2	24.7	1.57	1.14	>	24.00
15									
16	0.270	329.0	0.35	7.3					0.06
17	0.160	97.0	0.27	6.4					0.07
18	0.130	126.0	0.26	13.9					13.90
19	0.180	145.0	0.14	8.1					24.00
20	0.170	184.0	0.28	12.0					10.00
21	0.180	160.0	0.18	8.0					21.00

	Organism	Jul 24 1991	Aug 14 1991	Sept 9 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	March	April 1 1992	April 28 1992	May 20 1992	June 10 1992
1	Aster form	134	13	-	-	-	-	-	40	40	-	-	-	-	-
2	Cocconeis	-	-	-	-	-	-	13	-	-	-	-	-	-	-
3	Cyclo men	-	13	-	-	-	-	-	-	-	-	-	-	-	-
4	Cyclo oct	-	174	-	-	-	-	-	-	-	-	-	-	-	-
5	Cyclo sp	134	-	134	67	196	-	54	603	200	-	80	-	-	201
6	Cymbella	-	-	-	45	-	-	-	-	-	-	-	-	-	-
7	Fragil sp	-	94	134	-	22	-	-	-	-	-	-	-	-	101
8	Melos gran	-	-	-	-	-	13	-	-	-	-	-	-	-	-
9	Navicula	-	54	-	-	-	-	13	-	360	-	-	-	-	-
10	Nitzschia	-	13	-	-	-	-	-	-	-	-	-	-	-	-
11	Stephanod	-	-	67	22	-	-	-	-	-	-	-	-	-	-
12	Tab fenest	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Ank braun	-	-	-	-	-	-	-	-	-	-	1286	-	-	-
18	Ank conv	-	214	1206	22	22	-	-	228	720	-	11340	1206	-	4927
19	Ank falc	402	-	-	-	22	13	54	-	760	-	1327	-	-	603
20	Chlam ep	-	107	-	-	-	-	-	-	-	-	-	-	-	-
21	Chlam glob	201	40	-	-	-	-	-	-	-	-	-	-	-	-
22	Chlam poly	-	-	67	-	-	-	-	-	-	-	-	-	-	-
23	Chlamyd sp	-	-	1876	-	-	-	27	40	-	-	120	201	-	201
24	Chlorella	-	-	-	-	-	94	40	-	-	-	120	-	-	-
25	Closteriop lon	-	27	201	-	-	-	-	-	-	-	80	-	-	-
26	Closterium ac	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	Clost cynth	-	-	-	-	-	-	-	40	-	-	-	201	67	-
28	Clost sp	-	-	134	-	-	-	13	-	-	-	-	-	-	-
29	Coelastrum	-	-	-	-	-	-	-	27	-	-	-	-	67	201
30	Cosmarium fo	-	-	-	-	-	-	-	-	-	-	-	201	-	-
31	Crucig quad	-	-	-	-	-	67	-	-	-	-	-	-	268	101
32	Dict pulch	-	-	339	-	-	-	-	-	-	-	-	-	-	-
33	Oocystis lim	-	-	-	-	-	-	-	-	-	-	40	-	-	-
34	Ooc pus	-	-	402	-	-	-	-	-	-	-	40	7239	-	-
35	Oocys sol	-	13	-	-	-	13	-	-	-	-	-	-	-	-
36	Oocys sp	-	94	-	22	-	-	-	13	-	-	-	-	-	-
37	Pand mor	-	-	335	-	-	-	-	-	-	-	-	-	-	-
38	Ped bory	-	40	134	-	-	40	107	40	-	-	-	201	-	101
39	Ped dup	67	-	-	-	22	13	-	40	-	-	-	-	-	-
40	Ped tet	-	13	-	-	22	13	-	-	-	-	-	-	-	-
41	Quadrig lac	-	-	-	22	-	-	-	-	-	-	-	-	-	101
42	Scened arc	-	-	-	-	-	-	-	-	-	-	-	201	402	-
43	Scened bij	134	201	-	-	-	-	40	80	-	-	522	-	-	402
44	Scened obl	-	-	-	22	-	-	-	-	-	-	-	-	-	-
45	Scened opol	-	-	67	-	-	-	-	-	-	-	-	-	-	-
46	Scened quad	-	-	134	-	67	54	40	13	-	-	40	201	134	402
47	Schroed jud	-	-	-	-	-	-	-	-	1880	-	-	-	-	-
48	Schroed set	-	-	-	-	-	-	-	13	1960	-	-	-	134	302
49	Selenast min	-	-	-	-	67	54	67	322	-	-	402	-	67	201
50	Selenast west	-	27	335	22	22	-	40	94	2000	-	4745	4424	67	503
51	Staurast ping	201	-	-	-	-	-	-	-	-	-	-	-	-	-
52	Staurast sp	-	40	67	-	-	-	-	-	-	-	40	-	-	101
53	Tetraedron lun	-	-	335	-	-	-	-	-	-	-	-	-	-	-
54	Tet min	-	94	-	22	22	13	-	-	-	-	-	-	-	-
55	Tetraed sp	-	-	-	-	-	-	-	27	-	-	-	-	-	-
56	Tetrast staur	-	-	-	-	-	-	-	-	-	-	322	603	-	-
57	Oocystis erem	-	-	-	-	-	-	-	-	-	-	-	-	5295	11059
58	Sphaerocystis	-	-	-	-	-	-	-	-	-	-	-	-	-	804
59	Golenkinia sp	-	-	-	-	-	-	-	-	-	-	-	-	-	101
60	Lagerheimia q	-	-	-	-	-	-	-	-	-	-	-	-	-	101
61	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
62	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
63	Euglena grac	67	-	-	-	-	-	-	-	-	-	-	-	-	-
64	Euglena sp	-	-	67	-	-	-	-	-	2560	-	-	-	-	-
65	Trachelo chark	-	-	-	-	-	-	-	-	-	-	40	-	-	-
66	Trachelo sp	-	-	-	-	-	-	-	-	-	-	-	-	67	201
67	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68	Crypto arc	-	-	-	-	-	-	-	-	-	-	-	-	201	-
69	Crypto acuta	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	Crypto erosa	-	-	-	-	-	-	27	27	2800	-	-	-	-	-
71	Crypto ovata	-	-	268	-	22	-	-	-	-	-	-	-	-	302
72	Crypto reflex	-	13	-	201	692	188	-	-	-	-	40	402	-	-
73	Crypto sp	-	-	-	-	-	-	27	-	-	-	-	-	-	-

Bomere Pool Phytopl. 1991/92

	Organism	Jul 24 1991	Aug 14 1991	Sept 9 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	March	April 1 1992	April 28 1992	May 20 1992	June 10 1992
74	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75	Rhodo min	-	40	67	112	67	308	147	214	3000	-	1246	22722	536	302
76	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
77	Unid flag	-	-	-	-	-	-	-	-	-	-	-	-	-	-
78	*	-	-	335	-	-	-	-	-	-	-	-	-	-	-
79	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80	Gymnodinium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
81	Pered cinct	-	-	-	-	-	-	13	-	-	-	-	-	-	-
82	Pered sp	67	-	-	-	-	-	-	-	-	-	-	-	-	-
83	*	-	27	67	22	-	-	-	-	-	-	-	-	-	-
84	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
85	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
86	Anab aff	-	-	-	-	-	-	-	-	-	-	-	-	-	-
87	Anab circ	-	-	335	-	-	-	-	-	-	-	-	-	-	-
88	Anab spir	-	67	201	-	-	-	-	-	-	-	-	-	-	-
89	Anab sp	-	-	201	358	-	-	-	-	-	-	-	-	-	-
90	Aphan flos aq	-	-	-	-	22	-	-	-	-	-	-	-	-	-
91	Aphan elach	-	-	3686	178	22	13	-	-	-	-	-	-	-	-
92	Aphanocap sp	9181	-	-	-	-	-	-	-	-	-	-	201	-	-
93	Coelosph sp	-	-	-	-	-	-	-	67	-	-	-	-	-	-
94	Dact facic	-	-	-	-	22	-	-	-	-	-	-	-	-	-
95	Dact raphid	-	-	-	-	-	-	-	-	-	-	-	-	-	-
96	Gloeocapsa	-	-	-	-	-	-	-	-	-	-	201	-	-	-
97	Microcyst aer	-	27	-	-	-	-	-	-	-	-	-	-	-	-
98	Microcyst eur	-	-	-	-	-	-	-	-	-	-	-	-	-	-
99	Oscill tenuis	-	134	-	-	-	-	-	-	-	-	-	-	-	-
100	Oscill sp	134	27	-	-	-	-	-	-	-	-	-	-	-	-
101		-	-	-	-	22	-	-	-	-	-	-	-	-	-
102	Total diatoms	268	361	335	134	218	13	80	643	600		80	0	0	302
103	Total greens	1005	920	5632	132	266	374	428	977	7320		20424	14678	6501	20211
104	Total others	134	80	804	335	781	496	214	241	8360		1326	23124	804	805
105	Total blue gr	9315	255	4423	536	88	13	0	67	0		201	201	0	0
106	Total	10722	1616	11194	1137	1353	896	722	1928	16280		22031	38003	7305	21318
107															
108	Diatoms %	2.5	22.3	3	11.8	16.1	1.5	11.1	33.4	3.69		0.4	0	0	1.4
109	Greens %	9.4	56.9	50.3	11.6	19.7	41.7	59.3	50.7	45.0		92.7	38.6	89	94.8
110	Others %	1.3	4.95	7.2	29.5	57.7	55.4	29.6	12.5	51.4		6.0	60.8	11.0	3.8
111	Blue gr %	86.9	15.8	39.5	47.1	6.5	1.5	0	3.5	0		0.9	0.5	0	0
112															
113		Diatoms	Greens	Others	Blue greens										
114	Winter mean%	12.4(14.6)	49.2(7.7)	37.2(20)	1.25(1.66)										
115	Growth mean%	6.4(8.3)	51.4(34.6)	20.3(23.6)	21.9(30.2)										
116	Allyear mean%	8.25(10.3)	50.8(28.5)	25.5(23.2)	15.6(26.6)										

Bomere



N
Na
Sparse vegetation
Nt
Eh
Dense vegetation
Pb
Na
Nl
Na
95 % Na
5 % Nl
90 % Na
10 % Nl
Na
Dense Ec
growth
Ec
Ec
Pb
Pa
Pb
Ec
Na
Nl
Pb
Small amount
Eh
Po
Small amount
Ec
70 % Na
30 % Nl
Pa
Nl
95% Na
5% Nl
Ec
Pb
Dense bed
Pb
Pa
Ec
0
30
60
90
120
metres
Pa and
Nl
Pb
Eh
Dense
vegetation

(e) CHAPEL MERE

(i) Morphometry and water budget

Chapel Mere is small (6.5ha) and shallow (2.4m). It has two prominent surface inflows, one draining the buildings area of Cholmondley castle(CHD) and the other the land to the west of the lake (CHI). It also has a distinct outflow (CHO). The gauged inflows (0.44 million cubic metres per year) match, within the errors of gauging small muddy streams of low discharge at infrequent intervals, the outflow (0.50) and this suggests that surface flows dominate the hydrology. Based on the outflow, the retention time of the lake in winter is about six weeks (flushing rate 8.1 per year) and in the growth season only a little longer, about nine weeks, with a flushing rate of 5.8 per year. On an annual basis the retention time averages eight weeks with a flushing rate of 6.5 per year. There is a small inflow that was too small to gauge, near the lakeside boathouse (CHBI) and a local stream (CHSt) that does not deliver water to the lake but by passes it. This stream was analysed for the information that it might give on local water quality.

(ii) Land use changes

Several parishes potentially contribute to the water supply of Chapel Mere and there have been several amalgamations since 1931. Cholmondley, Egerton, Bickerton and Bulkeley are considered to contribute to the catchment.

	1931	1987
Cattle(head)	4149	6406
nutrient units	50618	78153
Pigs(head)	2257	204
nutrient units	10834	979
Sheep(head)	2702	230
nutrient units	4053	345
Poultry(head)	22355	26465
nutrient units	3130	3705
Total nutrient units	68635	83182
Permanent grazing(ha)	2988	2007
Temporary grazing	188	716

Arable	144	562
Woodland	4	1
Rough grazing	23	14
Total hectarage	3347	3300

The common pattern of increasing numbers of cattle, declines in pigs and movement of land from permanent grazing to trmporary grazing and arable is shown. Overall this means some potential increase in nutrient loads. An additional change in this catchment has been the development of tourism to the castle. The effluent from the treatment unit which copes with the castle sewage appears to drain into CHD.

(iii) Major ion water chemistry and nutrient loads.

The water chemistry around Chapel Mere is fascinating in several respects. It has a very high conductivity linked to a high alkalinity and this must reflect very soluble minerals in the surface soils of the catchment. CHSt may give some idea of the local water chemistry unaffected by the Castle, which determines the chemistry of one inflow (CHD) and the farm which may determine that of CHI. Chapel Mere Stream carries a very high conductivity (1207 uS per cm) which is nearly twice as great as the castle drain and about a third higher than the main inflow (CHI). This may mean a localised set of soils rich in ions to the north of the mere. The stream's alkalinity, however is a little lower than that of CHI and its chloride content is unremarkable. We cannot say what the high conductivity is caused by but a likely contender may be sulphate. The stream carries only moderate (for this area) concentrations of soluble reactive and total phosphorus though on a national scale they are quite high (SRP 42 ug/l; Total P 131 ug/l). It has low nitrate and ammonium concentrations at all times.

Chapel Mere inflow (CHI) carries the bulk of the water entering the lake (378000 cubic metres per year, 86% of the total inflow). It has notably high phosphorus and nitrate concentrations, both much higher than CHSt. These may be derived from stock at the local farm but it is then surprising that the ammonium concentrations are not also high. The nitrate concentrations exceeded 11 mg/l on two occasions and the total annual load of nitrogen passing down the inflow was estimated as 2.18 tonnes per year. The phosphorus load was 88 kg.

Chapel mere drain (CHD) gave even higher phosphorus and ammonium concentrations and comparable values for nitrate. It had lower conductivity and alkalinity suggesting that the water itself was derived partly from extra-local sources through the domestic water supply to the castle area. At around 1mg/l phosphorus and with the high nitrate value also, it is clear that the nutrient load is derived from waste water but in absolute terms the drain contributes a much lesser total load of nitrogen (308 kgN per year) than the main inflow, though only a slightly smaller phosphorus load (57 kg P per year).

The boathouse inflow is insignificant in its contributions of either water or nutrients to the mere but is of interest in that its major ion chemistry is consistent with other local waters (high conductivity and alkalinity) but that its phosphorus concentrations are very low as are its nitrate and ammonium concentrations. It drains a small area of permanent pasture and reedswamp close to the lake and may indicate the nature of the local water quality when unaffected by point nutrient sources of excretal origin.

The water chemistry of Chapel Mere itself is clearly determined by the combined influence of the drain and the inflow with year-around high phosphorus concentrations. The denitrifying properties of the surrounding reedswamp are clearly shown, however in the markedly low nitrate and ammonium concentrations that are found even in winter in the lake. With two exceptions in spring, nitrate concentrations were always lower than 1mg/l N and in summer were barely detectable. There was a clear pattern of higher winter and spring values compared with those of summer so that algal and plant uptake in the growth season is superimposed on the denitrification that must take place year around in the wetland and its soils.

(iv) Phytoplankton and zooplankton

Considering the huge annual loading of nitrogen (38 g per metre squared per year) and phosphorus (2.2 g per metre squared per year) on the lake and the relatively long retention time for a small water body, the phytoplankton crops are negligible with a growth season mean of only 13 ug /l chlorophyll a. On only one occasion in spring did algal crops rise to what would be considered high values in shallow lakes and this may have been due to accumulation of a blue green alga towards the surface giving an inflated value for the water column. The reason for the low algal crops is probably to be found in the large concentrations of ***Daphnia*** that the lake supports. These averaged over 100 animals per litre in the growth season, could reach over 550 per litre and included the large bodied ***Daphnia magna***.

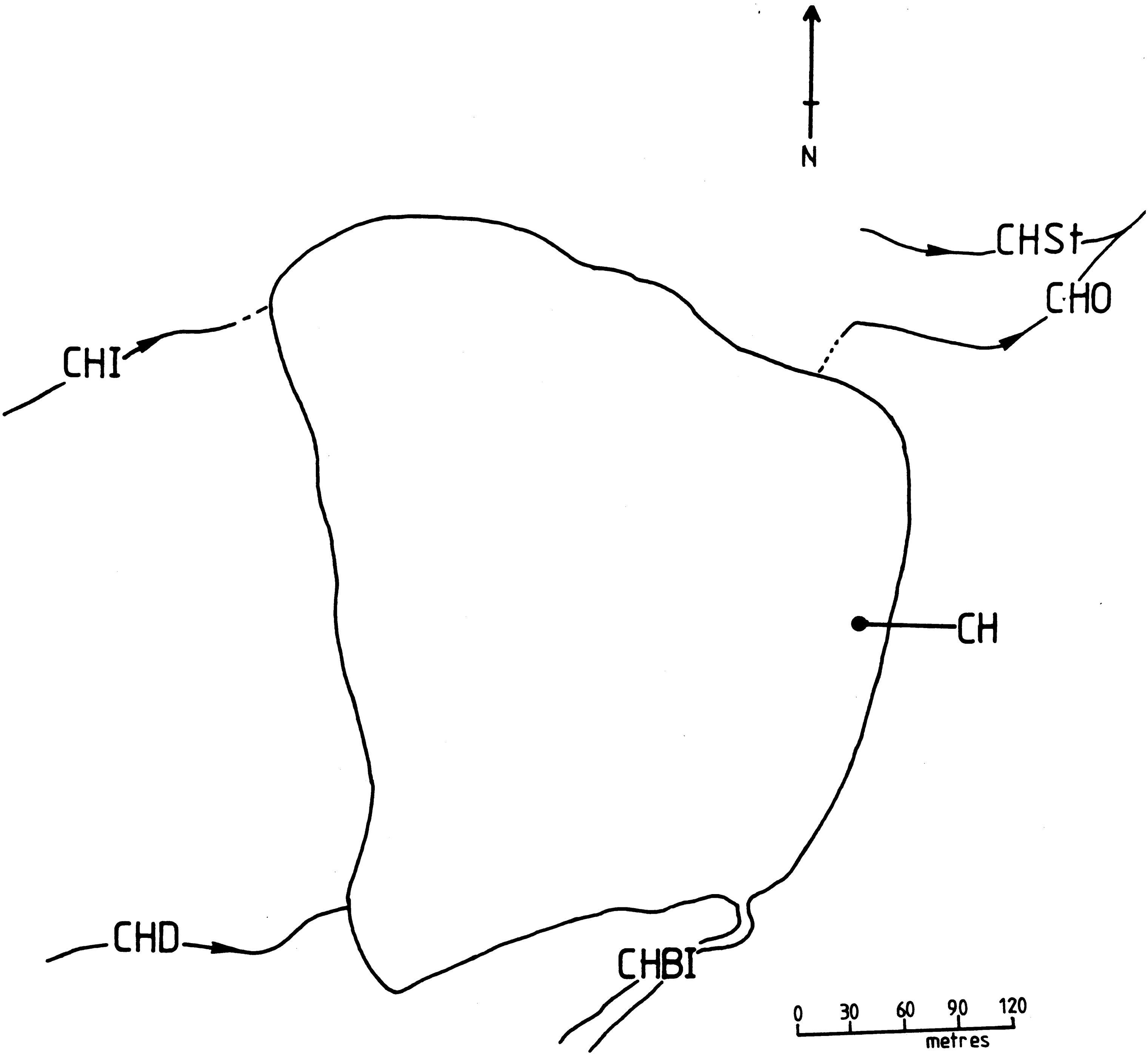
(v) Aquatic Plants

Because of the effects of zooplankton grazing and the consequential low algal populations and clear water, Chapel Mere has an aquatic plant community of large biomass if of low diversity.

It is dominated by ***Elodea*** and ***Lemna trisulca*,** both tolerant of high nutrient loadings and the trophic score, at 8.6, is consequentially high.

(vi) Overall Assessment

Were it not for the zooplankton grazing, Chapel Mere would contain a rich algal soup. Its nutrient loading rates and retention time could support phytoplankton populations regularly exceeding 100 ug/l chlorophyll a in highly turbid water devoid of much if any submerged plant growth. The existence of the large grazer populations, including ***Daphnia magna***, which is essentially intolerant of much predation, must depend on a negligible fish stock in the mere. This may have arisen from a past fish kill coupled with the relative isolation of the mere from the main river system, which delays subsequent recolonisation. To maintain the mere in its present state there should be no stocking of fish and removal of any still present that might build up future zooplanktivorous populations. Lakes artificially lacking fish, however, are not desirable from several viewpoints. The alternative is to attempt a restoration of the lake by control of the nutrient loading initially at low fish stock levels but with a view to future reintroduction of fish. The loads from both the drain and the main inflow would need to be reduced in phosphorus or diverted around the mere. Diversion would increase the retention time and hence the effectiveness of the reduced load in supporting algal crops but it might be possible to divert the higher quality, presently by-passing, stream through the lake to compensate for this. A more detailed study would be required to investigate the feasibility of these potential measures.


N
CHSt
CHO
CHI
CH
CHD
CHBI
0 30 60 90 120
metres

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	1021	0.40	5.85	7.29	28.6	774	941	69.0	1010
2	Aug 28 1991	893	0.20	5.30	7.49	29.8	596	500	91.0	590
3	Sep 18 1991									
4	Oct 23 1991	1054	0.60	5.40	7.88	35.0	787	787	152.0	938
5	Nov 13 1991	937	0.50	5.00	7.77	34.3	377	425	0.0	425
6	Dec 4 1991	1059	1.00	6.35	7.92	34.0	445	480	29.7	509
7	Jan 14 1992	965	0.30	5.90	8.34	40.0	239	256	54.0	311
8	Feb 5 1992	975	0.45	5.35	8.65	44.0	334	337	18.0	355
9	Mar 4 1992	899	0.55	5.45	8.00	43.0	153	179	35.0	213
10	Mar 25 1992	866	0.40	5.20	8.14	40.0	117	170	0.0	170
11	April 15 1992	798	0.35	4.05	7.98	39.2	216	252	103.0	355
12	May 13 1992	727	0.25	3.55	7.77	42.0	80	1025	331.0	1357
13	June 6 1992	948	0.30	5.95	7.97	33.3	534	614	26.0	639
14	June 26 1992	1004	0.10	6.15	8.08	35.3	595	595	0.0	595
15										
16	Winter mean	984	0.56	5.65	8.17	38.1	349			400
17	SD	53	0.30	0.60	0.40	4.8	86			87
18	Growth mean	912	0.35	5.21	7.84	36.2	428			652
19	SD	107	0.16	0.87	0.28	5.2	286			392
20	Allyear mean	934	0.42	5.35	7.94	36.8	404			574
21	SD	98	0.22	0.80	0.34	4.9	240			345

Chapel Mere Inflow CHI

	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1		56	6.46	-				
2	3.90	59	2.74	+				
3								
4	1.64	203		0.001	1.120		0.570	
5	2.01	99	4.43	0.025	31.900		6.430	
6	1.64	103	4.50	0.003	3.200		0.920	
7	2.88	180	3.99	0.016	29.600		3.010	
8	4.97	141	3.10	0.009	27.800		1.930	
9	11.30	118	3.43	0.02	138.100		2.580	
10	14.30	102	3.10	0.029	252.600		2.980	
11	3.43	197	2.85	0.009	19.700		1.900	
12	5.29	169	3.99	0.00001	0.030		0.008	
13	2.63	579	4.45	+				
14	2.13	250	5.08	+		2184.000		88.100
15								
16	2.88	131	4.00	0.013				
17	1.50	38	0.64	0.009				
18	5.58	193	4.00	0.012				
19	4.67	160	1.30	0.013				
20	4.68	174	4.01	0.012				
21	4.03	135	1.08	0.010				

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Total Sol P	Partic P	Total P
1	Aug 7 1991	723	0.40	3.40	7.56	45.0	1341	1611	3651	5262
2	Aug 28 1991	717	0.10	3.40	7.67	46.8	1110	907	543	1450
3	Sep 18 1991	585	0.20	3.10	7.84	42.6	2180	2109	1482	3591
4	Oct 23 1991	680	0.35	3.75	8.02	47.4	884	1047	0	1047
5	Nov 13 1991	721	0.30	3.10	7.76	38.4	489	621	0	621
6	Dec 4 1991	819	0.35	4.15	7.91	48.0	856	1210	181	1390
7	Jan 14 1992	775	0.20	3.75	8.29	44.0	689	689	19	708
8	Feb 2 1992	775	0.30	3.40	8.36	52.0	653	873	0	873
9	Mar 4 1992	722	0.00	3.35	7.67	43.0	1319	1458	233	1691
10	Mar 25 1992	683	0.20	4.00	7.54	40.0	413	413	22	434
11	April 15 1992	605	0.20	2.70	7.57	39.2	542	592	241	833
12	May 13 1992	727	0.25	3.55	7.77	42.0	80	1025	331	1357
13	June 3 1992	703	0.00	3.95	7.82	47.1	1689	1737	487	2224
14	June 22 1992	711	0.00	3.80	8.04	47.1	874	874	657	1532
15										
16	Winter mean	773	0.29	3.60	8.08	45.6	672			898
17	SD	40	0.06	0.45	0.29	5.8	151			344
18	Growth mean	686	0.17	3.50	7.75	44.0	1043			1942
19	SD	51	0.14	0.40	0.18	3.1	624			1451
20	Allyear mean	710	0.20	3.53	7.84	44.5	937			1644
21	SD	62	0.14	0.40	0.26	3.9	553			1313

Chapel Mere Drain CHD

	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kgP/week	kg P/year
1		742	5.18	0.00010			0.320	
2	6.13	317	3.25	0.00100	3.900		0.880	
3	4.14	858	4.97	0.00060	1.800		1.300	
4	4.69	404		0.00300	9.240		1.900	
5	3.05	107	5.81	0.00100	1.910		0.380	
6	2.57	385	5.73	0.00100	1.790		0.840	
7	1.64	148	5.33	0.00200	2.160		0.860	
8	5.67	180	4.48	0.00200	7.080		1.060	
9	4.63	652	4.72	0.00300	9.580		3.070	
10	8.38	171	4.49	0.00500	25.860		1.310	
11	3.29	477	3.61	0.00300	6.830		1.510	
12	5.29	169	3.99	0.00001	0.030		0.008	
13	5.36	2506	4.97	0.00100	4.760		1.350	
14	6.37	798	5.28	0.00050	2.170	308.000	0.460	56.600
15								
16	3.23	205	5.34	0.00150				
17	1.72	124	0.61	0.00060				
18	5.36	709	4.50	0.00200				
19	1.48	679	0.70	0.00200				
20	4.71	565	4.76	0.00200				
21	1.80	615	0.80	0.00200				

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7	*	*	*	*	*	*	*	*	*
2	Aug 28	*	*	*	*	*	*	*	*	*
3	Sept 18	670	0.6	5.1	7.74	25.5	61	0	0	61
4	Oct 23	647	0.2	4.4	7.6	26.8	13.3	18.6	14.8	33.4
5	Nov 13	688	0.3	3.85	7.41	26.3	9.4	18.3	4.4	22.7
6	Dec 4 1991	717	0.2	4.5	7.56	26.0	7.5	17	5.2	22.3
7	Jan 14 1992	695	0.15	3.6	7.85	26.0	26	26	0	26
8	Feb 5 1992	No flow								
9	Mar 4 1992	694	0.1	3.7	7.67	25.5	28.6	33.1	0	33.1
10	Mar 25 1992	No flow								
11	April 15 1992	644	0.2	4.0	7.65	24	10	28	0	28
12	May 13 1992	626	0.25	4.35	7.6	26.0	22.6	33.7	0	34
13	June 3 1992	No flow								
14	June 22 1992	No flow								
15										
16	Winter mean	700(15)	0.22(0.08)	3.98(0.46)	7.61(0.22)	26.1(0.2)	14(10)			24(2)
17	Growth mean	656(26)	0.27(0.19)	4.31(0.52)	7.65(0.06)	25.6(1.0)	27.2(20)			38(13)
18	Allyear mean	673(31)	0.25(0.15)	4.18(0.49)	7.64(0.13)	25.8(0.8)	22.4(18)			33(12)

	Nitrate N	Ammonium N	Silicate Si	Discharge
1	*	*	*	*
2	*	*	*	*
3	0.004	14	4.38	+
4	0.04	49		+
5	0.14	10.5	4.79	+
6	0.24	129	4.39	+
7	0.36	51	3.93	+
8				
9	0.28	59	2.58	+
10				
11	0.22	42	1.94	+
12	0.05	66	1.28	+
13				
14				
15				
16	0.25(0.11)	64(60)	4.37(0.43)	
17	0.12(0.12)	46(20)	2.55(1.3)	
18	0.17(0.13)	53(37)	3.33(1.4)	

Chapel Mere Outflow CHO

	Date	Conductivity	Phenolph Alk	Total alk	pH	Chloride	Sol React P	Total Sol P	Partic P	Total P
1	Aug 7 1991	710	0.6	4.5	7.62	36.7	1106	1238	186	1424
2	Aug 28 1991	734	0.3	4.8	7.74	32.0	859	1153	317	1469
3	Sept 18 1991	*	*	*	*	*	*	*	*	*
4	Oct 23 1991	721	0.55	4.35	7.79	33	1081	1218	194	1412
5	Nov 13 1991	693	0.4	4.65	7.79	36.4	1047	1047	288	1335
6	Dec 12 1991	728	0.4	5.05	7.5	38	961	1094	174	1268
7	Jan 14 1992	740	0.3	4.7	8.28	36	973	973	6.3	979
8	Feb 5 1992	766	0.35	4.35	8.52	40	776	776	232	1009
9	Mar 4 1992	725	1.2	4.45	8.78	35.3	406	406	0	406
10	Mar 25 1992	748	0.7	4.7	8.69	40	442	442	0	442
11	April 15 1992	744	0.3	4.5	8.2	35.3	428	452	53	505
12	May 13 1992	713	0.5	4.75	8.19	34.0	778	878	0	878
13	June 3 1992	732	0	4.85	7.98	35.3	1450	1450	0	1450
14	June 22 1992	728	0	5.0	7.86	35.3	1273	1273	82	1355
15										
16	Winter mean	732(300	0.36(0.05)	4.69(0.29)	8.02(0.46)	37.6(1.8)	939(115)			1148(180)
17	Growth mean	728(13)	0.46(0.4)	4.66(0.20	8.09(0.4)	35.2(2.3)	869(388)			1038(476)
18	Annual mean	729919)	0.43(0.31)	4.67(0.23)	8.07(0.41)	36.0(2.4)	891(323)			1072(402)

	Nitrate N	Ammonium N	Silicate Si	Discharge	Discharge SD	kg N/week	kg N/year	kg P/week	kg P/year
1	1.33	83.0	4.54	0.0001		0.085		0.086	
2	1.66	72.3	3.19	0.0001		0.105		0.089	
3	*	*	*	0.0000		0.000		0.000	
4	0.94	70.3		0.0110		4.060		9.390	
5	0.66	24	4.57	0.0130		5.380		10.500	
6	0.81	203	4.16	0.0200		12.300		15.300	
7	0.9	138	4.3	0.0270		16.950		16.000	
8	0.9	33	3.38	0.0190		10.720		11.600	
9	0.71	19	0.73	0.0240		10.600		5.890	
10	1.43	155	0.98	0.0800		76.600		21.400	
11	2.45	94	1.24	0.0020		3.080		0.610	
12	0.57	53	1.9	0.0145		5.460		7.700	
13	0.83	472	4.89	0.0070		5.500		6.100	
14	1.26	75	4.35	0.0040		3.230	572.000	3.300	401.000
15									
16	0.82(0.11)	100(86)	4.1(0.5)	0.0200	0.006				
17	1.24(0.58)	121(136)	2.73(1.7)	0.0140	0.024				
18	1.11(0.52)	115(120)	3.19(1.6)	0.0160	0.020				

Chapel Mere Stream CHSt

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	1206	0.5	5.0	7.42	32.7	48	50	113	163
2	Aug 28 1991	1258	0.2	5.4	7.79	34.0	71	68	235	303
3	Sept 18 1991	*	*	*	*	*	*	*	*	*
4	Oct 23 1991	*	*	*	*	*	*	*	*	*
5	Nov 13 1991	1197	0.2	3.75	7.17	30.3	32	48	31	80
6	Dec 4 1991	1245	0.25	4.65	7.49	34	34	42	26	67
7	Jan 14 1992	1241	0	3.75	7.5	34	50	49.5	5.2	54.7
8	Feb 5 1992	1193	0.25	3.65	8.38	36	34	52	27	80
9	Mar 4 1992	No flow								
10	Mar 25 1992	1245	0	3.0	7.08	36	22	22	29	51
11	April 15 1992	1173	0.2	3.4	7.09	37.3	27	40	64.9	105
12	May 13 1992	No flow								
13	June 3 1992	1146	0	4.95	7.57	29.4	56	74	135	209
14	June 22 1992	1170	0	5.0	7.61	33.3	47	47	153	200
15										
16	Winter mean	1219(28)	0.18(0.12)	3.95(0.47)	7.64(0.52)	33.6(2.4)	37.5(8)			71(12)
17	Growth mean	1200(45)	0.15(0.2)	4.46(1.00	7.42(0.30	33.8(2.8)	45.2(18)			172(88)
18	Annual mean	1207(38)	0.16(0.16)	4.26(0.8)	7.51(0.390	33.7(2.5)	42.1(15)			131(84)

	Nitrate N	Ammonium N	Silicate Si	Discharge
1	0.43	106	5.27	0.0001
2	0.24	88	3.48	+
3	*	*	*	0
4	*	*	*	0
5	0.28	178	5.69	+
6	0.25	107	5.57	+
7	0.77	80	5.75	+
8	0.56	76	4.66	+
9				
10	1.54	180	4.96	+
11	0.56	84	4.08	+
12				
13	0.3	145	4.33	+
14	0.32	136	4.58	+
15				
16	0.47(0.25)	110(47)	5.42(0.51)	
17	0.57(0.5)	123(37)	4.45(0.64)	
18	0.53(0.4)	118(39)	4.84(0.75)	

Chapel Mere CH

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	690	0.60	4.50	8.01	38.8	1318	1507	110.0	1617
2	Aug 28 1991	714	0.40	4.75	8.22	36.2	1107	1547	0.0	1547
3	Sep 18 1991	711	0.80	5.20	8.37	34.1	1819	1694	75.0	1769
4	Oct 23 1991	699	0.80	4.80	8.36	39.2	1257	1560	91.2	1651
5	Nov 13 1991	691	0.30	4.60	7.91	34.3	1047	1579	0.0	1579
6	Dec 4 1991	725	0.50	5.30	7.74	36.0	958	1365	0.0	1365
7	Jan 14 1992	745	0.30	4.70	8.25	40.0	1018	1018	0.0	1018
8	Feb 5 1992	758	0.40	4.40	8.60	40.0	803	1002	0.0	1002
9	Mar 4 1992	717	1.20	4.40	8.75	37.3	416	430	0.0	430
10	Mar 25 1992	746	0.51	4.61	8.74	40.0	435	650	221.0	871
11	April 15 1992	739	0.45	4.55	8.52	35.3	433	505	2.1	507
12	May 13 1992	713	0.65	4.70	8.64	34.0	789	942	185.0	1127
13	June 3 1992	717	0.35	4.75	8.63	39.2	1464	1525	250.0	1775
14	June 22 1992	725	0.35	4.20	8.71	39.2	1483	1483	0.0	1483
15										
16	Winter mean	730	0.38	4.75	8.13	37.6	957			
17	SD	29	0.10	0.39	0.38	2.9	109			1241
18	Growth mean	717	0.61	4.65	8.50	37.3	1052			281
19	SD	17	0.27	0.27	0.25	2.3	505			1278
20	Allyear mean	721	0.54	4.68	8.39	37.4	1025			512
21	SD	21	0.25	0.29	0.33	2.4	426			1267
										447

Chapel Mere CH

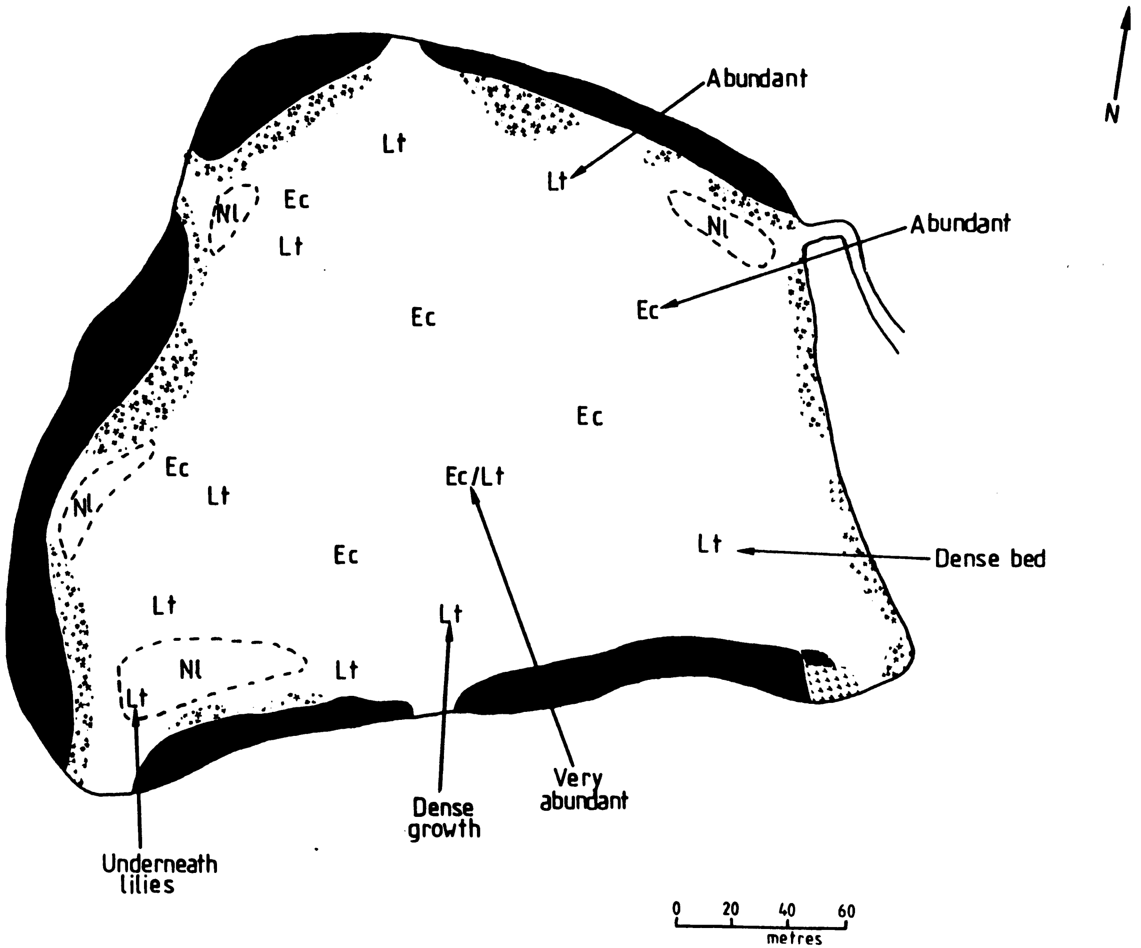
	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.06	89.0	4.57	0.00	1.30	>	0.76	>	305.9
2	0.00	112.0	2.77	0.67	6.70	10	0.87	>	15.3
3	0.00	58.0	4.80	6.40	13.33	2.11	0.91	>	16.9
4	0.16	32.4		5.40	10.00	1.88	1.04	>	0.3
5	0.15	75.0	3.97	1.70	5.30	3.22	0.90	>	0.5
6	0.37	133.0	3.50	1.10	5.00	5.0	0.60	>	3.6
7	0.70	118.0	4.59	8.40	12.70	1.65	0.95	>	0.2
8	0.89	167.0	3.40	26.40	26.00	1.08	1.24	>	0.1
9	0.42	100.0	0.52	14.30	20.70	1.59	1.04	>	0.0
10	1.37	192.0	0.89	0.40	2.30	7.0	0.88	>	138.6
11	2.19	106.0	0.93	1.10	4.30	4.3	1.00	>	50.2
12	0.10	91.0	1.87	5.10	6.00	1.29	1.12	>	17.5
13	0.06	439.0	4.94	90.60	50.70	0.62	1.21	>	2.4
14	0.03	244.0	2.68	6.20	10.00	1.76	1.06	>	554.0
15									
16	0.53	123.0	3.87	9.40					1.1
17	0.33	38.0	0.54	11.80					1.7
18	0.44	146.0	2.66	13.00					100.1
19	0.74	120.0	1.76	27.60					184.0
20	0.46	140.0	3.03	12.00					71.8
21	0.64	102.0	1.60	23.70					160.0

	Organism	Aug 7 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 13 1991	Dec 4 1991	Jan 14 1992	Feb 5 1992	March 4 1992	Mar 25 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
1	Achnanthes sp	13	.	.	.	.	.	.	.	.	.	.	.	.	.
2	Amphora sp	13	.	.	.	.	.	.	.	.	.	.	.	.	.
3	Amphora ov	.	27	.	.	.	.	.	.	.	.	.	.	.	.
4	Cocconeis sp	.	86	67	2212	67	.	.	.	130	22	.	.	.	.
5	Cyclo menegh	40	.	.	.	.	.	.	.	.	.	.	.	.	.
6	Cyclot sp	.	67	67	67	94	40	54	8120	7670	134	27	.	.	.
7	Cymbella sp	.	.	13	.	.	.	.	.	.	.	.	.	.	.
8	Diatoma sp	.	.	27	.	.	.	.	.	.	.	.	.	.	.
9	Denticula sp	.	27	.	.	.	.	.	.	.	.	.	.	.	.
10	Fragilaria sp	.	40	121	.	.	.	.	.	.	.	.	.	.	.
11	Gompho vent	13	.	.	.	.	.	.	.	.	.	13	13	.	.
12	Gompho sp	13	.	161	871	80	.	.	40	.	.	.	.	.	.
13	Melosira gran	.	.	.	.	.	.	13	.	.	.	.	.	.	.
14	Navicula sp	13	147	415	335	67	.	.	80	.	22	40	.	.	20
15	Nitzschia sp	54	107	.	.	.	.	.	.	.	.	.	13	.	.
16	Nitzsch sigm	.	.	40	.	.	.	.	.	.	.	.	40	.	.
17	Pinn virid	13	.	.	67	.	.	.	.	.	.	.	.	.	.
18	Pinn sp	.	27	.	.	13	.	.	.	.	.	.	.	.	.
19	Rholcosph cur	.	.	27	67	.	.	.	40	.	22	.	.	.	.
20	Synedra sp	27	.	.	.	40	.	.	.	.	.	.	.	.	.
21	Synedra ulna	.	86	40	.	.	.	.	.	.	45	.	.	.	.
22	Frag crot	.	.	.	.	.	.	.	.	.	.	.	27	.	.
23	Melosira ital	.	.	.	.	.	.	.	.	.	.	.	.	.	2513
24	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
25	Ankist conv	.	.	.	.	.	.	.	160	130	.	.	.	.	20
26	Ankist falc	.	13	.	.	.	.	.	.	.	.	13	.	.	.
27	Carteria cord	13	.	.	.	.	.	.	.	.	.	27	13	.	.
28	Chlamydo sp	121	.	.	.	.	.	.	.	.	.	.	.	.	.
29	Chlamydo glob	13	.	.	201	.	.	.	.	.	.	54	.	.	.
30	Chlamydo min	.	.	.	.	.	.	.	.	.	.	.	.	.	.
31	Chlamydo poly	.	.	.	1005	.	.	.	.	.	.	.	.	.	.
32	Chlamydo sno	13	.	.	.	.	.	.	.	.	.	.	.	.	.
33	Chlamydo spha	13	.	.	.	.	.	.	.	.	.	.	.	.	.
34	Chlamydo sp	.	27	67	.	54	40	27	1360	2730	67	.	80	201	121
35	Chlorella sp	13	.	.	.	.	.	.	.	.	.	27	.	201	.
36	Chlorog sp	.	.	.	.	107	724	27	1460	.	.	.	.	.	.
37	Closterops long	13	.	.	.	.	.	.	.	.	.	.	.	.	.
38	Crucig quad	.	.	.	.	.	.	.	.	130	.	.	.	.	.
39	Oocystis sp	.	.	13	.	.	.	.	40	.	.	.	.	.	.
40	Oocystis pus	54	.	.	.	.	.	.	.	.	.	.	.	.	.
41	Pandor mor	.	13	.	.	.	.	.	.	.	.	.	.	.	.
42	Quadrig lac	.	.	40	.	.	.	.	.	.	.	.	.	.	.
43	Scened quad	.	.	13	.	.	.	13	.	.	.	.	.	.	.
44	Schroeder seti	67	147	134	.	.	.	.	.	.	.	.	241	.	.
45	Ulothrix sp	.	.	.	67	.	.	.	.	.	.	.	.	.	.
46	Carteria celoe	.	.	.	.	.	.	.	.	.	.	.	.	.	20
47	Planktosph gel	.	.	.	.	.	.	.	.	.	.	.	.	.	20
48	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
49	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
50	Euglena sang	.	.	.	.	.	.	.	480	130	.	.	.	.	.
51	Lepocinclis sp	.	.	.	.	.	.	.	.	130	.	.	.	.	.
52	Phacus sp	.	13	.	.	.	.	.	.	130	.	.	.	.	.
53	Trach ac	.	.	13	.	.	.	.	.	.	.	.	.	.	.
54	Trach sp	.	.	.	.	13	.	.	.	.	.	.	.	.	.
55	Euglena sp	.	.	.	.	.	.	.	.	.	.	.	.	.	60
56	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
57	Gonyost sem	27	.	.	.	.	.	.	.	.	.	.	.	.	.
58	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
59	Crypto ac	.	.	.	.	.	.	.	40	.	.	.	.	.	.
60	Crypto er	.	.	.	.	.	.	.	.	260	45	.	.	201	.
61	Crypto ov	13	54	.	670	.	107	54	120	.	.	.	.	.	.
62	Rhodo min	.	27	174	8311	657	201	509	12760	1690	.	.	1501	402	281
63	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
64	Ochromonas	.	.	.	.	.	.	.	.	.	.	.	.	.	1005
65	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
66	Ceratium hir	.	27	.	.	.	.	.	.	.	.	.	.	.	20
67	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
68	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
69	Mallomonas	.	.	.	67	.	.	.	.	.	.	.	.	.	.
70	Chlorochro	1223	.	.	.	.	.	.	.	.	.	.	.	.	.
71	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
72	Anabaena sp	40	40	.	.	.	.	.	.	.	.	.	.	.	.
73	Aph flos aq	.	.	.	536	.	.	40	.	.	.	.	67	19907	20

Chapel Mere Phytopl 1991/92

	Organism	Aug 7 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 13 1991	Dec 4 1991	Jan 14 1992	Feb 5 1992	March 4 1992	Mar 25 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
74	Aphanoc elach	-	13	-	-	-	-	-	-	-	-	-	-	-	-
75	Dactyl acic	13	-	-	-	-	-	-	-	-	-	-	-	-	-
76	Microcystis sp	-	-	-	-	-	-	54	-	-	-	-	-	-	-
77	Nostoc sp	13	-	-	-	-	-	-	-	-	-	-	-	-	-
78	Osc tenuis	-	94	-	67	13	-	-	40	-	-	13	-	-	-
79	Osc sp	-	-	67	-	-	-	-	-	-	-	-	-	201	-
80	Osc agard	-	-	-	-	-	-	-	-	-	-	-	13	-	-
81	Coelosphaeriu	-	-	-	-	- -	-	-	-	-	-	-	27	-	-
82															
83	Total diatoms	199	614	978	3619	361	40	67	8280	7800	245	80	93	0	2533
84	Total greens	320	200	267	1273	161	764	67	3020	2990	67	121	334	402	161
85	Total others	1263	121	187	9048	670	308	563	13400	2340	45	0	1501	603	1366
86	Tòtal blue gr	6	147	67	603	13	0	40	40	0	0	13	107	20108	20
87	Total	1848	1082	1499	14543	1205	1132	737	24740	13130	357	214	2035	21113	4080
88															
89	Diatoms %	10.8	56.7	65.2	24.9	30.0	5.3	9.1	33.5	59.4	68.6	37.4	4.6	0	62.1
90	Greens %	17.3	18.5	17.8	8.8	13.4	67.5	9.1	12.2	22.8	18.8	56.5	16.4	1.9	4.0
91	Others %	68.3	11.2	12.5	62.2	55.6	27.2	76.4	54.2	17.8	12.6	0	73.8	2.9	33.5
92	Blue gr %	3.6	13.6	4.5	4.2	1.1	0	5.4	0.2	0	0	6.1	5.3	95.2	0.5
93															
94		Diatoms	Greens	Others	Blue greens										
95	Winter mean%	19.5(14.3)	25.6(28.0)	53.4(20.2)	1.7(2.5)										
96	Growth mean%	39.0(26.9)	18.3(15.0)	29.5(28.2)	13.3(29.1)										
97	Allyear mean%	33.4(25.2)	20.4(18.7)	36.3(27.8)	10.0(24.8)										

CHAPEL MERE



● Phalaris arundinacea

(f) COLE MERE

(i) Morphometry and water budget

Colemere is a deep (11.5m), relatively large mere (27.6 ha). It appears to have no permanent surface inflows other than an overspill from the Shropshire Union Canal which delivers water over a weir. Thre is an outflow, which was gauged, but which has passed through an area of grassland before it reaches the access point where it could be gauged. In some respects, e.g. a small increase in nitrate, the outflow stream differs in water chemistry from the mere suggesting that it acquires extra water between its exit from the mere and the gauging point. Estimates of retention tine are thus underestimates and of flushing rate, overestimates. For the year overall, growth season and winter season, the flushing rates were calculated to be 0.8, 0.79, and 0.91per year respectively and the retention times 1.25, 1.26 and 1.1 years respectively. The mere thus has a relatively long retention time that varies little seasonally. This might be expected because it is fed by a canal which itself is supplied from an upland region with copious water supplies. The amount of water supplied by the canal, however cannot easily be determined but is unlikely to be negligible because Cole Mere has a conductivity (239 uS) that is intermediate between that of the canal (140) and those of the waters in the nearby Crosemere(474), and Whitemere (309). Data in Reynolds (1979) give values of 121 for the nearby Blake Mere which may also be influenced by the canal, and for Kettle Mere, White Mere, Ellesmere Mere, & Crose Mere, which are not, of 158 239, 272, and 373.

The water supply that Cole Mere receives from other sources must be of ground origin and a simple mixing equation based on condctivity suggests thst this water must constitute between 61% and 82% of the total. For this calculation ground water conductivity was calculated from the average conductivity values for the nearby meres in Reynolds (1979) which gives the higher value and from the current estimates from Crosemere and Whitemere which give the lower. There is evidence that local conductivity values have risen since 1979 as a result of weather changes and so the higher value is probably an overestimate. The lower value, however, may be biased by the use of data from only the two most conductive local meres.

(ii) Changes in land use

Cole Mere has a groundwater catchment which is probably contained within the parishes of Ellesmere Rural, Cockshutt and Lyneal and Welshampton for which the land use changes have been as follows:

	1931	1987
Cattle(head)	11502	15842
nutrient units	139174	187332
Pigs(head)	5931	8945
nutrient units	28469	42936
Sheep(head)	12314	13557
nutrient units	18471	20336
Poultry(head)	54738	3351
nutrient units	7663	469
Total nutrient units	193777	251073
Permanent grass(ha)	8135	4410
Temporary grass(ha)	686	1725
Arable(ha)	820	2617
Woodland(ha)	17	152
Rough grazing	28	147
Total hectarage	9675	9051

There has thus been the fairly common pattern of increase in cattle keeping with a movement also into arable crops though in this case also an increase in pigs and sheep and the loss of a lot of land to non-agricultural uses.

(iii) Major ion water chemistry and nutrient loads

Cole Mere has a moderately high conductivity and alkalinity though neither is large compared with some of the more northern meres. Its soluble reactive and total phosphorus concentrations are nonetheless very high and little of this phosphorus can come from the canal overspill which is exceptionally low in this nutrient. Both canal and mere have low inorganic nitrogen concentrations, even in winter. Moderately high ammonium values in winter in the mere may suggest a local excretory source of nutrients and indicate the possibility that some of the very high phosphorus concentrations may be explained by such a source.

(iv) Phytoplankton and zooplankton

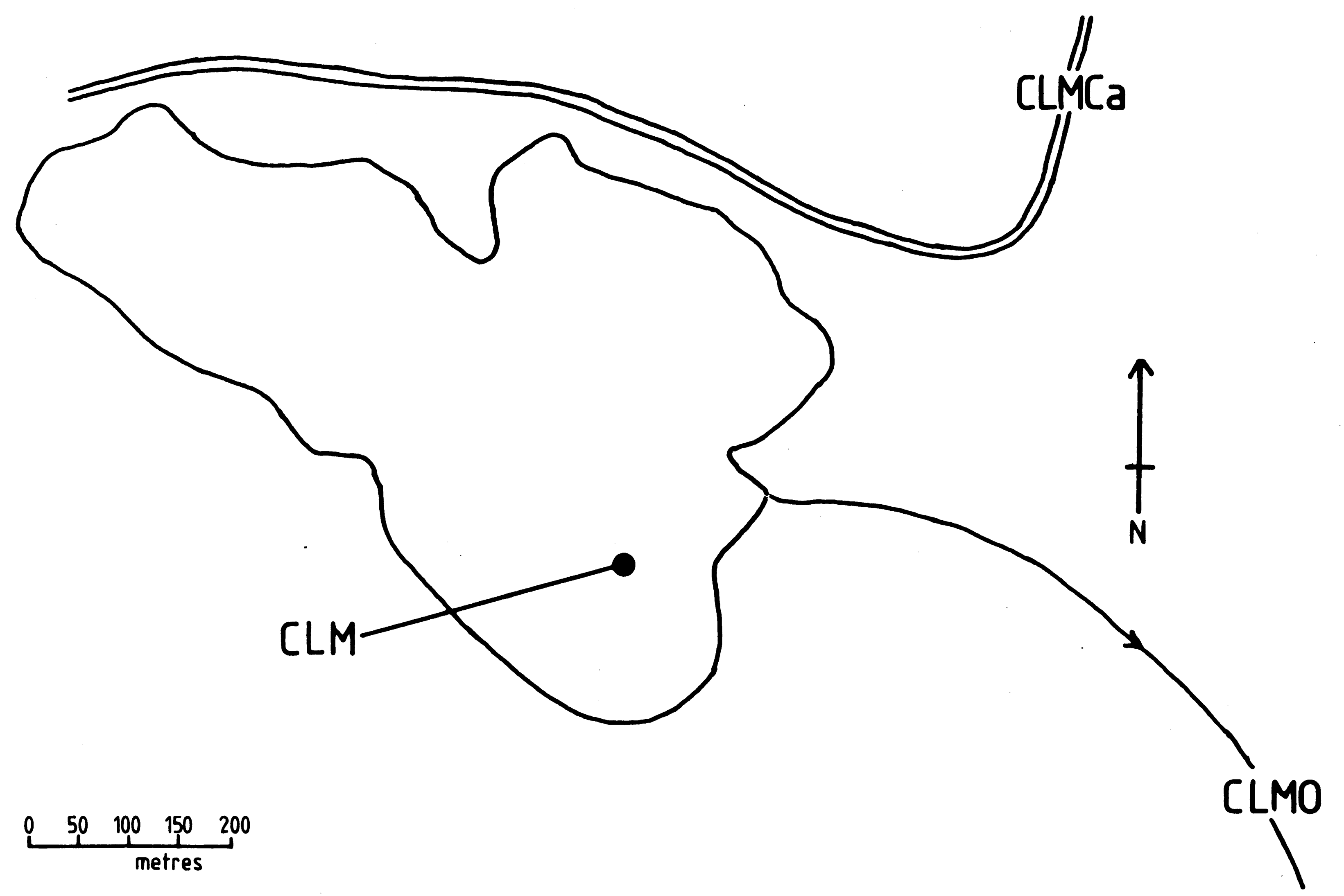
Chlorophyll a concentrations in Cole Mere are relatively high in the growth season though they exceeded 50 ug/l on only one occasion. The Mere is beset by surface algal blooms which may bias the estimate for the mere as a whole. This is consistent with the relatively large abundance of ***Daphnia*** and the likelihood of substantial grazing pressure. Blue-green algae are generally grazer resistant and constituted nearly half (by numbers) of the total algal crop in the growth season and probably a greater proportion of the biomass. The sutrface bloom formers, ***Anabaena circinalis*** and ***Aphanizomenon flos-aquae*** were particularly prominent. Other, smaller, grazeable algae, by contrast, were relatively scarce. The ***Daphnia*** species were the smaller bodied ones suggesting a modest fish predation but not an absence of predation altogether.

(v) Aquatic plants

Cole Mere does not have extensive development of submerged vegetation though relatively dense beds of ***Elodea canadensis*** and ***Ranunculus circinatus*** occur in the western shallows. The sparseness is probably a result of the morphometry and the exposure to wind expected along the shoreline of a moderate sized lake in an open landscape. Severe shading by phytoplankton is unlikely but the relatively high phosphorus load may stimulate epiphyte burdens that reduce the growth of the plants.

(vi) Overall assessment

Cole Mere may be one of the 'classic' meres with blue green algal blooms supported in stratified water that is naturally phosphorus-rich and nitrogen-poor. The relatively high ammonium concentrations, interpretable as coming from an excretal source, may cast some doubt on this but equally they may arise from the mineralisation of nitrogen fixing blue green algae like ***Anabaena*** and ***Aphanizomenon*** and thus be consequential rather than causal. There are no immediately local aggregations of stock and the Country Park toilets are on mains drainage. On balance it seems likely that Cole Mere is a naturally eutrophic lake and hence no restoration measures are feasible or desirable.


CLMCa
N
CLM
CLMO
0 50 100 150 200
metres

Colemere Canal CLMCa

Tue, Sep 1, 1992 5:27 am

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	119	0	0.40	8.96	16.3	10.0	4.0	128	132.0
2	Aug 14 1991	96	0	0.35	8.64	20.4	9.2	24.0	92	116.0
3	Sept 4 1991	92	0	0.40	7.47	12.2	7.6	28.0	51	79.0
4	Oct 10 1991	86	0	0.40	7.65	21.7	10.0			60.2
5	Oct 30 1991	116	0	0.30	7.24	20.2	15.7	38.0	41	80.0
6	Nov 20 1991	211	0	0.90	7.35	28.0	49.0	67.0	26	93.0
7	Dec 18 1991	148	0	0.50	7.55	24.2	27.0	27.0	161	188.0
8	Jan 22 1992	137	0	0.50	7.51	19.2	17.3	31.9	0	32.0
9	Feb 19 1992	140	0	0.50	7.51	23.5	12.0	38.0	20	58.0
10	Mar 11 1992	235	0	0.45	8.19	22.6	9.8	11.0	10	21.0
11	April 1 1992	141	0	0.55	8.08	19.6	6.9	6.9	59	66.0
12	April 29 1992	137	0	0.60	8.21	20.0	1.2	7.3	67	75.0
13	May 20 1992	109	0	0.80	8.45	20.0	4.0	11.0	84	94.0
14	June 10 1992	191	0	1.05	7.74	17.6	10.0	10.0	16	26.0
15										
16	Winter mean	159	0	0.60	7.48	23.7	26.0			93.0
17	SD	35	0	0.20	0.09	3.6	16.0			68.0
18	Growth mean	132	0	0.53	8.06	19.1	8.4			75.0
19	SD	47	0	0.23	0.54	3.0	3.9			35.0
20	Annual mean	140	0	0.55	7.89	20.4	13.6			80.0
21	SD	45	0	0.22	0.53	4.0	12.0			45.0

	Nitrate	Ammonium N	Silicate Si
1	0.48	66	0.50
2	0.34	50	0.97
3	0.19	47	0.86
4	0.23	62	1.39
5	0.58	86	1.80
6	1.15	195	2.29
7	1.03	246	1.75
8	1.03	45	1.73
9	0.65	95	1.49
10	0.99	15	0.81
11	1.65	30	1.37
12	1.06	15	0.73
13	0.57	38	0.41
14	1.42	63	1.36
15			
16	0.97	145	1.82
17	0.22	92	0.34
18	0.75	47	1.02
19	0.50	23	0.44
20	0.81	75	1.25
21	0.44	66	0.55

Cole mere Outflow CLMO

Tue, Sep 1, 1992 5:21 am

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	267	0.30	1.60	8.98	26.5	222	234	122	356
2	Aug 14 1991	235	0.30	1.55	9.27	24.5	240	287	143	430
3	Sept 4 1991	312	0.00	1.18	7.79	24.5	288	426	90	516
4	Oct 10 1991	348	0.00	2.30	7.35	30.4	275			275
5	Oct 30 1991	252	0.10	1.80	7.40	24.2	592	549	0	549
6	Nov 20 1991	266	0.05	1.65	7.35	20.0	386	414	25	439
7	Dec 18 1991	325	0.00	2.05	7.28	24.2	379	379	58	437
8	Jan 22 1992	240	0.00	1.45	7.81	26.9	413	522	1	523
9	Feb 19 1992	247	0.00	1.50	7.65	25.5	342	342	73	415
10	Mar 11 1992	220	0.10	1.45	8.77	29.0	237	237	0	237
11	April 1 1992	227	0.05	1.40	8.41	23.5	172	172	242	415
12	April 29 1992	238	0.20	1.50	8.87	24.0	90	124	64	188
13	May 20 1992	205	0.00	0.90	9.78	28.0	67	138	122	260
14	June 10 1992	237	0.00	1.35	7.44	27.5	176	176	0	176
15										
16	Winter mean	270	0.01	1.66	7.52	24.2	380			453
17	SD	39	0.03	0.27	0.25	3.0	29			48
18	Growth mean	254	0.11	1.50	8.41	26.2	236			340
19	SD	44	0.12	0.37	0.87	2.4	145			133
20	Annual mean	259	0.08	1.55	8.15	25.6	277			373
21	SD	42	0.11	0.34	0.84	2.6	139			125

	Nitrate N	Ammonium N	Silicate Si	Discharge
1	0.460	166.0	0.78	0.040
2	0.087	92.0	1.65	0.032
3	0.840	456.0	2.45	0.004
4	1.670	381.0	2.60	0.019
5	0.230	1048.0	2.47	0.025
6	1.390	963.0	2.76	0.070
7	1.310	689.0	2.81	0.010
8	0.500	1033.0	2.56	0.060
9	0.660	540.0	2.16	0.044
10	1.120	145.0	0.35	0.015
11	1.090	4.0	0.23	0.051
12	0.520	37.0	0.69	0.016
13	0.160	30.0	0.80	0.030
14	1.090	503.0	1.05	0.149
15				
16	0.970	806.0	2.57	0.046
17	0.450	231.0	0.30	0.026
18	0.730	286.0	1.31	0.038
19	0.520	324.0	0.91	
20	0.790	435.0	1.67	0.040
21	0.490	380.0	0.97	0.036

Cole Mere CLM

	Date	Conductivity	Phenolph Alk	Total alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	263	0.45	1.50	9.83	26.5	202	259	91.00	350
2	Aug 14 1991	239	0.50	1.55	9.62	24.5	214	244	129.00	374
3	Sept 4 1991	242	0.20		9.09	22.5	322	323	121.00	444
4	Oct 10 1991	256	0.20	1.70	7.77	26.1	331			374
5	Oct 30 1991	251	0.10	1.80	7.40	28.3	472	656	0.00	656
6	Nov 20 1991	229	0.00	1.50	7.57	24.0	445	445	35.00	480
7	Dec 18 1991	249	0.00	1.70	7.63	24.2	502	502	0.00	502
8	Jan 22 1992	238	0.00	1.45	8.12	23.1	430	500	26.00	530
9	Feb 19 1992	230	0.10	1.50	7.83	29.4	422	422	119.00	541
10	Mar 11 1992	299	0.40	1.40	9.18	30.6	259	259	0.82	259
11	April 1 1992	220	0.20	1.40	9.16	23.5	191	292	141.00	433
12	April 29 1992	211	0.50	1.40	8.97	24.0	102	116	50.00	166
13	May 20 1992	210	0.15	1.25	9.31	26.0	139	186	97.00	283
14	June 10 1992	210	0.00	1.25	7.94	21.6	209	213	0.00	213
15										
16	Winter mean	237	0.03	1.54	7.79	25.2	450			513
17	SD	9	0.05	0.11	0.25	2.9	36			28
18	Growth mean	240	0.27	1.47	8.83	25.4	244			355
19	SD	29	0.18	0.19	0.83	2.7	107			140
20	Annual mean	239	0.20	1.49	8.53	25.3	303			400
21	SD	24	0.19	0.17	0.85	2.7	133			138

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoid	480:663	430:410	Secchi	Total Daphnia
1	0.12	164	0.74	67.80	55.7	0.90	1.20	1.65	0.35
2	0.00	130	1.66	48.80	70.0	1.45	1.31	0.48	1.56
3	0.00	68	1.90	35.00	75.3	2.17	1.29	0.65	22.40
4	0.00	598	2.29	6.40	17.0	2.68	1.00	3.30	23.10
5	0.12	1047	2.42	2.40	4.4	1.86	1.10	>	27.20
6	0.38	860	2.60	2.60	6.0	2.57	0.92	3.95	418.00
7	0.23	1153	2.51	0.73	7.7	11.50	0.97	2.75	13.00
8	0.44	806	2.31	2.60	5.7	2.43	0.97	>	0.10
9	0.52	715	1.94	1.10	3.0	3.00	1.13	2.9	1.27
10	0.82	169	0.34	29.00	35.3	1.34	1.21	>	2.18
11	0.88	21	0.31	35.20	43.7	1.36	1.31	1.3	1.85
12	0.37	23	0.27	19.40	26.7	1.51	1.19	2.0	86.30
13	0.18	94	0.80	42.20	40.3	1.05	1.19	0.5	79.60
14	0.22	205	0.45	10.30	13.3	1.43	1.20	1.85	3.86
15									
16	0.39	884	2.34	1.76					108.00
17	0.12	189	0.29	0.98					207.00
18	0.27	252	1.19	29.70					24.80
19	0.33	325	0.86	20.60					32.30
20	0.31	432	1.47	21.70					48.60
21	0.28	411	0.93	21.50					110.00

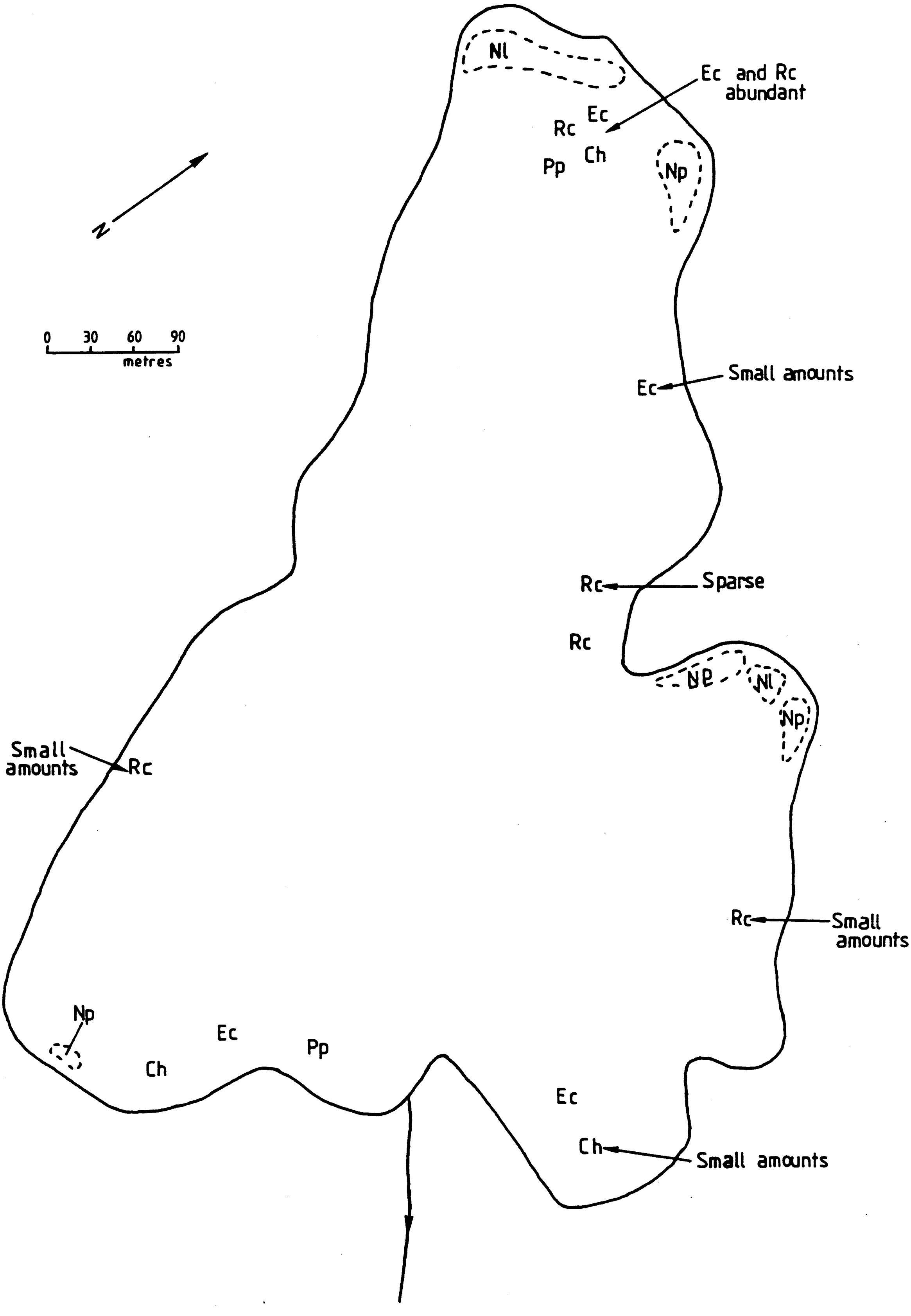
Colemere Phytoplankton 1991/2

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 29 1992	April 1 1992	April 28 1992	May 20 1992	June 10 1992
1	Amphora sp	-	-	-	22	-	-	-	-	-	-	-	-	-
2	Aster form	-	-	-	-	-	13	13	27	697	13	-	-	-
3	Cocconeis	34	-	-	-	-	-	-	13	-	-	-	-	-
4	Cyclotella sp	67	-	-	-	-	-	13	-	858	161	-	-	-
5	Cymbella sp	-	-	-	-	-	-	-	13	-	-	-	-	-
6	Fragilaria sp	-	-	-	-	-	-	13	-	-	-	-	-	-
7	Nitschia sp	-	268	-	-	-	-	-	-	-	-	-	-	-
8	Rhoicosphenia	-	-	-	-	-	-	-	13	-	-	-	-	-
9	*	-	-	-	-	-	-	-	-	-	-	-	-	-
10	*	-	-	-	-	-	-	-	-	-	-	-	-	-
11	*	-	-	-	-	-	-	-	-	-	-	-	-	-
12	*	-	-	-	-	-	-	-	-	-	-	-	-	-
13	Ankist conv	-	-	-	-	-	-	-	-	-	415	-	-	-
14	Ankist falc	168	-	-	-	-	-	-	-	-	13	-	-	13
15	Carteria	-	335	-	-	-	-	-	27	228	13	-	-	-
16	Chlamyd sp	1441	-	-	-	-	-	-	-	-	-	-	-	-
17	Chlamyd glob	-	201	-	-	-	-	-	-	-	-	-	-	-
18	Chlamyd sp	-	-	-	-	-	-	54	-	-	630	-	40	-
19	Chlamyd sph	-	-	-	-	-	-	-	-	-	-	27	-	-
20	Chlorogonium	-	-	-	-	-	-	-	13	65	-	-	-	-
21	Coelastrum mi	-	-	-	-	-	-	-	-	-	13	-	-	-
22	Coelastrum sp	101	-	-	-	-	-	-	-	-	-	-	-	-
23	Crucigenia irr	-	-	-	-	-	-	-	-	-	13	-	-	-
24	Eudorina eleg	34	-	-	-	-	-	-	-	-	-	-	-	-
25	Micractinium	-	-	40	-	-	-	-	-	-	-	-	-	-
26	Nephrocytium	-	-	-	-	-	-	-	-	-	27	-	-	-
27	Ooc pus	34	-	-	-	-	-	-	-	13	-	-	-	-
28	Pandor mor	-	-	-	-	-	-	-	-	-	-	335	40	-
29	Selenast west	101	134	-	-	-	-	-	-	-	951	-	-	-
30	Scened bij	-	-	40	-	-	13	-	-	-	13	-	-	-
31	Scened quad	67	-	40	-	-	-	-	-	-	13	-	-	-
32	Scened q long	34	-	-	-	-	-	-	-	-	-	-	-	-
33	Schroed set	-	-	-	-	67	-	-	13	161	-	-	-	429
34	Schroed jud	-	-	-	-	-	27	-	-	-	-	-	-	-
35	Staurastrum	-	-	-	-	-	-	-	13	-	-	-	-	-
36	Planktosphaer	-	-	-	-	-	-	-	-	-	-	-	-	13
37	Sphaer schr	-	-	-	-	-	-	-	-	-	-	-	-	27
38	*	-	-	-	-	-	-	-	-	-	-	-	-	-
39	*	-	-	-	-	-	-	-	-	-	-	-	-	-
40	*	-	-	-	-	-	-	-	-	-	-	-	-	-
41	Euglena sp	-	-	40	-	-	-	13	-	-	-	-	-	13
42	Trachelo sp	-	-	-	-	-	-	-	-	-	-	13	-	13
43	Phacus sp	-	-	-	-	-	-	-	-	39	-	-	-	-
44	*	-	-	-	-	-	-	-	-	-	-	-	-	-
45	*	-	-	-	-	-	-	-	-	-	-	-	-	-
46	Crypto er	-	-	40	156	-	-	-	-	-	-	-	-	-
47	Crypto sc	-	-	-	-	-	-	-	13	39	-	-	-	-
48	Crypto ov	67	-	-	45	54	27	13	-	52	-	67	-	322
49	Crypto refl	-	-	-	-	-	-	13	-	-	-	-	-	-
50	Rhodo min	-	67	-	-	-	54	375	27	228	-	27	-	362
51	Chroomonas	-	-	-	-	-	-	-	-	-	-	-	864	-
52	*	-	-	-	-	-	-	-	-	-	-	-	-	-
53	Ceratium hir	101	134	241	22	-	-	-	-	-	13	-	-	-
54	Gymnodin sp	-	-	-	-	-	-	-	13	-	-	-	-	-
55	Peredinium	-	67	40	-	-	-	-	-	-	-	-	-	-
56	*	-	-	-	-	-	-	-	-	-	-	-	-	27
57	*	-	-	-	-	-	-	-	-	-	-	-	-	-
58	Chlorochrom	134	-	-	-	-	-	-	-	-	-	-	-	-
59	*	-	-	-	-	-	-	-	-	-	-	-	-	-
60	*	-	-	-	-	-	-	-	-	-	-	-	-	-
61	Anab circ	-	67	-	-	-	-	-	-	-	-	482	1387	-
62	Anab sp	1374	-	-	-	-	-	-	-	-	-	-	-	-
63	Aphanocap el	4055	1608	-	-	-	-	-	-	-	27	-	-	-
64	Aph flos aq	-	-	-	-	-	13	-	27	52	13	536	3296	362
65	Aphanothece s	-	268	-	-	-	-	-	-	-	-	-	-	-
66	Gloeocaps rup	101	-	-	-	-	-	-	-	-	-	-	-	-
67	Microcyst aer	235	536	684	-	-	-	13	-	-	-	-	-	-
68	Osc agard	-	-	40	-	-	-	-	-	-	-	-	-	-
69	Osc ten	905	1072	4423	-	-	-	-	-	-	-	-	-	-
70	Osc sp	-	-	-	22	-	-	-	-	-	-	-	-	-
71														
72	Total diatoms	101	268	0	22	0	1.3	39	66	1555	174	0	0	0
73	Total greens	1980	700	120	0	67	40	54	66	467	2101	362	80	482

Colemere Phytoplankton 1991/2

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 29 1992	April 1 1992	April 28 1992	May 20 1992	June 10 1992
74	Total others	302	268	361	223	54	81	414	53	358	13	107	864	737
75	Total bl grns	6670	3551	5147	22	0	13	13	27	52	40	1018	4683	362
76	Total	9053	4787	5628	267	121	147	520	212	2432	2328	1487	5627	1581
77														
78	Diatoms %	1.1	5.6	0	8.2	0	2.5	7.5	31.1	63.9	7.5	0	0	0
79	Greens %	21.9	14.6	2.1	0	55.4	7.7	10.4	31.1	19.2	90.2	24.3	1.4	30.5
80	Others %	3.3	5.6	6.4	83.5	44.6	55.1	79.6	25	14.7	0.6	7.2	15.4	46.6
81	Bl Grns %	73.7	74.1	91.5	8.2	0	2.5	2.5	12.7	2.1	1.7	68.5	83.2	22.9
82														
83		Diatoms	Greens	Others	Blue Grns									
84	Winter mean %	26.3(28)	17.1(10.5)	43.6(29.5)	4.95(5.2)									
85	Growth mean%	2.5(3.5)	26.7(29.6)	23.7(28)	47.1(38)									
86	Annual mean %	9.8(18.3)	23.8(25.2)	29.8(29.1)	34.1(37.2)									

Cole Mere



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Ch
Small amounts

(g)COMBER MERE

(i)Morphometry and water budget

Comber Mere is the largest mere studied, with 51.5 ha but at 11.8 m by no means the deepest. It has one substantial (COMI1) and one lesser(COMI2) inflow and is flanked by rising ground that suggests a predominance of surface input over ground water. However the outflow stream was found to carry about three times as much water as the two inflows combined and this suggests a substantial contribution either by ground water or overland surface flow after heavy rain. The low conductivity of the mere (513 uS) compared with the inflows (954 and 735 uS) suggest that low conductivity surface rain water is the extra source. The matter is slightly complicated by a small increase in conductivity in the outflow stream at the point where it could be gauged compared with the mere itself. This suggests a small water contribution to the stream after it has left the mere. Based on the outflow, nonetheless, estimates of the annual, winter and growth season flushing rates are 0.6, 0.87, and 0.06 per year respectively. The corresponding retention times are 1.66, 1.15, and 16 years. There is thus considerable stagnation of the mere in the warmer months and quite a long retention time even in the wetter ones.

(ii) Land use changes

The likely catchment of Comber Mere lies in the parishes of Dodcott cum Wilkesley, Marbury cum Quoisley, and Whitchurch (urban and rural) whose combined land use changes have been as follows:

	1931	1987
Cattle(head)	9927	14735
nutrient units	121109	179767
Pigs(head)	5502	24516
nutrient units	26410	117677
Sheep(head)	6952	4559
nutrient units	10428	6839
Poultry(head)	68912	37964
nutrient units	9648	5315
Total nutrient units	167595	309598

Permanent grass(ha)	6684	4120
Temporary grass(ha)	615	1857
Arable(ha)	677	573
Woodland(ha)	6	41
Rough grazing(ha)	36	149
Total hectarage	8018	6740

The changes here have thus been towards a marked increase in cattle and pig keeping, no increase in arable but a transfer of permanent pasture to temporary and a marked loss of land to non agricultural purposes.

(iii) Major ion chemistry and nutrient loads

Comber Mere has a relatively high conductivity and alkalinity but both are much lower than they might be if the major surface inflow(COMI1) dominated the overall water supply. COMI 1 has a mean conductivity of 954 uS, and an alkalinity of 5.6 mequiv/l compared with 513 and 3.0 in the mere itself. Even the much smaller COMI2 has higher conductivity (735) and alkalinity (4.7). Such values in the inflows suggest that they contain water that has had extensive contact with the surrounding soils, i.e. that they are ultimately spring fed in contrast with the bulk of the water entering the mere which must fairly rapidly run off the immediately surrounding parkland, with little soil contact.

COMI 2 carries a low phosphorus load and has low phosphorus concentrations when it flows in winter and spring though its nitrate concentrations are moderate. It is low in ammonium and has the characteristics of water draining permanent, lightly fertilised pasture land. Its quality is probably similar to that of the run-off water that appears to dominate the water budget. COMI1 on the other hand , has very poor quality with very large phosphorus, ammonium and nitrate concentrations. This combination of both high P and ammonium N suggests a major excretory source discharging to it.

Calculation of the phosphorus budget of the mere indicates that COMI1 contributes 364 kg per year, COMI2 1kg and the surface run off 81 kg of the total entering of 446 kg. For this calculation the surface run off has been assumed to have a similar water quality to that of COMI2. For inorganic nitrogen COMI1 contributes 7366 kg, COMI2, 51 kg and surface run-off 3278kg of the total input of 10695kg.. Thus COMI1 is providing 82% of the phosphorus budget and 69% of the nitrogen budget.

The mere itself is rich in phosphorus year around but relatively scarce in nitrogen probably because of rapid denitrification in the littoral zone and uptake in the plant beds.

(iv) Phytoplankton and zooplankton

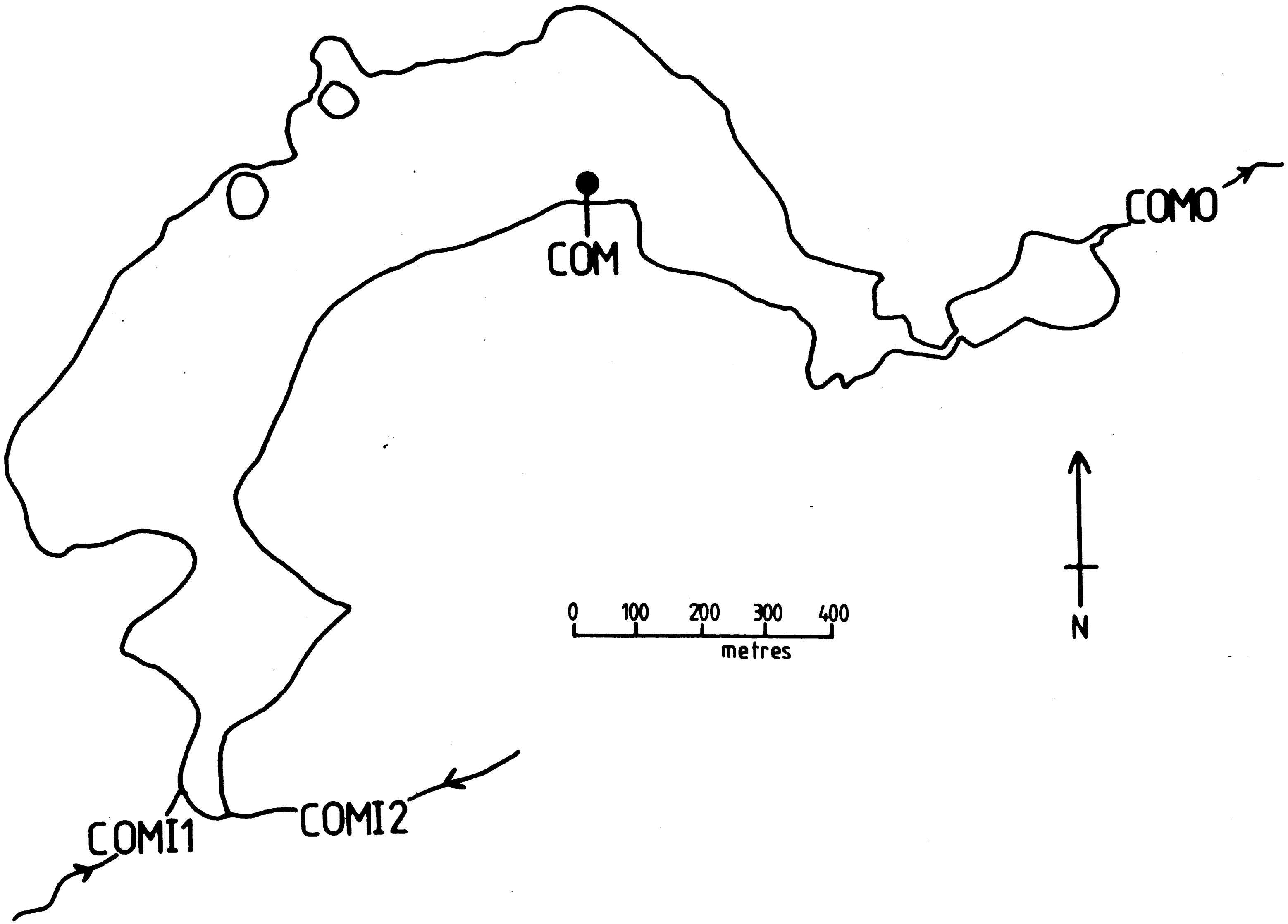
Chlorophyll a values are modest (maximum 42.8 ug/l, growth season mean only 20.5 ug/l), considering the relatively large phosphorus and nitrogen loads (0.86gP/metre squared, and 20.8 gN/metre squared). The mere is saved by its size. ***Daphnia*** populations are also moderately large and grazing is therefore also likely to be important in limiting the size of the algal crops. Crops of most algal groups are modest and blue-green algal blooms, although present in August are not major features.

(v) Aquatic plants

Aquatic plant development was not extensive with only sparsely distributed stands of ***Ranunculus circinatus, Zannichellia palustris, Polygonum amphibium*** and ***Enteromorpha*** in addition to the white and yellow water lilies. This may reflect the deepness of the lake and the wind exposure of its shorelines for the water transparency is sufficient to support healthy beds of submerged plants. The trophic score was high(8.85).

(vi) Overall assessment

Comber Mere is very probably artificially eutrophicated through the water that enters in COMI1. Its size and probable low fish stock (hence abundant ***Daphnia***) prevent the planktonic algal crops from being very high but nutrient-induced high epiphyte burdens as well as physical factors may limit the aquatic plant growth. It would be in the interests of stabilising the present situation and of restoring a less eutrophicated state if measures were taken to remove N and P from COMI1 which is clearly the main culprit. The nutrient source is probably a farm, holding substantial head of stock. In the interim, fish stocking of the lake (except with piscivores) should be avoided.


COMO
COM
COMI1
COMI2
0 100 200 300 400
metres
N

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 28 1991	1046	0.15	6.90	7.83	40.4	762	836	259	1094
2	Sept 18 1991	919			8.07	63.8	636	667	116	783
3	Oct 23 1991	1043	0.25	8.00	7.76	80.4	1332	1343	285	1628
4	Nov 13 1991	1234	0.10	6.95	7.53	59.5	2062	2105	0	2105
5	Dec 4 1991	1002	0.40	7.20	7.84	70.0	1433	1681	0	1681
6	Jan 14 1992	926	0.15	4.20	8.23	74.0	371	371	0	371
7	Feb 5 1992	1032	0.35	2.55	8.32	44.0	403	517	117	633
8	Mar 4 1992	782	0.30	4.25	7.91	70.6	307	337	101	439
9	Mar 25 1992	875	0.30	3.20	7.76	60.0	205	395	150	545
10	April 15 1992	880	0.25	4.65	7.83	66.7	416	467	133	599
11	May 13 1992	861	0.55	6.15	7.96	60.0	464	560	166	726
12	June 3 1992	906	0.00	6.15	7.83	78.4	1674	1674	81	1756
13	June 22 1992	896	0.00	7.00	8.03	62.8	1389	1389	37	1425
14										
15	Winter mean	1049	0.25	5.23	7.98	61.9	1067			1198
16	SD	32	0.15	2.20	0.37	13.4	827			828
17	Growth mean	912	0.23	5.79	7.89	64.8	798			999
18	SD	85	0.18	1.61	0.10	11.8	534			495
19	Annual mean	954	0.23	5.60	7.91	63.9	881			1060
20	SD	116	0.16	1.80	0.20	11.8	614			587

Combermere Infl. 1 COMI

	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	0.535	3700	3.59	0.0010	2.560		0.660	
2	3.530	111	4.98	0.0017	3.740		0.810	
3	2.360	2512		0.0025	7.370		2.460	
4		3461	7.56	0.0070			8.910	
5	0.160	2829	6.02	0.0060	10.850		6.100	
6	4.820	72	4.68	0.0570	169.000		12.800	
7	0.970	259	1.98	0.0270	19.900		10.300	
8	10.800	25	3.21	0.0440	288.000		11.680	
9	24.070	285	3.95	0.0780	1149.000		25.700	
10	10.130	356	3.24	0.0020	12.700		0.730	
11	4.270	99	2.52	0.0090	23.800		3.950	
12	2.980	972	5.58	0.0040	9.560		4.250	
13	1.820	161	4.84	0.0030	3.590	7366.000	2.590	364.000
14								
15	1.980	1655	5.06	0.0240				
16	2.490	1741	2.40	0.0240				
17	6.720	913	3.99	0.0160				
18	7.400	1308	1.05	0.0260				
19	5.530	1142	4.35	0.0190				
20	6.800	1423	1.58	0.0250				

Combermere Inflow 2 COMI2

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol react P	Tot Sol P	Partic P	Total P
1	*	*	*	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*	*	*	*
3	*	*	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*	*	*
5	*	*	*	*	*	*	*	*	*	*
6	*	*	*	*	*	*	*	*	*	*
7	Jan 14 1992	797	0	4.1	7.46	34	51	51	0.5	52
8	Feb 5 1992	751	0.6	5.2	8.22	40	13	62	36	98
9	Mar 4 1992	*	*	*	*	*	*	*	*	*
10	Mar 25 1992	*	*	*	*	*	*	*	*	*
11	April 15 1992	697	0.85	4.25	7.94	43.1	28	35	18	53
12	May 13 1992	695	0.4	5.10	8.04	38.0	32	41	22	63
13	June 3 1992	No flow								
14	June 22 1992	No flow								
15										
16	Winter mean	774(33)	0.3(0.4)	4.7(0.8)	7.84(0.53)	37(4)	32(27)			75(33)
17	Growth mean	696(1.4)	0.63(0.32)	4.7(0.6)	7.99(0.07)	40.6(4)	30(3)			58(7)
18	Annual mean	735(49)	0.46(0.36)	4.7(0.57)	7.9(0.32)	38.8(4)	31(16)			67(22)

Combermere Inflow 2 COMI2

	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	*	*	*	*				
2	*	*	*	*				
3	*	*	*	*				
4	*	*	*	*				
5	*	*	*	*				
6	*	*	*	*				
7	3.56	38	4.52	+	0.240		0.003	
8	2.7	98	3.77	+	0.190		0.006	
9	*	*	*	*				
10	*	*	*	*				
11	2.55	45	3.26	0.004	7.260		0.128	
12	1.77	42	3.77	0.003	3.970	50.500	0.114	1.090
13								
14								
15								
16	3.1(0.6)	68(42)	4.2(0.5)	+				
17	2.16(0.6)	44(2)	3.5(0.4)	0.0018(0.002)				
18	2.65(0.7)	56(28)	3.83(0.52)	0.001(0.0016)				

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 28 1991	*	*	*	*	*	*	*	*	*
2	Sept 18 1991	*	*	*	*	*	*	*	*	*
3	Oct 23 1991	*	*	*	*	*	*	*	*	*
4	Nov 13 1991	519	0.2	2.95	7.56	44.4	371	405	0	405
5	Dec 4 1991	524	0.3	3.3	7.81	42.0	362	362	47	408
6	Jan 14 1992	526	0.15	3.15	8.16	44.0	404	413	18	431
7	Feb 5 1992	539	0.4	3.0	8.37	48	386	392	94	486
8	Mar 4 1992	1027	0.4	3.95	7.74	66.7	42	52	35	86
9	Mar 25 1992	900	0.3	3.9	7.74	72	46	56	58	114
10	April 15 1992	533	0.4	3.3	8.61	51.0	214	265	35	300
11	May 13 1992	No flow								
12	June 3 1992	No flow								
13	June 22 1992	No flow								
14										
15	Winter mean	527(9)	0.26(0.11)	3.1(0.16)	7.98(0.36)	44.6(2.5)	381(18)			433(38)
16	Growth mean	820(256)	0.37(0.06)	3.82(0.19)	8.03(0.5)	63.2(11)	101(98)			167(116)
17	Annual mean	653(216)	0.3(0.1)	3.4(0.41)	8.0(0.39)	52.6(11.9)	261(161)			319(159)

	Nitrate N	Ammonium N	Silicate Si	Discharge
1	*	*	*	0.000
2	*	*	*	0.000
3	*	*	*	0.000
4	0.48	465	2.38	0.077
5	0.85	214	2.13	0.092
6	0.72	106	2.48	0.116
7	1.39	154	2.18	0.051
8	2.63	57	6.05	+
9	7.53	78	4.79	0.011
10	1.68	79	0.97	0.0001
11				
12				
13				
14				
15	0.86(0.39)	235(160)	2.3(0.17)	0.084(0.03)
16	3.95(3.13)	71(12)	3.94(2.7)	0.006(0.008)
17	2.18(2.47)	165(143)	3.0(1.77)	0.058(0.046)

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 28 1991	472	0.50	2.50	9.00	42.6	15.5	35	92	126
2	Sept 18 1991	481			8.30	46.8	90.5	106	31	137
3	Oct 23 1991	508	0.10	3.10	7.89	41.2	347.0			347
4	Nov 13 1991	524	0.30	3.05	7.84	40.4	360.0	47	407	451
5	Dec 4 1991	516	0.25	3.30	7.95	44.0	378.0	384	57	442
6	Jan 14 1992	516	0.20	3.20	8.38	42.0	503.0	503	0	503
7	Feb 5 1992	527	0.35	2.90	8.32	44.0	403.0	517	117	633
8	Mar 4 1992	524	0.20	3.10	8.18	51.0	273.0	308	72	380
9	Mar 25 1992	531	0.50	3.20	8.97	44.0	272.0	470	206	675
10	April 15 1992	530	0.20	3.00	8.73	39.2	232.0	247	68	315
11	May 13 1992	527	0.35	3.25	8.48	44.0	203.0	234	69	302
12	June 3 1992	515	0.35	2.20	8.86	39.2	155.0	185	51	236
13	June 22 1992	494	0.75	3.20	9.42	43.1	100.0	118	46	164
14										
15	Winter mean	521	0.28	3.10	8.12	42.6	411.0			507
16	SD	6	0.07	0.20	0.27	2.0	64.0			88
17	Growth mean	509	0.37	2.94	8.64	43.5	188.0			298
18	SD	22	0.21	0.40	0.48	4.0	106.0			169
19	Annual mean	513	0.34	3.00	8.49	43.2	256.0			362
20	SD	19	0.18	0.33	0.48	3.0	141.0			176

Combermere COM

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.00	2.35	0.96	42.8	65.7	1.55	1.30	0.95	6.00
2	0.00	154.00	0.84	27.6	39.3	1.44	1.23	0.90	8.25
3	0.21	734.00		16.2	19.7	1.23	1.14	>	1.52
4	0.23	754.00	1.93	3.7	7.0	1.91	0.98	>	0.06
5	0.36	567.00	2.03	0.0	0.3	>	0.87	>	0.07
6	0.33	424.00	2.27	2.9	4.7	1.75	1.16	>	0.94
7	0.97	259.00	1.98	0.0	0.0	-	-	>	0.20
8	1.16	243.00	2.19	26.8	28.0	1.15	1.17	>	0.56
9	1.04	112.00	0.42	17.6	23.7	1.48	1.18	1.0	2.28
10	1.63	39.00	0.79	20.5	25.0	1.34	1.19	>	2.59
11	0.78	24.00	1.17	0.0	16.7	>	1.12	>	30.60
12	0.55	320.00	0.96	2.2	2.7	1.33	1.13	>	200.70
13	0.21	34.00	0.52	30.4	30.3	1.1	1.21	>	51.00
14									0.30
15	0.40	501.00	2.05	1.6					0.42
16	0.34	210.00	0.15	1.9					33.70
17	0.62	185.00	0.98	20.5					64.90
18	0.57	233.00	0.54	13.5					23.40
19	0.58	282.00	1.34	14.7					55.40
20	0.50	265.00	0.69	14.3					

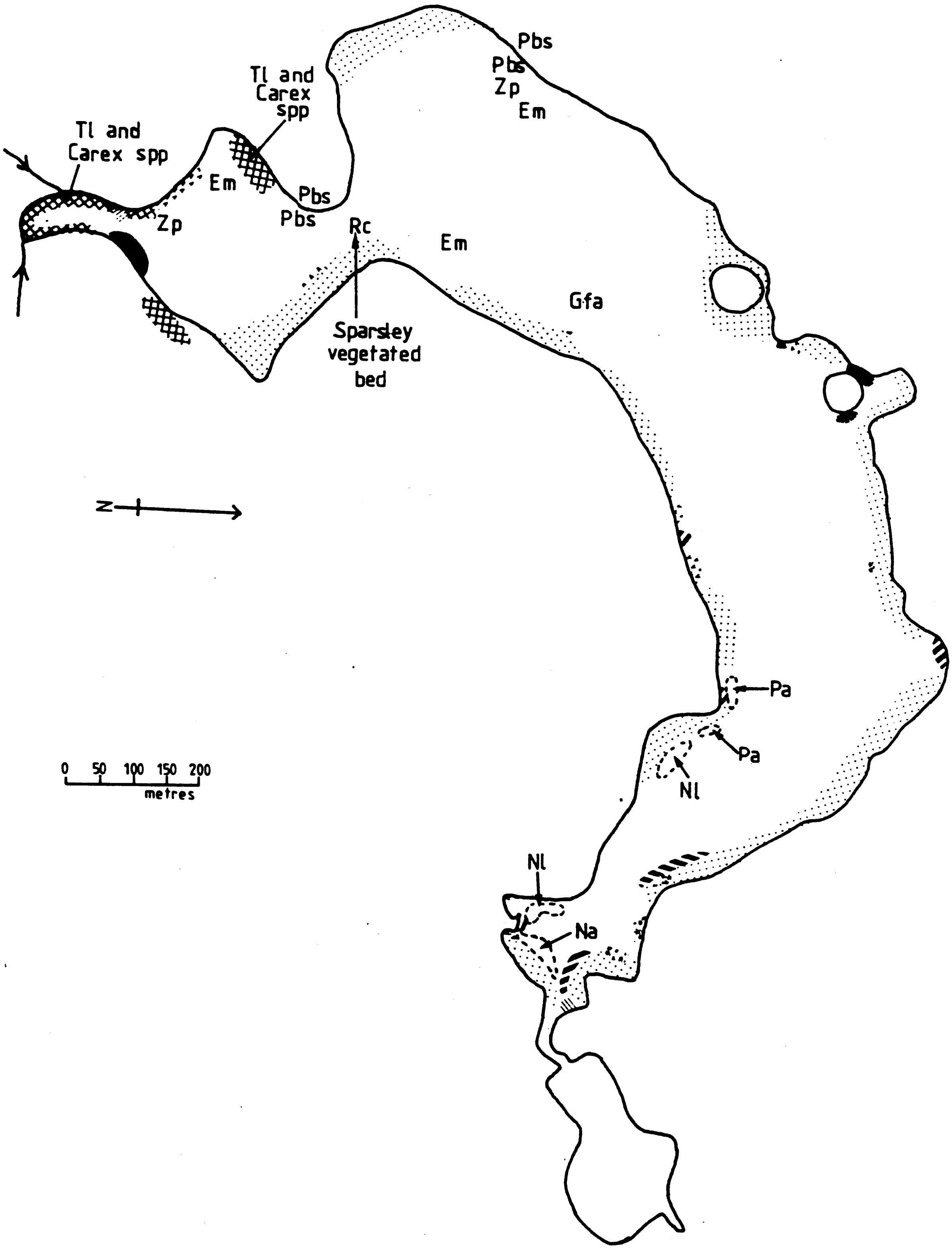
	Organism	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 13 1991	Dec 4 1991	Jan 14 1992	Feb 5 1992	March 4 1992	Mar 25 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
1	Aster form	-	-	804	13	-	-	-	40	-	-	13	-	-
2	Coscinodiscus	-	-	-	-	-	-	-	120	-	-	-	-	-
3	Cyclotella	844	13	-	80	13	13	201	6360	4142	161	268	-	-
4	Cymbella pros	-	-	-	-	-	-	-	-	40	-	-	-	-
5	Frag coonstr	-	94	-	-	-	-	-	-	-	-	-	-	-
6	Gomphonema	-	-	22	-	-	-	-	-	-	-	-	-	-
7	Melosira sp	-	-	-	-	-	-	-	80	-	-	-	-	-
8	Melosira gran	121	147	-	-	-	-	-	-	-	-	-	-	-
9	Navicula	-	-	22	-	-	13	13	-	-	-	13	-	-
10	Rhoicosphenia	-	-	-	-	-	-	-	40	-	-	-	-	-
11	Synedra sp	-	-	-	13	-	-	-	-	40	-	-	-	-
12	Frag crot	-	-	22	-	-	-	-	-	-	-	-	-	-
13	Cocconeis sp	-	-	-	-	-	-	-	-	40	-	-	-	-
14	Melosira ital	-	-	-	-	-	-	-	-	-	-	-	-	469
15	*	-	-	-	-	-	-	-	-	-	-	-	-	-
16	*	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Ankist sp	-	13	-	-	-	-	-	-	-	-	-	-	-
18	Ank falc	181	-	-	-	-	-	-	-	-	121	27	-	-
19	Ank conv	-	-	-	-	-	-	-	-	40	161	13	-	-
20	Botryococcus	-	-	-	-	-	-	-	-	-	-	13	-	-
21	Carteria cord	-	-	-	-	-	-	-	-	-	-	13	-	-
22	Chlamyd sph	-	-	-	-	-	-	-	-	-	80	-	-	-
23	Chlamyd glob	101	-	-	27	-	-	-	-	-	-	-	-	-
24	Chlamyd sp	60	147	134	67	80	-	65	160	282	-	67	54	94
25	Chlamyd ep	20	-	-	-	-	-	-	-	-	-	-	-	-
26	Clost cynth	60	-	-	-	-	-	-	-	-	-	-	-	27
27	Clost sp	-	-	89	-	-	-	13	-	-	-	-	-	-
28	Clostops long	101	-	-	-	-	-	-	-	-	-	-	-	-
29	Crucigenia	-	-	22	-	-	-	-	-	-	-	-	-	-
30	Chlorella	-	-	-	67	67	-	-	-	2051	-	-	-	-
31	Chlorogonium	-	-	-	-	-	13	52	-	-	-	-	-	-
32	Coelastrum	-	-	-	-	-	-	-	40	-	-	-	-	-
33	Crucigenia vul	-	-	-	-	-	-	-	-	-	40	-	-	-
34	Ocyst pus	60	-	-	-	-	-	-	-	-	-	-	-	-
35	Quadrig lac	-	-	-	-	-	-	-	-	-	-	13	-	-
36	Scened acum	-	-	22	-	-	-	-	-	-	-	-	-	-
37	Selenast west	20	-	-	-	-	-	-	-	-	201	-	-	-
38	Scened quad	-	-	22	-	-	-	-	-	-	40	-	-	-
39	Schroed set	-	27	22	-	-	-	-	-	-	-	-	40	13
40	Staurastrum	-	-	-	-	-	-	-	-	-	-	13	-	228
41	Pediast dupl	-	-	-	-	-	-	-	-	-	-	-	-	13
42	Pandor morum	-	-	-	-	-	-	-	-	-	-	-	-	13
43	*	-	-	-	-	-	-	-	-	-	-	-	-	-
44	*	-	-	-	-	-	-	-	-	-	-	-	-	-
45	*	-	-	-	-	-	-	-	-	-	-	-	-	-
46	*	-	-	-	-	-	-	-	-	-	-	-	-	-
47	Euglena sang	-	-	-	-	-	-	-	40	121	-	80	-	-
48	Euglena sp	-	13	-	-	-	-	-	-	-	-	-	-	-
49	Trachelo sp	-	-	22	-	-	-	-	-	80	-	13	-	27
50	*	-	-	-	-	-	-	-	-	-	-	-	-	-
51	*	-	-	-	-	-	-	-	-	-	-	-	-	-
52	Crypto acuta	-	-	-	-	-	67	-	240	-	161	362	80	-
53	Crypto erosa	-	-	268	-	-	-	13	-	-	-	-	-	-
54	Crypto ovata	603	322	402	67	27	13	-	240	241	483	1032	40	94
55	Rhodo min	322	482	45	-	13	831	523	3000	603	4383	308	13	348
56	*	-	-	-	-	-	-	-	-	-	-	-	-	-
57	*	-	-	-	-	-	-	-	-	-	-	-	-	-
58	Ochromonas	-	-	-	-	-	-	-	-	40	-	-	-	-
59	Unid flag	482	-	-	-	-	-	-	-	1649	-	-	-	-
60	Ophiocytium	-	-	-	-	13	-	-	-	-	-	-	-	-
61	Mallomonas	-	-	-	-	-	-	-	-	-	161	-	-	-
62	*	-	-	-	-	-	-	-	-	-	-	-	-	-
63	*	-	-	-	-	-	-	-	-	-	-	-	-	-
64	Ceratium hir	20	-	-	-	-	-	-	-	-	-	-	-	13
65	Glenodinium	-	-	-	-	-	-	-	-	482	-	-	-	-
66	Peredinium	80	-	-	-	-	-	-	-	-	-	-	-	-
67	*	-	-	-	-	-	-	-	-	-	-	-	-	-
68	*	-	-	-	-	-	-	-	-	-	-	-	-	-
69	*	-	-	-	-	-	-	-	-	-	-	-	-	-
70	*	-	-	-	-	-	-	-	-	-	-	-	-	-
71	*	-	-	-	-	-	-	-	-	-	-	-	-	-
72	Anab aff	60	-	-	-	-	-	-	-	-	-	-	-	-
73	Anab circ	-	40	112	-	-	-	-	-	-	40	-	27	-

Combermere Phytopl 1991/92

Organism	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 13 1991	Dec 4 1991	Jan 14 1992	Feb 5 1992	March 4 1992	Mar 25 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
Anab fl aq	2533	13	45	-	-	-	-	-	-	-	54	-	27
Anab spir	201	13	-	-	-	-	-	-	-	-	94	-	67
Aphanocapa sp	-	13	-	-	13	-	-	-	-	-	-	-	-
Aph elach	342	-	-	-	-	-	13	-	-	-	-	-	-
Aphaniz fl aq	-	-	-	-	-	-	-	-	-	-	-	-	-
Coelos naeg	20	-	-	-	-	-	-	-	-	-	-	-	-
Merismo punct	-	-	-	-	-	-	-	-	-	-	-	-	-
Microcyst aer	181	1179	-	-	-	-	-	-	-	-	13	-	-
Oscillat sp	-	40	-	-	-	-	-	-	-	-	-	-	-
Rhabdoderma	101	-	-	-	-	-	-	-	-	-	-	-	-
Merismo punc	-	-	22	-	-	-	-	-	-	-	-	-	-
Total diatoms	965	254	870	106	13	26	214	6640	4262	161	294	0	469
Total greens	610	187	311	161	147	13	130	200	2373	643	160	94	389
Total others	1507	817	737	67	53	911	536	3520	3936	5188	1795	133	482
Total bl grns	3438	1299	179	0	13	0	13	0	0	40	161	27	94
Total	6520	2557	2097	334	226	950	893	10360	10571	6032	2410	254	1434
Diatoms %	14.8	9.9	41.5	31.7	5.8	2.7	24	64.1	40.3	2.7	12.2	0	32.7
Greens %	9.4	7.3	14.8	48.2	65	1.4	14.6	1.9	22.4	10.7	6.6	37	27.1
Others %	23.1	32	35.2	20.1	23.5	95.9	60	34	37.2	86	74.5	52.4	33.6
Bl Greens %	52.7	50.8	8.5	0	5.8	0	1.5	0	0	0.7	6.7	10.6	6.6

	Diatoms	Greens	Others	Blue greens
Winter mean %	16.1(14)	32.3(29.4)	49.9(35.6)	1.8(2.7)
Growth mean%	24.2(21.5)	15.2(11.4)	45.3(21.4)	15.2(21.1)
Annual mean %	21.72(19.3)	20.5(19.2)	46.7(25)	11.1(18.4)

Comber Mere


Tl and
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N
0 50 100 150 200
metres
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Pa
Nl
Nl
Na

(h) COP MERE

(i) Morphometry and water budget

Cop Mere is moderately large (16.8ha) but shallow (2.7m). It is fed by the River Sow which feeds into the wetland to the west of the lake and by two smaller inflows to the north which amalgamate before entering the mere. There is a substantial outflow- the continuation of the River Sow, which discharged nearly 3 million cubic metres of water in the year investigated. The flushing rates for the year, the winter and the growing season were 12.9, 13.6 and 12.9 per year respectively and the corresponding retention times were 4,3.8 and 4 weeks respectively. The lake is thus very frequently flushed and there is little seasonal variation. The northern inflows provided 126144 cubic metres or about 4.3% of the total inflow of 2.93 million cubic metres.

(ii) Changes in land use

Cop Mere has a relatively large catchment in the parishes of Eccleshall, High Offley, Mucklestone, Ashley, Adbaston and Loggerheads for which the combined land use changes have been as follows:

	1931	1987
Cattle(head)	9972	20523
nutrient units	121658	250381
Pigs(head)	2540	7959
nutrient units	12192	38203
Sheep(head)	12015	9305
nutrient units	18023	13958
Poultry(head)	56075	36374
nutrient units	7851	5092
Total nutrient units	159724	307634
Permanent grass(ha)	7332	5415
Temporary grass(ha)	1205	2666
Arable(ha)	1780	5546
Woodland(ha)	11	254
Rough grazing(ha)	97	106
Total hectarage	10425	13987

There has thus been a major increase in cattle and pig keeping and a drift towards arable and temporary grass. Changes in parish boundaries since 1931 however give an increased hectarage which confuses simple interpretation.

(iii) Major ion chemistry and nutrient loads

Cop Mere has a moderately high conductivity and alkalinity which must arise from the chemistry of the River Sow water modified by its passage through the wetland and by the minor addition of the northern inflows. Cop Mere has higher conductivity than the R. Sow but lower than the small inflows. The difference between Mere and river is about 12%, too great to be explicable by the 4% water input through the northern inflow alone so wetland processes are probably significant. Of the northern inflows, CPI1 brings in 87 kgN and 9.6 kgP, whilst the other stream , CPI2 carries 327kg N and 10 kg P per year. In contrast, the River sow contributes 10500 kg N and 783 kg P to the system but some of these loads may be retained or denitrified in the wetland. The northern inflows alone load 0.12 gP per square metre and 2.5g N per square metre. In the absence or diversion of the R. Sow, these loads would be quite small even considering that the retention time of the lake would be much increased. Both inflows are rich in nitrate but only the smaller is very rich in phosphorus. Concentrations of both N and P are high in the river Sow.

The Mere is rich in both available phosphorus and available nitrogen at almost all times of year. Retention times though short are long enough for substantial plankton development.

(iv) Phytoplankton and zooplankton

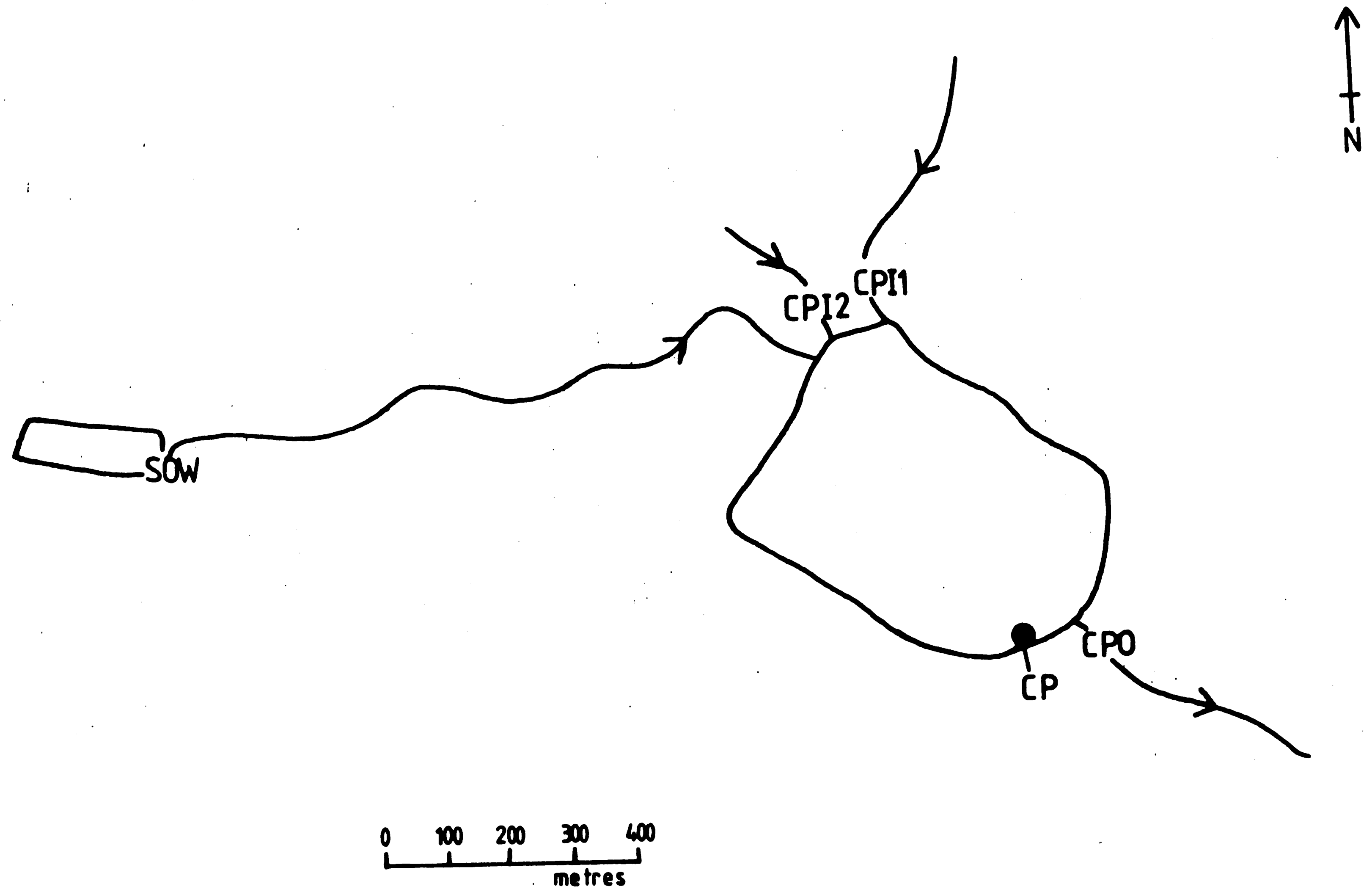
The mean chlorophyll a concentration in Cop Mere was relatively high but it was conditioned by a small number of occasions when very large crops of diatoms or flagellates were present, two of them in winter. At other times the crops were only moderate. Blue-green algae were present in moderate numbers in summer. There was apparently little grazing pressure for ***Daphnia*** numbers were low, rising to double figures per litre only in early summer. Occasionally large numbers of plant associated species like ***Scapholeberis mucronata*** were present suggesting the possibility of extra grazing pressure at night when such species drift out into the open water.

(v) Aquatic plants

Cop Mere does not have a particularly prolific submerged flora but it is not a sparse one either. Three species of Potamogetonaceae were present, two of them classed as frequent and clumps of ***Chara vulgaris*** and ***Elodea canadensis*** were found. The trophic score was 8.5.

(vi) Overall assessment

Cop Mere is clearly eutrophicated by the nutrient-rich River Sow water which carries high concentrattions of both soluble reactive phosphorus and of nitrate. The mere water had higher concentrations of nitrate than other of the meres, but nitrogen was relatively scarce in summer when nitrogen fixing blue-green algae developed. The highest chlorophyll a concentrations developed in autumn after the period of plant growth and hence the apparent paradox of high algal populations yet persistence of submerged plants. Some safeguarding of the aquatic plant populations would follow from the control of phosphorus in the River Sow, provided that the wetland to the west of the lake remains intact. This wetland undoubtedly removes some of the nitrogen load to the system and attempts to diffuse the river water as it passes into the wetland would be beneficial. The source of phosphorus in the Sow is not known but is likely to be a point excretal source or sources. Fish predation probably reduces the potentiality for grazer control of the algae (there is an active fishing club, which probably means a large fish stock). Reduction of the fish stock would undoubtedly be beneficial but likely to be politically difficult and readily frustrated by restocking by the angling club. One of the inflows, CPI1 has low water quality but its contribution to the total inflow is so small that it would be unprofitable to tackle it unless major efforts were being made to improve the quality of the river Sow, to divert it around or culvert it through the lake.


N
CPI2
CPI1
SOW
CPO
CP
0
100
200
300
400
metres

Cop Mere Inflow 1 CPI1

Thu, Sep 3, 1992 6:47 am

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	524	0.35	3.9	7.45	24.5	655	773	18	791
2	Aug 28 1991	558	0.10	4.1	7.77	25.5	740	758	77	835
3	Sept 18 1991	*	*	*	*	*	*	*	*	*
4	Oct 23 1991	*	*	*	*	*	*	*	*	*
5	Nov 12 1991	570	0.25	4.05	7.7	30.3	380	380	55	435
6	Dec 12 1991	590	0.4	3.8	7.8	36.0	212	242	0	242
7	Jan 15 1992	536	0.2	2.4	7.64	40.0	182	182	2.2	184
8	Feb 4 1992	595	0.4	4.0	8.62	32.0	152	165	11	176
9	Mar 3 1992	557	0.25	3.3	8.02	34.6	170	170	16	185
10	Mar 24 1992	500	0.2	2.7	8.27	32.0	127	127	90	218
11	April 15 1992	570	0.3	4.2	8.22	29.4	21	38	172	210
12	May 13 1992	539	0.35	3.95	8.12	30.0	188	223	45	269
13	June 3 1992	489	0.05	3.95	8.22	25.5	396	426	72	498
14	June 22 1992	512	0.2	4.15	8.37	23.5	355	355	48	403
15										
16	Winter mean	573(27)	0.31(0.1)	3.56(0.78)	7.94(0.46)	34.6(4.3)	232(102)			259(121)
17	Growth mean	531(30)	0.23(0.11)	3.78(0.52)	8.06(0.3)	28.1(4.00	332(257)			426(262)
18	Annual mean	545(34)	0.25(0.11)	3.71(0.59)	8.02(0.35)	30.3(5.0)	298(217)			371(233)

	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	0.54	50	5.58	0.0002	0.120		0.096	
2	0.69	46	4.20	+	0.020		0.025	
3	*	*	*	0	0.000		0.000	
4	*	*	*	0	0.000		0.000	
5	0.18	29	7.22	0.005	0.630		1.320	
6	1.9	27	3.1	0.00005	0.060		0.007	
7	5.1	39	4.57	0.003	9.320		0.330	
8	6.78	91	4.88	0.0002	0.830		0.020	
9	6.77	103	4.02	0.0002	0.830		0.020	
10	8.21	47	2.99	0.0007	3.500		0.090	
11	3.07	69	3.54	0.003	6.820		0.380	
12	2.33	58	2.04	0.0003	0.430		0.049	
13	0.99	123	2.97	0.0004	0.270		0.120	
14	1.91	0	5.07	0.0005	0.580	87.000	0.120	9.570
15								
16	3.49(2.99)	46.5(30)	4.9(1.7)	0.002(0.002)				
17	3.06(2.9)	62(38)	3.8(1.2)	.0006(.0009)				
18	3.21(2.79)	56.8(35)	4.18(1.4)	0.001(.0015)				

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	*	*	*	*	*	*	*	*	*
2	Aug 28 1991	*	*	*	*	*	*	*	*	*
3	Sept 18 1991	604			8.27	34.1	62	76	0	76
4	Oct 23 1991	*	*	*	*	*	*	*	*	*
5	Nov 12 1991	605	0.25	4.3	7.54	34.3	47	50	11	61
6	Dec 12 1991	616	0.5	5.1	7.9	34.0	63	63	0	63
7	Jan 15 1992	581	0.15	3.65	7.52	46.0	84	84	0	84
8	Feb 4 1992	565	0.35	3.65	8.55	48.0	55	64	17	81
9	Mar 3 1992	584	0.25	2.6	7.81	53.8	28	46	45	91
10	Mar 24 1992	554	0.15	2.85	7.9	64.0	52.5	63.6	129	192
11	April 15 1992	519	0.35	3.35	8.18	39.2	3	28	80	108
12	May 13 1992	525	0.25	4.05	7.97	36.0	21	46	51	97
13	June 3 1992	476	0	3.55	7.9	29.4	91	123	136	259
14	June 22 1992	512	0	3.9	8.19	33.3	99	99	31	130
15										
16	Winter mean	592(23)	0.31(0.15)	4.18(0.69)	7.88(0.48)	40.6(7.5)	62.3(16)			72.3(12)
17	Growth mean	539(44)	0.17(0.14)	3.38(0.57)	8.03(0.18)	41.4(12.7)	51(36)			136(66)
18	Annual mean	558(45)	0.23(0.16)	3.7(0.71)	7.98(0.310	41.1(10.6)	55.1(30)			113(61)

	Nitrate N	Ammonium N	Silicate Si	Discharge	Discharge SD	kg N/week	kg N/year	kg P/week	kg P/year
1	*	*	*	0.0000		0.000		0.000	
2	*	*	*	0.0000		0.000		0.000	
3	2.11	38	4.86	0.0020		2.600		0.090	
4	*	*	*	0.0000		0.000		0.000	
5	1.93	51	5.99	0.0020		2.400		0.070	
6	4.07	276	6.17	0.0003		0.790		0.010	
7	3.59	19	4.96	0.0060		13.100		0.310	
8	6.34	93	4.79	0.0070		27.300		0.340	
9	3.07	4	4.33	0.0060		11.200		0.330	
10	4.45	51	2.69	0.0015		4.080		0.170	
11	2.67	30	1.96	0.0070		11.400		0.460	
12	2.5	32	2.03	0.0040		6.130		0.240	
13	2.15	97	3.31	0.0030		4.080		0.470	
14	2.72	62	3.21	0.0030		5.050	327.300	0.240	10.140
15									
16	3.98(1.82)	110(115)	5.48(0.7)	0.0040	0.003				
17	2.81(0.8)	45(29)	3.2(1.1)	0.0030	0.003				
18	3.24(1.31)	69(75)	4.03(1.48)	0.0030	0.003				

Cop Mere Outflow CPO

	Date	Conductivity	Phenolph Alk	Total alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	481	0.25	3.20	7.43	26.5	814.0	1177.0	0	1127
2	Aug 28 1991	480	0.60	3.50	8.73	29.8	458.0	583.0	133	715
3	Sept 18 1991	524			7.59	27.7	835.0	769.0		735
4	Oct 23 1991	482	0.80	3.60	8.77	28.9	126.0	140.0	155	295
5	Nov 12 1991	454	0.60	3.20	9.02	26.3	16.0	45.0	123	168
6	Dec 12 1992	482	0.00	2.60	8.55	30.0	67.0	78.0	8	86
7	Jan 15 1992	487	0.25	3.25	7.57	36.0	195.0	198.0	0	198
8	Feb 4 1992	505	0.15	2.95	8.74	32.0	154.0	175.0	5	179
9	Mar 3 1992	494	0.30	4.00	8.33	30.8	54.0	75.0	37	112
10	Mar 24 1992	420	0.40	2.40	9.14	28.0	7.9	7.9	101	109
11	April 15 1992	443	0.35	2.85	8.80	29.4	17.0	35.0	24	59
12	May 13 1992	470	0.20	3.00	8.53	29.0	106.0	139.0	20	159
13	June 3 1992	339	0.65	2.05	9.85	27.5	86.0	103.0	52	155
14	June 221992	386	0.90	2.65	9.61	27.5	218.0	245.0	0	245
15										
16	Winter mean	482	0.25	3.00	8.47	31.1	108.0			158
17	SD	21	0.25	0.30	0.63	4.0	81.0			49
18	Growth mean	452	0.49	3.03	8.68	28.5	272.0			371
19	SD	56	0.25	0.62	0.77	1.3	319.0			360
20	Annual mean	461	0.42	3.02	8.62	29.2	225.0			310
21	SD	50	0.27	0.53	0.72	2.5	279.0			317

Cop Mere Outflow CPO

	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	0.34	1092	7.42	0.0990	89.000		67.500	
2	0.08	269	4.82	0.0750	15.800		32.400	
3	0.54	1404	9.41	0.0640	75.200		28.400	
4	1.63	67		0.0710	72.900		12.700	
5	1.17	19	2.56	0.1070	76.900		10.900	
6	1.33	187	3.10	0.0710	65.300		3.700	
7	2.05	325	5.58	0.1450	208.300		17.400	
8	3.05	317	5.46	0.0690	141.000		7.500	
9	3.44	142	4.62	0.1390	301.000		9.400	
10	2.54	78	0.43	0.0167	26.400		1.100	
11	1.15	57	0.92	0.1610	117.500		5.740	
12	1.75	118	2.49	0.1130	127.700		10.900	
13	0.05	44	1.02	0.1300	7.400		12.200	
14	0.05	163	3.83	0.0410	5.280	4939.000	6.080	839.000
15								
16	1.90	212	4.18	0.0980				
17	0.86	143	1.57	0.0360				
18	1.16	343	3.88	0.0900				
19	1.17	487	3.07	0.0500				
20	1.37	306	3.97	0.0930				
21	1.10	415	2.63	0.0410				

Cop Mere R. Sow inflow

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jan 15 1992	418	0.10	2.50	7.64		189	189	3	192
2	Feb 4 1992	410	0.20	2.30	8.42	28.0	148	148	39	187
3	Mar 3 1992	411	0.30	2.60	7.99	27.0	126	144	44	187
4	Mar 24 1992	387	0.30	2.30	7.92	24.0	186	186	454	640
5	April 15 1992	397	0.25	2.65	8.78	27.5	111	117	64	182
6	May 13 1992	408	0.20	2.80	8.00	24.0	105	129	103	231
7	June 3 1992	383	0.00	2.60	7.89	25.5	270	233	97	330
8	June 22 1992	402	0.10	2.90	8.28	25.5	105	105	178	283
9										
10	Winter mean	414	0.15	2.40	8.03	28.0	169			190
11	SD	6	0.07	0.14	0.60		29			4
12	Growth mean	398	0.20	2.64	8.14	25.6	151			309
13	SD	12	0.12	0.21	0.34	1.5	66			172
14	Annual mean	402	0.18	2.60	8.12	25.9	155			279
15	SD	12	0.10	0.21	0.36	1.6	58			155

	Nitrate N	Ammonium N	Silicate Si
1	2.46	56	5.02
2	4.81	117	4.41
3	4.60	29	3.90
4	4.85	155	3.40
5	2.36	49	2.69
6	4.30	11	2.71
7	3.24	381	3.94
8	2.44	54	1.64
9			
10	3.64	87	4.72
11	1.70	43	0.43
12	3.63	113	3.05
13	1.10	140	0.88
14	3.63	107	3.46
15	1.12	120	1.08

	Date	Conductivity	Phenolph Alk	Total alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	482	0.00	3.30	7.45	26.5	817.0	1051.0	21	1072
2	Aug 28 1991	453	1.10	3.40	9.05	29.8	323.0	477.0	180	657
3	Sept 18 1991	530			7.80	29.8	831.0	17.0	177	993
4	Oct 23 1991	480	0.80	3.50	8.80	26.8	117.0	133.0		
5	Nov 12 1991	443	0.90	3.20	9.07	26.3	8.0	8.0	154	162
6	Dec 12 1991	482	0.40	3.45	8.64	28.0	62.9	63.0	72	135
7	Jan 15 1992	490	0.15	3.05	7.52	28.0	188.0	188.0	6	194
8	Feb 4 1992	504	0.30	3.10	8.03	40.0	147.0	152.0	20	172
9	Mar 3 1992	495	0.35	3.15	8.16	30.8	47.0	53.0	65	118
10	Mar 24 1992	423	0.35	2.45	9.12	32.0	3.4	3.4	92	95
11	April 15 1992	437	0.35	3.00	8.84	31.4	10.0	35.0	23	58
12	May 13 1992	466	0.20	3.15	8.52	28.0	91.0	91.0	61	152
13	June 3 1992	343	0.75	2.00	9.93	27.5	68.0	99.0	24	123
14	June 22 1992	373	1.05	1.55	9.96	27.5	169.0	169.0	0	169
15										
16	WINTER MEAN	480	0.44	3.20	8.32	30.6	102.0			166
17	SD	26	0.30	0.20	0.70	6.0	81.0			24
18	GROWTH MEAN	448	0.55	2.83	8.76	29.0	248.0			382
19	SD	57	0.40	0.70	0.82	2.0	317.0			410
20	ANNUAL MEAN	457	0.51	2.95	8.64	29.5	206.0			315
21	SD	51	0.36	0.60	0.80	3.5	276.0			351

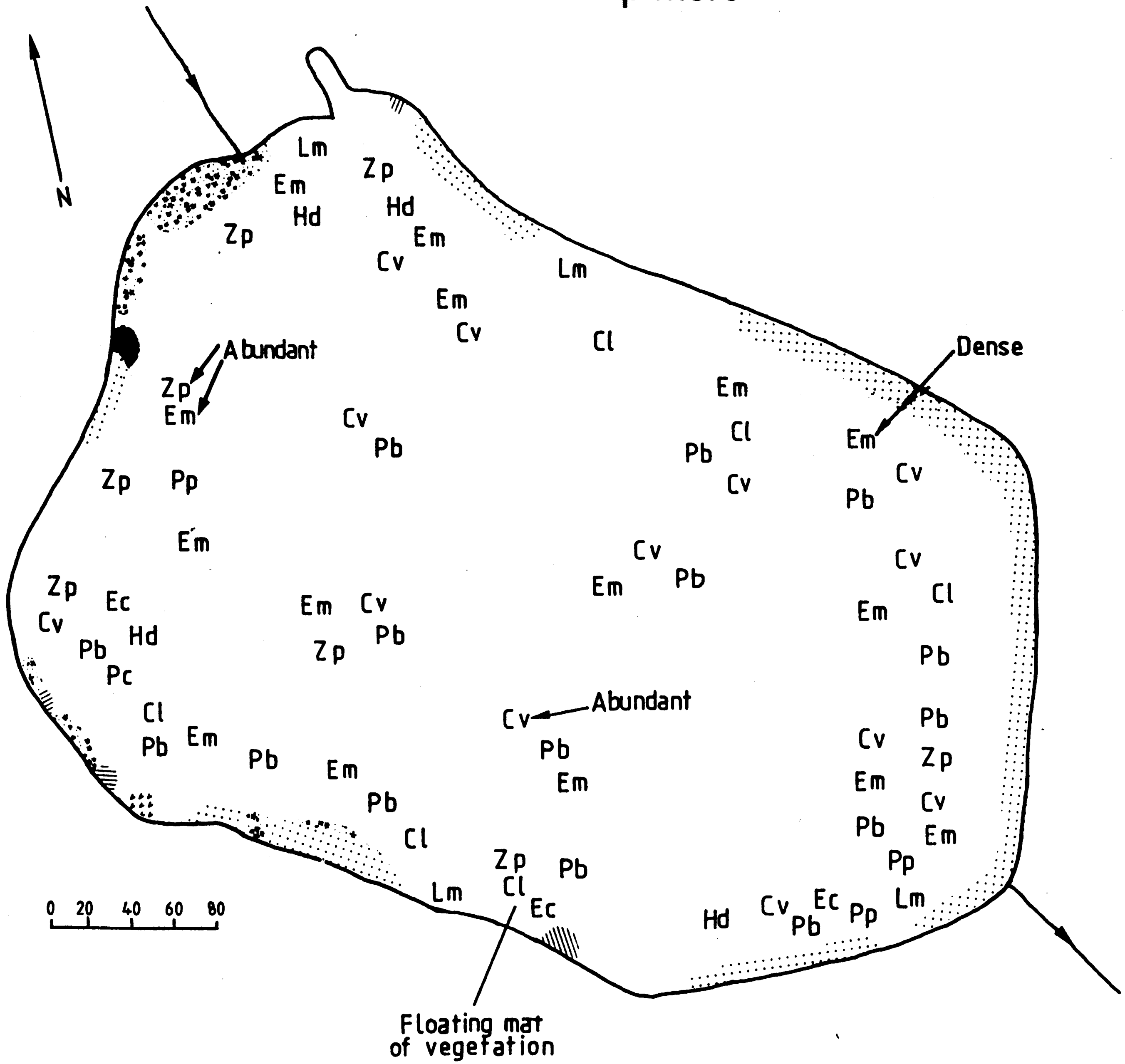
	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.330	1248	7.29	0.30	0.70	2.00	0.90	>	0.10
2	0.016	329	4.80	136.00	219.70	1.63	1.20	0.6	6.20
3	0.290	1831	9.90	2.36	10.33	4.43	0.89	>	0.86
4	1.510	116		234.00	256.00	1.10	1.32	0.65	1.25
5	1.220	39	2.24	194.00	218.00	1.13	1.22	0.7	0.17
6	1.690	239	2.75	85.00	87.30	1.12	1.05	>	0.09
7	2.510	390	5.55	3.30	9.70	3.22	0.96	>	6.47
8	2.910	354	5.79	0.00	0.00	-	-	>	3.20
9	3.780	130	5.18	38.50	45.30	1.3	1.24	0.5	0.18
10	2.400	89	0.47	55.40	64.00	1.27	1.28	>	0.06
11	1.230	69	1.04	8.80	16.30	2.04	1.01	>	0.20
12	1.650	175	3.12	11.00	18.70	1.87	1.2	>	18.12
13	0.150	75	1.11	26.40	29.00	1.07	1.26	>	2.86
14	0.270	31	3.65	39.60	49.70	1.38	1.23	>	10.64
15									
16	2.080	256	4.08	70.60					2.48
17	0.770	158	1.85	91.00					3.03
18	1.160	409	4.06	55.20					4.05
19	1.220	617	3.12	74.00					6.03
20	1.430	365	4.07	59.60					3.60
21	1.160	524	2.70	76.00					5.30

Cop Mere Phytopl. 1991/2

	Organism	Aug 8 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 12 1991	Dec 4 1991	Jan 15 1992	Feb 4 1992	Mar 3 1992	Mar 24 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
1	Amphora oval	13	-	22	-	-	-	-	-	40	-	27	-	-	-
2	Cocconeis	-	-	-	-	-	-	-	13	-	-	-	-	-	-
3	Cyclo menegh	54	965	-	-	-	22119	-	-	-	-	469	188	-	-
4	Cyclot sp	94	-	156	-	1810	-	94	65	19760	15483	-	-	40	-
5	Cyclo glom	-	-	-	27411	-	-	-	-	-	-	-	-	-	-
6	Cyclo ocell	-	563	-	-	-	-	-	-	-	-	-	-	-	-
7	Frag crot	-	-	-	-	201	-	-	-	-	-	-	-	-	-
8	Frag constr	-	-	-	-	-	-	-	-	-	-	13	-	-	161
9	Gomphonema	-	-	22	-	-	-	-	-	40	-	-	-	-	-
10	Gomph oliv	-	-	-	-	-	-	-	-	-	201	-	-	-	-
11	Gomph ventr	-	-	-	-	-	-	-	-	-	-	40	-	-	-
12	Gomph parv	27	-	-	-	-	-	-	-	-	-	-	-	-	-
13	Navicula	13	-	22	-	201	-	13	52	-	101	121	13	-	-
14	Nitzschia	27	80	-	-	-	-	-	-	-	-	27	-	-	-
15	Pinnularia	-	-	22	-	-	-	-	-	-	-	-	-	-	-
16	Stephanodiscus	-	-	-	-	40618	-	-	-	-	-	-	-	-	-
17	Synedra aff	-	-	-	-	-	-	-	-	40	-	-	-	-	-
18	Synedra ulna	-	-	-	-	-	-	-	-	-	201	27	-	-	-
19	Synedra	-	-	-	-	-	-	-	-	-	-	-	-	-	40
20	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	Asterococcus	-	-	-	-	-	-	-	-	-	-	-	1635	-	-
25	Carteria celos	-	-	-	-	-	-	13	-	-	-	13	-	-	-
26	Chlamydo sp	67	1250	201	335	1809	1206	-	13	160	5731	174	40	40	-
27	Chlamydo glob	-	40	-	-	-	-	-	-	-	-	13	-	-	-
28	Chlorog elong	-	-	-	-	-	-	-	-	200	-	-	-	-	-
29	Chlorella sp	-	-	-	-	-	201	-	-	-	-	-	-	-	-
30	Oocystis pus	40	-	-	-	-	-	-	-	-	-	-	-	-	-
31	Oocystis pyr	13	-	-	-	-	-	-	-	-	-	-	-	-	-
32	Schroed set	-	-	-	-	-	-	-	-	40	-	-	13	80	-
33	Schroed jud	-	-	826	67	-	-	-	-	-	-	-	-	-	40
34	Tetrast staur	-	-	-	-	-	-	-	-	-	-	13	-	-	-
35	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	Euglena sang	-	-	-	-	-	-	-	-	-	-	-	54	-	-
42	Trachelo sp	-	-	-	67	-	-	-	-	-	100	-	-	-	-
43	Euglena sp	-	-	-	-	-	-	-	-	-	-	-	-	40	-
44	Cryptom ac	-	-	-	-	-	-	-	-	-	-	-	-	-	442
45	Crypto er	-	15079	-	737	-	-	-	-	-	-	-	-	-	-
46	Crypto ov	-	-	22	-	201	-	-	-	80	-	40	13	-	-
47	Rhodo min	27	2694	1474	134	201	-	27	-	80	704	13	375	160	684
48	Crypto ac	-	-	-	-	-	-	-	-	-	-	-	-	40	-
49	Chloroch min	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	Unid flag	67	-	-	-	-	-	-	-	-	-	-	-	-	-
51	*	27	2051	-	-	-	-	-	-	-	301	-	-	-	-
52	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
53	Glenodinium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
54	Gymnodinium	-	-	-	-	-	-	-	-	-	101	-	-	-	-
55	*	-	-	-	-	-	201	-	-	-	-	-	-	-	-
56	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
57	Anab flos aq	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58	Aphan flos aq	94	80	-	-	-	-	-	-	-	-	-	-	-	-
59	Chroococ var	-	-	-	-	-	-	-	-	-	101	13	1340	3860	5268
60	Gloeocystis	-	-	-	-	-	-	-	-	80	-	-	-	-	-
61	Hapalosiphon	13	-	-	-	-	-	-	-	-	-	-	-	-	-
62	Nostoc	-	-	-	-	-	-	27	-	-	-	-	-	-	-
63	Osc tenuis	13	-	-	-	-	-	-	-	-	-	-	-	-	-
64	Stigonema	-	40	-	-	-	-	-	-	-	-	-	-	-	-
65		-	-	-	-	-	-	-	13	-	-	-	-	-	-
66	Total diatoms	228	1608	244	27411	42830	22119	107	130	19880	15987	724	201	40	201
67	Total greens	120	1290	1027	402	1809	1407	13	13	400	5731	213	1688	120	40
68	Total others	121	19824	1496	938	402	201	27	0	160	1206	53	442	240	1126
69	Total blue grns	120	120	0	0	0	0	27	13	80	101	13	1340	3860	5268
70	TOTAL	589	22842	2767	28751	45041	23727	154	156	20520	23025	1003	3671	4260	6635
71															
72	Diatoms %	38.7	7.0	8.8	95.3	95.1	93.2	69.5	83.3	96.9	69.4	72.2	5.5	0.9	3.0
73	Greens %	20.4	5.6	37.1	1.4	4.0	5.9	8.4	8.3	1.95	24.9	21.2	46.0	2.8	0.6

	Organism	Aug 8 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 12 1991	Dec 4 1991	Jan 15 1992	Feb 4 1992	Mar 3 1992	Mar 24 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
74	Others %	20.5	86.8	54.1	3.3	0.9	0.9	17.5	0	0.8	5.2	5.3	12.0	5.6	17.0
75	Blue greens %	20.4	0.53	0	0	0	0	17.5	8.3	0.4	0.44	1.3	36.5	90.6	79.4
76															
77		Diatoms	Greens	Others	Blue greens										
78	Winter mean %	85.3(11.7)	6.7(2.1)	4.8(8.5)	6.5(8.3)										
79	Growth mean%	39.8(39.9)	16.2(16.3)	21.1(28)	23(35)										
80	Annual mean %	52.8(39.9)	13.5(14.3)	16.4(24.7)	18.2(30)										

Cop Mere



N
Abundant
Dense
Abundant
Floating mat of vegetation
0 20 40 60 80
Lm Em Hd Zp Cv Cl Pb Pp Ec Pc

(i) CROSE MERE

(i) Morphometry and water budget

Crose Mere is moderately large (15.2ha) and deep (9.3m). It is ground-water fed but has a surface outflow which discharged 12600 cubic metres of water in the year in question. Fllow was relatively even seasonally and the annual flushing rate was calculated to be 0.18 per year with a retention time of 5.6yr. These values compare with those of Reynolds(1979) who calculated a retention time of 2.25 years in a relatively wetter period.

(ii) Changes in land usage

The catchment of Crose Mere lies in the parishes of Ellesmere Rural and Cockshutt, changes in whose land usage have been as follows:

	1931	1987
Cattle(head)	10821	14420
nutrient units	130934	174482
Pigs(head)	5574	8943
nutrient units	26755	42926
Sheep(head)	11780	13055
nutrient units	17670	19583
Poultry(head)	47795	9236
nutrient units	6691	1293
Permanent grass(ha)	7642	3949
Temporary grass(ha)	652	1623
Arable(ha)	776	2540
Woodland(ha)	7	152
Rough grazing(ha)	28	144
Total hectarage	9105	8408

The catchment has thus seen an increase in cattle, pig and sheep keeping, adrift to arable and a loss of permanent grazing. There has also been some woodland planting and loss of presumably permanent grazing to rough grazing.

(iii) Major ion chemistry and nutrient loads

The water of Crose Mere is relatively hard with high conductivity and alkalinity. The concentrations of soluble reactive and total phosphorus are high but those of inorganic nitrogen compounds are low. The values recorded are similar to those found by Reynolds(1979) except for the probably climatically-related higher conductivity values.

(iv) Phytoplankton and zooplankton

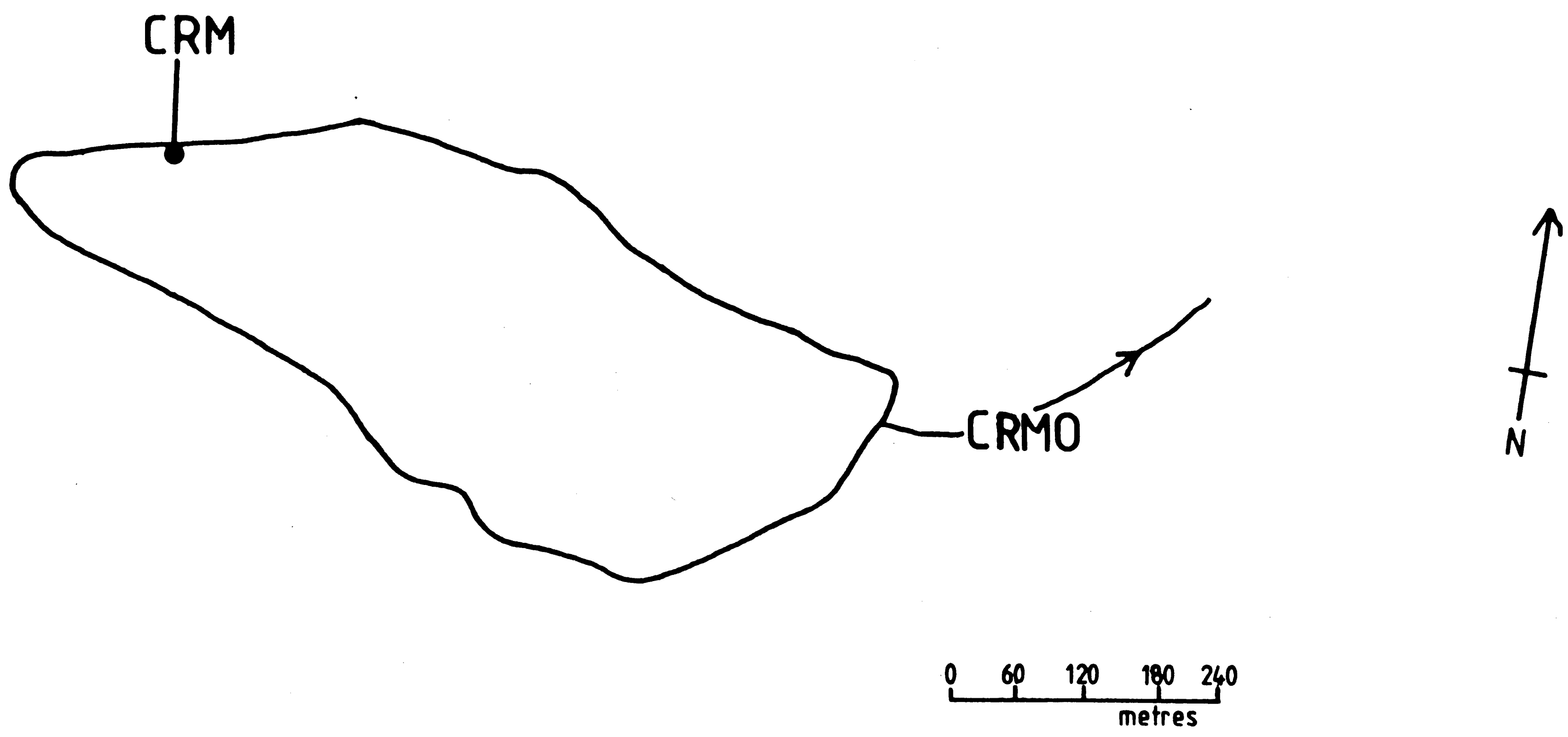
Phytoplankton crops were low reaching a maximum of only 33.4 ug/l of chlorophyll a and having a growth season mean of only 9.2. Blue green algae were scarce during the year in question in contrast to earlier years when the mere was used extensively for the study of bloom forming behaviour (Reynolds 1971). Diatoms and flagellates were the most common phytoplankters and grazing pressure was probably high because ***Daphnia*** was relatively abundant in summer. The presence of ***Daphnia magna*** and ***Daphnia pulex*** suggest that the fish stock is low.

(v) Aquatic plants

Despite the clear water, the abundance of aquatic plants was comparatively low with only ***Nuphar lutea*** being locally abundant. An unusual feature was the area of colonial ***Cymbella***, a diatom on the north side. The trophic score was calculated to be 8.95, intermediate between the 1979 value of 9.3 and the 1987 value of 7.9. The DAFOR score was 2.5 , an apparent increase over 1987 (0.5) and 1991 (2). The reasons for the sparse plants include the steeply shelving basin and the wind exposed shorelines.

(vi) Overall assessment

Crose Mere does not seem to be threatened by agents of eutrophication over and above that expected of an agricultural area. Its nitrogen supply remains low and its phosphorus supply, coming from ground water is probably naturally derived. Zooplankton grazing is probably reducing the algal crops more than at some times in the past and is probably linked to a low fish stock. This may have resulted from a fish kill some time in the recent past or may be a reflection of natural variation in recruit ment. There appear to be no restorative measures that need to be taken at present.


CRM
CRMO
0 60 120 180 240
metres
N

Crosemere Outflow CRMO

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	463	0.00	2.5	8.99	36.7	48	1	89	90
2	Aug 14 1991	474	0.35	2.9	8.44	36.7	60	96	19	114
3	Sept 4 1991	489	0.20		8.21	34.7	68	111		111
4	Oct 10 1991	*	*	*	*	*	*	*	*	*
5	Oct 30 1991	*	*	*	*	*	*	*	*	*
6	Nov 20 1991	461	0.15	3.05	7.76	34	227	231	40	271
7	Dec 18 1991	495	0.15	3.25	7.79	36.4	242	242	104	346
8	Jan 22 1992	489	0.15	3.0	8.15	34.6	242	284	28	312
9	Feb 19 1992	493	0.2	3.15	8.04	39.2	212	232	0	232
10	Mar 11 1991	655	0.2	3.75	8.05	45.2	343	343	111	455
11	April 1 1992	469	0.45	3.15	8.94	35.3	116	135	189	324
12	April 29 1992	No flow								
13	May 20 1992	No flow								
14	June 10 1992	470	0.25	2.95	8.48	33.3	103	103	0	103
15										
16	Winter mean	485(16)	0.16(0.03)	3.11(0.11)	7.94(0.19)	36.1(2.3)	247(25)			290(49)
17	Growth mean	510(82)	0.24(0.15)	3.05(0.46)	8.52(0.38)	37.0(4.2)	123(111)			200(153)
18	Annual mean	499(60)	0.21(0.12)	3.08(0.33)	8.29(0.43)	36.6(3.5)	173(106)			236(127)

	Nitrate N	Ammonium N	Silicate Si	Discharge
1	0.160	138	1.83	0.0002
2	0.004	245	2.47	0.0050
3	0.036	53	1.74	0.0001
4	*	*	*	0.0000
5	*	*	*	0.0000
6	0.35	22	3.96	0.0070
7	0.37	290	2.81	0.0040
8	0.42	165	2.13	0.0100
9	0.25	86	1.72	0.0035
10	3.99	317	3.67	+
11	0	0	0.39	0.024
12				
13				
14	0.08	12	0.96	0.001
15				
16	0.38(0.04)	159(134)	2.97(0.93)	0.005(0.004)
17	0.75(1.6)	122(120)	1.83(1.05)	0.004(0.008)
18	0.63(1.27)	133(118)	2.17(1.1)	0.004(0.007)

Crosemere CRM

	Date	Conductivity	Phenolph alk	Total alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	457	0.30	2.90	9.20	34.7	38.0	53	13.0	66
2	Aug 14 1991	476	0.35	2.95	8.64	40.8	56.0	99		80
3	Sept 4 1991	479	0.20		8.47	36.7	58.4	105	8.4	113
4	Oct 9 1991	497	0.40	2.90	7.93	39.0	210.0			282
5	Oct 30 1991	490	0.35	3.50	7.87	36.4	232.0	290	1.4	291
6	Nov 20 1991	443	0.20	3.10	7.82	34.0	237.0	251	0.0	251
7	Dec 18 1991	488	0.15	3.20	8.08	36.4	254.0	371	0.0	371
8	Jan 22 1992	485	0.10	2.95	8.15	32.7	237.0	282	0.0	282
9	Feb 19 1992	471	0.40	3.25	8.36	37.3	219.0	219	70.0	289
10	Mar 11 1992	472	0.30	3.15	8.78	35.5	171.0	171	58.0	229
11	April 1 1992	466	0.45	3.65	8.93	35.3	120.0	747	65.0	312
12	April 29 1992	475	0.30	3.20	8.37	36.0	131.0	149	8.0	157
13	May 20 1992	473	0.30	3.10	8.57	34.0	119.0	152	18.0	170
14	June 10 1992	469	0.25	1.80	8.50	35.3	101.0	101	0.0	101
15										
16	Winter mean	472	0.21	3.13	8.10	35.1	237.0			298
17	SD	21	0.13	0.13	0.22	2.1	14.0			51
18	Growth mean	475	0.32	3.02	8.53	36.4	124.0			180
19	SD	11	0.07	0.53	0.40	2.1	65.0			92
20	Annual mean	474	0.29	3.05	8.41	36.0	156.0			214
21	SD	14	0.10	0.44	0.41	2.1	76.0			98

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.350	89	1.26	3.3	5.3	1.78	1.02	>	0.20
2	0.000	87	2.19	2.4	4.7	2.00	1.24		0.70
3	0.008	119	1.66	1.7	5.0	3.00	1.10	>	38.40
4	0.000	558	3.18	3.0	7.0	2.33	1.05	>	25.90
5	0.090	603	3.25	0.0	4.0	>	0.97	>	1.80
6	0.290	416	3.98	5.5	9.0	1.8	1.02	>	0.42
7	0.320	445	2.77	19.8	31.7	1.76	1.18	>	0.80
8	0.340	267	2.04	10.6	14.7	1.52	0.99	>	0.00
9	0.260	87	1.86	9.5	12.0	1.38	1.18	>	0.63
10	4.610	0	1.78	31.9	31.7	1.09	1.23	>	0.30
11	0.000	0	0.63	33.4	37.0	1.22	1.24	>	2.15
12	0.020	57	0.74	6.2	12.0	2.13	0.98	>	16.00
13	0.030	42	0.25	5.9	8.3	1.56	1.02	>	10.33
14	0.130	99	0.94	4.4	9.0	2.25	1.02	>	221.40
15									
16	0.300	304	2.66	11.4					0.46
17	0.040	164	0.96	6.0					0.35
18	0.070	165	1.59	9.2					31.70
19	0.100	223	1.04	12.5					68.00
20	0.140	205	1.90	9.8					22.80
21	0.140	211	1.10	10.8					58.00

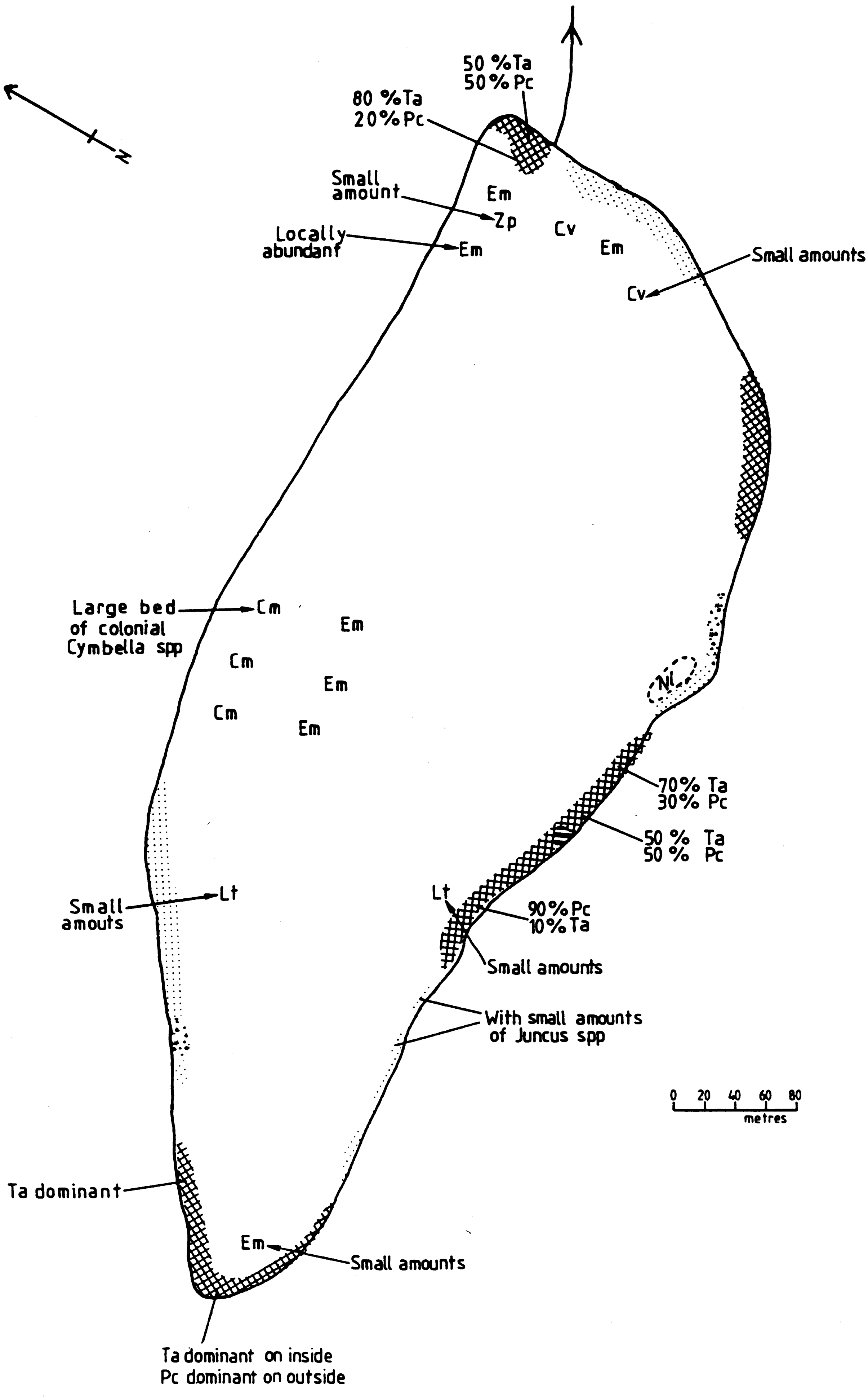
Crosemere Phytopl. 1991/92

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	April 1 1992	April 28 1992	May 20 1992	June 10 1992
1	Aster form	-	241	-	-	-	67	2593	710	1260	-	13	-	-
2	Amphora sp	-	-	-	-	13	-	-	27	-	-	-	-	-
3	Cyclotella sp	22	-	22	54	54	-	40	616	440	697	-	-	-
4	Fragilaria sp	22	-	-	-	-	-	-	-	-	-	27	-	-
5	Frag crot	-	-	-	-	-	-	-	-	-	40	27	13	-
6	Gomph ventr	-	-	-	-	-	-	-	-	-	13	-	-	-
7	Melosira sp	-	-	-	-	-	-	-	-	-	-	-	-	-
8	Melosira gran	-	-	22	-	-	-	-	-	-	-	-	-	-
9	Navicula sp	-	-	-	-	-	-	20	26	20	-	-	-	-
10	Stephanod ast	-	-	-	-	-	-	-	-	20	536	13	-	-
11	Synedra sp	-	-	-	-	-	13	20	-	-	-	-	-	-
12	Rhoicosphenia	-	-	-	-	-	-	-	-	-	-	-	-	-
13	*	-	-	-	-	-	-	-	-	-	-	-	-	13
14	*	-	-	-	-	-	-	-	-	-	-	-	-	-
15	*	-	-	-	-	-	-	-	-	-	-	-	-	-
16	*	-	-	-	-	-	-	-	-	-	-	-	-	-
17	Ankist falc	22	-	-	-	-	-	-	-	100	-	-	-	-
18	Ankist conv	-	-	-	-	-	-	-	-	40	134	-	-	-
19	Carteria sp	-	-	179	-	-	-	80	-	-	13	-	-	-
20	Chlamyd sphag	-	-	-	-	-	-	-	-	80	-	-	-	-
21	Chlamyd glob	156	54	-	-	-	-	-	-	-	-	-	-	-
22	Chlamyd sp	-	27	-	40	80	54	-	40	40	13	-	-	22
23	Chlamyd ov	-	-	-	-	-	-	-	-	60	-	-	-	-
24	Chlorella vulg	-	-	-	-	-	-	-	-	100	13	-	-	-
25	Crucigenia sp	-	-	-	-	-	-	-	-	20	-	-	-	-
26	Crucigenia qua	-	-	-	-	-	-	-	-	-	-	-	-	-
27	Micract pus	-	-	-	-	-	-	-	-	-	54	-	-	-
28	Oocystis pus	134	-	-	-	-	-	-	-	-	-	-	-	-
29	Ped bory	22	-	-	-	-	-	-	-	-	-	-	-	27
30	Ped dup clath	22	-	-	-	-	-	-	-	-	-	-	-	-
31	Quadrig lac	-	-	-	-	-	-	-	-	-	228	-	-	-
32	Scened quad	-	-	-	-	-	-	-	-	-	13	-	-	-
33	Scened bijug	-	-	-	-	-	-	-	-	20	121	-	-	-
34	Selenast west	-	-	-	-	-	-	-	-	140	241	-	-	-
35	Staurastrum	-	-	-	13	-	13	-	-	-	-	-	-	-
36	Schroed jud	179	-	-	-	40	13	-	-	-	-	-	-	-
37	Schroed setig	-	13	112	13	-	-	-	-	-	-	-	-	94
38	Tetraedron	-	-	22	-	-	-	-	-	-	-	-	-	-
39	Ulothrix	22	-	-	-	-	-	-	-	-	-	-	-	-
40	Sphaerocyst g	-	-	-	-	-	-	-	-	-	-	-	13	-
41	Closterium sp	-	-	-	-	-	-	-	-	-	-	-	-	13
42	*	-	-	-	-	-	-	-	-	-	-	-	-	-
43	*	-	-	-	-	-	-	-	-	-	-	-	-	-
44	Euglena sp	-	-	-	-	-	-	-	27	-	-	-	-	-
45	Euglena grac	22	-	-	-	-	-	-	-	-	-	-	-	-
46	Trachelo sp	-	-	-	-	-	-	-	-	40	-	-	-	-
47	*	-	-	-	-	-	-	-	-	-	-	-	-	-
48	*	-	-	-	-	-	-	-	-	-	-	-	-	-
49	Rhodom min	67	-	246	255	134	402	121	27	1680	375	348	509	643
50	Crypto ov	22	255	-	-	13	27	20	-	120	268	161	147	94
51	Crypto sp	-	-	-	134	-	-	-	13	-	-	-	-	-
52	Crypto marrs	-	-	-	-	-	67	-	-	-	-	-	-	-
53	Crypto ref	-	-	-	-	-	-	20	-	20	-	-	-	-
54	Crypto erosa	-	-	-	-	-	-	-	-	100	509	-	-	-
55	Crypto acuta	-	-	-	-	-	-	-	-	-	-	-	80	-
56	*	-	-	-	-	-	-	-	-	-	-	-	-	-
57	Chlorochr min	-	1366	-	-	-	-	-	-	-	-	-	-	-
58	Mallomonas	-	-	-	-	-	-	-	27	-	-	-	-	-
59	Merotrichia	-	-	-	-	-	-	-	-	-	13	-	-	-
60	Trachychloron	-	-	-	-	-	-	-	-	-	54	-	-	-
61	*	-	-	-	-	-	-	-	-	-	-	-	-	-
62	*	-	-	-	-	-	-	-	-	-	-	-	-	-
63	*	-	-	-	-	-	-	-	-	-	-	-	-	-
64	Glenodinium	-	-	-	-	-	-	-	-	300	-	-	-	-
65	*	-	-	-	-	-	-	-	-	-	-	-	-	-
66	*	-	-	-	-	-	-	-	-	-	-	-	-	-
67	Anabaena fl aq	-	-	-	13	-	-	-	-	-	-	-	-	-
68	Anab circ	-	-	-	-	-	-	-	-	160	-	-	-	40
69	Aphaniz f aq	-	-	89	-	-	-	-	-	-	27	-	27	-
70	Anabaena sp	-	-	-	-	-	-	-	-	-	-	-	67	-
71	Chroococ lim e	67	-	-	-	-	-	-	-	-	-	-	-	-
72	Dact smith	45	-	-	-	-	-	-	-	-	-	-	-	-
73	Gloeocapsa sp	-	-	-	-	-	-	-	-	-	27	-	-	-

Crosemere Phytopl. 1991/92

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	April 1 1992	April 28 1992	May 20 1992	June 10 1992
74	Oscillat sp	-	-	-	-	-	-	-	13	-	-	-	-	-
75	Phormidium sp	22	-	-	-	-	-	-	-	-	-	-	-	-
76														
77	Total diatoms	44	241	44	54	67	80	2673	1379	1740	1286	80	13	13
78	Total greens	557	94	313	66	120	80	80	40	600	830	0	13	156
79	Total others	111	1621	246	389	147	496	161	94	2260	1219	509	736	737
80	Total blue grns	134	0	89	13	0	0	0	13	160	54	0	94	40
81	TOTAL	846	1956	692	522	334	656	2914	1526	4760	3389	589	856	946
82														
83	Diatoms %	5.2	12.3	6.4	10.3	20	12.2	91.7	90.4	36.6	38	13.6	1.5	1.4
84	Greens %	65.8	4.8	45.2	12.6	35.9	12.2	2.8	2.6	12.6	24.5	0	1.5	16.5
85	Others %	13	82.9	35.5	74.5	44	75.6	5.5	6.2	47.5	36	86.4	86	77.9
86	Blue grns %		0	12.9	2.5	0	0	0	0.9	3.4	1.6	0	11	4.2
87														
88		Diatoms	Greens	Others	Blue greens									
89	Winter mean%	57.7(39.8)	7.6(5.6)	33.7(34.1)	1.08(1.6)									
90	Growth mean%	12.1(11.4)	17.6(16.5)	65.4(22.8)	5.4(6.2)									
91	Annual mean%	26.1(31)	14.3(14.4)	54.8(29.9)	4.04(5.6)									

Crose Mere


N
50 %Ta
50% Pc
80 %Ta
20% Pc
Small
amount
Em
Zp
Cv
Em
Locally
abundant
Em
Small amounts
Cv
Large bed
of colonial
Cymbella spp
Cm
Em
Cm
Em
Cm
Em
Nl
70% Ta
30% Pc
50 % Ta
50 % Pc
Small
amouts
Lt
Lt
90% Pc
10% Ta
Small amounts
With small amounts
of Juncus spp
0 20 40 60 80
metres
Ta dominant
Em
Small amounts
Ta dominant on inside
Pc dominant on outside

(j) FENEMERE

(i) Morphometry and water budget

Fenemere is shallow (2.2m) and small (9.4ha). It is part of a hydrologically complex system in which water may enter it through a channelised watercourse coming from the west to join a small stream (FMD) which connects Fenemere with Marton Pool. Further water supplies enter Marton Pool and eventually drain into Fenemere. There is a distinct outflow from Fenemere which is joined by a small stream emerging from the east before it discharges to the War Brook to the south. The outflow stream was accessible for gauging only after this stream had entered . A correction has thus been applied to allow for the estimated one quarter contribution of this stream to the outflow. The outflow was very small in summer but greater in winter. Calculated annual, winter and growth season values for flushing rate were 4.8,9.6 and 3.1 per year respectively. Corresponding retention times were 10.8, 5.4 and 16.8 weeks. Despite its small size Fenemere thus has substantial retention particularly in summer. All of the inflows are separately quite small and intermittent. The inflow that was gauged and which flows into Marton Pool accounted for only 6300 cubic metres per year or about 1.3%. The stream connecting Marton Pool and Fenemere accounted for even less, about 3153 cubic metres. This seems to indicate that the water in Fenemere is determined to a large extent by ground water flow from the surrouding very flat wet grasslands and that events in Marton Pool and its catchment may have a much lesser importance than the apparently well developed drainage system visible on the maps might indicate.

(ii) Changes in land usage

The catchment of Fenemere lies within the parishes of Baschurch, Myddle and Petton for which the combined land use changes have been as follows:

	1931	1987
Cattle(head)	5348	12905
nutrient units	64711	156187
Pigs(head)	2641	2989

nutrient units	12677	14347
Sheep(head)	7051	4632
nutrient units	10577	6948
Poultry(head)	25127	609
nutrient units	3518	85
Permanent grass(ha)	4051	2023
Temporary grass(ha)	316	1008
Arable(ha)	856	2208
Woodland(ha)	6	82
Rough grazing(ha)	86	41
Total hectarage	5315	5362

There has thus been a considerable increase in stock keeping particularly of cattle, and a drift to arable and temporary grazing from permanent grazing.

(iii) Major ion chemistry and nutrient loads

Fenemere has a high conductivity consistent with that of its surface water inflows and presumably also its ground water supply. Its alkalinity is also very high as are the local chloride concentrations. Soluble reactive and total phosphorus concentrations are high and higher than those of the direct inflow drain. This might suggest high ground water concentrations of phosphorus but might also be linked to internal release of phosphorus from the sediment. Nitrate nitrogen concentrations in the mere are very low in summer but modest in winter and the streams also carry quite high concentrations. The ammonium concentrations in the northern inflow to Marton Pool are sometimes exceptionally high and must indicate a substantial source of farm effluent draining into this stream. The connector stream between Fenemere and Marton Pool is rich in nitrate year around, presumably drawing much of its supply from the channelised drain entering it through the pastures to the west. Nonetheless processes of nitrogen loss in the mere and its surrounding wetlands result in a severe shortage of inorganic nitrogen in summer.

(iv) Phytoplankton and zooplankton

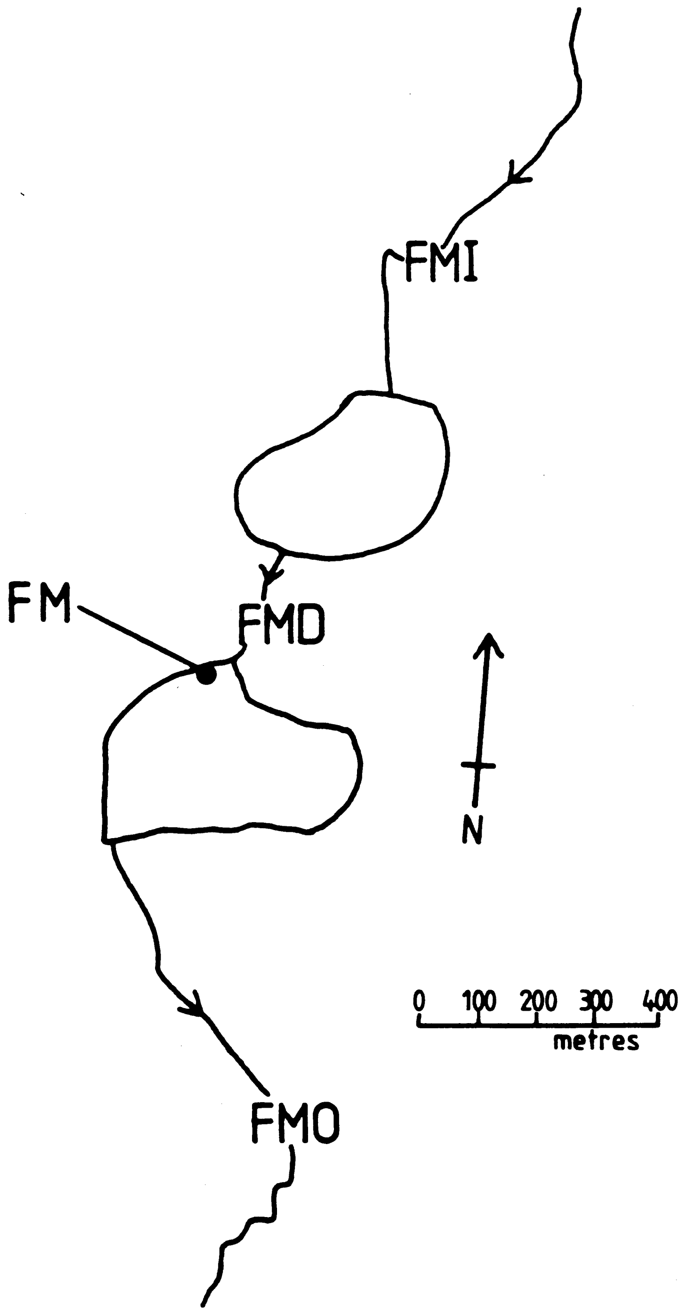
Chlorophyll a concentrations in Fenemere were generally high and on average above 50ug/l even in the winter months. Diatoms, green algae, and flagellates were all very abundant from time to time but there was a particular dominance of green algae. Blue - green algae were only lesser components and when they were abundant it was the non -nitrogen- fixing genus ***Oscillatoria*** that predominated. *Daphnia* numbers were large for a short period in spring and early summer but thereafter were nearly absent. Grazing was thus an important factor for only a limited period.

(v) Aquatic plants

Only emergent plants , including both ***Nuphar lutea*** and ***Nymphaea alba*** were abundant in Fenemere. Apart from scraps of ***Ceratophyllum demersum***, submerged plants were rare. This might be expected from the large algal crops. Trophic score has been around 7.5 in the past but has now risen to 8.5 whilst the DAFOR score has been 0.5 and 0 in 1979 and 1991. It remains probably unchanged at a value of 1.

(vi) Overall assessment

We are told that Fenemere supports a rich common carp fishery though there are no quantitative data available. However, the lack of submerged aquatic plants in water that supports large but not huge growths of algae is consistent with this. Carp disturb the botttom and caan increase thre turbidity quite considerably. The phosphorus loading from ground water is probably naturally high but the nitrogen loading has undoubtedly been increased by intensification of the local agriculture and stockkeeping. There may be little that can practicably be done about this without major changes in farming policy. If there is a population of carp in the lake then some improvement in water quality and hence light climate for aquatic plants could come from removal of this introduced species. Carp not only disturb sediment, they mobilise phosphorus from sediment and may be at least partly responsible for the high phosphorus availability and perhaps a supply of excreted ammonium that is immediately snapped up by the nitrogen limited phytoplankton. The importance of the lake for carp angling vis a vis conservation would need to be determined before such management was attempted. In general carp and aquatic plant conservation are incompatible.



FMI
FM
FMD
N
0 100 200 300 400
metres
FMO

Fenemere Inflow FMI

	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	1.49	12750	6.98	0.0002	1.720		0.110	
2	*	*	*	0	0.000		0.000	
3	*	*	*	0	0.000		0.000	
4	*	*	*	0	0.000		0.000	
5	*	*	*	0	0.000		0.000	
6	*	*	*	0	0.000		0.000	
7	*	*	*	0	0.000		0.000	
8	*	*	*	0	0.000		0.000	
9	4.84	4232	5.82	0.0002	1.100		0.040	
10	*	*	*	0	0.000		0.000	
11	20.98	435	6.9	0.018	233.000		7.910	
12				0	0.000		0.000	
13				0	0.000		0.000	
14	6.19	499	7.41	0.0004	1.620	882.000	0.064	30.200
15								
16	4.84	4232	5.82	.002(.001)				
17	9.6(10.2)	4561(7091)	7.1(0.27)	.002(.006)				
18	8.4(8.6)	4479(5793)	6.78(0.68)	.0002(.005)				

Fenemere Inflow FMI

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	818	0	4.65	8.1	77.6	1150	543	331	874
2	Aug 14 1991		*	*	*	*	*	*	*	*
3	Sept 4 1991	*	*	*	*	*	*	*	*	*
4	Oct 9 1991	*	*	*	*	*	*	*	*	*
5	Oct 30 1991	*	*	*	*	*	*	*	*	*
6	Nov 20 1991	*	*	*	*	*	*	*	*	*
7	Dec 18 1991	*	*	*	*	*	*	*	*	*
8	Jan 22 1992	*	*	*	*	*	*	*	*	*
9	Feb 19 1992	1026	0.2	5.4	7.76	97.2	144	190	137	327
10	Mar 11 1992	*	*	*	*	*	*	*	*	*
11	April 1 1992	664	0	2.5	7.46	51.0	252	587	140	727
12	April 29 1992	No flow								
13	May 20 1992	No flow								
14	June 10 1992	681	0	3.7	7.38	47.1	263	263	0	263
15										
16	Winter mean	1026	0.2	5.4	7.76	97.2	144			327
17	Growth mean	721(84)	0	3.6(1.1)	7.65(0.4)	58.6(16.6)	555(515)			621(319)
18	Annual mean	797(167)	0.05(0.1)	4.1(1.3)	7.68(0.32)	68.2(23.6)	452(468)			548(299)

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	721	0.0	4.7	8.08	65.3	808	263	514	777
2	Aug 14 1991	752	0.1	5.0	7.60	73.5	895	1097	100	1197
3	Sept 4 1991	*	*	*	*	*	*	*	*	*
4	Oct 9 1991	*	*	*	*	*	*	*	*	*
5	Oct 30 1991	*	*	*	*	*	*	*	*	*
6	Nov 20 1991	784	0.2	4.65	7.75	84.0	293	350	68	417
7	Dec 18 1991	789	0	5.0	7.65	74.7	234	278	120	398
8	Jan 22 1992	802	0	4.35	8.28	76.9	139	182	142	324
9	Feb 19 1992	852	0.6	4.0	7.89	80.4	156	252	260	512
10	Mar 11 1992	780	0.3	4.15	8.11	77.4	40.7	40.7	57.9	98.6
11	April 1 1992	742	0	3.2	7.52	70.6	254	543	190	733
12	April 29 1992	774	0.2	5.8	7.87	76.0	161	188	24	213
13	May 20 1992	No flow								
14	June 10 1992	736	0	3.3	7.14	78.4	489	489	303	792
15										
16	Winter mean	807(31)	0.2(0.28)	4.5(0.43)	7.89(0.28)	79(4.1)	206(72)			413(77)
17	Growth mean	751(23)	0.1(0.13)	4.36(1.0)	7.72(0.4)	73.5(5)	441(351)			635(409)
18	Annual mean	773(38)	0.14(02)	4.4(0.8)	7.79(0.33)	75.7(5.2)	347(292)			546(329)

Fenemere Outflow FMO

	Nitrate N	Ammonium N	Silicate Si	Discharge	N export/year	P export/year
1	0.120	868	8.31	0.0002		
2	0.023	682	7.80	0.0015		
3	*	*	*	0.0000		
4	*	*	*	0.0000		
5	*	*	*	0.0000		
6	4.09	105	7.07	0.0500		
7	0.76	272	3.09	0.0480		
8	2.11	422	5.0	0.0001		
9	2.42	1220	4.62	0.059		
10	0.76	91	2.65	0.030		
11	7.92	122	3.3	0.001		
12	1.04	79	1.44	0.021		
13				0.000		
14	5.85	158	8.48	0.081	1662 kg	362 kg
15						
16	2.35(1.37)	505(494)	4.95(1.6)	0.039(0.027)		
17	2.62(3.4)	333(348)	5.33(3.2)	0.014(0.026)		
18	2.51(2.65)	402(396)	5.18(2.6)	0.021(0.028)		

Fenemere Drain FMD

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	*	*	*	*	*	*	*	*	*
2	Aug 14 1991	*	*	*	*	*	*	*	*	*
3	Sep 4 1991	*	*	*	*	*	*	*	*	*
4	Oct 9 1991	*	*	*	*	*	*	*	*	*
5	Oct 30 1991	*	*	*	*	*	*	*	*	*
6	Nov 20 1991	795	0.15	4.2	7.76	76.0	94	129	40	169
7	Dec 18 1991	850	0	5.00	7.75	74.7	115	115	56	170
8	Jan 22 1992	854	0.15	4.4	7.89	83.0	224	293	83	376
9	Feb 19 1992	880	0.35	5.05	8.05	80.4	119	148	94	242
10	Mar 11 1992	856	0.3	4.85	8.26	83.9	33	33	93	126
11	April 1 1992	795	0.2	3.6	8.11	70.6	46	46	349	395
12	April 29 1992	825	0.3	4.9	8.02	80.0	71	71	102	178
13	May 20 1992	No flow								
14	June 10 1992	No flow								
15										
16	Winter mean	845(36)	0.16(0.14)	4.7(0.4)	7.86(0.14)	78.5(4)	138(58)			239(97)
17	Growth mean	825(31)	0.27(0.06)	4.45(0.74)	8.13(0.12)	78.2(7)	50(19)			233(1430
18	Annual mean	836(33)	0.21(0.12)	4.6(0.530	7.98(0.19)	78.4(5)	100(64)			237(107)

Fenemere Drain·FMD

	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	*	*	*	0.000	0.000		0.000	
2	*	*	*	0.000	0.000		0.000	
3	*	*	*	0.000	0.000		0.000	
4	*	*	*	0.000	0.000		0.000	
5	*	*	*	0.000	0.000		0.000	
6	4.9	162	3.76	0.001	3.060		0.100	
7	4.67	104	5.26	0.0001	0.290		0.010	
8	4.12	194	3.86	0.0002	0.520		0.045	
9	7.14	288	3.28	0.0001	0.900		0.015	
10	0.26	18	1.21	0.0001	0.020		0.008	
11	6.66	166	1.48	0.0001	0.410		0.024	
12	6.78	7	0.52	0.0001	0.410		0.011	
13				0.000	0.000		0.000	
14				0.000	0.000	20.800	0.000	0.790
15								
16	5.2(1.3)	187(77)	4.04(0.85)	0.0004				
17	4.57(3.7)	64(89)	1.07(0.5)	0.00003				
18	4.94(2.4)	134(100)	2.77(1.72)	0.0001				

Fenemere FM

	Date	Conductivity	Phenolph Alk	Total alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	772	0.35	4.45	7.82	71.4	730	154	408	562
2	Aug 14 1991	715	1.00	4.90	8.72	75.5	763			1037
3	Sept 4 1991	722	0.38	3.16	8.59	73.5	869	1058	367	1425
4	Oct 9 1991	740	0.40	6.30	8.25	87.0	607			607
5	Oct 30 1991	740	0.65	5.70	8.09	78.8	506			579
6	Nov 20 1991	681	0.15	5.10	8.05	76.0	241	282	113	395
7	Dec 18 1991	786	0.35	5.05	7.89		192	260	83	342
8	Jan 22 1992	853	0.15	4.45	7.99	82.7	217	217	133	349
9	Feb 19 1992	792	0.35	4.65	8.45	80.4	27	61	286	348
10	Mar 11 1992	804	0.50	4.85	8.44	80.7	14	22	91	113
11	April 1 1992	745	0.60	4.45	8.66	78.4	3	33	249	282
12	April 29 1992	778	0.40	4.80	7.95	76.0	143	162	30	192
13	May 20 1992	738	0.50	4.50	8.61	80.0	85	135	43	178
14	June 10 1992	716	0.30	4.30	8.29	78.4	413	413	0	413
15										
16	Winter mean	778	0.25	4.81	8.10	79.7	169			359
17	SD	71	0.12	0.32	0.25	3.0	97			25
18	Growth mean	747	0.51	4.74	8.34	78.0	413			539
19	SD	29	0.21	0.84	0.31	4.3	331			416
20	Annual mean	756	0.43	4.76	8.27	78.4	344			487
21	SD	44	0.22	0.71	0.31	4.0	302			356

Fenemere FM

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.14	205.0	7.52	39.6	87.7	2.44	1.27	>	0.00
2	0.00	126.0	7.69	49.5	79.7	1.63	1.30	>	0.00
3	0.00	0.0	7.00	81.1	114.0	1.42	1.26	0.45	0.59
4	0.00	49.5	0.58	41.7	53.0	1.28	1.18	>	1.03
5	0.44	13.0	7.91	65.7	73.7	1.13	1.21	>	0.22
6	1.01	77.0	6.69	64.2	66.3	1.14	1.16	>	0.21
7	2.41	62.0	4.31	36.3	50.0	1.24	1.22	*	0.00
8	4.36	202.0	3.83	33.7	36.7	1.20	1.09	>	0.00
9	2.97	112.0	4.20	123.2	118.0	1.05	1.27	>	0.11
10	1.59	51.0	1.64	63.8	68.7	1.18	1.21	>	0.18
11	1.67	35.0	0.32	93.9	101.7	1.19	1.17	>	0.40
12	1.04	202.0	1.83	7.3	9.7	1.45	1.02	>	104.90
13	0.03	4.0	2.30	32.3	28.0	0.95	1.24	>	66.10
14	0.44	2.0	5.56	53.2	57.0	1.18	1.16	1.0	93.10
15									
16	2.69	113.0	4.76	57.9					0.08
17	1.39	63.0	1.30	31.0					0.10
18	0.54	69.0	4.24	52.8					26.70
19	0.66	80.0	3.20	24.9					43.40
20	1.15	81.5	4.38	56.1					19.06
21	1.33	76.0	2.72	29.3					38.20

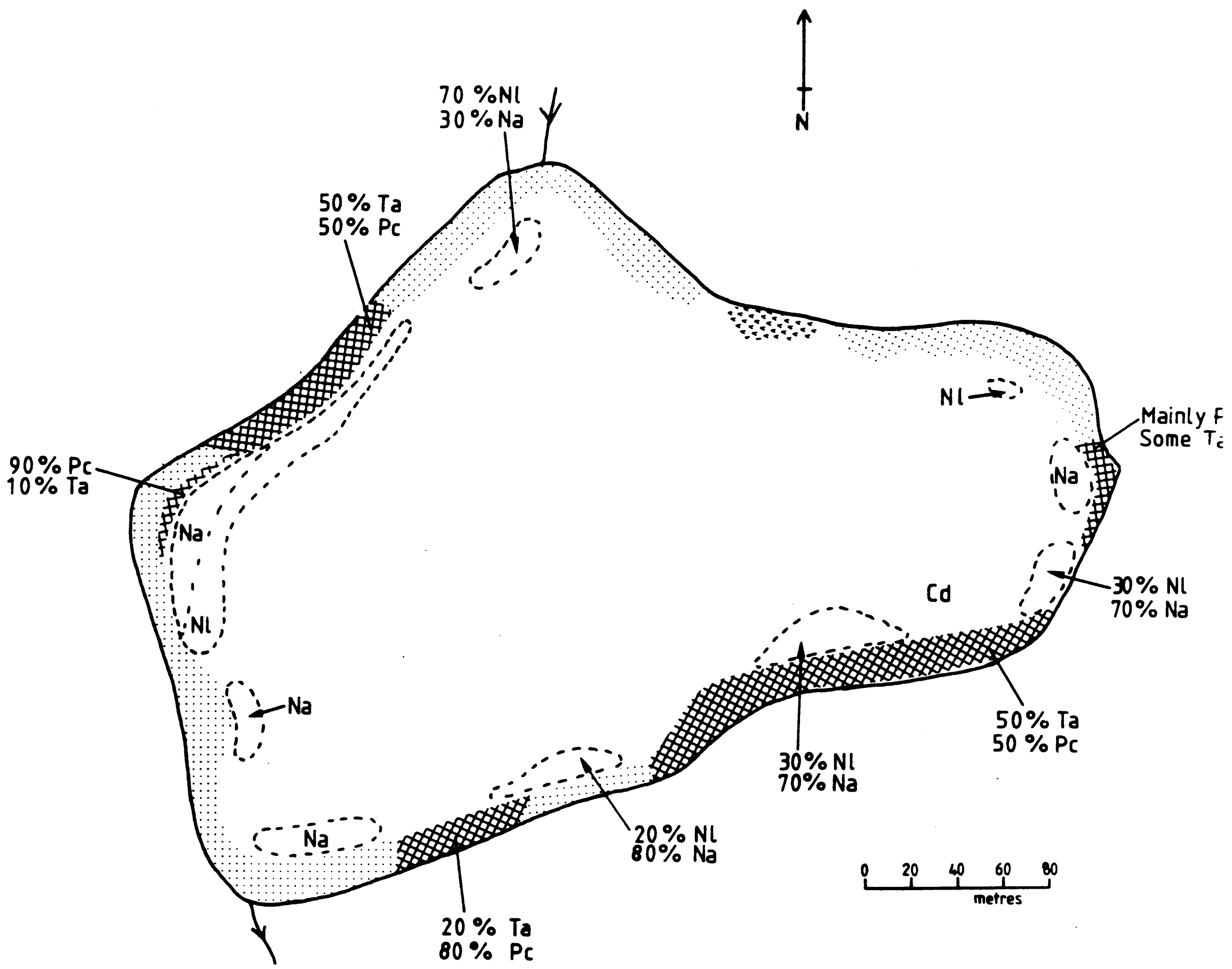
	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	March	April 1 1992	April 28 1992	May 20 1992	May 27 1992	June 10 1992
1	Aster form	201	-	402	-	-	-	335	-	-	-	-	-	-	-	-
2	Amphora ov	-	-	268	-	-	-	-	-	-	-	-	-	-	-	-
3	Cyclotella	67	-	4155	1045	8848	12266	6970	3016	2300	-	21516	-	-	-	11361
4	Cyclot menegh	-	965	670	-	-	-	-	-	-	-	-	-	-	-	-
5	Cyclo ocell	-	13761	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Fragilaria sp	-	3337	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Frag crot	-	-	1273	201	-	-	134	-	-	-	-	-	-	-	101
8	Gomphonema	-	-	-	-	-	-	67	-	-	-	-	-	-	-	302
9	Gomphonela	-	-	-	-	-	-	-	67	-	-	-	-	-	-	-
10	Meloeira gran	-	-	1139	-	-	-	-	-	-	-	-	-	-	-	-
11	Meloeira ital	-	-	-	-	-	-	-	-	-	-	201	-	-	-	-
12	Stephanodisc	-	-	-	-	-	201	-	-	-	-	-	-	-	-	-
13	Synedra sp	-	241	402	-	-	201	-	-	1600	-	603	-	-	-	-
14	Synedra ulna	-	-	-	-	-	-	1139	-	-	-	-	-	-	-	-
15	Tabell fenest	-	-	-	201	-	-	-	-	-	-	-	-	-	-	-
16	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	Actinast hant	-	723	2212	-	-	-	-	-	-	-	-	-	-	-	101
22	Ank falc	201	6715	-	1608	19304	1307	871	402	1400	-	2815	-	-	-	503
23	Chlamydo sp	-	-	-	-	-	-	-	-	-	-	-	-	18801	-	-
24	Ank conv	-	483	7305	7238	18902	5731	-	469	1200	-	5228	-	100	-	101
25	Ank fract	-	-	603	-	-	-	-	-	-	-	-	-	-	-	-
26	Carteria	-	-	-	-	-	-	67	67	-	-	-	-	-	-	-
27	Closterium	-	-	-	40	-	-	-	-	-	-	-	-	-	-	-
28	Chlamydo sph	-	-	-	-	-	-	335	603	-	-	-	-	-	-	-
29	Crucig fenest	-	-	-	161	2614	302	67	-	-	-	-	-	-	-	-
30	Chlamydo glob	-	-	-	-	-	1508	-	-	-	-	-	4021	-	-	-
31	Chlamydo sp	2758	-	1206	241	2815	-	1542	402	1900	-	2010	-	-	884	2514
32	Chlorogonium	-	-	-	-	201	-	-	-	-	-	-	-	-	-	-
33	Crucig tet	-	-	67	885	-	-	-	-	-	-	-	-	-	-	-
34	Closteriopsis	-	-	-	-	-	101	-	-	-	-	-	-	-	-	-
35	Clost acutum	-	-	268	-	-	-	-	-	-	-	-	-	-	-	-
36	Clost cynthia	-	-	-	-	603	-	-	-	-	-	-	-	-	-	-
37	Cosmarium sp	134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	Crucigenia sp	-	-	-	-	-	301	-	-	-	-	-	-	-	-	-
39	Coelast sphaer	-	-	469	-	-	-	-	-	-	-	-	67	-	-	201
40	Chlamydo poly	-	-	-	-	-	-	-	-	600	-	-	-	-	-	-
41	Dictyo pulch	-	-	1743	121	2413	-	-	67	200	-	-	-	-	-	-
42	Kirchneriella	-	-	-	-	804	-	-	-	100	-	402	-	-	-	101
43	Pediast integ	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-
44	Lager quad	-	-	-	-	-	-	-	134	-	-	-	-	-	-	-
45	Oocystis pus	1003	80	603	-	-	-	-	-	-	-	-	-	-	-	1207
46	Oocystis cras	-	-	-	-	-	-	-	-	-	-	-	-	704	-	-
47	Oocystis sol	603	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	Micractinium	-	-	-	-	-	-	-	67	200	-	-	-	-	-	-
49	Oocystis erem	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-
50	Ped bory	1005	-	134	40	-	101	-	-	100	-	-	201	201	20	804
51	Crucig quad	-	-	-	-	-	-	-	201	1000	-	-	-	-	-	-
52	Ped duplex	67	201	135	-	-	-	-	-	-	-	201	-	-	-	-
53	Quadrig lac	-	-	-	40	-	-	-	-	-	-	-	-	-	20	-
54	Scened acum	-	121	335	-	1207	-	201	67	200	-	603	67	-	-	101
55	Lobomonas	-	-	-	-	-	-	-	-	-	-	804	-	-	-	-
56	Scened q long	2547	80	-	-	-	-	-	-	-	-	-	-	-	-	-
57	Scened arc	-	-	-	522	-	-	-	-	-	-	-	-	-	-	-
58	Scened dimor	67	483	268	1005	-	704	201	-	-	-	-	-	-	-	-
59	Scened bij	134	322	335	40	-	-	67	67	-	-	804	-	-	-	101
60	Scen bij alt	134	-	-	-	-	-	-	-	-	-	-	-	-	-	-
61	Schroed jud	-	-	-	-	-	-	-	-	-	-	-	-	-	302	-
62	Schroed setig	-	402	201	-	-	-	-	-	-	-	-	268	905	2593	-
63	Sphaerocystis	-	-	-	-	-	-	-	-	-	-	-	-	-	322	503
64	Selenast min	-	402	1743	40	1408	101	67	67	200	-	201	-	-	-	-
65	Sphaerellops	-	-	-	-	-	-	-	-	100	-	-	-	-	-	-
66	Tetraedron	67	-	-	80	-	-	-	-	-	-	-	-	-	-	-
67	Selenast west	-	241	335	442	1005	201	536	-	-	-	201	-	-	-	-
68	Tetradesmus	-	-	-	-	-	-	-	-	-	-	402	-	-	-	-
69	Tetrallantos	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-
70	Tetraed min	-	121	67	-	-	-	-	-	-	-	-	-	-	-	-
71	Tetrast staur	-	-	-	-	-	-	-	-	-	-	1005	67	-	-	-
72	Scened incras	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-
73	Scened quad	-	-	1139	1126	1608	302	134	268	400	-	603	-	101	60	804

Fenemere Phytopl 1991/92

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	March	April 1 1992	April 28 1992	May 20 1992	May 27 1992	June 10 1992
74	Ulothrix		121													
75	Staurastrum			201	40											
76	Scened alt			67												
77	Schroederia				121	402										
78	Chlorella vulg															302
79	•															
80	•															
81	•															
82	•															
83	•															
84	•															
85	•															
86	•															
87	•															
88	Euglena sang							603								
89	Phacus sp				129											
90	Euglena sp	67					101			200			67			
91	Phacus cren	134														
92	Eugl poly			3016												
93	Phacus helic			201												
94	Phacus caud			201												
95	Lepocinc sp			67												
96	Trachelo sp			268		201	302	1005	67							
97	•															
98	•															
99	•															
100	•															
101	Rhodo min	603		1005	201	1005	1810	402	603	300		8445	67	101	583	7440
102	Crypto ov	335	121	469	80		2212	469	1072				134	302	80	
103	Crypto erosa					402										302
104	Crypto refl							134								
105	Crypto acuta							201		11905		603	402	101		
106	•															
107	•															
108	•															
109	Mallomonas							469								
110	Ophiocytium									100						
111	Ochromonas											603				
112	•															
113	•															
114	•															
115	Peredinium			134	40											
116	•															
117	•															
118	•															
119	Anabaena sp	2479														101
120	Anabaena spir			67												
121	Aphaniz fl aq				121											
122	Aphanocap gre		241													
123	Aphanocap el	67	161		684		101									
124	Dact fasc			1742			503									
125	Dact raph		482					134	469	400		6837				
126	Gloeocap rup		121													
127	Gloeocapsa sp															
128	Gomphosph sp	603														
129	Gomph apon	7841			40											
130	Gomph lacust			2944		402										
131	Merismop sp		282	268	161	1005										101
132	Merismo ten	67														
133	Microcyst aer	1474	80													
134	Dact sp			67	643	1207										
135	Coeloeph sp			134				67								
136	Osc agard		3740													
137	Osc tenuis	21446		4423												
138	Osc rubesc		80													
139	Phormidium sp															
140	Oscill sp				804											
141	Rhabdoderma			3820												
142																
143	Total diatoms	268	18304	8309	1447	8848	12668	8645	3083	3900		22320	0	0		11764
144	Total greens	8720	10695	19436	13790	53286	10659	4088	2851	7600		15279	4691	20812		7343
145	Total others	1139	121	5361	450	1608	4425	3283	1742	12505		9651	670	504		7742
146	Total blue grns	33977	5187	13465	2453	2614	604	201	469	400		6837	0	0		202

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Oct 30 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	March	April 1 1992	April 28 1992	May 20 1992	May 27 1992	June 10 1992
147	TOTAL	44104	34307	46571	18140	66356	28356	16217	8145	24405		54087	5361	21316		27051
148																
149	Diatoms %	0.6	53.4	17.8	8	13.3	44.7	53.3	37.9	16.0		41.3	0	0		43.5
150	Greens %	19.8	31.2	41.7	76	80.3	37.6	25.2	35.0	31.1		28.3	87.5	97.6		27.1
151	Others %	2.6	0.35	11.5	2.5	2.4	15.6	20.2	21.4	51.2		17.8	12.5	2.36		28.6
152	Blue grns %	77.0	15.1	28.9	13.5	3.9	2.1	1.2	5.8	1.6		12.6	0	0		0.75
153																
154		Diatoms	Greens	Others	Blue greens											
155	Winter mean %	38.0(15.9)	32.2(5.4)	27.1(16.3)	2.7(2.1)											
156	Growth mean%	19.8(20.90	53.4(30.5)	9.0(9.5)	16.9(24.5)											
157	Annual mean %	25.4(20.8)	47.6(27.2)	14.5(14.2)	12.5(21.1)											

FENEMERE



N
70 %Nl
30 %Na
50 % Ta
50% Pc
90% Pc
10% Ta
Na
Nl
Na
Na
Nl
Mainly P
Some Ta
Na
Cd
30% Nl
70% Na
50% Ta
50 % Pc
30% Nl
70% Na
20% Nl
80% Na
20 % Ta
80 % Pc
0
20
40
60
80
metres

(k) HATCH MERE

(i) Morphometry and water budget

Hatch Mere is 4.7 ha in area and 3.8m deep. It has anumber of small drains but is likely to be fed mostly through ground water percolating through the higher ground to its north and west and to some extent from the east. There is a distinct outflow to the south which dried up during the summer period. The annual flushing rate based on this outflow was 2.4 per year with a retention time of 21 weeks. However the corresponding growth season and winter values were 1.06 per year, and 49 weeks and 5.1 per year and 10 weeks respectively.

(ii) Changes in land use

Hatch Mere has acatchment in the parishes of Norley, Kingsley and Crowton for which the land use changes have been as follows:

	1931	1987
Cattle(head)	2189	2895
nutrient units	26487	35030
Pigs(head)	416	834
nutrient units	1997	4003
Sheep(head)	443	1262
nutrient units	665	1893
Poultry(head)	26615	3394
nutrient units	3726	475
Total nutrient units	32875	41401
Permanent grass(ha)	1062	842
Temporary grass(ha)	433	551
Arable(ha)	566	834
Woodland(ha)	39	57
Rough grazing(ha)	17	46
Total hectarage	2117	2330

There has thus been a modest increase in the keeping of stock and some loss of permanent pasture to temporary pasture and arable.

(iii) Major ion chemistry and nutrient budgets

Hatch Mere has moderate alkalinity and conductivity. Its soluble reactive phosphorus,total phosphorus and inorganic nitrogen concentrations are low and nitrogen becomes extremely scarce in summer.

(iv)Phytoplankton and zooplankton

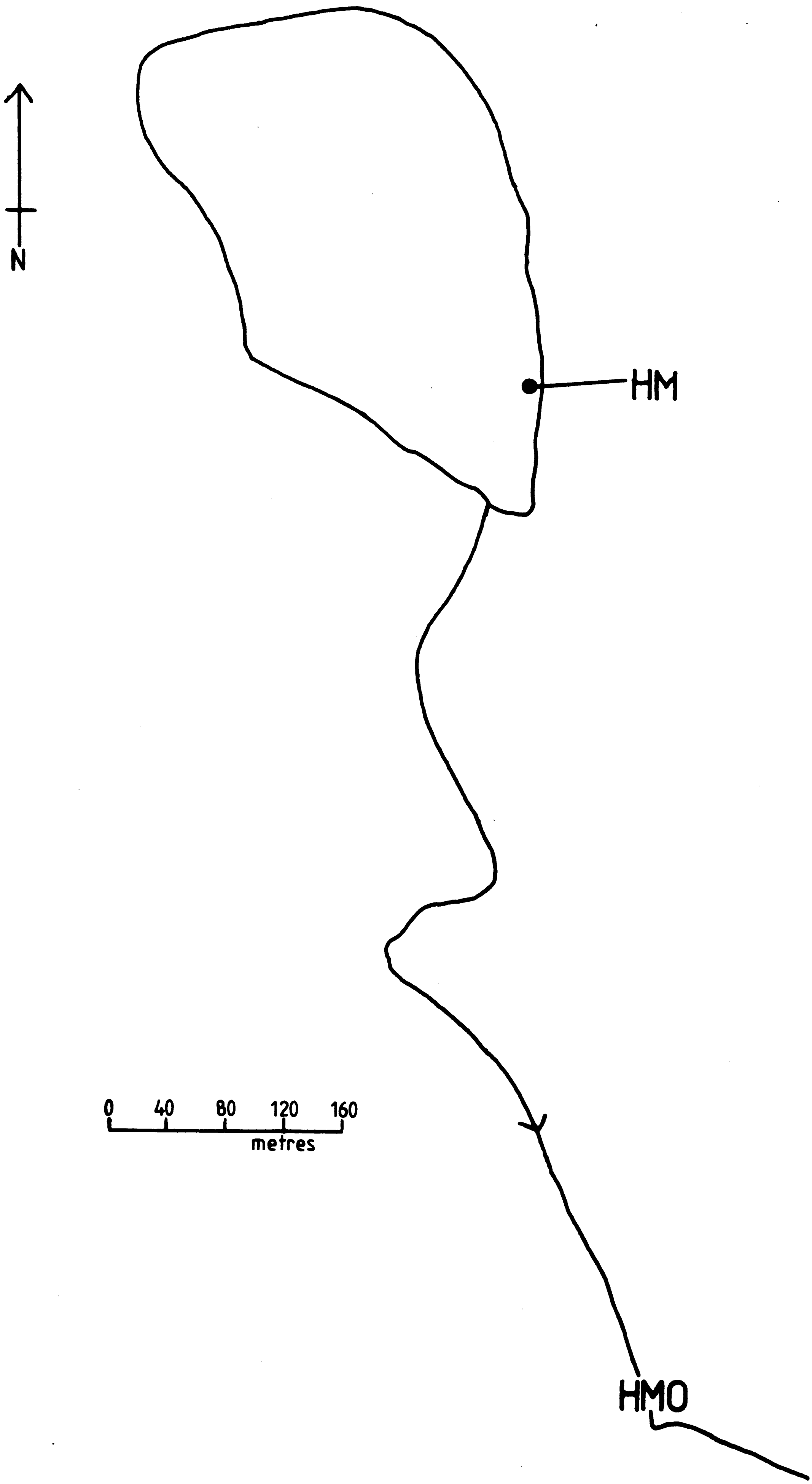
The available nutrient supplies are probably fully used by the phytoplankton because chlorophyll a concentrations are relatively high whereas grazing pressure as reflected in ***Daphnia*** populations is low. Blue green algae are relatively scarce and the plankton is dominated by diatoms in winter and flagellates in summer.

(v) Aquatic plants

Hatch Mere has a fairly steep sided basin and the possibilities for aquatic plant colonisation are low because of this. There are substantial beds of ***Nuphar lutea*** and ***Nymphaea alba*** at the edges but no compleyely submerged species were found. the trophic score is currently 7.6, having previosly been 7.9 in 1979 and 8.5 in 1987. The DAFOR score for submerged plants has been 0 since 1987 but was apparently 0.5 in 1979.

(vi) Overall assessment

Hatch Mere is protected by the wetlands through which the drains must enter on the north and west sides and its catchment to the east is dominated by the bog vegetation of Flaxmere. There are no practicable nutrient control measures that can be taken and indeed the semi-natural nature of the immediate catchment suggests that the water chemistry is also near natural. The lack of ***Daphnia*** probably reflects a high degree of fish predation and some increase in water clarity might ensue from a reduction in fish stock. However this lack of ***Daphnia*** might also be natural in such a lake in which physical factors prevent the development of large areas of suitable plant refuges. No management is therefore suggested in the present state of knowledge about the lake.


N
HM
0
40
80
120
160
metres
HMO

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	*	*	*	*	*	*	*	*	*	*
2	*	*	*	*	*	*	*	*	*	*
3	*	*	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*	*	*
5	*	*	*	*	*	*	*	*	*	*
6	Nov 27 1991	459	1.15		7.53	54.9	6	22	47	68
7	Dec 18 1991	482	-	-	7.77	-	-	-	-	-
8	Jan 29 1992	489	0.0	2.1	8.21	44.4	10	19	36	55
9	Feb 26 1992	491	0.05	2.05	7.90	52.0	7	35	74	109
10	Mar 17 1992	485	0.1	2.1	8.11	50.8	6	18	86	104
11	April 8 1992	473	0.3	1.9	7.97	50.5	8	43	69	112
12	May 6 1992	478	0.0	2.05	7.81	46.0	22	61	24	85
13	May 27 1992	No flow								
14	June 17 1992	477	0.0	2.2	8.09	48.5	44	44	22	66
15										
16	Winter mean	480(15)	0.4(0.65)	2.08(0.004)	7.85(0.3)	50.4(5)	8(2)			77(28)
17	Growth mean	478(5)	0.1(0.14)	2.06(0.13)	8.0(0.14)	49(2.2)	20(18)			92(21)
18	Annual mean	479(10)	0.22(0.42)	2.07(0.1)	7.92(0.22)	49.6(3.6)	15(14)			86(23)

	Nitrate N	Ammonium N	Silicate Si	Discharge	Discharge SD
1	*	*	*	0.000	
2	*	*	*	0.000	
3	*	*	*	0.000	
4	*	*	*	0.000	
5	*	*	*	0.000	
6	0.14	286	2.78	0.001	
7	1.68	85	3.17	0.045	
8	2.50	65	2.24	0.005	
9	2.31	133	0.72	0.007	
10	2.67	49	1.03	0.016	
11	3.83	39	0.97	0.016	
12	2.52	115	0.64	0.005	
13				0.000	
14	1.49	53	0.93	0.003	
15					
16	1.66(1.1)	142(100)	2.23(1.07)	0.014	0.020
17	2.63(0.96)	64(35)	0.89(0.17)	0.003	0.007
18	2.14(1.07)	103(81)	1.56(1.01)	0.007	0.012

Hatch Mere HM

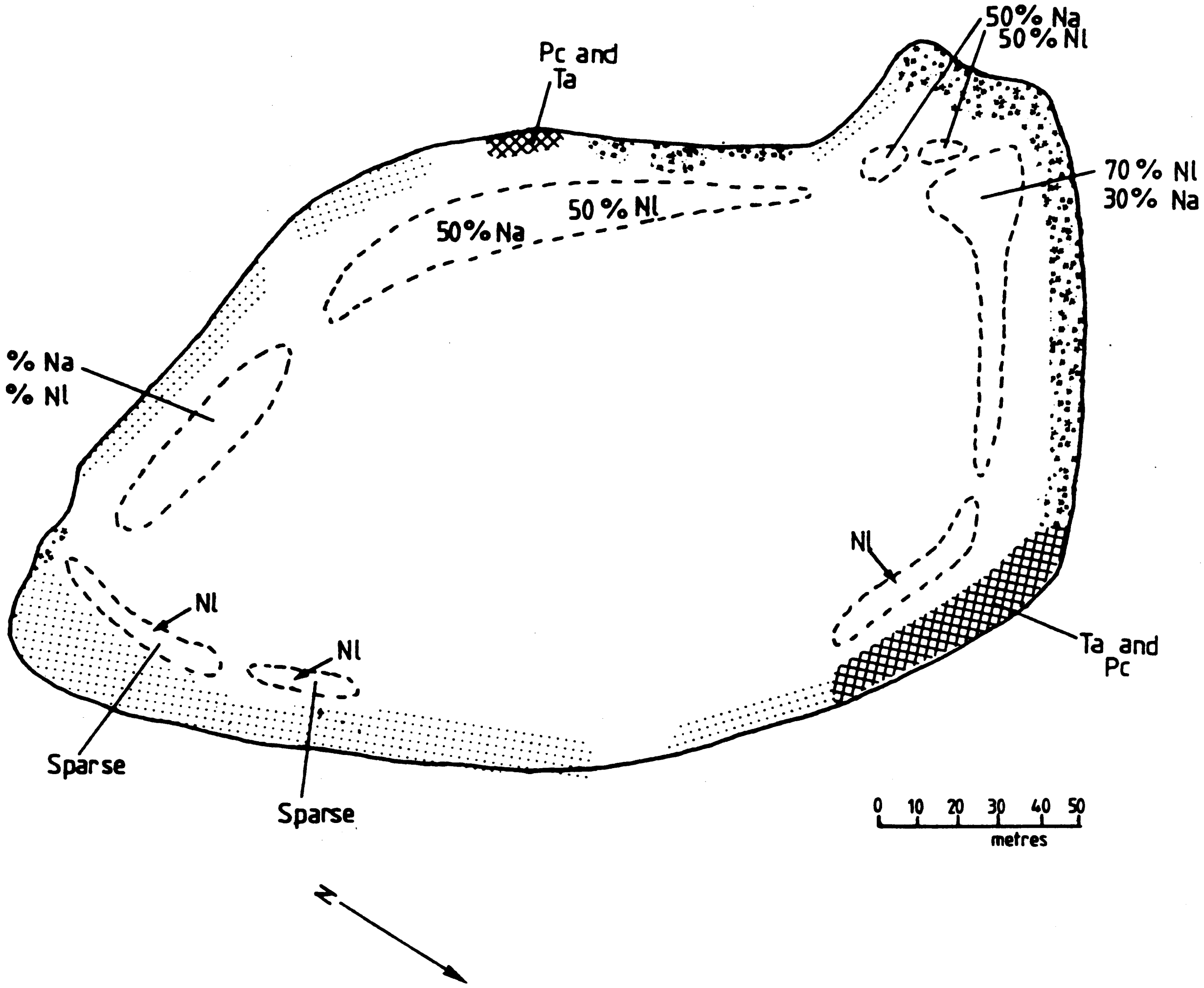
	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 31 1991	492	0.0	2.28	7.73	44.9	3	32	17	49
2	Aug 21 1991	491	0.2	2.60	8.43	46.8	10	29	60	89
3	Sept 11 1991	503	0.0	2.60	8.00	51.1	24			126
4	Oct 16 1991	488	0.3	3.00	8.03	49.0	16	16	168	183
5	Nov 6 1991	476	0.1	2.50	7.81	46.0	10	16	99	115
6	Nov 27 1991	448	0.2	2.75	8.12	51.0	5	17	60	77
7	Dec 18 1992	481	-	-	7.97	-	-	-	-	-
8	Jan 29 1992	490	0.0	2.2	8.21	48.2	10	21	7	28
9	Feb 26 1992	490	0.15	2.15	8.21	52.0	3	33	34	67
10	Mar 17 1992	481	0.2	2.1	8.66	47.6	9	30	47	77
11	April 8 1992	474	0.4	2.0	8.40	46.6	29	29	64	93
12	May 6 1992	478	0.05	2.05	8.15	48.0	20	59	29	88
13	May 27 1992	495	0.0	2.2	7.94	48.0	15	47	15	62
14	June 17 1992	485	0.05	2.25	8.35	46.5	6	6	42	47
15										
16	Winter mean	477	0.11	2.4	8.06	49.3	7			72
17	SD	17	0.09	0.28	0.17	2.7	4			36
18	GRowth mean	487	0.13	2.34	8.19	47.6	15			90
19	SD	9	0.15	0.33	0.29	1.8	9			43
20	Annual mean	484	0.13	2.36	8.14	48.1	12			85
21	SD	13	0.13	0.3	0.26	2.1	8			40

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoid	480:663	430:410	Secchi	Total Daphnia
1	0.500	84	0.93	15.4	18.7	1.33	1.21	>	0.53
2	0.010	73	1.94	21.9	27.0	1.37	1.21	>	0.00
3	0.000	18	2.52	22.9	33.3	1.47	1.17	>	0.00
4	0.004	52	3.15	59.3	65.3	1.11	0.64	>	0.12
5	0.050	16	2.67	33.7	36.7	1.10	1.06	>	0.00
6	0.230	209	2.41	33.4	40.0	1.32	1.12	>	0.00
7	1.520	142	3.17	27.9	31.3	1.24	1.01	>	0.00
8	2.160	3	2.06	21.3	25.3	1.31	1.18	>	0.00
9	2.190	102	0.62	21.6	30.0	1.53	1.13	>	0.52
10	2.810	85	0.90	43.6	48.3	1.22	1.17	>	0.00
11	4.020	0	0.81	80.7	67.7	0.92	1.23	>	2.07
12	2.940	292	0.81	7.7	10.3	1.48	1.00	>	0.00
13	2.950	87	0.98	13.5	18.2	1.49	1.07	>	0.52
14	1.880	37	0.69	9.9	17.3	1.93	1.00	>	1.51
15									
16	1.230	94	2.19	27.6					0.10
17	1.030	87	0.96	6.1					0.23
18	1.680	81	1.41	30.5					0.53
19	1.600	85	0.90	25.3					0.76
20	1.520	86	1.69	29.5					0.38
21	1.380	83	0.96	20.1					0.65

	Organism	July 31 1991	August	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 6 1992	June 17 1992
1	Asterio form	-	-	-	121	13	94	-	40	200	-	-	-	-
2	Cocconeis	-	-	-	-	-	-	13	-	-	-	-	-	-
3	Cyclotella men	-	-	-	-	-	-	-	-	-	-	141	-	-
4	Cyclotella sp	40	-	322	2975	1474	1260	80	5880	460	844	-	141	221
5	Cymbella turg	-	-	-	-	-	-	-	-	-	40	-	-	-
6	Diatoma sp	-	-	-	-	-	13	-	-	-	-	-	-	-
7	Fragilaria sp	-	-	-	60	-	-	-	640	-	-	-	40	-
8	Frag crot	-	-	-	-	-	13	-	-	20	-	-	-	-
9	Gomphonema	-	-	-	-	-	-	27	-	-	-	-	-	-
10	Melosira	-	-	-	141	-	-	-	560	140	161	60	-	-
11	Melosira gran	-	-	-	121	54	13	-	-	-	-	-	-	20
12	Navicula	-	-	-	20	27	-	174	40	-	-	20	40	-
13	Nitzschia sig	-	-	-	-	-	-	27	-	-	-	-	-	-
14	Stephanod ast	-	-	-	342	-	-	-	-	-	-	20	-	201
15	Stephanod sp	-	-	-	-	-	-	-	-	-	-	-	20	-
16	Synedra sp	-	-	-	-	-	13	-	40	2680	322	-	-	-
17	Synedra ulna	-	-	-	-	-	-	107	-	-	-	241	-	40
18	•	-	-	-	-	-	-	-	-	-	-	-	-	-
19	•	-	-	-	-	-	-	-	-	-	-	-	-	-
20	•	-	-	-	-	-	-	-	-	-	-	-	-	-
21	•	-	-	-	-	-	-	-	-	-	-	-	-	-
22	•	-	-	-	-	-	-	-	-	-	-	-	-	-
23	Ank falc	-	-	20	20	-	27	-	80	-	-	-	-	-
24	Ank conv	-	-	-	20	-	-	-	40	120	201	20	-	-
25	Ankist sp	-	-	-	-	13	-	-	-	-	-	-	-	-
26	Carteria sp	-	-	-	-	-	-	-	-	-	-	-	20	-
27	Chlamydo glob	-	-	40	-	-	-	-	-	-	80	-	-	-
28	Clost acutum	-	-	241	-	-	-	-	-	-	-	-	-	-
29	Chlamydo sp	80	-	20	80	132	603	214	480	680	483	101	121	80
30	Chlamydo sph	-	-	-	-	-	13	-	240	-	-	-	-	-
31	Chlamydo poly	-	-	322	-	-	-	-	-	-	-	-	-	-
32	Chlorella vulg	20	-	-	-	-	-	-	-	-	-	40	-	302
33	Clost cynth	101	-	-	60	54	67	-	-	-	-	-	-	80
34	Coelast sphaer	-	-	101	-	-	-	-	-	-	-	-	-	-
35	Crucigenia tet	-	-	-	-	-	13	-	-	-	-	-	-	-
36	Dictyo pulch	-	-	302	462	13	-	-	-	20	-	-	-	2151
37	Crucigenia qua	-	-	-	20	-	54	-	-	-	-	-	-	-
38	Crucigenia sp	-	-	-	20	-	-	-	-	-	-	-	-	-
39	Elakatothrix	-	-	-	-	13	-	-	-	-	-	-	-	-
40	Elakat gelat	-	-	-	-	-	27	-	-	-	-	20	-	-
41	Eudorina eleg	20	-	-	-	-	-	-	-	20	-	-	-	-
42	Golenkinia rad	-	-	-	-	-	-	-	-	-	80	-	-	-
43	Kirchn lun	-	-	-	-	-	-	-	40	-	-	-	-	-
44	Micractin pus	-	-	-	-	13	-	-	40	-	-	-	-	-
45	Nephro ob	-	-	2392	-	-	-	-	-	-	-	-	-	-
46	Nephro agard	20	-	20	-	-	-	-	-	-	-	-	-	-
47	Nephro lim	-	-	101	-	-	-	-	-	-	-	-	-	-
48	Oocystis pus	121	-	643	-	-	-	-	-	-	-	-	-	-
49	Oocystis erem	-	-	20	-	-	-	-	-	-	-	-	-	-
50	Oocystis sp	100	-	-	80	-	-	-	-	-	-	-	-	-
51	Oocystis cras	-	-	20	-	-	-	-	-	-	-	20	-	-
52	Ped bory	-	-	-	-	-	-	-	-	-	40	-	-	-
53	Pandor mor	-	-	60	-	-	-	-	-	-	-	-	-	-
54	Pediast dup	-	-	-	-	-	13	-	-	-	-	-	-	-
55	Quadrig sp	-	-	20	-	-	-	-	-	-	-	-	-	-
56	Quadrig lac	-	-	-	-	-	-	-	-	20	40	20	-	-
57	Scenedi bi alt	80	-	-	-	-	-	-	-	-	-	-	-	-
58	Scened bijuga	-	-	362	-	161	147	13	160	180	201	-	20	-
59	Scened obliq	-	-	-	-	40	-	-	-	-	-	-	-	-
60	Scened quad	201	-	101	60	27	40	-	-	20	121	80	221	80
61	Scened ac plat	-	-	-	20	-	-	-	-	-	-	-	-	-
62	Selenast min	-	-	221	-	214	-	-	-	-	-	-	-	-
63	Schroed jud	-	-	-	-	-	-	40	-	-	-	-	-	101
64	Schroed setig	-	-	20	-	-	-	-	-	-	-	-	-	281
65	Staurast sp	-	-	20	-	13	-	-	-	-	-	-	-	-
66	Tetraed min	-	-	101	121	27	-	-	-	-	40	-	-	-
67	Tetrast sp	-	-	-	-	107	-	-	-	-	-	-	-	-
68	Tetrast staur	-	-	-	-	-	-	-	880	-	-	60	20	-
69	Tetraedron	-	-	-	-	-	-	-	-	-	-	-	-	181
70	Scened incras	-	-	-	-	-	-	-	-	-	-	-	-	60
71	Coelast micro	-	-	-	-	-	-	-	-	-	-	-	-	40
72	•	-	-	-	-	-	-	-	-	-	-	-	-	-
73	•	-	-	-	-	-	-	-	-	-	-	-	-	-

	Organism	July 31 1991	August	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 6 1992	June 17 1992
74	*	-	-	-	-	-	-	-	-	-	-	-	-	-
75	*	-	-	-	-	-	-	-	-	-	-	-	-	-
76	*	-	-	-	-	-	-	-	-	-	-	-	-	-
77	Lepocinclis	60	-	-	-	-	-	-	-	-	-	-	-	-
78	Phacus sp	-	-	-	-	-	-	-	-	-	40	-	-	-
79	Euglena sp	-	-	-	-	-	-	-	40	140	40	-	-	-
80	Euglena sang	-	-	-	80	-	40	-	-	-	-	-	-	-
81	Euglena grac	20	-	-	-	-	-	-	-	-	-	-	-	-
82	Euglena poly	-	-	60	-	-	-	-	-	-	-	-	-	-
83	Lepocinclis sp	-	-	-	-	-	-	-	-	-	-	20	-	-
84	Trachelo sp	-	-	20	1849	335	442	13	-	1100	322	40	-	20
85	Trach acul	-	-	120	-	-	-	-	-	-	-	-	-	-
86	Phacus orbic	-	-	-	20	-	-	-	-	-	-	-	-	-
87	Phacus long	-	-	-	-	-	-	-	-	40	201	-	-	-
88	*	-	-	-	-	-	-	-	-	-	-	-	-	-
89	*	-	-	-	-	-	-	-	-	-	-	-	-	-
90	*	-	-	-	-	-	-	-	-	-	-	-	-	-
91	Crypto ov	462	-	-	40	67	616	13	-	320	201	-	40	40
92	Crypto acuta	-	-	-	-	-	-	-	-	-	-	101	201	422
93	Rhodo min	2312	-	1146	40	214	214	831	-	1160	8323	764	2834	944
94	*	-	-	-	-	-	-	-	-	-	-	-	-	-
95	*	-	-	-	-	-	-	-	-	-	-	-	-	-
96	Mallomonas	-	-	-	-	-	13	-	-	-	-	1889	-	20
97	Uroglena	-	-	-	-	-	-	-	-	-	-	-	-	-
98	Ophiocyt cap	-	-	-	-	-	-	-	-	-	-	-	-	40
99	*	-	-	-	-	-	-	-	-	-	-	-	-	-
100	Peredinium sp	-	-	-	-	-	40	-	-	-	-	-	-	-
101	Glenodinium sp	-	-	-	-	-	-	-	-	-	201	-	-	-
102	Gymnodinium	-	-	-	-	-	-	-	-	-	80	-	-	-
103	*	-	-	-	-	-	-	-	-	-	-	-	-	-
104	*	-	-	-	-	-	-	-	-	-	-	-	-	-
105	Anabaena sp	40	-	-	-	-	-	-	-	-	-	-	-	40
106	Aphanocaps sp	-	-	-	-	-	40	-	40	-	-	-	-	-
107	Aphano elach	703	-	-	-	-	-	-	-	-	-	-	-	-
108	Aphano eleg	40	-	-	-	-	-	-	-	-	-	-	-	-
109	Chroococc var	20	-	-	-	-	-	-	-	-	-	-	-	-
110	Coelosphaer	20	-	-	-	13	-	-	-	-	-	-	-	-
111	Dactylococ sp	20	-	-	-	-	-	-	-	280	-	-	-	-
112	Dact raph	-	-	-	-	-	107	-	160	-	362	-	-	-
113	Dact fasc	-	-	-	-	-	27	-	-	-	-	-	-	-
114	Gloeocapsa	40	-	-	-	-	-	-	-	-	-	-	-	-
115	Gomphosph lac	-	-	-	-	-	13	-	-	-	-	-	-	-
116	Microcystis	321	-	-	-	-	-	-	-	-	-	-	-	-
117	Microcyst aer	-	-	-	-	13	13	-	-	-	-	-	-	-
118	Oscillat sp	20	-	-	-	-	-	-	-	-	-	-	-	-
119	Oscill ten	-	-	-	-	-	-	54	-	-	-	-	-	-
120	Coelosph naeg													20
121														
122	Total diatoms	40		322	3760	1568	1406	428	7200	3500	1367	482	241	481
123	Total greens	742		4846	963	827	1004	267	1960	1060	1286	361	402	3356
124	Total others	2854		1346	2029	616	1365	857	40	2760	9408	2814	3075	1486
125	Total blue grns	1224		0	0	26	200	54	200	280	362	0	0	60
126	TOTAL	4860		6514	6752	3037	3975	1606	9400	7600	12423	3657	3718	5383
127														
128	Diatoms %	0.8		4.9	55.7	51.6	35.4	26.7	76.6	46.1	11.0	13.2	6.5	8.9
129	Greens %	15.3		74.4	14.3	27.2	25.3	16.6	20.9	14.0	10.4	9.9	10.8	62.3
130	Others %	58.7		20.7	30.1	20.3	34.3	53.4	0.4	36.3	75.7	76.9	82.7	27.6
131	Blue greens %	25.2		0	0	0.9	5.0	3.4	2.1	3.7	2.4	0	0	1.1
132														
133		Diatoms	Greens	Others	Blue greens									
134	Winter mean	47.3(19)	20.8(5.6)	28.9(19.8)	3.02(1.6)									
135	Growth mean	14.4(18.6)	28.2(27.7)	53.2(26.5)	4.17(9.3)									
136	Annual mean	28.1(24.6)	25.1(21)	43.1(26.10	3.7(7.0)									

Hatch Mere



Pc and
Ta
50% Na
50% Nl
70 % Nl
30% Na
50 % Nl
50% Na
50 % Na
50 % Nl
Nl
Nl
Nl
Ta and
Pc
Sparse
Sparse
0 10 20 30 40 50
metres
N

(I) LITTLE MERE

Little Mere is part of the Mere Mere SSSI and is a basin at the north end of Mere Mere that is separated from it by a permanent sluice. Recent coring suggests that it is a man-made lake formed by the damming of a stream and the flooding of a former bog in relatively recent times Only a brief account is given here as a very detailed study of it will be included in a thesis to be available in mid-1993.

(i) Morphometry and water budget

Little Mere is both small (2.5ha) and shallow (1.7m). It receives water from Mere Mere over the sluice but in the last two years there has been little or no flow in the growing season. It also received water from a small sewage treatment works situated directly on its bank until early in 1991. The effluent from this works dominated the water chemistry and, through the nutrients stored in the sediments will continue to do so for some future period.

(ii) Land use changes

The catchment of Little Mere is essentially that of Mere Mere (q.v.) but the dominance of the sewage treatment works has been so great as to make catchment influences minor at present.

(iii) Major ion chemistry and nutrient loads

Data are given for the mere for the period after the effluent was diverted by pipeline to an outlet below the mere. It has a modest alkalinity but a relatively high chloride concentration which may be related to the use of road salt on the main highways that surround it. The soluble reactive and total phosphorus concentrations remain very high, as does that of ammonium. Nitrate concentrations are relatively low. Because the water of Mere Mere is low in these nutrients and in any case because the inflow did not flow for much of the year in question, the source of the nutrients (other than nitrate) can be confidently ascribed to the sediments. Values have fallen since the diversion of the effluent but are still very high, particularly where ammonium is concerned.

(iv) Phytoplankton and zooplankton

Despite the huge nutrient potential for algal growth, algal crops were very small except on a single occasion in late May. The reason for this is the large population of ***Daphnia magna*** which exists in the open water and more especially at the edges of the beds of water lilies that cover large areas in the mere. Grazing is clearly very important in Little Mere and is permitted by the very low fish stocks. The fish stock has been kept low by deoxygenation due to the quality of the effluent entering the mere. The oxygen concentrations are still low but increasing and recolonisation of fish from Mere Mere is now becoming feasible. The current phytoplankters in the mere are small flagellates and green algae. Blue green algae are scarce perhaps because they are disfavoured by the relatively high free carbon dioxide concentrations arising from the richly organic bottom sediments. Again this is a situation that may change as the mere adjusts to the diversion of the effluent.

(v) Aquatic plants

The aquatic plant community is well developed in the clear water and includes extensive beds of lilies and ***Polygonum amphibium***. Also present are ***Potamogeton*** spp. Beds of ***Hydrodictyon*** were abundant in 1992.

(vi) Overall assessment

Little Mere is part of a management experiment involving the diversion of sewage effluent from the Mere Mere- Rostherne Mere system. The situation in it is being continuously monitored and should reveal a considerable body of valuable information on lake recovery. No further management should therefore be applied until it has reached some sort of new stable state and the changes evaluated.

	Date	Phenolph alk	Total alk	pH	Chloride	Sol React P	Total Sol P	Total P	Nitrate N	Ammonium N	Silicate Si	Chlorophyll a	Carotenoids	A480:A663	A430:A410	Secchi depth	Total Daphnia
1	Jan 7 1991	0.000	1.400	7.540	67.300	196.000	280.000	311.000	1.430	816.000	2.080	1.100	6.200	6.200	0.900	>	2.950
2	Jan 22 1991																
3	Feb 5 1991	0.000	1.550	7.370	70.100	703.000	795.000	2016.000	0.900	2016.000	2.680	15.600	19.200	1.350	1.280	>	
4	Feb 19 1991	0.000	1.450	7.420	71.000	511.000	556.000	608.000	0.570	1425.000	2.130	23.300	28.000	1.320	1.270	>	
5	Mar 5 1991	0.000	1.450	7.670	73.500	727.000	798.000	847.000	0.580	2334.000	2.230	14.100	20.800	1.600	1.200	>	1.200
6	Mar 19 1991	0.000	1.380	7.760	75.000	553.000	612.000	627.000	0.610	1873.000	1.400	11.900	20.200	1.900	1.100	>	31.200
7	April 2 1991	0.000	1.550	7.770	75.500	688.000	761.000	777.000	0.300	1932.000	1.420	3.100	8.800	3.100	0.970	>	16.700
8	April 16 1991	0.000	1.580	7.560	75.500	1176.000	1288.000	1317.000	0.350	2624.000	1.660	3.300	10.600	3.500	0.900	>	55.200
9	April 30 1991	0.000	1.850	7.550	69.400	2082.000	2231.000	2143.000	0.240	4834.000	2.080	4.400	16.300	4.100	1.000	>	32.200
10	May 14 1991	0.000	2.100	7.560	73.500	2646.000			0.250	5807.000	1.940	4.600	8.400	2.000	1.100	>	26.900
11	May 27 1991	0.150	1.800	9.000	74.200	2035.000	2163.000	2485.000	0.580	3433.000	2.030	141.000	167.000	1.300	1.300	>	1.960
12	June 11 1991	0.025	1.780	7.370	73.500	2451.000	2717.000	2720.000	0.130	2473.000	3.050	2.600	7.600	3.200	1.000	>	42.800
13	June 25 1991	0.000	1.980	7.380	64.000	3107.000	3445.000	3459.000	0.120	4861.000	2.860	3.300	9.200	3.100	0.900	>	37.300
14	July 9 1991	0.000	1.700	7.370	67.300	1754.000	1919.000	1912.000	0.120	2928.000	1.820	1.300	6.400	5.300	0.800	>	31.000
15	July 22 1991	0.000	1.750	7.360	73.500	1598.000	1729.000	1774.000	0.060	4123.000	2.450	12.800	15.000	1.300	1.000	>	75.700
16	Aug 6 1991	0.000	1.550	7.160	71.400	1196.000	1280.000	1384.000	0.170	1593.000	2.680	6.160	13.200	2.400	1.000	>	4.000
17	Aug 20 1991	0.000	1.550	7.530	74.200	1306.000	1288.000	1464.000	0.090	2166.000	2.880	0.440	2.400	6.000	0.900	>	31.000
18	Sept 9 1991	0.000	1.650	7.480	79.200	1551.000	1483.000	1657.000	0.120	1376.000	3.770	6.600	10.300	1.700	1.100	>	3.400
19	Sept 23 1991	0.000	2.250	7.260	75.500	857.000	707.000	1140.000	0.010	1245.000	3.920	4.000	10.000	2.700	0.900	>	3.100
20	Oct 9 1991	0.000	2.250	7.000	78.300	1277.000	1101.000	1586.000	0.120	1937.000	4.470	2.900	6.000	2.300	0.900	>	25.300
21	Oct 22 1991	0.000	1.830	7.190	76.300	1197.000	1448.000		0.090	1998.000	3.390	0.400	4.700	14.000	0.800	>	22.600
22	Nov 9 1991	0.000	1.980	7.240	73.400	1307.000	1307.000	1112.000	0.220	1453.000	3.600	0.000	11.300		0.900	>	3.900
23	Dec 3 1991	0.000	2.130	7.350	72.000	825.000		851.000	0.430	845.000	2.810	0.000	3.000		0.800	>	1.600
24	Dec 18 1991	0.000	1.680		72.700	383.000			0.290	636.000	1.570	0.000	4.700		0.800	>	
25																	
26	Winter mean	0.000	1.700	7.380	71.800	746.000		980.000	0.640	1275.000	2.560	6.700					2.800
27	SD		0.300	0.110	1.300	357.000		651.000	0.460	547.000	0.760	10.200					1.200
28	Growth mean	0.010	1.760	7.530	73.600	1541.000		1686.000	0.230	2796.000	2.590	13.100					26.000
29	. SD	0.040	0.260	0.430	3.600	725.000		773.000	0.190	1352.000	0.900	33.200					20.000
30	Annual mean	0.008	1.760	7.500	73.200	1360.000		1510.000	0.340	2451.000	2.560	11.400					22.500
31	SD	0.030	0.260	0.390	3.300	736.000		792.000	0.330	1370.000	0.800	28.900					21.000

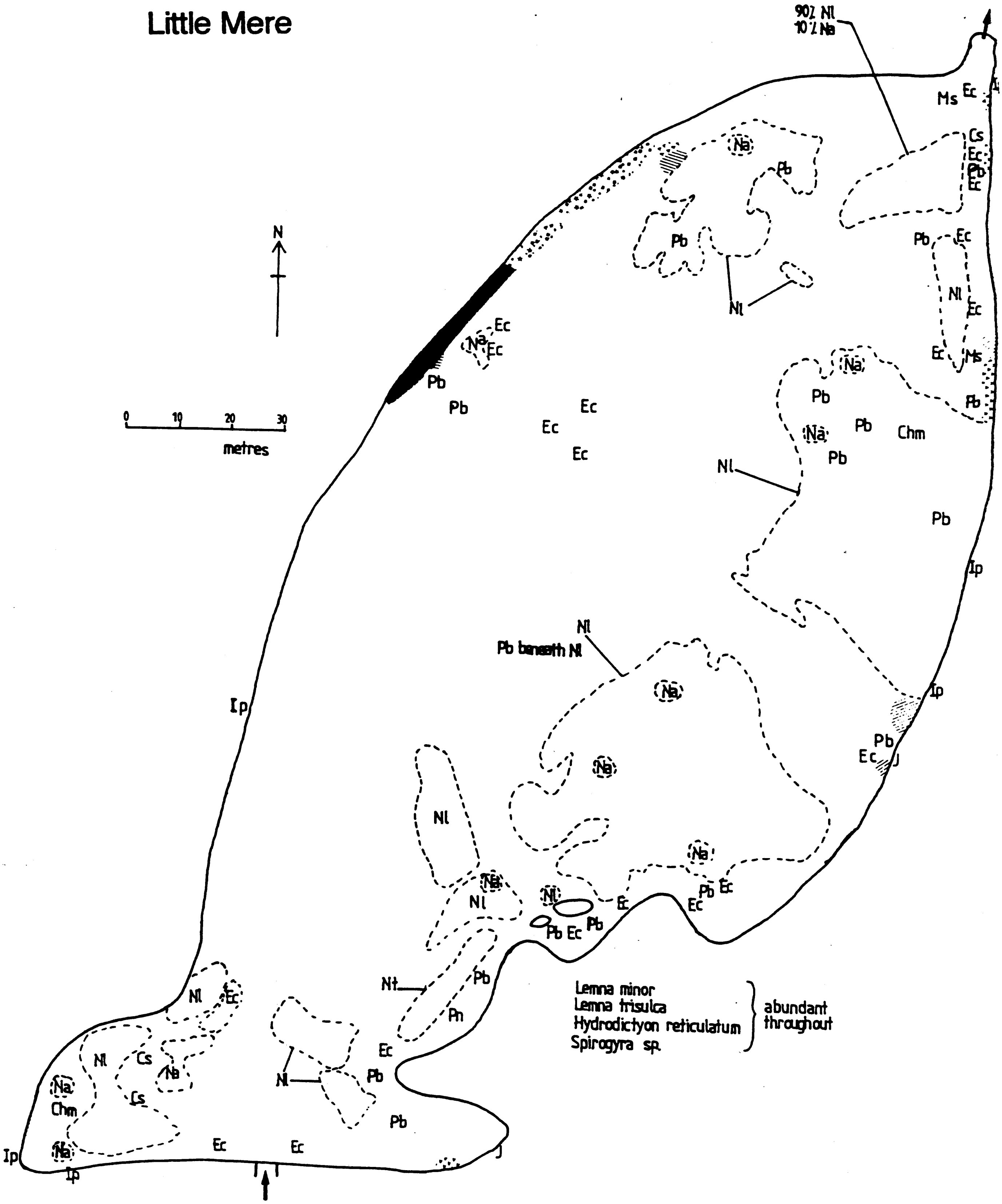
Little Mere Phytopl 1991

	Organism	Jan 1 1991	Jan 22 1991	Feb 5 1991	Feb 19 1991	Mar 5 1991	Mar 19 1991	April 2 1991	April 16 1991	April 30 1991	May 14 1991	May 27 1991	June 11 1991	June 25 1991	July 9 1991	July 22 1991	Aug 6 1991	Aug 20 1991
1	Achnanthes													91				
2	Amphora							12										
3	Aster form	17				872	588	73									81	
4	Cyclotella	17		67			1318					16423						
5	Diatoma								12									
6	Fragilaria					61			24									
7	Gompho ventr													36				
8	Melosira																	
9	Navicula	8			134			12			12					40		
10	Nitzschia						41			12								
11	Pinnularia																	
12	Stephan hantz	17			335	811	223			109	1679	50364	353	1515				
13	Synedra ulna								49			365		91				
14	*																	
15	Coelast micro																41	
16	Gloeocystis																	
17	Oocystis																	
18	Kirchneriella																	
19	Selen min			67			20											
20	Ankistrod					142	182	12										
21	Closterium						182											
22	Schroederia					852	55	255	158	122	1362	1825	182		134	1906	426	292
23	Elakatothrix						55											
24	Scenedesmus	34																
25	Micractinium																	
26	Chlamydo sp		1206	9786	13137	2859	182			12								
27	Eudorina eleg						182											
28	Volvox																	
29	*																	
30	Euglena			67														
31	Trachelomonas		402		134													
32	Phacus	8																
33	*																	
34	Rhodo min	17			134	81	81				12		85		24	1318	142	158
35	Cryptomonas	8		67		142	345	24								41		24
36	Unid flag	67	12400	4156	1005	1054	527	146	36	12			146	219	24	41	101	36
37	*																	
38	Gymnodinium								12									
39	*																	
40	Anabaena																81	
41	Aphan fl aq															20	41	
42	Coelosphaer																	
43	BG unicells																	
44	Oscillatoria	17		67		162	81	12		12				36				12
45																		
46	Total diatoms	59	0	67	469	1744	2170	97	85	121	1691	67952	353	1747	0	40	81	0
47	Total greens	34	1206	9853	13137	3853	858	267	158	134	1362	1825	182	0	134	1906	467	292
48	Total others	120	12802	4290	1273	1277	953	170	48	12	12	0	231	219	48	1400	243	218
49	Total blue grns	17	0	0	0	162	81	12	0	12	0	0	0	36	0	20	122	12
50	TOTAL	230	14008	14008	14879	7036	3644	546	291	279	3065	69777	766	2002	182	3366	913	522
51	.																	
52	Diatoms %	25.7	0	0	3.2	24.8	59.5	17.8	29.2	43.4	55.2	97.4	46.1	87.3	0	1.2	8.9	0
53	Greens %	14.8	8.6	8.6	88.3	54.8	23.6	48.9	54.3	48	44.4	2.6	23.8	0	73.6	56.6	51.2	56
54	Others %	52.1	91.4	91.4	8.6	18.2	26.1	31.1	16.5	4.3	0.4	0	30.2	10.9	26.4	41.6	26.6	41.8
55	Blue greens %	7.4	0	0	0	2.3	2.2	2.2	0	4.3	0	0	0	1.8	0	0.6	13.4	2.3

		Diatoms	Greens	Others	Blue greens
56					
57					
58	Winter mean	6.2(8.5)	35.1(32.8)	57.7(29)	2.4(3.1)
59	Growth mean	28.6(31.4)	33.1(24.7)	36.3(31)	2.3(3.7)
60	Annual mean	21.4(28.1)	33.7(26.9)	43.1(31.4)	2.2(3.4)

	Sept 9 1991	Sept 23 1991	Oct 9 1991	Oct 22 1991	Nov 5 1991	Nov 19 1991	Dec 3 1991	Dec 18 1991
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	18	-	6	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	6	-	-
7	-	-	-	6	-	-	-	-
8	-	-	-	-	-	-	-	-
9	4	12	-	-	-	-	12	9
10	-	12	-	9	-	-	-	-
11	-	-	-	-	-	-	-	-
12	13	-	-	18	-	-	-	4
13	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-
22	22	-	36	73	61	-	6	4
23	-	-	-	-	-	-	-	4
24	-	-	-	-	49	85	-	-
25	-	-	-	-	-	-	-	-
26	-	-	18	-	12	-	-	-
27	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-
29	-	-	-	-	-	18	-	-
30	-	-	-	-	-	-	-	-
31	-	-	-	-	-	6	12	-
32	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-
34	49	426	408	1022	97	73	109	107
35	93	36	-	18	12	6	18	4
36	60	36	36	36	49	24	12	31
37	-	-	-	-	-	-	-	-
38	-	-	-	-	-	-	-	-
39	-	-	-	-	-	-	-	-
40	12	-	-	-	-	-	-	9
41	-	-	-	-	-	-	-	-
42	-	-	-	-	-	-	-	-
43	-	-	-	-	-	-	-	-
44	12	-	6	-	12	-	-	-
45								
46	17	24	0	51	0	12	12	13
47	22	0	54	73	122	103	6	8
48	202	498	444	1076	158	119	151	142
49	24	0	6	0	12	0	0	9
50	265	522	504	1300	292	234	169	172
51								
52	6.4	4.6	0	3.9	0	5.1	7.1	7.6
53	8.3	0	10.7	5.6	11.8	44.0	3.6	4.7
54	76.2	95.4	88.1	82.8	54.1	50.9	89.3	82.6
55	9.1	0	1.2	0	4.1	0	0	5.2
56								
57								
58								
59								
60								

Little Mere



90% Nl
10% Na
N
0 10 20 30
metres
Ms Ec
Cs
Ec
Pb
Ec
Na
Pb
Pb
Pb Ec
Nl
Nl
Ec
Ec
Ms
Ec
Na
Ec
Pb
Pb
Na
Pb
Pb
Ec
Ec
Na
Pb
Chm
Ec
Pb
Nl
Pb
Ip
Nl
Pb beneath Nl
Ip
Na
Ip
Pb
Ec
Na
Nl
Na
Na
Pb
Ec
Nl
Nl
Ec
Ec
Pb Ec
Pb
Nt
Pb
Pn
Lemna minor
Lemna trisulca
Hydrodictyon reticulatum
Spirogyra sp.
abundant throughout
Nl
Ec
Nl
Cs
Na
Ec
Nl
Pb
Na
Cs
Chm
Pb
Na
Ip
Ec
Ec
Ip

(m) MERE MERE

Mere mere will be the subject of a detailed thesis to be available in mid-1993 and hence only a brief summary is given here.

(i) Morphometry and nutrient budget

Mere mere is 15.8 ha in area and 8.1 m in maximum depth. With the golf driving range that occupies part of its western littoral, it may lay claim to have one of the more bizarre uses of waterspace in the UK. It receives water from a small stream at the southern end and discharges over a weir to Little Mere to the north. There may also be a ground water supply.

(ii) Changes in land use

	1931	1987
Cattle(head)	475	897
nutrient units	5795	10943
Pigs(head)	148	559
nutrient units	710	2683
Sheep(head)	131	1006
nutrient units	197	1509
Poultry(head)	4530	38400
nutrient units	634	5376
Total nutrient units	7336	20511
Permanent grass(ha)	262	159
Temporary grass(ha)	171	180
Arable(ha)	350	417
Woodland(ha)	2	1
Rough grazing(ha)	34	2
Total hectarage	819	759

There has thus been a major increase in stock keeping, some loss of grazing and a drift towards arable, with some loss of agricultural land to other uses.

(iii) Major ion chemistry and nutrient loads

Mere Mere has moderately hard water with a mean conductivity of 523 uS/cm and alkalinity of 1.51 mequiv/l. Its soluble reactive and total phosphorus concentrations are low, with the former building up a little in winter but falling in summer.Nitrate and ammonium concentrations are also very low to vanishing point in summer.

(iv) Phytoplankton and zooplankton

The phytoplankton crops were modest, averagingonly 20.1 ug/l chlorophyll a in summer but reached occasional much higher peaks in late summer associated with blue-green algae. These may have been biased by surface aggregation although an integrated tube sample was used in the epilimnion for this lake. Numerically, small flagellates dominated the phytoplankton with other groups having moderate proportions. Daphnia was relatively scarce and probably only moderate grazing pressure was exerted.

(v) Aquatic plants

Mere mere has a well developed plant community with one of the highest diversities of submerged species in the meres and a substantial biomass.

(vi) Overall assessment

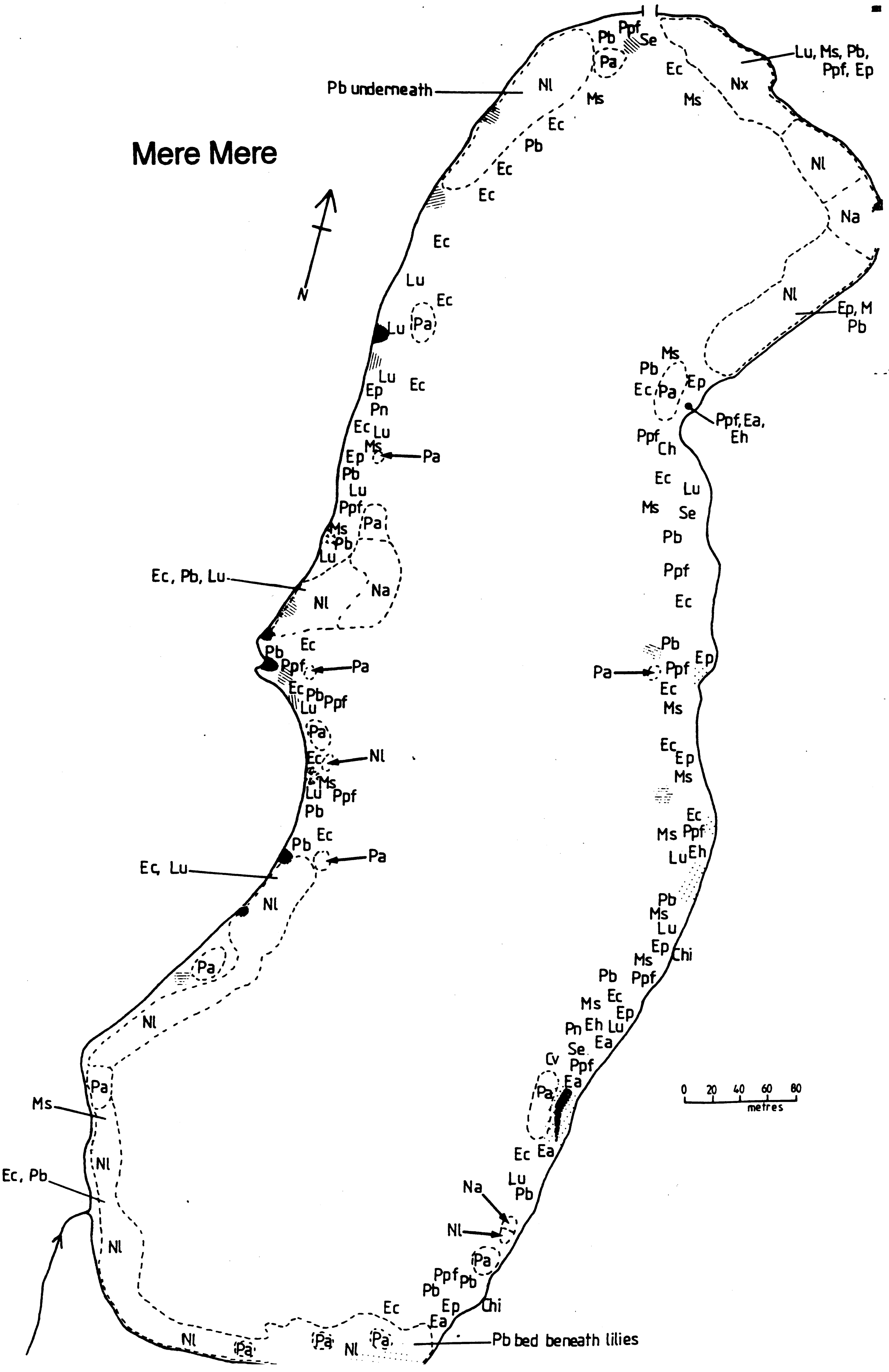
Despite its suburban setting, its banks lined with a golf course on one side and large houses on the other, Mere Mere persists in a state that has considerable conservation value. Almost certainly it has undergone some eutrophication, judging by the changes in land use but this appears not to have been serious and the nutrient concentrations are among the lowest in the mere's area. There are no immediate management measures that need be taken provided that no substantial changes occur in the bankside management of the golf course.

	Date	Conductivity	Phenolph alk	Total Alk	pH	Chloride	Sol React P	Tot sol P	Total P	Nitrate N
1	April 2 1991	-	0.000	1.300	7.730	73.500	2.000	17.000	68.000	1.420
2	April 6 1991	-	0.000	1.200	7.540	75.500	1.000	11.000	35.000	1.470
3	April 30 1991	-	0.000	1.200	7.790	77.600	0.000	20.000	40.000	1.340
4	May 14 1991	-	0.000	1.550	7.800	77.600	3.000			0.970
5	May 27 1991	-	0.000	1.280	7.700	76.300	6.000	30.000	58.000	0.920
6	June 11 1991	-	0.250	1.650	7.730	77.600	0.000	49.000	56.000	0.630
7	June 25 1991	-	0.000	1.300	7.789	74.000	1.000	0.000	27.000	0.630
8	July 9 1991	-	0.000	1.400	8.010	73.500	0.000	15.000	35.000	0.430
9	July 22 1991	-	0.250	1.430	8.870	77.600	5.000	22.000		0.000
10	Aug 6 1991	-	0.230	1.380	9.120	73.500	0.000	13.000	80.000	0.030
11	Aug 20 1991	-	0.000	1.300	8.390	74.200	2.000	17.000	72.000	0.060
12	Sept 9 1991	-	0.000	1.550	8.150	75.000	2.000	24.000	58.000	0.000
13	Sept 23 1991	-	0.000		7.730	75.500	2.000	5.000	90.000	0.000
14	Oct 10 1991	-	0.000		7.710	78.300	9.000	32.000	90.000	0.040
15	Oct 22 1991	-	0.000	1.750	7.720	74.200	6.000	11.000	69.000	0.160
16	Nov 5 1991	-	0.000	1.650	7.320	74.700	13.000	22.000		0.120
17	Nov 19 1991	-	0.000	2.000	7.730	77.500	14.000			0.250
18	Dec 3 1991	-	0.000	1.700	7.660	72.000	11.000	21.000	32.000	0.370
19	Dec 18 1991	495	0.000	1.700	7.780	74.700	21.000	20.000	35.000	0.370
20	Jan 9 1992	512	0.000	1.450	7.580	74.500	24.000		40.000	1.110
21	Jan 21 1992	-	0.000	1.430	7.480	73.800	23.000	59.000	45.000	1.430
22	Feb 3 1992	-	0.000	1.400	7.040	80.000	12.000	50.000	56.000	1.340
23	Feb 18 1992	-	0.000	1.900	7.540	81.600	22.000	28.000	70.000	2.130
24	Mar 3 1992	-	0.000	1.260	7.810	84.000	3.000	37.000	57.000	1.240
25	Mar 18 1992	-	0.100	1.300	8.130	78.100	1.000	47.000	62.000	1.440
26	April 1 1992	501	0.000	1.250	7.820	73.300	1.000	19.000	20.000	1.900
27	April 14 1992	-	0.000	2.200	7.800	72.000	0.000	36.000	45.000	2.000
28	April 28 1992	584	0.000	1.800	7.770	74.000	5.000	4.000	24.000	1.130
29	May 12 1992	-	0.000		7.810	68.000	16.000	5.000	73.000	1.200
30										
31	Winter mean	504	0.000	1.650	7.520	76.100	17.500		46.300	89.000
32	SD	12	0.040	0.220	0.240	3.300	5.500		14.000	0.720
33	Growth mean	543	0.090	1.450	7.950	75.400	3.100		56.000	0.810
34	SD	59	0.030	0.260	0.400	3.000	3.800		21.400	0.670
35	Annual mean	523	0.080	1.510	7.830	75.600	7.100		53.500	0.830
36	SD	41		0.260	0.410	3.000	7.800		20.000	0.670

	Ammonium N	Silicate Si	Chlorophyll a	Carotenoids	A480:A663	A430:A410	Secchi depth	Daphnia
1	0.000	0.620	27.500	33.200	1.330	1.220	1.450	1.900
2	0.000	0.370	14.100	18.600	1.500	1.230	1.900	0.400
3	3.000	0.460	10.600	18.700	1.900	1.160	2.000	
4	62.000	0.410	0.400	3.200	8.000	0.800	3.150	
5	72.000	0.590	8.100	13.600	1.800	1.030	3.100	8.000
6	27.000	0.500	12.300	18.800	1.700	1.130	2.250	10.800
7	0.000	0.600	13.200	21.800	1.800	1.200	2.500	28.100
8	12.000	0.670	16.100	23.800	1.600	1.160	2.050	46.400
9	0.000	0.800	62.300	84.800	1.500	1.290	1.000	7.100
10	14.000	0.470	74.800	105.600	1.600	1.300	0.700	6.300
11	73.000	0.920	28.200	37.200	1.500	1.190	1.000	10.300
12	20.000	0.260	23.700	34.300	1.600	1.250	1.430	8.700
13	16.000	0.480	42.900	45.300	1.200	1.200	0.930	2.500
14	232.000	0.990	18.300	30.000	1.800	1.100	1.600	6.900
15	173.000	0.000	20.900	27.700	1.500	1.160	1.900	4.200
16	142.000	0.040	12.800	23.300	2.000	1.000	1.950	13.500
17	179.000	0.620	0.000	6.000		1.200	2.450	7.600
18	157.000	0.810	5.900	10.000	1.900	0.900	3.750	2.100
19	167.000	0.510	0.370	4.700	14.000	0.800		0.100
20	230.000	1.030	1.100	3.700	3.700	0.900	2.300	4.100
21	169.000	1.340	0.400	2.300	7.000	0.800		0.030
22	163.000	1.390	2.200	4.000	2.000	0.900		0.100
23	218.000	1.710	3.700	7.700	2.300	1.100	2.600	1.400
24	4.000	1.460	13.900	19.300	1.500	1.100	2.050	0.900
25	0.000	1.220	8.800	13.700	1.700	1.100		5.400
26	51.000	1.060	7.700	7.660	1.100	1.110	1.800	1.300
27	18.000	1.040	9.530	15.000	1.700	1.120	1.630	
28	6.000	0.790	2.900	4.000	1.500	1.100	2.500	
29	5.000	0.600	6.400	17.600	3.000	0.800	2.410	
30								
31	178.000	0.930	3.300					3.600
32	30.000	0.540	4.300					4.800
33	37.500	0.680	20.100					9.300
34	61.000	0.340	18.900					11.900
35	76.300	0.750	15.500					7.400
36	83.000	0.410	17.800					10.700

	Column 1	April 16 1991	April 30 1991	May 14 1991	May 27 1991	June 11 1991	June 25 1991	July 9 1991	July 22 1991	Aug 8 1991	Aug 20 1991	Sept 9 1991	Sept 23 1991	Oct 9 1991	Oct 22 1991	Nov 5 1991	Nov 19 1991	Dec 3 1991
1	Aster form	2323	1072	23	-	11	179	22	503	302	-	22	-	11	346	212	34	13
2	Cyclotella	-	-	-	-	-	67	67	117	101	17	-	-	-	-	-	-	-
3	Diatoma elong	-	-	-	-	-	-	-	-	-	-	-	-	45	112	693	480	261
4	Fragilaria	45	-	-	-	-	-	-	34	101	67	123	67	34	22	67	56	194
5	Melosira	-	-	-	-	-	-	290	101	101	285	89	251	324	558	268	101	60
6	Steph ast	-	-	-	-	-	-	22	-	-	-	-	-	-	-	-	-	-
7	Steph hantz	-	-	-	-	-	-	-	-	-	-	-	17	123	168	34	47	20
8	Synedra acus	-	-	-	-	-	-	-	-	-	-	11	-	-	45	-	-	-
9	Synedra ulna	-	-	-	-	-	-	-	-	-	34	-	-	-	-	-	-	-
10	Navicula	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	Ank falc	268	-	-	22	179	45	67	-	-	-	-	-	-	-	-	-	-
13	Chlamydo sp	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-
14	Closterium	-	-	-	-	-	-	89	17	-	-	-	-	-	45	45	22	-
15	Coelastrum	-	-	-	22	-	-	45	17	34	17	11	-	-	22	11	-	-
16	Dictyo pulch	-	-	-	-	-	-	-	34	34	-	101	-	-	-	-	-	-
17	Elakat gelat	-	-	-	-	-	-	-	17	-	-	22	218	22	11	-	-	-
18	Oocystis sp	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-
19	Pandor mor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-
20	Pediast dupl	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-
21	Scenedesmus	-	179	-	-	-	-	-	-	134	34	45	302	112	89	89	-	40
22	Schroederia	-	-	-	-	-	-	45	-	-	-	-	-	-	11	-	-	-
23	Selenastrum	-	-	-	-	-	-	22	-	-	-	11	17	34	134	78	11	47
24	Sphaerocystis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	Tetraed trig	-	-	-	-	-	-	-	-	-	-	11	-	11	-	-	-	-
26	Volvox	-	-	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-
27	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	Phacus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	Trachelomonas	-	-	-	-	22	-	22	-	-	-	-	-	-	-	-	-	-
30	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	Rhodo min	45	938	63	432	1251	1921	357	1173	134	-	101	1324	357	257	369	223	80
32	Cryptomonas	-	357	112	15	89	447	1095	1508	268	168	78	754	78	78	101	45	13
33	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	Unid flag	5763	2949	-	37	-	-	-	-	-	-	-	-	-	-	78	190	221
35	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	Gymnodinium	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	Peredinium	-	-	112	-	45	45	22	-	-	184	-	-	212	-	-	-	-
38	Ceratium hir	-	-	-	30	67	112	67	84	134	101	101	17	-	-	-	-	-
39	Dinofl sp	-	-	-	30	-	-	-	-	-	-	145	134	-	34	34	11	-
40	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	Anabaena sp	-	-	-	-	-	-	179	737	3384	1508	235	84	-	-	22	11	-
42	Aphaniz fl aq	-	-	-	-	-	-	-	-	37	-	-	-	-	-	-	-	-
43	Coeloph naeg	-	-	-	-	11	-	67	268	1106	117	123	-	101	56	56	-	13
44	Oscillatoria	45	268	-	-	-	-	-	-	34	84	257	670	201	34	22	-	7
45																		
46	Total diatoms	2368	1072	23	0	11	246	399	755	605	403	245	335	536	1251	1274	718	548
47	Total greens	268	179	0	59	179	45	268	85	202	85	201	537	178	323	225	33	87
48	Total others	5853	4244	287	544	1474	2525	1663	2765	536	453	425	2229	647	369	582	469	314
49	Total blue grns	45	268	0	0	11	0	246	1005	4561	1706	615	754	302	90	100	11	20
50	TOTAL	8534	5763	310	603	1675	2816	2566	4410	5901	2647	1486	3855	1663	2033	2181	1231	969
51																		
52	Diatoms %	27.7	18.6	7.4	0	0.66	8.7	14.4	17.1	10.3	15.2	16.5	8.7	32.2	61.5	58.4	58.3	56.6
53	Greens %	3.1	3.1	0	9.8	10.7	1.6	9.7	1.9	3.4	3.2	13.5	13.9	10.7	15.9	10.3	2.7	9.0
54	Others %	68.3	73.6	92.6	90.2	88.0	89.7	60.1	62.7	9.1	17.1	28.6	57.8	38.9	18.2	26.7	38.1	32.4
55	Blue greens %	0.5	4.7	0	0	0.66	0	8.9	22.8	77.3	64.5	41.4	19.6	18.2	4.4	4.6	0.9	2.1
56																		
57		Diatoms	Greens	Others	Blue Greens													
58	Winter mean	25.9(26.7)	14.1(9.3)	60.4(27.4)	3.1(2.2)													
59	Growth mean	21.4(18.6)	9.6(7.5)	53.0(28.9)	16.2(23.5)													
60	Annual mean	24.6(21)	10.5(8.3)	51.9(26.4)	13(21)													

	Dec 18 1991	Jan 9 1992	Jan 21 1992	Feb 3 1992	Feb 18 1992	Mar 3 1992	Mar 18 1992	Apr 1 1992
1	6	3	-	-	-	-	45	380
2	-	-	-	-	-	-	67	-
3	8	3	-	-	-	45	89	89
4	11	-	-	-	-	-	-	34
5	-	17	-	-	-	45	67	123
6	-	-	-	-	22	22	-	101
7	11	17	17	45	-	2770	447	279
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	22	11
10	3	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-
12	6	-	6	8	22	156	380	547
13	-	-	-	-	22	-	22	-
14	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
17	28	6	6	-	-	-	-	78
18	3	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-
21	22	81	28	-	-	89	179	-
22	-	-	-	-	-	-	67	22
23	14	-	3	8	-	89	-	89
24	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	-
26	-	-	-	-	-	-	-	-
27	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-
29	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-
31	106	151	246	1005	1921	1117	1340	302
32	6	-	8	8	45	45	89	11
33	-	-	-	-	-	-	-	-
34	47	36	36	159	938	268	625	101
35	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	22	-
38	-	-	-	-	-	-	-	-
39	8	3	-	-	-	-	-	11
40	-	-	-	-	-	-	-	-
41	-	3	-	-	-	-	-	34
42	-	-	-	-	-	-	-	34
43	-	17	11	8	-	-	-	-
44	14	-	8	-	22	-	112	168
45								
46	39	40	17	45	22	2882	737	1017
47	73	87	43	16	44	334	648	736
48	167	190	290	1172	2904	1430	2076	425
49	14	20	19	8	22	0	112	236
50	293	337	369	1240	2992	4646	3573	2414
51								
52	13.3	11.9	4.6	3.6	0.7	62.0	20.6	42.1
53	24.9	25.8	11.7	1.3	1.5	7.2	18.1	30.5
54	57.0	58.4	78.6	94.5	97.1	30.8	58.1	17.6
55	4.8	5.9	5.2	0.7	0.7	0	3.1	9.8
56								
57								
58								
59								
60								



Mere Mere
N
Pb underneath
Lu, Ms, Pb, Ppf, Ep
Ep, M Pb
Ppf, Ea, Eh
Ec, Pb, Lu
Ec, Lu
Ms
Ec, Pb
Pb bed beneath lilies
0 20 40 60 80
metres

(n) OAKMERE

Oakmere will be the subject of a detailed thesis study which will be available in mid 1993. Only a brief treatment is therefore given here.

(i) Morphology and water budget

Oakmere is 18.3 ha in area and up to 5.6 m deep in normal years. In the last two years its level has been steadily falling as a result probably of reduced rainfall in the area and it is now more than 1m shallower. It lies in a sandy basin with peat underlying part of its northwestern end and appears to be entirely supplied by ground water. Its retention time is unknown but probably of the order of several months to several years.

(ii) Changes in land usage

Oakmere's probable catchment lies in Oakmere Parish for which the land use changes have been:

	1931	1987
Cattle(head)	623	462
nutrient units	7601	5636
Pigs(head)	119	3452
nutrient units	571	16570
Sheep(head)	96	72
nutrient units	144	108
Poultry(head)	4717	168
nutrient units	660	24
Total nutrient units	8976	22338
Permanent grass(ha)	342	192
Temporary grass(ha)	216	63
Arable(ha)	230	215
Woodland(ha)	1	4
Rough grazing (ha)	17	9

Total hectarage	806	483

The changes in this parish have thus been rather different from those in other mere parishes in that cattle numbers have declined at the expense of those of pigs, and that there has not been such extensive conversion to arable. Much land has been lost to non agricultural uses which are dominated by gravel and sand extraction.

(iii) Major ion chemistry and nutrient loads

Oakmere has very soft water of low conductivity and alkalinity. It also has a low pH (mean 5.14) and thus is unusual among the generally very alkaline meres. Soluble reactive and total phosphorus concentrations are also low though higher than might be expected from a lake of comparable conductivity and alkalinity in an upland catchment. Inorganic nitrogen is also scarce and both nitrogen and phosphorus may be limiting to algal growth in summer.

(iv) Phytoplankton and zooplankton

Algal crops were low (mean of 8.4 ug/l chlorophyll a in the growing season and this may partly be ascribed to nutrient limitation. The algal community was dominated by green algae with all other groups scarce or in the case of blue-green algae, negligible. Grazing may also have been an important determinant of the algal crops for in some years ***Daphnia*** is abundant and in others ***Diaphanosoma***.

(v) Aquatic plants

The aquatic plant community is sparse as might be expected in a lake of low fertility with a largely sandy substratum but extensive stands of ***Littorella uniflora*** grow in the littoral zone.

(vi)Overall assessment

Oakmere does not appear to be suffering from serious eutrophication. The catchment changes, as elsewhere in the area, have undoubtedly increased the nutrient loads to some extent this century, but there are no immediate practicable steps that can be taken to reduce them. The water level is a cause for concern as it is not certain that the present fall in level is solely linked with weather fluctuations. The fall appears to have been greater than for other meres but this may simply reflect the more permeable basin substrates at Oakmere. It has been suggested that nearby sand extraction may have been responsible but in a ground water fed basin this is unlikely. Sand extraction may expose the water table

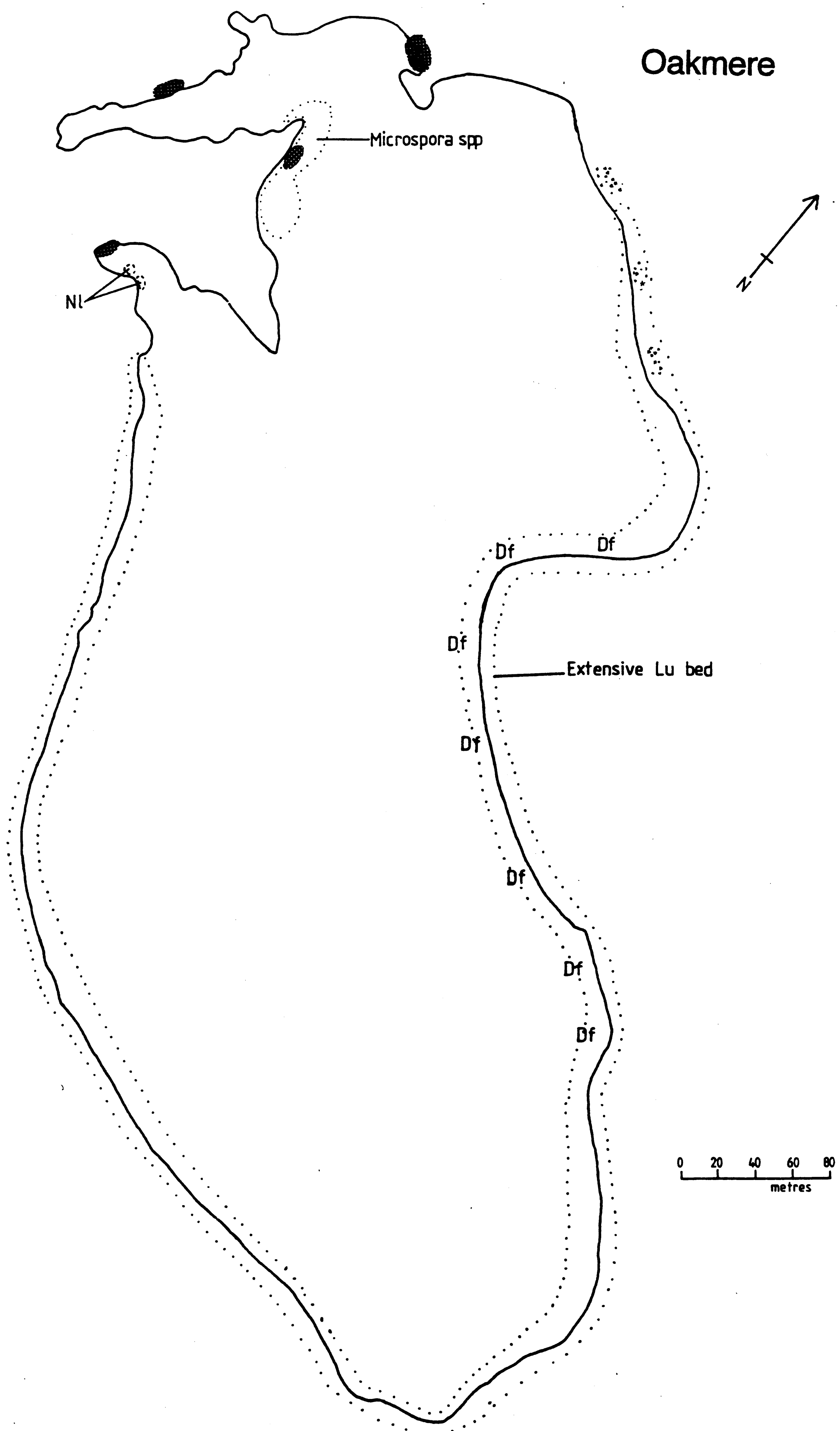
	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Total P	Nitrate N
1	Mar 19 1991	-	0.000	0.020	5.490	25.000	1.000	12.000	58.000	0.130
2	April 2 1991	-	0.000	0.070	5.650	22.400	6.000	27.000	63.000	0.220
3	April 16 1991	-	0.000	0.040	5.780	44.900	2.000	12.000	64.000	0.010
4	April 30 1991	-	0.000	0.030	5.450	26.500	0.000	12.000	71.000	0.000
5	May 14 1991	-	0.000	0.060	5.770	22.400	5.000	12.000	71.000	0.020
61	May 27 1991	-	0.000	0.020	5.290	22.700	1.000	31.000	30.000	0.030
7	June 11 1991	-	0.000	0.050	5.420	24.500	0.000	36.000	76.000	0.020
8	June 25 1991	-	0.000	0.010	5.210	22.000	0.000	0.000	37.000	0.020
9	July 9 1991	-	0.000	0.030	4.960	24.500	0.000	12.000	66.000	0.010
10	July 22 1991	-	0.000	0.030	4.980	22.400	8.000	21.000	48.000	0.010
11	Aug 8 1991	-	0.000	0.020	4.930	20.400	13.000	32.000	50.000	0.090
12	Aug 19 1991	-	0.000	0.020	4.930	23.400	1.000	12.000	55.000	0.100
13	Sept 9 1991	-	0.000	0.020	4.880	25.000	5.000	18.000	48.000	0.090
14	Sept 23 1991	-	0.000	0.060	5.110	24.500	4.000	10.000	52.000	0.000
15	Oct 9 1991	-	0.000	0.040	5.120	26.100	7.000	10.000	35.000	0.040
16	Oct 22 1991	-	0.000	0.040	5.020	26.100	8.000	22.000	40.000	0.060
17	Nov 5 1991	-	0.000	0.020	5.120	24.200	17.000	26.000	66.000	0.090
18	Nov 19 1991	-	0.000	0.000	5.480	24.500	23.000	47.000	54.000	0.090
19	Dec 3 1991	-	0.000	0.040	5.270	20.000	22.000	24.000	57.000	0.170
20	Dec 18 1991	195	0.000	0.020	4.750	24.200	19.000	24.000	99.000	0.190
21	Jan 9 1992	187	0.000	0.040	5.140	23.500	10.000	21.000	77.000	0.280
22	Jan 21 1992	-	0.000	0.020	4.920	21.400	18.000	29.000	93.000	0.240
23	Feb 3 1992	-	0.000	0.000	4.730	24.000	6.000	34.000	87.000	0.250
24	Feb 18 1992	-	0.000	0.000	4.880	23.300	22.000	45.000	54.000	0.250
25	Mar 3 1992	-	0.000	0.000	5.000	20.000	3.000	12.000	82.000	0.180
26	Mar 18 1992	-	0.000	0.040	4.910	18.700	18.000	46.000	65.000	0.210
27	April 1 1992	178	0.000	0.010	4.580	21.800	7.000	21.000	47.000	0.160
28										
29	Winter mean	191	0.000	0.018	5.040	23.100	17.000		73.400	0.200
30	SD	6	0.000	0.017	0.260	1.600	6.000		18.000	0.070
31	Growth mean	178	0.000	0.032	5.180	23.200	4.700		56.000	0.080
32	SD		0.000	0.019	0.330	2.200	4.800		15.000	0.080
33	Annual mean	187	0.000	0.028	5.140	23.200	8.400		61.000	0.170
34	SD	9	0.000	0.020	0.320	2.000	7.700		17.000	0.090

	Ammonium N	Silicate Si	Chlorophyll a	Carotenoids	A480:A663	A430:A410	Secchi depth	Daphnia/Dphs
1	15.000	0.130	15.400	19.300	1.290	1.090	1.050	0.000
2	0.000	0.400	11.900	15.000	1.390	1.080	0.950	0.000
3	0.000	0.340	9.900	16.400	1.800	1.100	0.840	0.000
4	0.000	0.540	6.600	12.300	2.100	1.050	0.750	0.000
5	0.000	0.220	7.000	4.800	0.800	0.900	1.400	0.000
6	0.000	0.230	11.900	15.000	1.390	1.090	2.250	0.050
7	0.000	0.080	8.400	13.000	1.700	0.950	1.350	0.100
8	19.000	0.060	3.500	10.200	3.200	1.000	2.000	0.000
9	0.000	0.240	3.300	6.400	2.100	0.900	1.700	141.000
10	136.000	0.370	3.700	9.000	2.600	1.000	3.500	31.400
11	101.000	0.210	2.600	5.200	2.200	0.900	3.400	83.400
12	131.000	0.340	7.040	14.400	2.300	1.000	1.860	17.700
13	64.000	0.470	4.000	7.600	2.100	1.100	3.000	16.600
14	17.000	0.480	10.100	23.000	1.500	1.100	1.750	24.200
15	32.000	0.980	8.100	13.000	1.800	1.100	1.450	4.300
16	28.000	0.060	11.400	19.300	1.900	1.100	1.550	0.800
17	93.000	1.120	7.000	14.000	2.200	0.700	1.000	0.000
18	154.000	0.800	0.400	5.700	17.000	0.900	1.000	0.000
19	177.000	0.760	5.100	9.300	2.000	0.900	1.500	0.000
20	151.000	0.770	9.200	15.300	1.800	0.900		0.000
21	108.000	0.460	7.700	11.700	1.700	0.900	1.400	0.000
22	128.000	0.830	5.900	8.300	1.600	0.900		0.200
23	141.000	0.730	4.000	5.300	1.500	0.900	1.900	0.000
24	117.000	0.730	1.800	3.300	2.000	1.000		0.000
25	1.000	0.590	8.100	13.000	1.800	1.000	1.400	0.000
26	8.000	0.550	16.500	16.700	1.100	1.100	1.000	0.000
27	8.000	0.560	9.900	9.000	1.000	1.100	1.000	0.000
28								
29	134.000	0.780	5.100					0.025
30	27.000	0.180	3.000					0.070
31	30.000	0.360	8.400					16.800
32	45.000	0.230	4.000					36.200
33	60.000	0.480	7.400					11.800
34	63.000	0.290	4.000					31.100

Oakmere Phytoplankton 1991/2

	Organism	April 16 1991	April 30 1991	May 14 1991	May 27 1991	June 11 1991	June 25 1991	July 9 1992	July 22 1991	Aug 6 1991	Aug 19 1991	Sept 9 1991	Sept 23 1991	Oct 9 1991	Oct 22 1991	Nov 5 1991	Nov 19 1991	Dec 3 1991
1	Cyclotella	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Diatoma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	Gomphonema	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Navicula	-	-	-	-	-	-	-	-	15	-	-	-	-	-	7	-	-
5	Stephanodisc	-	-	182	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Surirella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Tabellaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	*																	
9	Ankist falc	-	-	-	-	-	-	-	-	-	-	45	-	831	1206	891	894	413
10	Botryoc braun	-	22	-	-	-	67	22	22	305	938	892	536	751	456	469	331	469
11	Coelastrum	-	-	-	-	-	-	-	7	-	-	-	-	214	-	13	-	-
12	Elakat gelat	-	-	-	882	3083	5428	3284	491	60	4825	4685	21043	-	-	-	-	11
13	Gloeocystis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	Scenedesmus	-	-	-	-	-	-	89	-	-	-	-	-	-	-	-	-	-
15	Schroederia	-	-	-	-	-	-	-	-	-	-	-	-	4021	5361	80	-	-
16	Green colony	-	-	-	1184	3954	12331	67	-	-	-	134	-	-	-	-	-	-
17	*																	
18	Trachelo sp	-	-	-	-	-	134	-	-	-	-	-	-	-	-	-	-	-
19	*																	
20	Cryptomonas	-	-	-	-	-	-	-	-	7	45	45	-	27	-	13	9	34
21	*																	
22	Gymnodinium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	*																	
24	Oscillatoria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25																		
26	Total diatoms	0	0	202	0	0	0	0	0	15	0	0	0	0	0	7	0	0
27	Total greens	0	22	0	2066	7037	17826	3462	520	365	5763	5756	21580	5817	7023	1453	1225	895
28	Total others	0	0	0	0	0	134	0	0	7	0	45	0	27	0	13	9	34
29	Total blue grns	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	TOTAL	0	22	202	2066	7037	17960	3462	520	387	5763	5801	21580	5844	7023	1473	1234	929
31																		
32	Diatoms %	0	0	100	0	0	0	0	0	3.9	0	0	0	0	0	0.5	0	0
33	Greens %	0	100	0	100	100	99.3	100	100	94.3	100	99.2	100	99.5	100	98.6	99.3	96.3
34	Others %	0	0	0	0	0	0.7	0	0	1.8	0	0.8	0	0.5	0	0.9	0.7	3.7
35	Blue grns %	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36																		
37		Diatoms	Greens	Others	Blue greens													
38	Winter mean%	1.04(1.4)	86.9(12.4)	11.8(11.3)	0.15(0.4)													
39	Growth mean%	6.1(24.2)	82.9(33)	5.06(10.8)	0													
40	Annual mean%	4.3(20)	84.2(27.8)	7.2(11.2)	0.05(0.24)													

	Dec 18 1991	Jan 9 1992	Jan 21 1992	Feb 3 1992	Feb 18 1992	Mar 3 1992	Mar 18 1992	April 1 1992
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	5	10	-	-	5	-	-	-
7	-	-	-	12	5	-	-	-
8								
9	412	278	-	-	10	345	-	-
10	694	397	328	266	248	153	380	45
11	-	-	-	-	-	-	-	-
12	5	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	89	-
15	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
17								
18	-	-	-	-	-	-	-	-
19								
20	124	72	90	47	137	139	179	22
21								
22		-	-	2	-	-	-	-
23								
24	-	-	-	-	5	-	-	-
25								
26	5	10	0	12	10	0	0	0
27	1111	675	328	266	258	498	469	45
28	124	72	90	49	137	139	179	22
29	0	0	0	0	5	0	0	0
30	1240	757	418	327	410	637	648	67
31								
32	0.4	1.3	0	3.7	2.4	0	0	0
33	89.6	89	78.5	81.3	62.9	78.2	72.4	67.2
34	10	9.5	21.5	15	33.4	21.8	27.6	32.8
35	0	0	0	0	1.2	0	0	0
36								
37								
38								
39								
40								


Oakmere
Microspora spp
Nl
Df
Df
Df
Extensive Lu bed
Df
Df
Df
Df
0 20 40 60 80
metres
N

but not lower it unless there is vigorous pumping of water to a watercourse that removes the water well away from the area. The local operation does not appear to do this but the situation should be further investigated.

(o) OSS MERE

(i) Morphometry and water budget

Oss mere is 9.5 ha in area and has a maximum depth of about 3m. It has no apparent surface inflows and is presumed to be fed entirely by ground water. No estimate of its retention time can yet be made.

(ii) Changes in land use

Potentially the catchment area of the mere lies within the parishes of Whitchurch, Marbury cum Quoisley, Dodcott cum Wilkesley and Wirswall. Changes in these parishes have been as follows:

	1931	1987
Cattle(head)	10390	15657
nutrient units	126758	191015
Pigs(head)	5694	6635
nutrient units	27331	31848
Sheep(head)	7314	4853
nutrient units	10971	7280
Poultry(head)	70441	117041
nutrient units	9862	16386
Total nutrient units	174922	246529
Permanent grass(ha)	7006	4297
Temporary grass(ha)	639	1953
Arable(ha)	702	1536
Woodland(ha)	6	49
Rough grazing(ha)	36	149
Total hectarage	8389	7984

There has thus been a marked increase in cattle keeping, a loss of permanent grassland to temporary grassland and arable and some loss of agricultural land overall.

(iii) Major ion chemistry and nutrient loads

Oss Mere has water of moderately high conductivity and alkalinity, high soluble reactive and total phosphorus concentrations and very low inorganic nitrogen concentrations. It appears that these reflect the nature of the surrounding drift for there are no obvious sources of nutrients other than this and catchments that have experienced similar agricultural changes elsewhere in the area have much lower phosphorus concentrations.

(iv) Phytoplankton and zooplankton

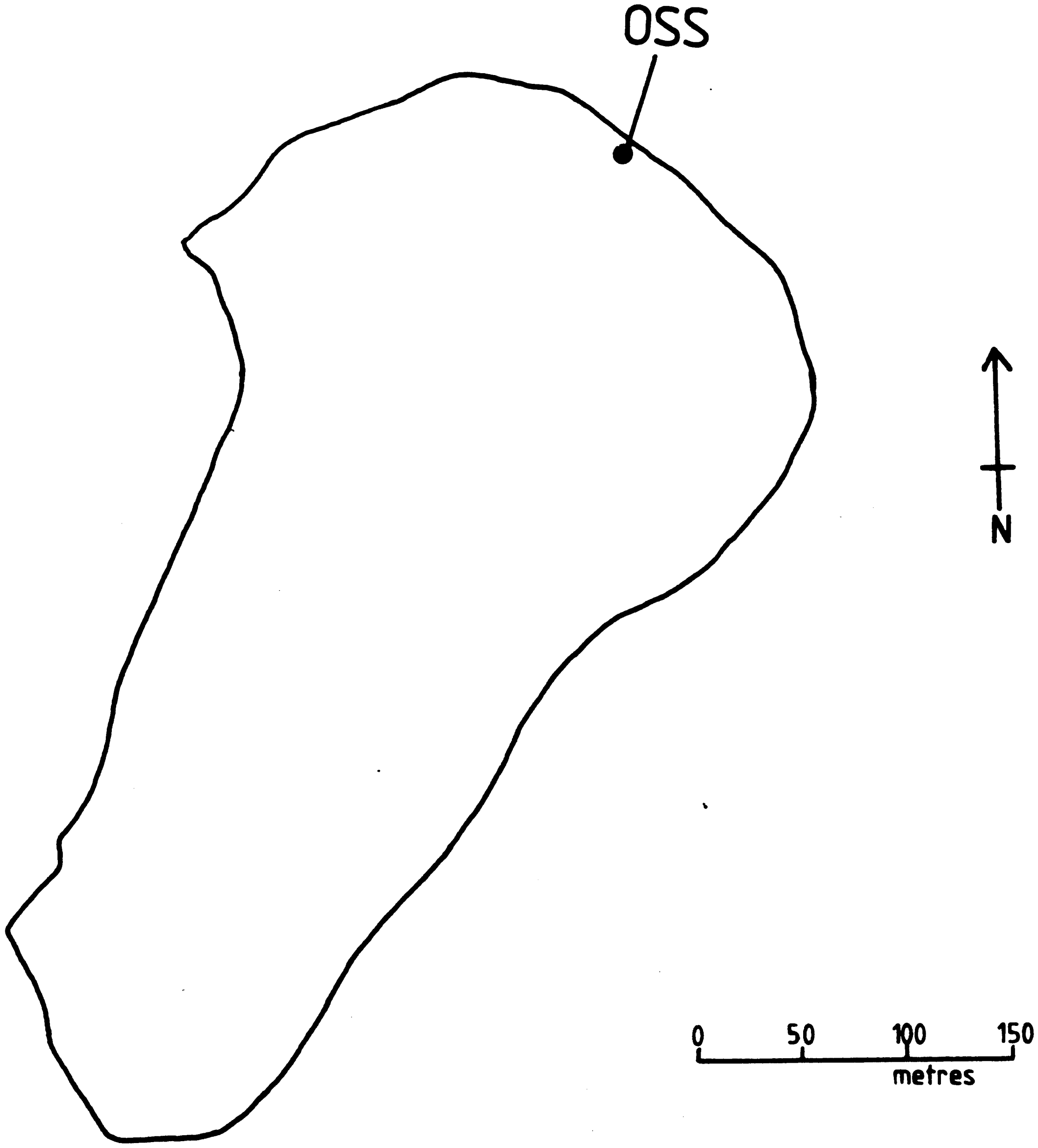
Oss Mere had moderate phytoplankton crops (growing season mean 31.7 ug/l chlorophyll a) which had a relatively strong representation of blue-green algae, though green algae and diatoms were more numerous. The populations of ***Daphnia*** were relatively high, reaching 305/l on one occasion so it is surprising that the chlorophyll a concentrations were as high as they were. Partly it was because chlorophyll values were high in winter when ***Daphnia*** was scarce and it is also possible that some of the summer values were biased high by blue-green algal aggregation towards the water surface. The bloom forming ***Microcystis aeruginosa*** was a common member of the plankton.

(v) Aquatic plants

The aquatic plant community of Oss Mere was sparse in species and low in biomass. No species was more plentiful than 'rare'. The shape of the basin and the open, exposed situation may preclude against colonisation. The trophic score has varied from 7.9 in 1979 and 1991 to 8.6 in 1987. The DAFOR score was 5 in 1979, 1 in 1987 and is 2 at present. It is likely that this fluctuation arises from differences between observers rather than swings in biomass.

(vi) Overall assessment

Though there are some peculiar features that may have been too simply rationalised (the chlorophyll/***Daphnia*** paradox and the scarcity of aquatic plants) it appears on balance that Oss Mere is in a reasonably natural state and is not being significantly affected by inputs of nutrients from anthropogenic sources. There are thus no measures that need be taken to manage it at present.


OSS
N
0
50
100
150
metres

Oss Mere OSS

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	478	0.75	3.25	8.72	40.8	377.0	448.0	150.0	598
2	Aug 28 1991	467	1.10	3.30	9.33	42.6	201.0	257.0	180.0	437
3	Sept 18 1991	484			9.30	46.8	312.0	329.0	136.0	465
4	Oct 23 1991	521	0.35	3.50	8.15	41.2	513.0	530.0	0.0	530
5	Nov 12 1991	496	0.25	2.15	8.16	38.4	300.0	300.0	115.9	416
6	Dec 4 1991	500	0.30	3.30	8.03	40.0	143.0	143.0	84.0	226
7	Jan 14 1992	490	0.25	3.05	8.64	40.0	56.0	73.0	68.0	141
8	Feb 5 1992	497	0.35	2.50	8.39	40.0	28.0	57.0	87.0	144
9	Mar 4 1992	497	0.20	2.80	8.23	39.2	7.1	35.5	80.0	115
10	Mar 25 1992	490	0.35	2.70	8.38	40.0	3.0	28.0	139.0	167
11	April 15 1992	491	0.45	3.05	8.08	37.3	24.0	64.0	47.0	111
12	May 13 1992	492	0.25	3.25	8.31	40.0	23.0	75.0	14.0	89
13	June 3 1992	497	0.15	3.35	8.19	39.2	281.0	344.0	12.0	356
14	June 22 1992	479	0.60		9.09	39.2	253.0	285.0	60.0	344
15										
16	Winter mean	496	0.29	2.75	8.31	39.6	132.0			232
17	SD	4	0.05	0.52	0.27	0.8	122.0			129
18	Growth mean	490	0.47	3.15	8.58	40.6	199.0			321
19	SD	15	0.31	0.28	0.50	2.6	179.0			189
20	Annual mean	491	0.41	3.02	8.50	40.3	180.0			296
21	SD	13	0.27	0.40	0.45	2.2	164.0			174

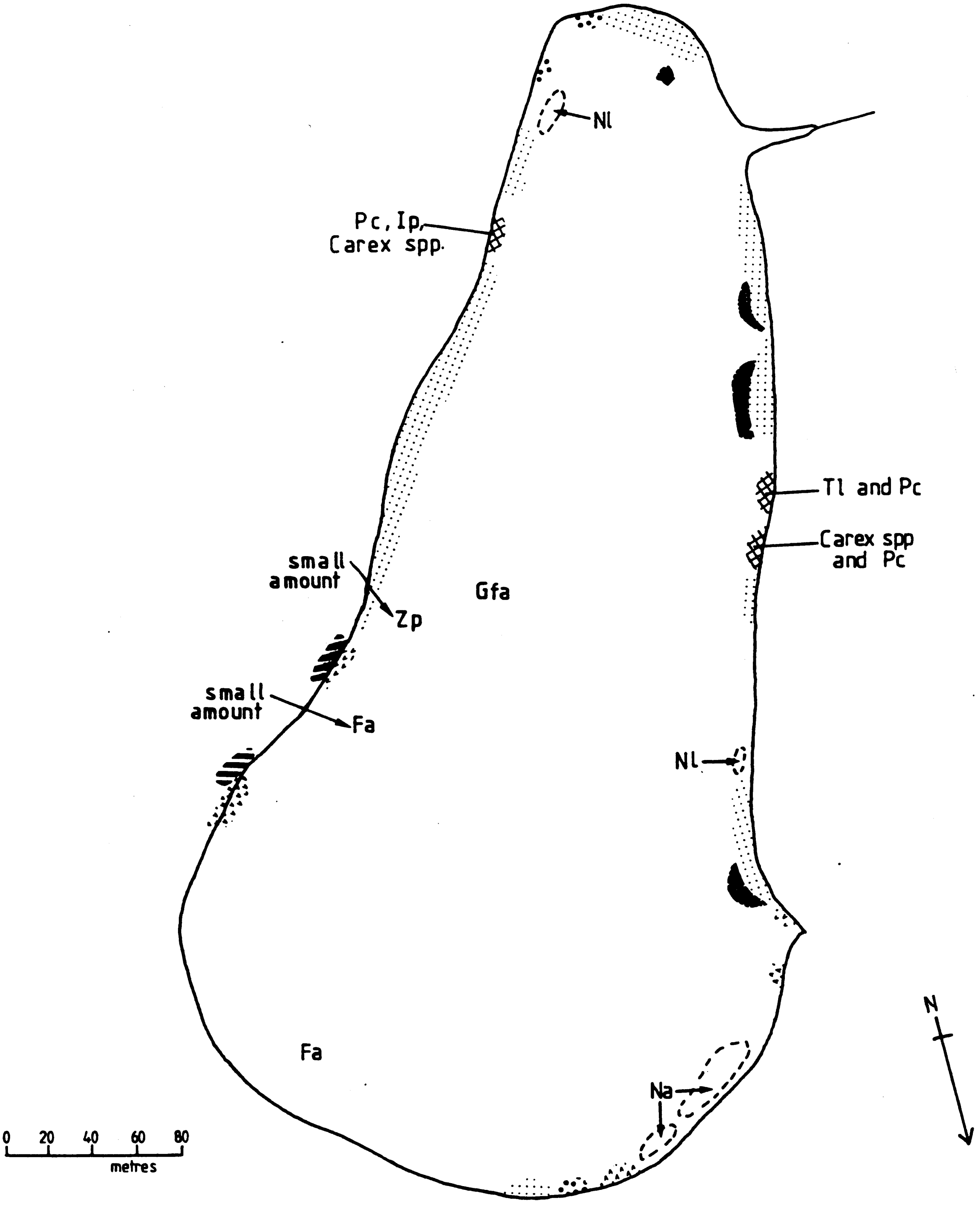
	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoid	480:663	430:410	Secchi	Total Daphnia
1	0.03	36	2.54	36.7	71.3	1.96	1.27	0.55	0.53
2	0.00	12	2.26	84.8	152.0	1.81	1.28	0.45	32.00
3	0.00	40	4.39	69.0	118.0	1.74	1.33	0.50	6.75
4	0.10	388		1.7	6.0	3.60	0.97	>	1.38
5	0.08	1	5.07	39.7	46.0	1.17	1.20	>	0.18
6	0.05	168	3.20	27.9	31.3	1.24	1.20	>	0.18
7	0.14	64	2.60	71.5	80.7	1.24	1.16	0.85	2.52
8	0.03	36	1.43	39.6	53.7	1.49	1.13	0.85	2.28
9	0.13	34	1.52	29.3	30.0	1.13	1.13	0.75	104.30
10	0.25	131	0.89	34.5	36.7	1.17	1.11	0.6	1.02
11	0.34	150	1.01	5.9	45.0	8.44	1.10	>	305.00
12	0.00	0	1.73	27.5	28.0	1.12	1.24	>	91.30
13	0.08	781	2.66	7.3	12.7	1.90	0.64	>	23.00
14	0.12	0	3.04	19.8	27.7	1.54	1.24	1.2	15.20
15									
16	0.08	67	3.08	44.7					1.29
17	0.05	72	1.52	19.0					1.29
18	0.11	157	2.23	31.7					58.00
19	0.11	249	1.10	27.0					94.50
20	0.10	132	2.49	35.4					41.80
21	0.10	214	1.24	25.0					83.00

Oss Mere Phytopl. 1991/92

	Organism	Aug 7 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 12 1991	Dec 4 1991	Jan 14 1992	Feb 5 1992	March 4 1992	Mar 25 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
1	Amphora oval	-	-	-	-	-	-	-	-	-	-	13	-	-	-
2	Aster form	-	-	-	-	-	-	-	-	-	-	13	-	-	-
3	Cocconeis	-	121	-	-	-	-	-	-	-	-	-	-	-	-
4	Cyclotella	-	-	134	45	2251	2553	-	32800	5300	-	-	-	-	-
5	Cyclo menegh	-	-	-	-	-	-	-	-	-	6635	-	-	-	-
6	Diatoms	121	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Fragilaria	-	-	-	-	40	-	-	2200	-	-	-	-	-	-
8	Frag constr	-	-	67	-	-	20	-	-	100	-	-	-	-	-
9	Melosira ital	-	-	-	-	-	-	-	-	-	-	13	-	-	27
10	Melosira sp	-	322	-	-	-	-	-	-	-	101	-	-	-	-
11	Melosira gran	-	-	-	-	-	-	13	-	-	-	-	-	-	-
12	Navicula sp	40	-	-	22	41	40	27	-	-	-	27	-	-	27
13	Nitszchia	-	241	-	-	-	-	-	-	-	201	-	-	-	-
14	Pinnularia	-	-	67	-	-	-	-	-	-	-	-	-	-	-
15	Stephanodisc	40	-	-	-	-	-	-	-	-	-	-	-	-	-
16	Synedra	-	-	-	-	-	20	-	-	300	603	-	-	-	13
17	Nitzsch sig	-	-	-	-	-	-	-	-	-	-	-	-	13	-
18	Gompho vent	-	-	-	-	-	-	-	-	-	-	-	-	13	-
19	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	Ankist falc	-	40	-	-	-	121	-	4400	-	-	27	-	-	-
22	Ank conv	-	-	-	-	20	-	-	-	-	402	-	-	-	-
23	Ank sp	-	-	-	-	-	-	-	-	-	101	-	-	-	-
24	Chlorella vulg	-	-	-	-	-	20	-	-	-	20	107	-	27	-
25	Chlamydo sp	-	724	-	89	1628	402	13	6400	4600	1206	121	-	27	134
26	Chlamydo ep	322	-	-	-	-	-	-	-	-	-	-	101	-	-
27	Chlamyd sphag	-	-	-	-	422	-	-	-	-	-	-	9752	-	-
28	Clost cynth	80	-	-	-	-	-	-	-	-	-	-	-	-	-
29	Clost sp	-	40	-	-	-	-	-	-	-	-	-	-	-	-
30	Closteriopsis	-	-	-	-	-	-	-	-	-	-	-	101	-	-
31	Coelast sphaer	80	-	-	-	-	-	-	-	-	-	-	-	13	27
32	Coelastrum sp	-	-	-	-	-	20	-	-	-	-	-	-	-	-
33	Kirchner sp	-	-	-	-	20	-	-	-	-	-	-	-	-	-
34	Lagerheim qua	-	-	-	-	-	-	-	3200	-	201	-	-	-	-
35	Micract pus	-	-	-	-	-	60	-	1200	-	-	-	-	-	-
36	Oocystis pus	161	-	-	-	-	-	-	-	-	-	40	-	-	-
37	Oocystis cras	-	-	-	-	-	-	-	-	-	-	13	603	13	108
38	Ped dupl	-	40	-	-	-	-	-	-	-	-	-	-	-	228
39	Ped bory	-	201	-	45	60	-	-	200	100	-	67	-	174	241
40	Quadrig chodat	-	-	-	-	-	-	-	-	-	-	13	-	-	-
41	Pediast gland	-	40	-	-	-	-	-	-	-	-	-	-	-	-
42	Quadrig lac	-	-	-	-	-	-	13	-	-	-	13	-	-	-
43	Scened dimorp	-	40	-	-	-	-	-	-	-	-	-	-	-	-
44	Scened acum	-	-	-	-	-	-	-	-	100	-	-	-	-	-
45	Scened serr	-	40	-	-	-	-	-	-	-	-	-	-	-	-
46	Scened arc pla	-	121	-	-	-	-	-	-	-	-	-	-	-	-
47	Scened bijug	362	-	-	-	-	20	-	600	600	101	-	-	-	-
48	Scened quad	2050	1166	134	-	201	221	-	1000	300	201	134	101	13	26
49	Scened quad lo	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50	Schroed set	-	161	-	-	-	-	-	-	-	101	13	201	13	-
51	Schroed jud	201	- -	-	313	-	-	13	-	-	-	-	101	-	-
52	Selenast west	-	16446	-	-	-	-	-	-	-	101	-	-	-	-
53	Selenast min	-	-	-	-	-	-	-	200	-	-	-	-	-	-
54	Staurast sp	40	40	-	-	-	-	-	-	-	-	-	-	-	-
55	Sphaerocystis	-	-	-	-	-	-	-	-	-	-	-	101	-	-
56	Tetraed min	121	161	-	-	20	- -	-	-	-	-	-	-	-	-
57	Tetraed sp	-	-	-	-	-	20	-	-	-	-	-	-	-	-
58	Ulothrix	2855	-	-	-	-	-	-	-	-	-	-	-	-	-
59	Tetrast staur	-	-	-	-	-	-	-	200	-	-	-	-	-	-
60	Sphaeroc schr	-	-	-	-	-	-	-	-	-	-	-	-	-	791
61	*	-	-	-	-	-	- -	-	-	-	-	-	-	-	-
62	*	-	-	-	-	-	- -	-	-	-	-	-	-	-	-
63	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
64	*	-	-	-	-	-	-	-	-	-	-	- -	-	-	-
65	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66	Euglena grac	-	-	-	-	-	-	-	-	-	-	-	-	-	13
67	Euglena sang	-	-	-	-	-	-	-	200	-	-	228	-	-	-
68	Trachelomonas	-	40	67	-	-	40	-	-	-	-	-	-	-	-
69	Eugl min	-	-	-	112	-	-	-	-	-	-	-	-	-	-
70	Eugl sp	-	-	-	-	181	-	13	-	-	-	-	-	-	-
71	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
72	*	-	-	-	-	-	- -	-	-	-	-	-	-	-	-
73	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-

.	Organism	Aug 7 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 12 1991	Dec 4 1991	Jan 14 1992	Feb 5 1992	March 4 1992	Mar 25 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
74	Crypto acuta	-	-	-	-	-	-	27	-	-	-	978	-	-	13
75	Crypto refl	-	-	-	-	-	141	-	-	100	-	-	-	-	-
76	Crypto ovata	-	40	-	-	905	161	40	-	-	-	67	1011	-	201
77	Crypto erosa	-	-	-	-	-	-	-	-	-	-	-	-	-	268
78	Rhodo min	121	-	-	178	20	20	201	-	-	-	161	-	871	844
79	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
81	Mallomonas sp	-	-	-	-	80	-	-	-	-	-	-	-	-	-
82	Ochromonas sp	-	-	-	-	-	-	-	-	-	905	-	-	-	-
83	Uroglena sp	-	-	-	-	-	-	-	-	-	-	94	-	-	-
84	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
85	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
86	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
87	Peredinium	-	161	-	-	-	-	-	-	-	-	-	-	-	-
88	Glenodinium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
89	Synechoc aer	-	-	-	-	101	-	-	-	-	-	-	-	-	13
90	Aphanizo sp	-	-	-	-	-	-	-	-	-	-	-	-	-	94
91	Anabaena sp	282	322	-	-	-	-	-	-	-	-	-	-	134	-
92	Anabaena circ	-	-	-	-	-	-	-	-	-	-	27	-	-	-
93	Aphanoth sp	-	-	-	-	-	-	-	-	-	704	-	-	-	-
94	Aphanocap del	121	-	-	-	-	-	-	-	-	-	-	-	-	-
95	Aphanocap elac	4101	-	-	22	-	-	-	-	-	-	-	-	-	-
96	Aphanocap pul	161	-	-	-	-	-	-	-	-	-	-	-	-	80
97	Aphanocap sp	-	-	-	-	-	-	-	-	-	-	13	-	13	-
98	Coeloaph sp	80	-	-	-	-	-	-	-	-	-	-	-	-	-
99	Dact fasc	-	282	-	-	-	-	-	-	-	-	-	-	-	-
100	Dact raph	-	-	-	-	40	-	-	-	700	14277	-	-	-	-
101	Gloeocyst maj	40	-	-	-	-	-	-	-	-	-	-	-	-	-
102	Gloeocaps rup	-	161	-	-	-	-	-	-	-	-	-	-	-	-
103	Merismop sp	-	-	-	-	-	-	-	1600	-	-	-	-	-	-
104	Microcyst aer	3096	684	4758	-	121	422	-	-	-	-	-	-	-	-
105	Microcyst sp	-	-	-	-	-	-	-	-	500	-	-	-	13	-
106	Nostoc sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-
107	Oscillat sp	201	-	-	-	-	-	-	-	-	-	-	-	-	-
108	Spirulina sp	40	-	-	-	-	-	-	-	-	-	-	-	-	-
109															
110	Total diatoms	201	684	268	67	2332	2633	40	35000	5700	7540	66	0	26	67
111	Total greens	6272	17974	134	447	2371	884	39	16200	5700	2434	538	11061	280	1556
112	Total others	121	241	67	290	1186	362	281	200	100	905	1528	1011	871	1226
113	Total blue grns	8122	1449	4758	22	161	422	0	1600	1200	14981	40	0	160	187
114	TOTAL	14716	20348	5227	826	6050	4301	360	53000	12700	25860	2172	12072	1337	3036
115															
116	Diatoms %	1.4	3.4	5.1	8.1	38.5	61.2	11.1	66.0	44.9	29.2	3.0	0	1.9	2.2
117	Greens %	42.6	88.3	2.6	54.1	39.2	20.6	10.8	30.6	44.9	9.4	24.8	91.6	20.9	51.3
118	Others %	0.8	1.18	1.3	35.1	19.6	8.4	78.1	0.38	0.79	3.5	70.3	8.4	65.1	40.4
119	Blue grns %	55.2	7.1	91	2.7	2.7	9.8	0	3.0	9.5	57.9	1.8	0	12.0	6.2
120															
121		Diatoms	Greens	Others	Blue greens										
122	Winter mean %	44.2(25)	25.3(12)	26.6(35.2)	3.9(4.2)										
123	Growth mean%	9.9(14.9)	43.1(300	22.7(27.9)	24.3(32)										
124	Annual mean %	19.7(23.6)	38(27)	23.8(28.8)	18.5(28.2)										

Oss Mere



Nl
Pc, Ip,
Carex spp.
Tl and Pc
Carex spp
and Pc
small
amount
Zp
Gfa
small
amount
Fa
Nl
Fa
Na
0 20 40 60 80
metres
N

(p) PETTY POOL

(i) Morphometry and water budget

Petty Pool is small (11.7 ha) and shallow (3.1 ha). It receives water from a main inflow stream (PPI) draining agricultural land to its west and a smaller inflow (PPWI) draining woodland and a golf course to the east. The distinct outflow to the south carried 1.13 million cubic metres of water in the year in question but the combined inflows could account for only about half of this, 0.5 million cubic metres. The errors in spot gauging can be considerable and the data may in fact reflect a reasonable balance. However there is clearly a possibility that ground water may also contribute significantly. The flushing rate was 6.2,9.2 and 4.5 per year on annual, winter and growth season bases, with corresponding retention times of 8.4, 5.6 and 11.5 weeks respectively. These calculations are based on the outflow volumes.

(ii) Changes in land use

The catchment of the pool is quite large and lies in the parishes of Cuddington, Weaverham, Hartford and Davenham for which the land use changes have been as follows:

	1931	1987
Cattle(head)	1548	2234
nutrient units	18731	27031
Pigs(head)	198	333
nutrient units	950	1598
Sheep(head)	344	859
nutrient units	516	1289
Poultry(head)	9993	321
nutrient units	1399	45
Total nutrient units	21596	29963
Permanent grass(ha)	1262	742
Temporary grass(ha)	384	353
Arable(ha)	468	647
Woodland(ha)	13	45
Rough grazing(ha)	20	34

Total hectarage	2147	1821

There has thus been the common pattern in the area of some increase in stockkeeping, particularly of cattle, a loss of permanent grass to to arable and some loss of land to non agricultural uses.

(iii) Major ion chemistry and nutrient loads

The conductivity of Petty Pool falls ,at 465us/cm, between those of the two inflow streams (500 and 306 uS/cm). The alkalinity, however is greater (2.35 mequiv/l) than either (0.83 and 1.68 mequiv/l). This suggests that the balance of the water budget is made up of ground water, as ground water ,through its longer contact with soil, tends to have high major ion concentrations. A similar pattern is found with chloride concentrations.

The nutrient concentrations in the main inflow, which is perhaps the closest in major ion composition to the ground water source, are very high and likely to be so because of farm contamination. The ground water nutrient concentrations cannot thus easily be predicted. Soluble reactive phosphorus concentrations in the main inflow averaged 737 ug/l, the total phosphorus was over 1mg/l, and the ammonium concentrations were extremely high as were nitrate levels. This combination undoubtedly points to a major excretal source of N and P on the stream. Total loads of 4616kg N and 405kg P were calculated for this stream. In contrast, the woodland inflow draining the golf course had rather low phosphorus concentrations and modest nitrate concentrations reflecting a degree of fertilisation but not a serious problem. Much of the nitrogen was denitrified in the littoral zone of the pool for nitrogen in summer fell to very low values whilst phosphorus was high.

The export of phosphorus from the outflow was 304 kg/yr which can easily be accounted for by the inputs from the streams. An estimate cannot thus be made of the ground water phosphorus concentration without an estimate of how much phosphorus is retained within the sediment at the bottom of the lake.

(iv) Phytoplankton and zooplankton

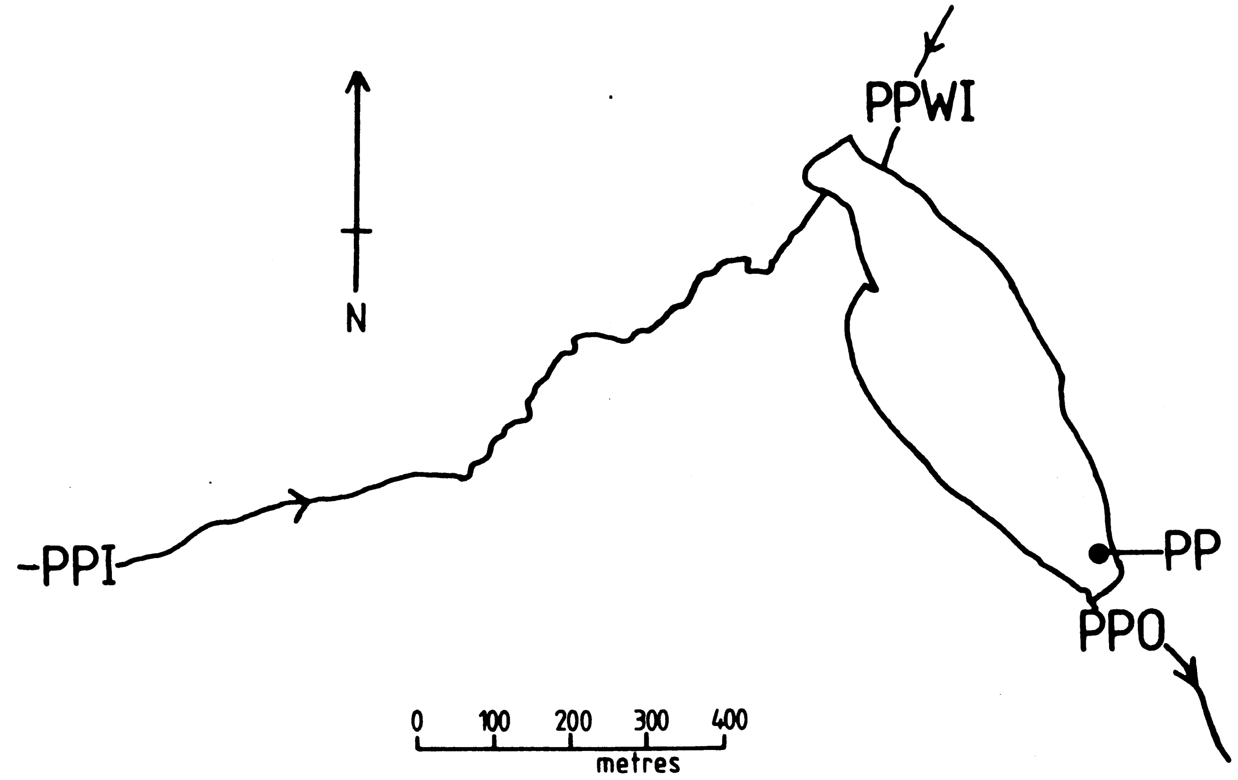
Phytoplankton crops in the pool were relatively high with autumn peaks of up to 157 ug/l chlorophyll a and an annual mean of 60.5 ug/l. Green algae and diatoms were prominent but blue green algae were not major components of the community. The major chlorophyll peaks were derived from autumnal diatom populations. Apart from an early summer population, ***Daphnia*** was scarce and grazing pressure is unlikely to be a major determinant of the algal crops.

(v) Aquatic plants

Submerged plants were very scarce in Petty Pool with only rare occurrence of ***Elodea canadensis***.. White water lilies and the floating ***Polygonum amphibium*** were locally abundant but the overall situation seems to reflect the poor light climate resultant from the large algal crops and relatively turbid water at most times of year.

(vi) Overall assessment

Although the pool may recieve substantial quantities of ground water of probably high quality, it seems very likely that the highly polluted main surface inflow is reducing the potentiality of the pool to support aquatic plants and hence its conservation value. Investigation and eventual removal of the farm nutrient sources to this stream would be highly desirable and should give some improvement. Alternatively, since the phytoplankton is a highly edible one , biomanipulation by removal of zooplanktivorous fish would also clarify the water on at least a short term basis. It would not be a permanent solution,however, because the phosphorus concentrations at present are well above the values at which a stable aquatic plant community can be expected to be maintained (50-150 ug/l total P).


N
PPWI
PPI
PP
PPO
0
100
200
300
400
metres

Petty Pool Woodland Infl PPWI

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	Jul 31 1991	240	0	1.44	7.09	24.5	52	65	21	86	1.53	279	3.26	0.0030	3.300		0.160	
2	Aug 21 1991	286	0	0.65	7.26	30.0	44	72	9	81	2.08	157	4.53	0.0001	0.140		0.005	
3	Sept 11 1991	250	0	0.55	7.82	23.4	35			48	1.78	70	4.60	0.0015	1.680		0.040	
4	Oct 16 1991	*	*	*	*	*	*	*	*	*	*	*	*	0.0000	0.000		0.000	
5	Nov 6 1991	240	0	0.9	6.73	28.0	19	19	54	73	0.68	74	6.55	0.0040	1.820		0.180	
6	Nov 27 1991	300	0	0.9	6.84	33.3	23	30	20	50	1.33	364	4.87	0.0050	5.120		0.150	
7	Jan 8 1992	379	0	0.8	6.75	56.0	51	62	9	71	2.14	185	6.68	0.0020	2.810		0.090	
8	Jan 29 1992	612	0	0.9	7.68	31.5	38	38	0	38	1.79	197	5.35	0.0007	0.840		0.016	
9	Feb 26 1992	359	-	-	6.88	-	35	35	37	72	1.49	176	5.73	0.0020	2.020		0.090	
10	Mar 17 1992	284	0	0.8	6.94	34.9	42	49	9	58	1.49	134	6.26	0.0020	1.960		0.070	
11	April 8 1992	267	0	0.9	6.71	31.0	33	51	0	51	2.35	92	5.48	0.0020	2.950		0.060	
12	May 6 1992	280	0	0.95	7.19	32.0	30	30	18	48	1.6	68	5.11	0.0020	2.020		0.060	
13	May 27 1992	249	0	0.95	7.04	28.0	37	37	19	56	2.17	106	4.72	0.0020	2.750		0.070	
14	June 17 1992	226	0	0.9	7.39	28.3	34	34	0	34	1.74	67	5.11	0.0008	0.870	105.000	0.017	3.7[illegible]
15																		
16	Winter mean	378	0	0.88	6.98	37.2	33			61	1.49	199	5.84	0.0030				
17	SD	142	0	0.05	0.4	13	13			16	0.55	104	0.78	0.0020				
18	Growth mean	260	0	0.81	7.18	29	38			58	1.84	122	4.88	0.0015				
19	SD	22	0	0.16	0.33	4	7			18	0.32	72	0.86	0.0010				
20	Annual mean	306	0	0.83	7.1	31.7	36			59	1.71	152	5.25	0.0020				
21	SD	103	0	0.13	0.36	8.3	10			16	0.44	90	0.93	0.0010				

Petty Pool Inflow PPI

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	Jul 31 1991	422	0.00	1.44	7.19	34.7	499	567	236	803	2.65	4318	5.03	0.0130	54.800		6.300	
2	Aug 211991	477	0.00	1.70	7.35	44.7	480	626	155	781	4.90	6023	4.40	0.0140	92.500		6.600	
3	Sept 11 1991	567	0.00	2.60	7.64	43.0	85			1270	3.67	10026	4.39	0.0073	60.500		5.600	
4	Oct 16 1991	429	0.00	1.95	7.22	22.6	669	976	56	1032	5.22	3649	4.61	0.0090	48.300		5.600	
5	Nov 6 1991	519	0.00	1.60	7.02	52.0	754	898	0	898	4.89	4388	5.25	0.0140	78.600		7.600	
6	Nov 27 1991	443	0.05	1.45	7.06	23.5	504	504	294	798	1.94	4273	4.13	0.0090	33.800		4.300	
7	Jan 8 1992	511	0.00	1.15	7.01	52.0	664	673	216	889	3.46	3449	5.40	0.0160	66.900		8.600	
8	Jan 29 1992	583	0.00	1.20	7.72	74.0	409	409	286	695	12.00	3470	5.09	0.0130	122.000		5.460	
9	Feb 26 1992	532	-	-	7.32	-	823	973	289	1262	9.12	5560	4.88	0.0130	115.000		9.920	
10	Mar 17 1992	480	0	1.2	7.14	44.5	586	637	0	637	11.20	472	5.31	0.0200	141.200		7.700	
11	April 8 1992	470	0	1.3	6.91	47.0	879	879	108	988	11.96	3054	4.85	0.0200	182.000		12.000	
12	May 6 1992	430	0	1.25	7.02	40.0	261	969	0	969	8.66	339	3.92	0.0400	218.000		23.400	
13	May 27 1992	579	0	2.55	7.32	48.0	1744	1854	208	2062	9.51	984	4.70	0.0040	25.400		5.000	
14	June 17 1992	556	0	2.5	7.45	43.5	1965	2314	468	2782	7.10	5331	4.84	0.0005	3.800	4616.000	0.840	405.0
15																		
16	Winter mean	518	0.01	1.35	7.22	50.4	631			908	6.28	4228	4.95	0.0130				
17	SD	50	0.02	0.21	0.30	21	172			214	4.20	864	0.50	0.0025				
18	Growth mean	490	0	1.83	7.25	40.9	796			1258	7.21	3800	4.67	0.0142				
19	SD	62	0	0.59	0.22	7.9	643			707	3.30	3120	0.41	0.0120				
20	Annual mean	500	0.004	1.68	7.24	43.8	737			1133	6.88	3953	4.77	0.0140				
21	SD	58	0.01	0.54	0.24	13	520			593	3.50	2503	0.44	0.0090				

Petty Pool Outflow

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge
1	Jul 31 1991	488	0.00	2.36	7.60	55.1	416.0	423	69	492	0.17	267	3.63	0.01
2	Aug 21 1991	482	0.00	2.60	7.89	55.3	347.0	415	116	531	0.00	229	4.37	0.019
3	Sept 11 1991	490	0.00	2.80	7.87	46.9	54.4			735	0.00	77	1.91	0.017
4	Oct 16 1991	465	0.20	2.90	7.87	18.9	241.0	301	0	301	0.22	195	0.57	0.02
5	Nov 6 1991	448	0.10	2.20	7.97	42.0	142.0	181	115	296	0.36	123	1.27	0.051
6	Nov 27 1991	429	0.20	2.50	8.97	47.1	16.0	46	111	158	0.46	87	0.41	0.051
7	Jan 8 1992	469	0.00	2.00	7.82	52.0	63.0	87	43	129	1.02	169	2.18	0.07
8	Jan 29 1992	472	0.05	2.25	8.15	48.2	29.0	29	0	29	1.42	69	2.29	0.027
9	Feb 26 1992	492	-	-	8.53	-	16.0	21	94	115	1.28	173	2.47	0.065
10	Mar 17 1992	478	0.25	2.05	8.75	57.2	15.0	42	74	116	1.30	173	1.90	0.047
11	April 8 1992	462	0.3	2.1	8.44	50.5	13.0	21	100	121	1.56	132	1.89	0.04
12	May 6 1992	446	0.3	2.25	9.08	50.0	2.3	99	37	136	0.44	49	0.32	0.021
13	May 27 1992	461	0.2	2.4	8.65	48.0	169.0	211	42	253	0.34	197	1.52	0.043
14	June 17 1992	432	0.8	2.65	9.53	46.5	284.0	366	0	366	0.07	66	1.14	0.02
15														
16	Winter mean	462	0.09	2.24	8.29	47.3	53.0			145	0.91	124	1.72	0.053
17	SD	24	0.09	0.21	0.46	4	53.0			97	0.48	47	0.87	0.017
18	Growth mean	467	0.23	2.46	8.41	51.2	171.0			339	0.46	154	1.92	0.026
19	SD	20	0.25	0.3	0.65	4	158.0			214	0.58	77	1.33	0.013
20	Annual mean	465	0.19	2.40	8.37	49.9	129.0			270	0.62	143	1.85	0.036
21	SD	21	0.22	0.29	0.57	4.4	140.0			201	0.57	67	1.15	0.02

Petty Pool PP

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.03	145	3.26	31.9	33.0	1.14	1.12	>	97.200
2	0.00	89	4.84	16.2	22.0	1.38	1.05	>	0.110
3	0.02	69	1.97	113.0	115.0	1.03	1.19	>	0.470
4	0.16	104	0.73	78.1	89.7	1.16	1.30	>	0.000
5	0.40	24	1.41	106.0	123.0	1.18	1.28	>	0.000
6	0.38	85	0.50	157.0	173.0	1.22	1.28	>	0.000
7	1.21	114	1.94	34.1	46.7	1.51	1.13	>	0.000
8	1.54	48	2.44	5.5	9.0	1.80	1.05	>	0.000
9	1.24	118	2.50	69.7	74.0	1.17	1.20	>	0.000
10	1.17	16	1.70	68.6	75.3	1.21	1.22	>	0.060
11	1.32	0	1.90	10.3	61.7	6.61	1.16	>	10.490
12	0.36	54	0.18	61.6	69.7	1.24	1.16	0.6	0.640
13	0.32	30	1.37	10.6	13.7	1.41	1.08	>	0.560
14	0.00	45	1.10	84.3	96.7	1.70	1.22	>	1.150
15									
16	0.95	78	1.76	74.5					0.000
17	0.53	41	0.83	60.0					0.000
18	0.38	61	1.89	52.7					12.200
19	0.51	46	1.40	37.0					32.000
20	0.58	67	1.85	60.5					7.900
21	0.58	43	1.20	45.0					25.800

Petty Pool PP

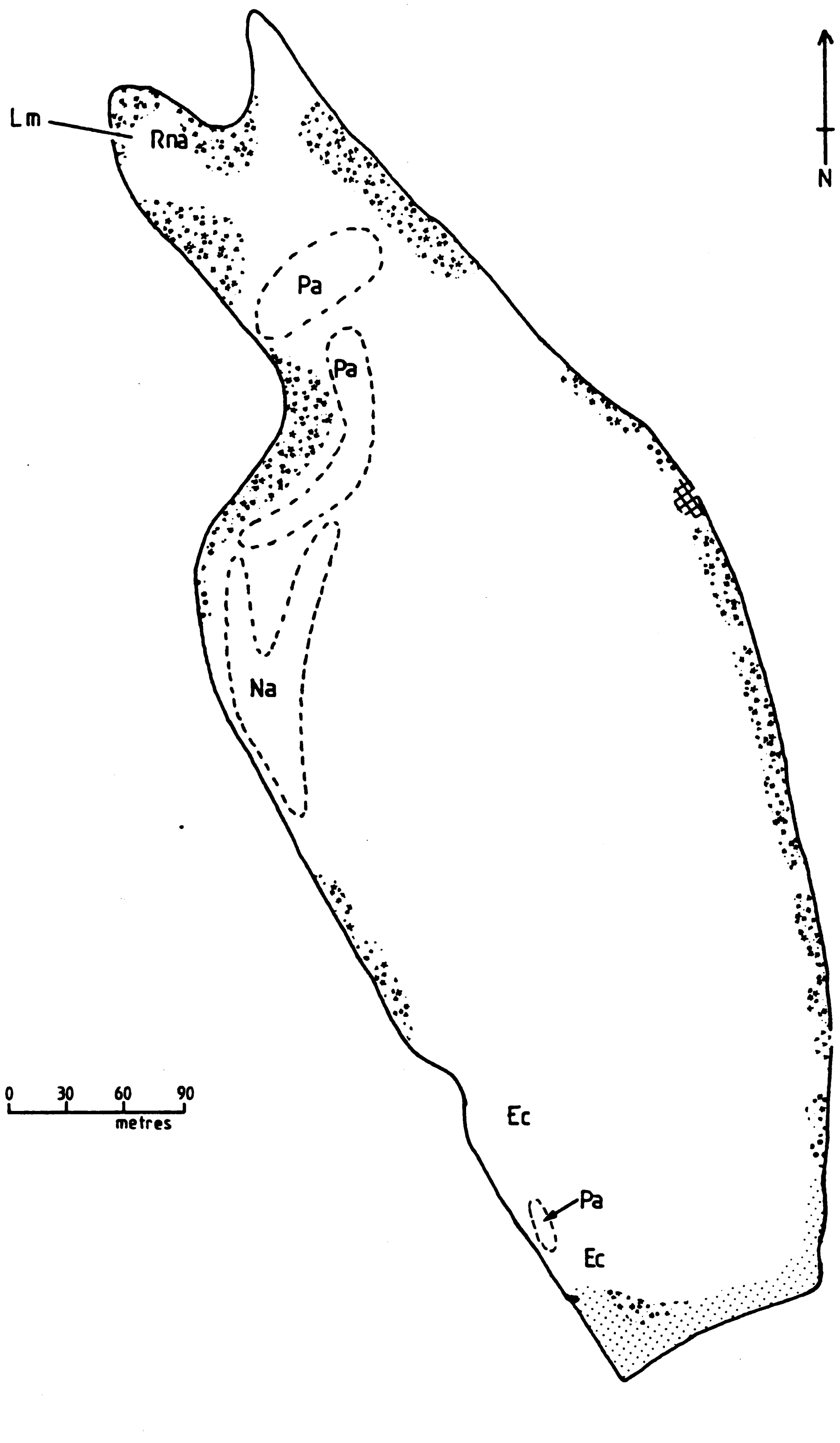
	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 31 1991	480	0.0	2.44	7.56	49.0	363	414	63	477
2	Aug 21 1991	483	0.0	2.60	7.64	46.8	340	412	34	446
3	Sept 11 1991	484	0.0	2.70	8.34	46.9	58			739
4	Oct 16 1991	479	0.2	2.50	8.15	22.6	208	320	0	320
5	Nov 6 1991	447	0.1	2.40	8.08	58.0	134	179	0	179
6	Nov 27 1991	431	0.2	2.50	9.03	49.0	20	46	132	178
7	Jan 8 1992	471	0.0	1.95	7.74	54.0	57	72	44	116
8	Jan 29 1992	463	0.0	2.10	8.16	46.3	35	46	0	46
9	Feb 26 1992	491	-	-	8.52	-	4	14	71	85
10	Mar 17 1992	485	0.3	2.1	8.76	54.0	5	25	56	81
11	April 8 1992	464	0.4	2.1	8.43	54.4	2	23	71	93
12	May 6 1992	445	0.25	2.2	9.15	52.0	0	9	98	108
13	May 27 1992	455	0.25	2.4	8.89	48.0	111	144	60	203
14	June 17 1992	427	0.7	2.5	9.66	46.5	262	356	231	587
15										
16	Winter mean	461	0.1	2.24	8.31	51.8	50			121
17	SD	23	0.1	0.26	0.49	5	51			58
18	Growth mean	467	0.23	2.39	8.51	49.7	150			339
19	SD	21	0.23	0.22	0.69	3.3	147			238
20	Annual mean	465	0.19	2.35	8.44	50.4	114			261
21	SD	21	0.21	0.23	0.61	4	129			218

Petty Pool Phytopl 1991/92

	Organism	July 31 1991	Aug 21 1991	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 27 1992	June 17 1992
1	Asterio form	-	13	121	523	2279	469	2011	80	-	-	-	-	-
2	Coccconeis	-	-	-	-	-	-	-	20	-	-	-	-	-
3	Cyclo ocel	-	402	-	-	-	-	-	-	-	-	-	-	26743
4	Cyclo menegh	-	389	80	-	-	21513	1944	-	-	-	-	-	9249
5	Cyclot sp	13	-	2654	121	8780	-	-	140	17600	47656	643	13	-
6	Cyclo stell	-	-	-	13792	-	-	-	-	-	-	-	-	-
7	Frag sp	-	201	80	-	-	-	-	20	-	-	-	-	-
8	Frag crot	-	-	-	-	-	-	-	-	200	-	-	-	-
9	Gomphonema	13	-	40	40	-	-	-	-	-	-	-	-	-
10	Gomph vent	-	13	-	-	-	-	-	-	-	-	-	-	-
11	Melosira sp	-	-	-	-	67	67	-	-	400	-	-	-	-
12	Meloisra gran	-	268	643	80	-	-	-	-	-	-	-	-	-
13	melos ital	-	54	-	-	-	-	-	-	-	-	-	-	-
14	Navicula	27	13	-	80	-	-	-	-	-	-	-	-	-
15	Nitzsch sig	-	13	-	-	-	-	-	-	-	-	-	-	-
16	Stephanod ast	-	-	-	-	-	-	-	-	-	-	-	13	-
17	Synedra	27	-	-	-	-	-	-	-	-	201	-	-	-
18	Synedra ulna	-	-	-	-	-	-	-	-	2400	-	-	-	-
19	Amphora ov	-	-	-	-	-	-	-	-	-	-	-	-	201
20	Scened incras	-	-	-	-	-	-	-	-	-	-	-	-	201
21	Tetraed tr gr	-	-	-	-	-	-	-	-	-	-	-	-	402
22	Actinastrum	-	40	8122	-	-	-	-	-	-	-	-	-	-
23	Ank conv	-	1367	5910	322	1206	737	134	280	1000	1407	3217	-	402
24	Ank fract	-	-	241	-	-	-	-	-	-	-	-	-	-
25	Ank falc mir	-	-	40	-	-	-	-	-	-	-	-	-	-
26	Ank falc	-	-	201	121	-	-	-	-	1200	201	804	-	-
27	Carteria	-	-	-	-	-	-	67	-	200	-	-	13	-
28	Chlorella vulg	-	-	-	-	-	-	-	120	-	201	-	938	1810
29	Chlamydo sp	214	442	-	40	536	268	536	140	3000	3016	241	-	603
30	Chlamydo glob	-	13	-	-	-	-	-	-	2400	-	-	-	-
31	Chlamydo spha	-	-	-	-	-	-	-	-	-	-	40	-	-
32	Clost cynth	-	-	-	-	-	-	-	-	-	-	-	-	-
33	Closterlopsis	-	-	40	-	-	-	-	-	-	-	322	-	-
34	Crucigenia sp	-	54	-	-	-	-	-	-	-	-	-	-	-
35	Crucig quad	-	-	-	-	-	67	-	20	-	-	-	-	-
36	Coelast sphaer	-	-	121	-	-	-	-	-	-	-	-	375	603
37	Dictyos pulch	-	-	684	40	67	-	-	-	-	-	-	-	603
38	Golenkinia	-	-	-	-	-	-	-	-	200	-	-	-	-
39	Haematococc	54	-	-	-	-	-	-	-	-	-	-	-	-
40	Kirchneriella	-	-	-	-	-	134	-	-	-	201	-	-	-
41	Kirch lun	-	-	-	-	-	-	-	160	-	-	-	-	-
42	Micract pus	-	13	-	-	134	-	67	-	1400	-	40	-	-
43	Lagerheim qu	-	-	-	-	-	-	-	100	9200	804	80	-	-
44	Oocystis erem	-	-	-	-	-	-	-	-	-	-	-	322	4826
45	Oocystis sp	-	-	-	-	67	-	-	-	200	-	-	-	-
46	Oocystis pus	27	27	40	-	-	-	-	-	200	-	-	389	-
47	Oocystis sol	-	40	-	-	-	-	-	-	-	-	-	-	-
48	Petromonas	-	-	-	-	134	-	-	-	-	-	-	-	-
49	Quadrigula	-	-	40	-	-	-	-	-	-	-	-	-	-
50	Quad lac	-	-	-	-	-	-	-	-	-	-	80	-	-
51	Ped bory	13	27	40	-	-	-	-	-	-	-	-	214	402
52	Ped dup	13	54	-	-	-	-	-	-	-	-	-	-	201
53	Schroed set	-	13	-	-	-	-	-	-	-	-	-	-	201
54	Schroed jud	-	-	-	-	-	-	-	-	-	-	-	13	-
55	Scened acum	-	-	86	80	67	-	-	-	-	-	-	-	201
56	Scened bij	13	-	40	121	-	67	-	120	2800	-	201	241	402
57	Scened dim	-	-	40	-	-	-	-	-	-	-	-	-	-
58	Scened quad	40	188	322	201	670	268	201	-	200	402	-	121	4826
59	Scened bij alt	-	-	80	-	-	-	-	-	-	-	-	-	-
60	Scened arc	-	-	-	121	67	-	-	-	-	-	-	-	402
61	Scen arc plat	-	-	-	-	-	-	-	-	-	-	-	214	-
62	Selenast min	-	13	-	-	67	-	134	140	600	603	402	-	402
63	Selenast west	40	-	40	442	2011	67	-	-	1000	201	121	-	-
64	Sphaerocystis	-	-	-	-	-	-	-	-	-	-	-	40	-
65	Tetraedron mi	-	-	-	-	-	-	-	-	-	-	-	298	9652
66	Tetrast sp	-	-	121	-	268	-	-	-	-	-	-	-	-
67	Tetrast staur	-	-	-	-	-	-	-	20	2600	1608	1407	107	201
68	Ulothrix	13	-	-	-	-	-	-	-	-	-	-	-	-
69	Chlorogonium	-	-	-	-	-	-	-	-	200	-	-	-	-
70	Crucig apic	-	-	-	-	-	-	-	-	-	-	-	-	9853
71	Coelast micro	-	-	-	-	-	-	-	-	-	-	-	-	603
72	Oocyst crass	-	-	-	-	-	-	-	-	-	-	-	-	402
73	Eugl sp	-	-	-	80	-	-	-	-	-	-	-	-	-

	Organism	July 31 1991	Aug 21 1991	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 27 1992	June 17 1992
74	Eugl poly	-	-	492	-	-	-	-	-	-	-	-	-	-
75	Eugl min	-	-	40	-	-	-	-	-	-	-	-	-	-
76	Phacus	-	-	121	-	-	-	-	-	-	-	-	-	-
77	Trachelomonas	-	-	1126	724	1273	-	-	80	1400	-	-	27	-
78	*	-	-	-	-	-	-	-	-	-	-	-	-	-
79	*	-	-	-	-	-	-	-	-	-	-	-	-	-
80	Crypto ref	-	-	-	-	-	-	-	120	-	-	-	-	-
81	Crypto erosa	-	389	-	-	-	-	-	-	1000	-	121	54	-
82	Crypto ov	194	54	603	402	134	2011	134	20	-	201	-	54	-
83	Rhodo min	-	-	483	-	268	536	-	-	200	1810	201	1179	6837
84	*	-	-	-	- -	-	-	-	-	-	-	-	-	-
85	*	-	-	-	-	-	-	-	-	-	-	-	-	-
86	Gonyost sem	-	-	-	40	-	-	-	-	-	-	-	-	-
87	Mallomonas	-	-	80	- -	-	-	67	20	-	-	-	-	201
88	Chlorochr min	107	643	-	-	-	-	-	-	-	-	-	-	-
89	*	-	-	-	- -	-	-	-	-	-	-	-	-	-
90	*	-	-	-	-	-	-	-	-	-	-	-	-	-
91	Gymnodinium	-	-	-	-	-	-	-	80	-	-	-	-	-
92	Peredinium	-	-	201	-	-	-	-	-	-	-	-	-	-
93	*	-	-	-	-	-	-	-	-	-	-	-	-	-
94	*	-	-	-	-	-	-	-	-	-	-	-	-	-
95	Anabaena	13	-	-	40	-	-	-	-	-	-	-	-	-
96	Aphanocap el	39	-	-	-	-	335	-	-	-	-	-	-	-
97	Aphanothece nl	-	-	-	-	-	-	-	-	-	1609	-	-	-
98	Coelosph sp	-	-	-	-	-	134	-	-	-	-	-	-	-
99	Dact acic	-	-	764	-	-	-	-	-	-	-	-	-	-
100	Dact fasc	-	13	-	-	-	-	-	-	-	-	-	-	-
101	Dact raph	-	-	80	-	-	-	-	-	400	2815	442	-	-
102	Gloeocystis sp	-	27	-	-	-	-	-	-	-	-	-	-	-
103	Gloeocapsa sp	-	-	-	-	-	-	-	-	200	-	-	-	-
104	Gloeocaps rup	-	-	-	-	-	-	-	-	-	1408	-	-	-
105	Merismop	-	-	241	-	-	-	-	-	-	-	80	-	-
106	Microcystis	-	27	-	-	335	-	-	-	-	201	-	-	-
107	Microc aerug	54	-	-	-	-	-	-	-	-	-	-	-	-
108	Oscillatoria sp	-	-	-	-	-	-	-	-	-	-	161	13	-
109														
110	Total diatoms	80	1366	3618	14636	11126	22049	3955	260	20600	47857	643	26	36113
111	Total greens	427	2291	16168	1487	5294	1608	1139	1100	26800	8643	6955	3285	37198
112	Total others	301	1090	3146	1246	1675	2547	201	320	2600	2011	322	1314	7038
113	Total blue grns	106	67	1085	40	335	469	0	0	600	6033	683	13	0
114	TOTAL	914	4814	24017	17409	18430	26673	5295	1680	50600	64544	8603	4638	80340
115														
116	Diatoms %	8.8	28.4	15.1	84.1	60.4	82.7	74.7	15.5	40.7	74.1	7.5	0.56	44.9
117	Greens %	46.7	47.6	67.3	8.5	28.7	6.0	21.5	65.5	53.0	13.4	80.8	70.8	46.3
118	Others %	32.9	22.6	13.1	7.2	9.1	9.6	3.8	19.0	5.1	3.1	3.7	28.3	8.8
119	Blue grns %	11.6	1.4	4.5	0.2	1.8	1.8	0	0	1.2	9.3	7.9	0.3	0
120														
121		Diatoms	Greens	Others	Blue greens									
122	Winter mean	54.8(27.2)	34.9(24)	9.3(6)	1(0.9)									
123	Growth mean	32.9(31.8)	47.7(26)	15(11.5)	4.4(4.6)									
124	Annual mean	41.3(30.9)	42.8(25)	12.8(9.9)	3.1(4)									

Petty Pool



(q) QUOISLEY MERES

(i) Morphometry and water budget

The two Quoisley Meres lie at the bottom of a prominent basin whose aesthetic is marred by prominent aerial electricity wires. Neither is very large- the Big Mere to the west is 4ha in area and has a maximum depth of 2.4m, whilst the Little Mere has an area of 2.2ha and a maximum depth of 1.8m. The two are connected through two drains running east-west to the south and north of the pair and there is probably a two way flow along these drains dependent on local conditions following rain. The net flow however is from two streams that drain into the south of the Little Mere and then from Little Mere to the Big Mere. An additional field drain is piped into the Big Mere and could be sampled by removal of a fibreglass lid that covered it. Two small surface drains may flow into the Big Mere but did not carry water during the period of this study. Run off water undoubtedly also enters the meres from the sides of the large bowl that contains them. Estimates of the flushing rate of the system as a whole from the stream and drain flows are thus underestimates and of retention time, overestimates. However the calculated flushing rates were 3.7, 4.5 and 2.9 per yearon annual, winter and growth season bases with respective retention times of 14,12, and 18 weeks.

(ii) Changes in land use

The catchment area of the meres includes parts of the parishes of Marbury cum Quoisley, Wirswall and Norbury for which land use changes have been as follows:

	1931	1987
Cattle(head)	2209	4322
nutrient units	26950	52728
Pigs(head)	1106	4234
nutrient units	5309	20323
Sheep(head)	1070	562
nutrient units	1605	843
Poultry(head)	12017	94387
nutrient units	1682	13214

Total nutrient units	35546	87108
Permanent grass(ha)	1043	1018
Temporary grass(ha)	123	483
Arable(ha)	162	219
Woodland(ha)	2	9
Rough grazing(ha)	3	29
Total hectarage	1333	1758

There has thus been a major increase in animal keeping, and an acquisition of land through boundary changes.

(iii) Major ion chemistry and nutrient loads

Conductivities and alkalinities in the area are high and values in the meres themselves are consonant with a simple mixing of the drain and inflows of slightly differing ionic strengths. The piped drain carrying water from the hillside fields to the south has the greatest strength but the streams are not much more dilute. The Big Mere has lower concentrations than the Little, which may mean that it recieves more direct rainfall run-off. Its slightly higher chloride concentration may also result from this. The two inflows entering the Little Mere have moderately high soluble reactive and total phosphorus concentrations with QOI1 being the richer of the two. It is also the richer in nitrate and concentrations are high (up to 14.9 mgN/l). The piped drain also has high phosphorus concentrations and very high nitrate levels. Ammonium concentrations are low and these waters have the characteristics of those that come from fertile pastures.

The Little Mere and the Big Mere, particularly the latter, have total phosphorus concentrations that are greater by far than any of the inflows and this must mean that release from the sediments is important in these shallow lakes. Nitrate concentrations in the Little Mere were lower than in the inflows but greater than in the Big Mere. This is consistent with the flow pattern and the progressive loss of nitrogen by uptake and denitrification as water passes through the system. Ammonium concentrations in the lakes are higher than those in the inflows and this also is consistent with release from the sediments.

(iv) Phytoplankton and zooplankton

Chlorophyll a concentrations were low in both meres with the Little Mere having some higher winter values. Blue green algae were not prominent and the only significant chlorophyll peaks came from cryptomonad flagellates. ***Daphnia*** were plentiful in both lakes and grazing is likely to have been an important determinant of the size of the algal crops.

(v) Aquatic plants

Nuphar lutea almost completely covers the Little Mere in summer to the exclusion of other species. The Big mere has less extensive coverage of lilies but ***Nymphaea alba*** is additionally present and ***Elodea canadensis*** i s locally abundant. The trophic score for the Big Mere has remained at 7.5/7.6 since 1979 and the DAFOR score has increased to 3 from 0 in 1979 and 1987.

(vi) Overall assessment

The catchment changes, as elsewhere in the mere's area, must have imposed a degree of eutrophication on the system but the nutrient sources are diffuse and not easily controllable. The Little Mere has such extensive lily beds that it is not surprising that it has no other plants. The daphnids may be abundant because fish are scarce but equally the lily beds provide an extensive refuge that could allow fish stocks and daphnids to coexist. The Big Mere also has large numbers of daphnids but fewer refuges and here a low fish stock is a feasible explanation. In such isolated meres it is quite likely that the fish stock may have been depleted or lost by past fish kills under winter ice or in very hot summers, for example. No nutrient control measures are here feasible but it is desirable that no fish stocking takes place until the current state of the fish community has been fully determined.

Quoisley Drain QOD

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge
1	Aug 7 1991	748	0.55	5.40	7.17	30.6	60.0	35.0	64.0	99.0	8.60	73.0	4.47	+
2	Aug 28 1991	Not sampled												
3	Sept 18 1991	775			7.97	34.0	42.0	24.5	36.8	61.3	6.65	65.0	4.26	+
4	Oct 23 1991	758	0.20	5.70	7.45	33.0	32.3	32.3	2.2	34.5	0.00	27.8		+
5	Nov 12 1991	766	0.30	5.65	7.62	30.3	25.0	40.8	30.7	71.5	6.27	26.0	5.10	+
6	Dec 4 1991	770	0.55	6.25	7.53	54.0	30.0	42.0	0.0	42.0	-	38.0	4.52	+
7	Jan 14 1992	742	0.10	4.60	7.78	34.0	50.0	50.0	17.0	51.0	5.61	11.0	4.53	+
8	Feb 5 1992	767	0.65	5.45	8.53	40.0	32.0	45.0	355.0	400.0	13.56	48.0	3.37	+
9	Mar 4 1992	754	0.30	5.50	7.44	35.3	26.0	34.0	199.0	233.0	1.11	52.0	3.17	+
10	Mar 25 1992	672	0.30	4.10	7.78	36.0	42.0	42.0	87.0	129.0	13.79	69.0	3.29	+
11	April 15 1992	646	0.30	4.40	7.50	31.4	45.0	45.0	135.0	180.0	7.05	53.0	3.39	+
12	May 13 1992	713	0.25	5.45	7.34	28.0	44.0	47.0	178.0	225.0	10.9	66.0	3.63	+
13	June 3 1992	719	0.00	5.40	7.55	33.3	53.0	70.0	0.0	70.0	11.06	11.3	4.01	+
14	June 22 1992	720	0.00	5.70	7.57	29.4	56.0	56.0	99.0	156.0	10.02	0.0	4.43	+
15														
16	Winter mean	761	0.40	5.49	7.87	39.6	34.3			141.0	8.48	30.8	4.38	
17	SD	13	0.25	0.68	0.46	10.4	11.0			173.0	4.4	16.0	0.73	
18	Growth mean	723	0.27	5.21	7.53	32.3	44.5			132.0	7.69	46.3	3.83	
19	SD	42	0.16	0.60	0.23	2.7	11.0			72.0	4.6	26.8	0.53	
20	Annual mean	734	0.32	5.30	7.63	34.6	41.3			135.0	7.89	41.5	4.01	
21	SD	40	0.20	0.62	0.34	6.6	12.0			105.0	4.4	24.5	0.63	

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	Date	Conductivity	Phenolph Alk	Total alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	Aug 7 1991	747	0.8	4.55	7.62	32.7	105	130	151	281	5.09	258	4.28	0.001	3.200		0.170	
2	Aug 28 1991	746	0.3	5.70	7.86	32.0	99	103	306	409	5.53	18	3.02	0.001	3.360		0.250	
3	Sept 18 1991	*	*	*	*	*	*	*	*	*	*	*	*	0.000	0.000		0.000	
4	Oct 23 1991	732	0.9	5.9	8.25	33.0	59	65	3.4	68	5.96	39		0.002	7.260		0.080	
5	Nov 12 1991	727	0.8	5.3	8.07	36.4	67	85	3.2	88	2.89	46	5.62	0.0035	6.200		0.190	
6	Dec 4 1991	729	0.6	6.05	8.24	34.0	67	67	42	109	-	169	4.91	0.005			0.330	
7	Jan 14 1992	648	0.15	5.7	8.48	36.0	97	97	0	97	4.85	42	4.82	0.007	20.700		0.410	
8	Feb 5 1992	700	0.65	4.85	8.53	40.0	94	94	35	129	8.95	46.8	3.95	0.005	27.200		0.390	
9	Mar 4 1992	687	0.45	5.1	8.16	35.3	77	77	78	155	8.98	64	4.12	0.005	27.300		0.470	
10	Mar 25 1992	655	0.6	3.9	8.14	36.0	73	73	409	482	14.87	58	3.83	0.008	7.500		2.330	
11	April 15 1992	668	0.45	4.85	8.23	35.3	69	89	57	146	5.61	42	3.85	0.007	23.900		0.620	
12	May 13 1992	694	0.7	6.6	8.24	32.0	69	83	0	83	8.25	14	4.03	0.002	10.000		0.100	
13	June 3 1992	691	0.4	5.7	8.42	33.3	103	103	75	178	6.56	0	4.31	0.004	15.900		0.430	
14	June 22 1992	696	0.05	5.55	8.42	33.3	95	111	94	205	7.08	41	4.81	0.003	12.900	662.000	0.370	22.800
15																		
16	Winter mean	701	0.55	5.48	8.33	36.6	81			106	5.56	76	4.83	0.005				
17	SD	38	0.28	0.52	0.21	2.5	17			18	3.09	62	0.68	0.0014				
18	Growth mean	703	0.52	5.32	8.15	33.7	83			223	7.55	59	4.03	0.003				
19	SD	35	0.26	0.81	0.26	1.5	17			142	3.03	77	0.51	0.0027				
20	Annual mean	702	0.53	5.37	8.2	34.6	83			187	7.05	65	4.3	0.004				
21	SD	34	0.26	0.71	0.25	2.2	16			129	3.04	71	0.67	0.003				

Quoisley Inflow 2 QOI2

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Total Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	Aug 7 1991	698	0.65	5.35	7.93	37.0	71.0	118	34	152	3.20	41	4.72	0.00016	0.310		0.150	
2	Aug 28 1991	726	0.30	6.10	8.12	34.0	71.0	105	124	228	3.40	53	3.22	0.00075	1.570		0.100	
3	Sept 18 1991	453			8.07	32.0	86.0	118	51	169	0.85	109	3.47	0.00130	0.750		0.130	
4	Oct 23 1991	716	0.90	5.65	8.11	33.0	26.7	32	46	78	4.93	20		0.00150	4.490		0.070	
5	Nov 12 1991	712	0.40	4.75	7.84	36.4	31.3	43	0	43	2.73	41	5.10	0.00140	2.350		0.036	
6	Dec 4 1991	721	0.45	4.65	8.15	36.0	24.0	24	15	38	-	146	4.90	0.00200			0.046	
7	Jan 14 1992	672	0.30	4.80	8.03	40.0	36.0	36	0	36	3.26	129	4.34	0.00300	6.150		0.065	
8	Feb 5 1992	689	0.65	4.55	8.50	36.0	26.0	53	9	62	6.28	147	3.60	0.00300	11.660		0.110	
9	Mar 4 1992	676	0.30	4.75	7.82	39.0	25.0	27	60	86	6.01	82	3.94	0.00200	7.370		0.100	
10	Mar 25 1992	660	0.20	3.70	7.66	44.0	22.0	30	131	161	11.77	104	3.54	0.00400	3.100		0.390	
11	April 15 1992	652	0.30	4.60	7.98	35.3	44.0	49	72	121	4.99	61	3.19	0.00300	9.160		0.220	
12	May 13 1992	666	0.45	5.15	8.00	36.0	25.3	43	155	199	6.48	50	2.76	0.00100	3.950		0.120	
13	June 3 1992	660	0.10	5.20	8.08	33.3	38.0	56	38	93	5.46	123	3.56	0.00100	3.380		0.060	
14	June 22 1992	647	0.40	5.15	8.30	35.3	52.0	105	148	252	5.47	31	3.60	0.00100	3.330	230.000	0.150	6.490
15																		
16	Winter mean	699	0.45	4.69	8.13	37.1	29.3			45	4.1	116	4.50	0.00200				
17	SD	22	0.15	0.11	0.28	1.9	5.4			12	1.9	51	0.67	0.00080				
18	Growth mean	655	0.40	5.07	8.01	35.9	46.1			154	5.26	67	3.60	0.00160				
19	SD	76	0.24	0.68	0.18	3.5	23.0			60	2.83	35	0.55	0.00100				
20	Annual mean	668	0.42	4.95	8.04	36.2	41.3			123	4.99	81	3.84	0.00180				
21	SD	67	0.21	0.59	0.21	3.1	21.0			72	2.6	44	0.72	0.00100				

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	634	0.20	4.90	7.12	36.7	168	225	33	258
2	Aug 28 1991	664	0.00	5.40	7.47	38.3	269	269	49	318
3	Sept 18 1991	683			7.52	43.0	319	422		422
4	Oct 23 1991	667	0.30	5.75	7.50	37.0	262	262	40	302
5	Nov 12 1991	662	0.30	5.30	7.60	38.4	200	232	208	440
6	Dec 4 1991	664	0.60	5.80	7.57	38.0	257	298	50	348
7	Jan 14 1992	645	0.25	5.25	7.95	40.0	151	151	10	161
8	Feb 5 1992	662	0.45	4.75	8.33	40.0	106	121	24	145
9	Mar 4 1992	638	0.35	4.55	8.23	43.1	10	34	93	127
10	Mar 25 1992	618	0.45	4.55	8.09	40.0	43	49	98	103
11	April 15 1992	608	0.30	4.40	8.01	37.3	20	50	17	67
12	May 13 1992	602	0.15	4.70	7.85	38.0	105	145	36	181
13	June 3 1992	597	0.00	4.85	7.61	35.3	419	431	58	489
14	June 22 1992	602	0.00	5.00	7.47	35.3	243	344	90	334
15										
16	Winter mean	658	0.40	5.28	7.86	39.1	179			273
17	SD	9	0.16	0.43	0.36	1.1	65			144
18	Growth mean	631	0.19	4.90	7.69	38.4	186			260
19	SD	31	0.17	0.44	0.35	3.0	139			139
20	Annual mean	639	0.25	5.02	7.74	38.6	184			264
21	SD	29	0.19	0.45	0.34	2.4	120			135

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Seccchi	Total Daphnia
1	0.03	66	4.01	0.30	1.3	4.00	0.86	>	23.1
2	0.00	128	2.40	1.35	5.0	3.75	2.08	>	67.4
3	0.00	136	3.96	0.00	5.0	>	0.75	>	0.0
4	0.11	216		9.10	9.7	1.07	1.09	>	17.8
5	0.46	280	5.16	49.80	60.3	1.22	1.14	>	57.2
6	-	406	6.28	40.00	36.7	1.01	1.18	>	1.2
7	2.37	454	6.21	3.70	8.0	2.4	0.93	>	72.8
8	2.39	421	5.17	0.00	3.0	-	0.80	>	111.6
9	1.73	0	3.55	57.90	52.3	0.99	1.23	>	0.3
10	2.42	226	2.96	7.30	11.3	1.7	1.07	>	0.0
11	2.79	135	2.76	5.50	8.3	1.67	1.00	>	3.2
12	0.75	225	0.98	0.70	14.7	22.0	1.06	>	428.4
13		862	4.51	1.80	4.3	2.6	0.89	>	427.8
14	0.01	105		20.90	25.7	1.35	0.99	>	115.2
15									
16	1.74	390	5.71	23.40					60.7
17	1.11	76	0.62	25.20					45.8
18	0.87	210	3.44	10.50					108.3
19	1.14	240	1.40	17.80					173.0
20	1.09	261	4.14	14.20					94.7
21	1.15	220	1.60	20.00					147.0

	Organism	Aug 2 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 12 1991	Dec 4 1991	Jan 19 1992	Feb 2 1992	Mar 4 1992	Mar 25 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
1	Amphora oval	-	-	-	22	-	-	-	-	-	13	-	-	-	-
2	Achnanthes	-	45	-	-	-	-	-	-	-	-	-	54	-	-
3	Cocconeis	-	-	27	22	27	27	-	13	-	-	-	-	-	-
4	Cyclotella	27	22	40	-	-	13	-	-	3564	-	-	-	13	-
5	Cyclo menegh	-	-	-	-	27	-	-	-	-	-	54	-	-	-
6	Cymb prost	27	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Denticula	-	-	-	-	-	-	-	13	-	-	-	-	-	-
8	Fragilaria	-	-	40	22	40	-	-	-	-	-	-	-	-	-
9	Frag constr	--	-	-	-	-	-	-	-	-	-	-	27	-	-
10	Gomphonema	-	89	13	45	-	-	-	52	-	13	-	-	-	-
11	Gomph vent	-	-	-	-	-	-	-	-	-	-	-	13	-	-
12	Navicula	-	-	40	45	-	94	13	78	594	54	27	161	40	13
13	Nitzschia	13	-	13	-	-	147	-	-	-	-	-	-	-	-
14	Nit sig	-	-	13	-	-	-	-	-	-	13	-	-	-	-
15	Pinnularia	-	-	-	-	-	-	-	-	132	-	-	-	-	-
16	Synedra ulna	13	45	27	45	-	54	13	-	-	-	40	67	-	-
17	Synedra sp	-	-	-	-	-	-	-	13	264	-	-	-	-	-
18	Synedra aff	-	-	-	-	-	-	-	-	66	-	-	-	-	-
19	Frag crot	-	-	-	-	-	-	-	-	-	-	-	-	-	13
20	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	Ank conv	-	-	-	-	-	-	-	13	-	-	-	-	-	-
22	Ank falc	-	-	13	-	-	-	-	-	-	-	13	-	-	-
23	Chlorella	-	-	-	-	121	40	147	13	462	-	-	-	-	-
24	Chlamyd ep	13	22	-	-	-	-	-	-	-	-	-	-	-	-
25	Chlamyd sp	1059	89	80	179	121	54	-	182	924	174	54	375	94	-
26	Chlamyd sphag	-	-	13	-	-	-	-	-	594	-	-	-	-	-
27	Closterium sp	13	-	-	-	-	-	-	-	-	-	-	-	-	-
28	Chlorogonium	-	-	-	-	27	-	27	26	6468	603	-	-	-	-
29	Haematococc	13	-	-	-	-	-	-	-	-	-	-	-	-	-
30	Crucig quad	-	-	-	-	-	-	-	-	-	13	-	-	-	-
31	Chlamydo glob	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	Carteria	-	-	-	-	-	-	-	-	-	-	-	-	13	-
33	Sphaerocystis	-	-	-	-	--	-	-	-	-	-	-	-	-	-
34	Schroed set	-	-	-	-	-	-	-	-	-	-	563	-	-	-
35	Scened bij	13	-	-	22	-	-	-	-	-	-	-	-	-	-
36	Scened quad	13	22	27	-	-	13	-	-	66	13	13	-	-	-
37	Schroed jud	-	-	-	22	-	-	-	-	-	-	-	-	-	-
38	Schroed sp	-	-	-	-	13	-	-	-	-	-	-	-	-	-
39	Selenast west	13	-	-	-	-	-	-	-	-	-	-	-	-	-
40	Selenast min	-	-	-	-	-	-	13	-	-	-	-	-	-	-
41	Tetraed min	-	22	-	-	-	-	-	-	-	-	-	-	-	13
42	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	Eugl poly	-	67	-	-	-	-	-	-	-	-	-	-	-	-
45	Eugl sp	-	-	27	-	-	-	-	-	66	-	-	-	-	-
46	Eugl sang	-	-	-	-	27	-	-	-	-	-	-	-	-	-
47	Phacus sp	27	22	-	-	-	-	-	-	-	-	-	-	-	13
48	Phacus long	-	-	-	425	-	-	-	-	-	-	-	-	-	-
49	Trachelomonas	-	-	-	-	-	40	-	-	198	-	-	13	-	40
50	Eugl grac	-	-	-	-	-	-	-	-	-	-	-	-	-	27
51	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
52	Crypto marss	-	-	-	-	-	-	-	-	-	13	-	-	-	-
53	Crypto acuta	-	-	-	-	-	-	-	26	198	161	174	-	-	-
54	Crypto ov	134	45	13	22	884	40	-	-	430	94	27	-	-	147
55	Crypto erosa	-	-	-	-	603	-	-	-	-	-	-	-	-	-
56	Crypto refl	-	-	-	-	-	456	-	-	-	27	54	-	-	188
57	Rhodo min	40	22	67	-	-	-	-	-	-	40	121	-	-	13
58	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60	Gonyostomum	13	-	-	45	-	-	-	-	-	-	-	-	-	-
61	Mallomonas	-	-	-	-	54	-	-	-	-	-	54	-	-	134
62	Uroglena	-	-	-	-	-	576	-	-	-	-	174	-	-	-
63	Chroomonas	-	-	-	-	-	-	-	-	-	-	27	-	-	-
64	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66	Anabaena sp	13	-	-	-	-	-	-	-	-	-	-	-	-	-
67	Arthros jenn	-	-	27	-	-	-	-	-	-	-	--	-	-	-
68	›hanocapsa elach	13	-	-	-	-	-	-	-	-	-	-	-	-	-
69	Aphaniz f aq	-	-	-	-	-	13	-	-	-	-	13	-	-	-
70	Dactyl sp	-	22	-	-	-	-	-	-	-	-	-	-	-	-
71	Gloeocystis m	80	-	-	-	-	-	-	-	-	-	-	-	-	-
72	Gloeothece rup	-	-	-	67	-	-	-	-	-	-	-	-	-	-
73	Lyngbya	-	-	-	-	-	-	13	-	-	-	-	-	-	-

	Organism	Aug 2 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 12 1991	Dec 4 1991	Jan 19 1992	Feb 2 1992	Mar 4 1992	Mar 25 1992	April 15 1992	May 13 1992	June 3 1992	June 22 1992
74	Microc aer	-	-	13	22	-	-	-	-	-	13	-	-	-	-
75	Osc agardh	-	-	-	-	-	-	-	-	66	-	-	-	-	-
76	Osc sp	-	-	40	22	-	27	13	-	-	-	-	-	-	-
77															
78	Total diatoms	80	201	213	201	94	335	26	169	4620	93	121	322	53	26
79	Total greens	1137	154	133	223	281	107	187	234	8514	803	643	375	107	13
80	Total others	214	156	107	492	1568	1112	0	26	892	315	631	13	0	562
81	Total blue grns	106	22	80	109	0	40	26	0	66	13	13	0	0	0
82	TOTAL	1537	531	533	1025	1943	1494	239	429	14092	1224	2201	710	160	601
83															
84	Diatoms %	5.2	37.9	40	19.6	4.8	22.4	10.9	39.4	32.8	7.6	41.8	45.4	33.1	4.33
85	Greens %	74	29	25	21.8	14.5	7.2	78.2	54.6	60.4	65.6	29.2	52.8	66.9	2.16
86	Others %	13.9	29.4	20.1	48.0	81.0	74.0	0	6.1	6.3	25.7	28.7	1.8	0	93.5
87	Blue greens %	6.9	4.1	15.0	10.6	0	2.7	10.9	0	0.5	1.1	0.6	0	0	0
88															
89		Diatoms	Greens	Others	Blue greens										
90	Winter mean	19.4(15.2)	38.6(33.6)	40.3(43.2)	3.4(5.2)										
91	Growth mean	26.8(16.1)	42.7(24.2)	26.7(27.7)	3.9(5.3)										
92	Annual mean	24.7(15.7)	41.5(25.9)	30.6(31.6)	3.74(5.1)										

Quoisley Big Mere QOM

	Date	Conductivity	Phenolph alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Aug 7 1991	605	0.40	4.30	7.73	36.7	573	706	22	728
2	Aug 28 1991	618	0.70	4.70	8.35	43.0	736	776		776
3	Sept 18 1991	625			8.37	42.6	831	749	184	932
4	Oct 23 1991	620	0.40	5.00	7.93	43.3	633	659	86	745
5	Nov 12 1991	621	0.35	4.80	7.87	40.4	390	395	0	395
6	Dec 4 1991	622	0.25	5.25	7.89	40.0	320	328	0	328
7	Jan 14 1992	611	0.20	4.85	8.41	40.0	291	291	4	295
8	Feb 5 1992	621	0.60	4.70	8.51	48.0	248	248	10	258
9	Mar 4 1992	613	0.35	4.45	8.16	43.1	110	110	32	142
10	Mar 25 1992	602	0.50	4.60	8.59	44.0	16	37	4	41
11	April 15 1992	598	0.55	4.45	8.38	39.2	39	55	45	100
12	May 13 1992	603	0.30	4.55	8.06	40.0	86	125	10	135
13	June 3 1992	601	0.10	4.60	8.01	45.1	404	446	44	490
14	June 22 1992	598	0.00	4.70	8.12	41.2	212	212	84	296
15										
16	Winter mean	619	0.35	4.90	8.17	42.1	314			319
17	SD	5	0.18	0.24	0.34	4.0	62			58
18	Growth mean	608	0.37	4.59	8.17	41.8	364			439
19	SD	10	0.22	0.20	0.25	2.5	310			335
20	Annual mean	611	0.36	4.69	8.17	41.9	356			404
21	SD	10	0.20	0.25	0.27	2.8	260			286

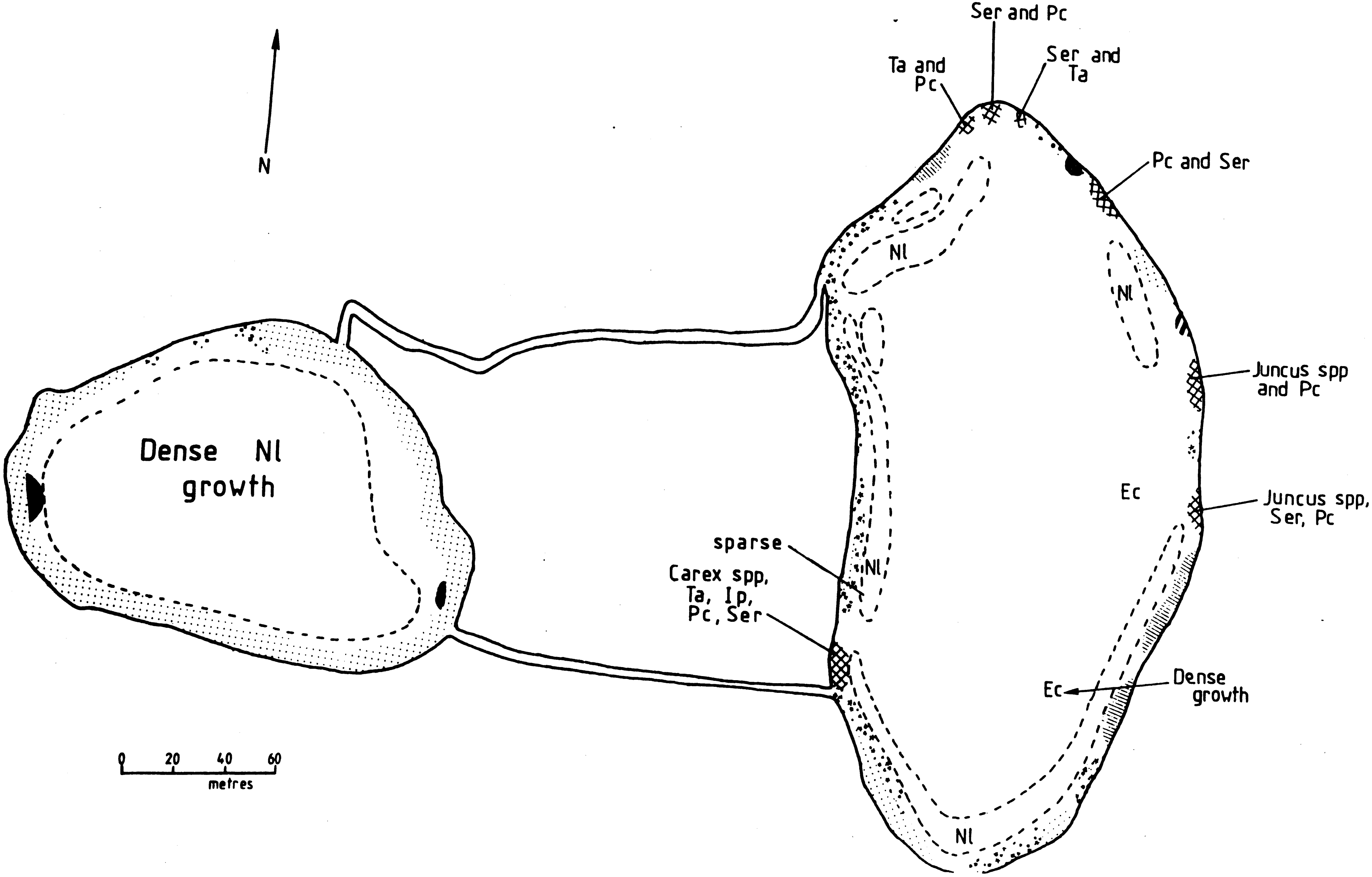
	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.05	55.0	4.79	16.2	19.0	1.19	1.10	>	275.0
2	0.00	2.0	1.25	18.9	28.0	1.50	1.17	>	1.8
3	0.00	393.0	2.48	17.8	29.3	1.66	1.24	>	339.0
4	0.26	123.0		8.8	12.0	1.38	1.10	>	0.4
5	0.26	178.0	3.94	2.7	4.0	1.50	1.00	>	10.4
6	-	3795.0	4.65	0.0	4.3	>	0.83	>	69.1
7	0.53	252.0	5.03	5.1	9.3	2.0	0.91	>	0.4
8	0.48	247.0	4.59	0.0	0.0	-	-	>	0.1
9	0.42	32.0	3.04	0.0	5.3	-	0.99	>	0.0
10	0.16	113.0	0.72	12.1	14.7	1.33	1.06	>	1.9
11	0.54	32.0	0.46	16.1	20.7	1.41	0.38	>	17.9
12	0.14	161.0	1.21	2.6	2.7	1.14	1.14	>	12.5
13	0.03	435.0	4.38	6.6	7.0	1.17	1.04	>	171.6
14	0	0.0	6.06	10.6	13.0	1.34	1.1	>	23.0
15									
16	0.42	1118.0	4.55	1.9					20.0
17	0.14	1785.0	0.45	2.5					33.1
18	0.16	135.0	2.71	11.0					84.0
19	0.19	157.0	2.00	6.5					129.0
20	0.22	416.0	3.27	8.4					65.9
21	0.21	982.0	1.87	7.0					113.0

	Organism	Aug 7 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 12 1991	Dec 4 1991	Jan 14 1992	Feb 5 1992	Mar 4 1992	Mar 25 1992	Apr 15 1992	May	June 3 1992	June 22 1992
1	Ast form	40	-	-	-	-	-	-	-	104	321	342	-	-	-
2	Cocconeis	-	-	-	40	13	-	13	-	13	-	-	-	-	-
3	Cyclotella	-	402	54	40	54	-	-	-	845	4785	-	-	-	-
4	Diatoma vulg	-	-	13	-	-	-	-	-	-	-	-	-	-	-
5	Fragilaria	-	22	-	-	-	-	-	-	-	-	40	-	-	-
6	Frag crot	-	-	-	-	13	-	-	-	-	-	-	-	-	-
7	Gomphonema	-	-	-	-	13	-	-	26	39	-	-	-	-	-
8	Gomphonels	-	-	-	-	-	-	-	-	-	40	-	-	-	-
9	Melosira gran	684	67	362	-	-	27	-	-	-	40	20	-	-	54
10	Melos ital	-	-	-	-	40	-	-	-	26	-	-	-	-	94
11	Navicula sp	282	22	13	40	13	-	-	-	-	-	20	-	27	13
12	Nitzschia sp	322	-	-	-	-	13	-	-	65	80	-	-	-	-
13	Pinnularia sp	-	-	-	-	-	13	-	-	65	-	-	-	-	-
14	Rhoicosphenia	-	-	-	-	-	-	-	-	26	-	-	-	-	-
15	Surirella sp	-	-	-	-	-	-	-	13	-	-	-	-	-	-
16	Synedra sp	-	-	13	-	-	-	-	-	-	-	-	-	-	-
17	Synedra ulna	40	-	-	-	-	-	-	-	-	-	20	-	-	-
18	Synedra aff	-	-	-	-	-	-	-	-	13	-	-	-	-	-
19	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	Ankist braun	-	-	-	-	-	-	-	-	-	-	80	-	-	-
24	Actinastrum	282	-	-	-	-	-	-	-	-	-	-	-	-	-
25	Ank falc	121	67	27	-	-	-	-	-	-	-	-	-	-	-
26	Ank conv	-	201	-	-	-	-	-	-	26	80	-	-	-	-
27	Chlorogonium	-	-	-	-	228	40	54	234	377	-	20	-	-	-
28	Chlorella vulg	40	-	-	-	-	13	27	39	13	80	-	-	-	54
29	Chlamydo sp	764	4085	-	40	80	13	40	52	52	684	80	-	40	27
30	Chlamydo glob	964	134	-	-	-	-	-	-	-	-	-	-	-	-
31	Chlamydo ep	563	-	-	-	-	-	-	-	-	-	-	-	-	-
32	Chlamydo sph	-	-	-	-	-	-	-	-	26	-	-	-	-	-
33	Chlamydo poly	402	-	-	-	-	-	-	-	-	-	-	-	-	-
34	Closterops lon	-	67	-	-	-	-	-	-	-	-	-	-	-	-
35	Dictyo pulch	-	22	-	-	-	-	-	-	-	-	-	-	13	-
36	Clost cynth	-	-	-	1247	94	-	-	-	-	-	-	-	-	-
37	Micract pus	-	-	-	-	-	-	-	-	-	40	-	-	-	-
38	Oocystis sp	-	-	13	-	-	-	-	-	-	-	-	-	-	-
39	Oocystis pus	40	-	-	-	-	-	-	-	-	-	-	-	-	-
40	Raciborsk uro	-	-	-	-	-	-	-	-	-	40	-	-	-	-
41	Quadrig sp	40	-	-	-	-	-	-	-	-	-	-	-	-	-
42	Quadrig lac	-	-	27	-	-	-	-	-	-	40	-	-	-	-
43	Scened quad	-	-	13	-	-	-	-	-	-	-	-	-	-	-
44	Schroed sp	-	22	-	-	-	-	-	-	-	-	-	-	-	-
45	Schroed setig	-	-	-	5670	-	-	-	26	-	121	3015	-	201	-
46	Schroed jud	121	-	-	-	27	-	67	-	-	-	20	-	13	-
47	Selenast min	-	938	13	-	-	-	-	-	-	40	-	-	-	-
48	Selenast west	-	-	67	-	-	-	-	-	26	-	-	-	-	-
49	Staurastrum	-	-	13	-	-	-	-	-	-	-	-	-	-	-
50	Tetraedron	4504	-	-	-	-	-	-	-	-	-	-	-	-	-
51	Sphaer schroe	-	-	-	-	-	-	-	-	-	-	-	-	-	40
52	Oocystis cras	-	-	-	-	-	-	-	-	-	-	-	-	-	13
53	Ped duplex	-	-	-	-	-	-	-	-	-	-	-	-	-	13
54	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
56	Euglena sp	-	-	-	40	-	13	-	-	-	-	-	-	-	13
57	Euglena min	-	335	-	-	-	-	-	-	-	40	-	-	-	-
58	Trachelo sp	-	-	-	-	13	-	-	-	-	80	-	-	-	13
59	Crypto refl	-	-	-	-	-	-	-	-	-	40	-	-	27	-
60	Crypto ac	-	-	-	-	-	-	13	-	130	3820	121	-	161	-
61	Crypto ov	282	268	13	-	-	13	-	26	78	442	161	-	-	-
62	Rhodo min	-	1542	121	1086	80	13	107	221	78	603	261	-	188	80
63	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
64	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	Uroglena sp	-	-	-	-	-	-	-	-	-	-	141	-	-	-
66	Ochromonas	-	-	-	-	-	-	-	-	-	-	-	-	-	-
67	Chlorochr min	161	-	-	-	-	-	-	-	-	-	-	-	-	-
68	Mallomonas	-	-	-	-	-	-	-	-	-	80	-	-	13	-
69	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	Peredinium	-	-	27	-	-	-	-	-	-	-	-	-	-	-
71	Gymnodinium	-	-	-	-	-	-	-	-	-	40	-	-	-	-
72	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Quoisley Mere Phytopl 1991/92

	Organism	Aug 7 1991	Aug 28 1991	Sept 18 1991	Oct 23 1991	Nov 12 1991	Dec 4 1991	Jan 14 1992	Feb 5 1992	Mar 4 1992	Mar 25 1992	Apr 15 1992	May	June 3 1992	June 22 1992
74	Anab circ	-	-	442	-	-	-	-	-	-	-	-	-	-	-
75	Anab spir	201	1474	107	-	-	-	-	-	-	-	-	-	-	-
76	Anab fl aq	-	402	54	-	-	-	-	-	-	-	-	-	-	-
77	Aphanocap el	40	-	-	-	-	-	-	-	-	-	-	-	-	-
78	Aphan fl aq	-	335	13	-	-	13	-	-	-	-	-	-	121	322
79	Gomphos apon	121	-	-	-	-	-	-	-	-	-	-	-	-	-
80	Merismo punct	-	-	13	-	-	-	-	-	-	-	-	-	-	-
81	Microcyst aer	523	-	-	-	-	-	-	-	-	-	-	-	-	-
82	Oscillat sp	-	22	-	-	-	-	-	-	-	-	-	-	-	-
83															
84	Total diatoms	1368	529	465	120	146	53	13	39	1196	5266	442		27	
85	Total greens	7841	5536	173	6957	429	66	188	351	520	1105	3215		267	
86	Total others	443	2145	161	1126	93	39	120	247	286	5145	684		389	
87	Total blue grns	884	2223	629	0	0	13	0	0	0	0	0		121	
88	TOTAL	10536	10433	1428	8203	668	171	321	637	2002	11516	4341		804	
89															
90	Diatoms %	13.0	5.1	32.6	1.5	21.9	31.0	4.0	6.1	59.7	45.7	10.2		3.4	
91	Greens %	74.4	53.1	12.1	84.8	64.2	38.6	58.6	55.1	26.0	9.6	74.1		33.2	
92	Others %	4.2	20.6	11.3	13.7	13.9	22.8	37.4	38.8	14.3	44.7	15.8		48.4	
93	Blue greens%	8.4	21.3	44.0	0	0	7.6	0	0	0	0	0		15.0	
94															
95		Diatoms	Greens	Others	Blue greens										
96	Winter mean	15.8(12.9)	54.1(11.0)	28.2(12)	2.5(4.4)										
97	Growth mean	21.4(21.9)	45.9(29.7)	21.6(16.1)	11.1(15.6)										
98	Annual mean	19.5(19)	48.7(24.7)	23.8(14.6)	8.03(13.4)										

Quoisley Big Mere



(r) ROSTHERNE MERE

Rostherne Mere will be the subject of a detailed thesis to be available in mid 1993. Only a brief account is given here.

(i) Morphometry and water budget

At 48.7 ha, Rostherne is nearly the biggest of the meres studied and by far the depest at 27.5m. It receives water from a stream which is ultimately derived from Little Mere and Mere Mere but receives water also from direct streams and possibly ground water. The hydrology is complex and no simple description can yet be given. Many data however are now available and are currently being fully analysed.

(ii) Changes in land usage

Rostherne Mere is served largely by Mere parish but also by Rostherne Parish. The combined changes in these have been as follows:

	1931	1987
Cattle(head)	828	1351
nutrient units	10102	16482
Pigs(head)	311	641
nutrient units	1973	3077
Sheep(head)	298	1565
nutrient units	449	2320
Poultry(head)	7042	38530
nutrient units	986	5394
Total nutrient units	13510	27273

Permanent grass(ha)	431	324
Temporary grass(ha)	243	276
Arable(ha)	522	580
Woodland(ha)	4	1
Rough grazing(ha)	35	4
Total hectarage	1235	1185

Stockkeeping has thus increased but field usage has remained relatively stable with some loss of land to non agricultural purposes.

(iii) Major ion chemistry and nutrient loads

Rostherne Mere has moderate alkalinity that is greater than those of Little Mere and Mere Mere upstream of it. This may reflect additional ground water supplies entering it. Its total and soluble reactive phosphorus concentrations are high and may (or may not) reflect the supply of sewage effluent that previously reached the mere from Little Mere. Nitrate concentrations are low but nitrate is rarely totally depleted whilst ammonium concentrations are rather higher in winter than might be expected.

(iv) Phytoplankton and zooplankton

Chlorophyll a concentrations are on average modest but rise to nearly 100 ug/l in late summer when blue-green algal blooms are common. ***Daphnia*** are not very abundant but not as scarce as in some of the meres. Grazing, however is unlikely to be a major factor in determining phytoplankton abundance.

(v) Aquatic plants

Rostherne is a deep lake and opportunities for plant colonisation are few. The submerged flora is sparse but ***Callitriche*** is abundant at the edges.

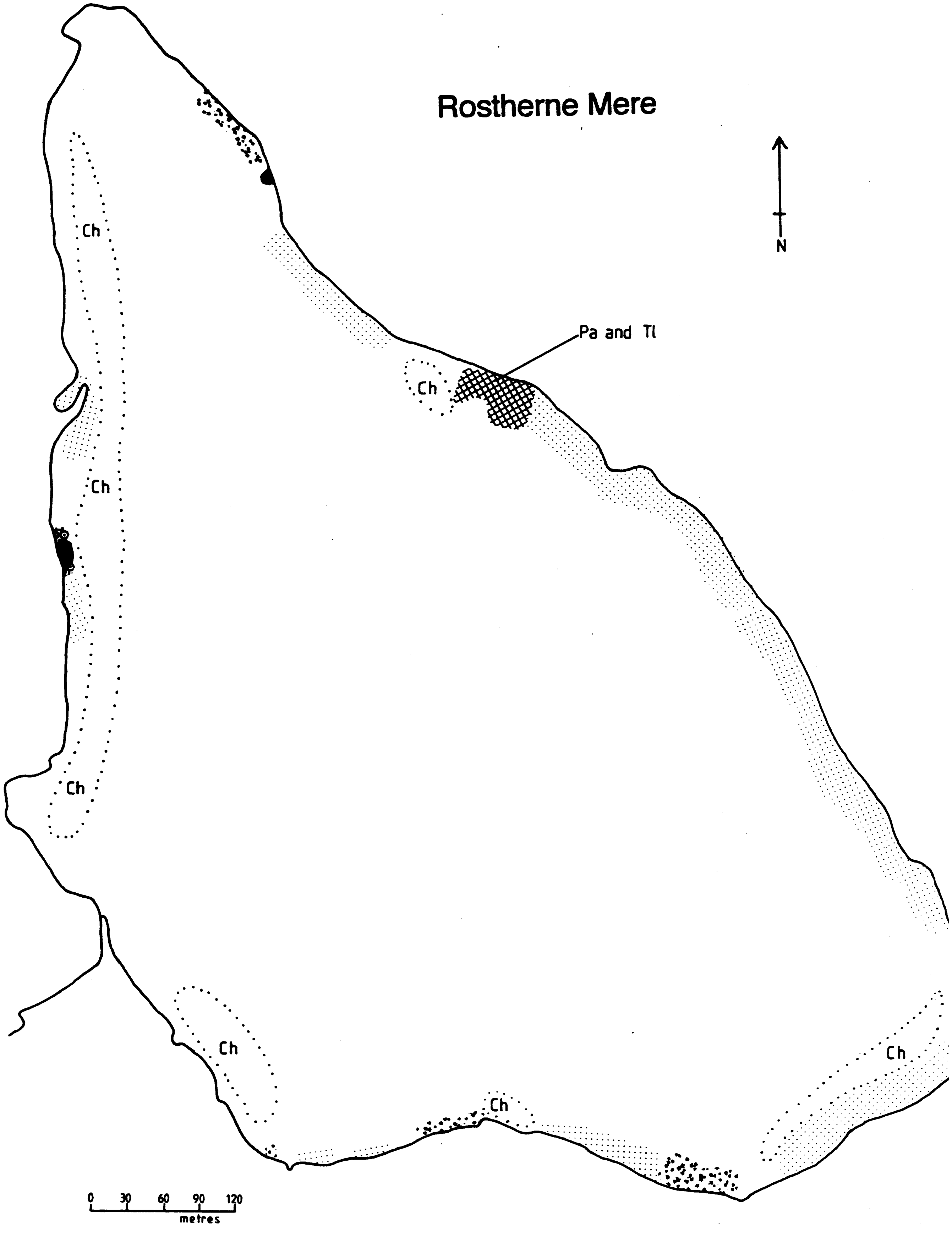
(vi) Overall assessment

It is difficult to assess the status of Rostherne Mere because it may be in a state of transition following the diversion of sewage effluent from it . For the moment it is sensible not to impose further management until the effects of the diversion have been assessed. This may take several years. A more detailed picture will emerge when data collected over the past three years have been fully analysed.

	Date	Phenolph alk	Total alk	pH	Chloride	Sol React P	Total Sol P	Total P	Nitrate N	Ammonium N	Silicate Si	Chlorophyll a	Carotenoids	A480:A663	A430:A410	Secchi depth	Total Daphnia
1	Jan 7 1991	0.000	2.300	8.000	42.900	402.000	418.000	422.000	0.650	373.000	1.550	0.000	2.000		0.900	1.750	0.00
2	Jan 22 1991	0.000	2.300	7.980	41.200	390.000	393.000	401.000	1.480	226.000	1.710	1.100	4.600	4.600	0.900		0.00
3	Feb 5 1991	0.000	2.180	7.790	43.300	385.000	431.000	417.000	1.430	16.000	2.000	0.000	0.800	4.600	1.000		0.00
4	Feb 19 1991	0.000	2.200	7.950	45.000	397.000	422.000	425.000	1.290	0.000	1.860	0.000	0.000				0.00
5	Mar 5 1991	0.000	2.200	8.020	44.900	417.000	434.000	438.000	1.030	0.000	1.840	0.440	1.800	4.500	1.000		0.00
6	Mar 19 1991	0.000	2.200	8.230	47.900	401.000	427.000	418.000	1.190	0.000	1.790	1.500	3.400	2.400	1.100	2.750	0.03
7	April 2 1991	0.025	2.330	8.140	44.900	391.000	392.000	442.000	1.890	0.000	1.670	5.060	8.200	1.800	1.170	3.100	0.60
8	April 16 1991	0.025	2.300	8.450	46.900	370.000	340.000	433.000	1.080	3.000	0.970	0.000	13.000	1.800	1.380	2.150	0.70
9	April 29 1991	0.100	2.200	8.370	40.800	360.000	338.000	392.000	0.930	0.000	0.960	5.300	9.800	2.000	1.180	3.900	8.60
10	May 13 1991	0.000	2.300	8.190	46.900	370.000			0.770	49.000	0.760	0.000	1.200		0.800	8.150	21.70
11	May 27 1991	0.100	2.300	8.480	47.400	326.000	305.000	357.000	0.960	18.000	0.860	9.900	13.600	1.500	1.040	4.500	9.50
12	June 11 1991	0.150	2.250	8.640	44.900	312.000	338.000	429.000	0.830	29.000	0.660	21.100	23.800	1.240	1.160	2.300	15.10
13	June 25 1991	0.100	2.330	8.660	40.000	302.000	313.000	357.000	1.210	16.000	0.720	16.700	21.800	1.400	1.230	2.800	6.00
14	July 9 1991	0.180	2.330	8.790	44.900	319.000	313.000	356.000	1.140	25.000	0.460	18.000	22.400	1.370	1.140		0.40
15	July 22 1991	0.180	2.430	8.890	46.900	268.000	306.000	336.000	0.680	0.000	1.120	22.400	29.000	1.420	1.000	2.700	2.30
16	Aug 5 1991	0.700	2.500		46.900	160.000	205.000	319.000	0.100	1.000	1.000	68.600	96.800	1.600	1.340	1.030	3.10
17	Aug 20 1991	0.700	3.150	9.670	45.400	162.000	184.000	305.000	0.060	5.000	1.920	77.400	92.800	1.320	1.340	1.000	1.60
18	Sept 9 1991	1.330	3.880	9.700	47.900	134.000	146.000	238.000	0.030	20.000	1.490	35.200	65.700	2.100	1.300	1.850	3.00
19	Sept 23 1991	0.900	3.300	9.590	44.900	193.000	203.000	257.000	0.000	94.000	1.390	42.500	72.000	1.900	1.300	1.240	39.80
20	Oct 9 1991	0.950	4.150	9.290	45.700	245.000	291.000	380.000	0.130	0.000	1.840	34.800	69.000	2.200	1.170	0.880	21.40
21	Oct 22 1991	0.550	3.350	8.650	47.400	309.000	391.000	455.000	0.260	52.000	1.080	24.900	49.300	2.000	1.280	1.150	4.40
22	Nov 5 1991	0.200	3.180	8.360	36.400	355.000	360.000	488.000	0.230	231.000	2.730	21.600	52.300	2.700	1.100	1.000	6.80
23	Nov 19 1991	0.180	3.200	8.100	46.900	610.000	646.000	847.000	0.230	607.000	2.110	1.100	10.300	10.300	1.040	1.700	10.00
24	Dec 3 1991	0.000	2.800	7.930	44.000	426.000	416.000	462.000	0.340	543.000	2.090	0.000	2.700		0.900	3.500	7.20
25	Dec 18 1991	0.130	2.680	7.870	46.500	486.000	581.000	696.000	0.370	537.000	2.270	0.370	5.000	15.000	0.800	2.500	1.50
26																	
27	Winter mean	0.064	2.610	9.800	43.300	431.000		520.000	0.810	317.000	2.040	3.000					6.4
28	SD	0.090	0.420	0.170	3.400	82.000		163.000	0.570	237.000	0.360	7.500					3.6
29	Growth mean	0.350	2.670	8.740	45.500	296.000		370.000	0.720	18.000	1.210	22.600					8.6
30	SD	0.420	0.630	0.550	2.300	92.000		66.000	0.540	26.000	0.470	23.200					11.0
31	Annual mean	0.260	2.650	8.500	44.700	341.000		419.000	0.730	114.000	1.470	16.300					8.2
32	SD	0.037	0.570	0.580	2.800	109.000		127.000	0.540	192.000	0.590	21.500					9.9

Rostherne Mere Phytopl 1991

	Organism	Jan 7 1991	Mar 5 1991	Mar 19 1991	April 2 1991	April 16 1991	May 13 1991	May 27 1991	June 11 1991	June 25 1991	July 9 1991	July 22 1991	Aug 5 1991	Aug 29 1991	Sept 9 1991	Sept 23 1991	Oct 9 1991	Oct 22 1991
1	Amphora ov	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	Aster form	-	168	3	-	700	22	-	-	-	365	-	-	-	-	-	-	-
3	Fragilaria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	Navicula sp	-	-	-	-	-	-	-	-	-	-	45	89	-	-	-	-	-
5	Nitzschia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	Synedra acus	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-
7	Cyclotella sp	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	Steph ast	-	-	9	46	128	-	-	-	-	-	-	-	-	-	-	-	-
9	Steph hantsch	-	-	255	3276	10657	-	-	-	-	-	581	-	-	-	-	-	-
10	Pinnularia	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	Gomphonema	-	-	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-
12	Synedra ulna	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	Melosira	-	7	-	119	-	-	-	-	-	-	-	-	-	-	-	-	-
14	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	Oocystis	-	-	-	-	-	-	-	-	-	61	-	-	-	-	-	-	-
16	Ankistrod	13	27	9	46	292	-	997	50	-	152	-	-	-	-	-	-	-
17	Chlorella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	Scened quad	-	27	-	36	-	-	-	201	-	-	-	-	-	-	-	-	-
19	Elakatothrix	-	-	-	-	-	58	-	-	-	-	-	-	-	-	-	-	-
20	Schroed setig	-	-	-	-	-	-	16	-	6022	30	402	-	-	-	-	-	-
21	Tetraed caud	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-
22	Pediastrum	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	Staurastrum	-	-	-	-	-	-	-	-	-	76	-	134	268	-	-	-	-
24	Chlamydo sp	-	-	119	265	-	15	917	-	-	-	-	-	-	-	-	-	-
25	Act hantz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
26	Trachelomonas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	-	-
27	Euglena sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	Phacus	-	-	-	-	377	-	-	-	-	-	-	-	-	-	-	-	-
29	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	Cryptomonas	-	7	-	82	140	-	48	50	-	1277	179	45	-	-	-	-	13
31	Rhodo min	7	409	-	73	657	88	772	302	182	776	625	45	-	-	281	13	13
32	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	Unid flag	74	174	-	392	109	139	434	302	547	274	134	-	-	-	27	20	-
34	Mallomonas	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-
35	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	Ceratium hir	-	-	-	-	-	-	-	-	-	30	45	45	45	142	74	10	4
37	Gymnodinium	-	-	-	9	-	-	-	-	-	30	-	-	-	-	-	-	-
38	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	Anab spir	-	-	-	-	-	7	193	1307	-	-	89	938	-	-	-	-	-
40	Aphan fl aq	-	-	-	-	-	-	-	-	-	-	89	849	223	-	-	-	-
41	Chroococcus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	Gomphosphaer	-	-	-	-	-	-	-	-	-	-	-	-	45	17	13	3	2
43	Microcyst aer	-	-	-	-	-	7	-	-	16606	3	134	313	938	184	174	77	67
44	Osc agard	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-
45																		
46	Total diatoms	0	196	267	3477	11485	22	0	0	0	365	626	89	0	0	0	0	0
47	Total greens	13	54	131	347	292	73	1930	251	6022	334	402	134	268	0	0	0	0
48	Total others	81	590	0	564	1283	227	1254	654	729	2387	983	135	45	142	409	43	30
49	Total blue grns	0	0	0	0	0	14	193	1307	16606	3	312	2100	1207	201	200	80	69
50	TOTAL	94	840	398	4388	13060	336	3377	2212	23357	3089	2323	2458	1520	343	609	123	99
51																		
52	Diatoms%	0	23.3	67.1	79.2	87.9	6.5	0	0	0	11.8	26.9	3.6	0	0	0	0	0
53	Greens %	13.8	6.4	32.9	7.9	2.2	21.7	57.2	11.3	25.8	10.8	17.3	5.5	17.6	0	0	0	0
54	Others %	86.0	70.2	0	12.9	9.8	67.6	37.1	29.6	3.1	77.3	42.3	5.5	3.0	41.4	67.2	35	30.3
55	Blue greens%	0	0	0	0	0	4.2	5.7	59.0	71.1	0.1	13.4	85.4	79.4	58.6	32.8	65.0	69.7
56																		
57		Diatoms	Greens	Others	Blue greens													
58	Winter mean	0	14(24.2)	58.8(26.8)	27.3(31.9)													
59	Growth mean	19.1(30.7)	13.5(15.4)	33.3(26.4)	34(34)													
60	Annual mean	14.6(27.8)	13.6(17.2)	39.4(28.2)	32.4(32.9)													



Rostherne Mere
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(s) TABLEY MERE AND TABLEY MOAT

(i) Morphometry ans water budget

Tabley Mere has a rather irregular shape compared with other of the meres and the existence of follies on an island and around it testifies to a degree of landscaping in the past, perhaps including the raising of water levels of a preexisting natural lake. There are really two lakes, the mere proper and a smaller pool to the north, which receives water from the mere. This pool is called Tabley Moat for it suurounds a former Hall. The Mere is 19.4 ha in area with a depth of 4.4m; the moat is about 2ha with a depth estimated at 1.5m. The mere has two main inflows, one (TBMMI) from the north in the direction of the M6 motorway, the other (TBMI1) draining land from the east. There are two outflows, a major one (TBMO) over a sliuice to the west and a smaller one which seeps through woodland to Tabley Moat. The Moat has a small inflow of its own coming in from the north of it but this was dry during this study and an outflow (TBLO) to the north west. To obtain some information on ground water in the area, a small pond (TBPd) and a field drain (TBFD) close to the mere were sampled throughout for the pond and when it flowed in winter for the drain.

The combined inflows to Tabley Mere delivered 1.28 million cubic metres of water per year. The combined outflows from the system lost 1.67 million cubic metres. This can be considered a reasonable balance and suggests that ground water is relatively insignificant in this system. Based on the outflow volumes the flushing rates of the Mere were 3, 4.4 and 1.9 per year on annual, winter and growth season bases with corresponding retention times of 17,12 and 27 weeks. For Tabley Moat the flushing rates were 12.6, 16.8 and 10.5 per year for the annual, winter and growth season periods. Respective retention times were 4,3 and 5 weeks.

(ii) Changes in land use

The catchment of the Tabley system lies in the parishes of Tabley inferior and superior and Bexley, for which the land use changes have been:

	1931	1987
Cattle(head)	1128	1741
nutrient units	13649	21066
Pigs(head)	189	43
nutrient units	907	206
Sheep(head)	428	346
nutrient units	642	519
Poultry(head)	10741	8135
nutrient units	1504	1139
Total nutrient units	16702	22930
Permanent grass(ha)	610	380
Temporary grass(ha)	341	259
Arable(ha)	322	462
Woodland(ha)	6	7
Rough grazing(ha)	19	44
Total hectarage	1298	1152

There has thus been the rather common pattern of some increase in cattle keeping at the expense of other stock, but with an overall increase in potential nutrient load, a loss of grassland to arable and some loss of land to non-agricultural uses.

(iii) Major ion chemistry and nutrient loads

As reflected in the conductivities of the pond and field drain, the ionic content of the immediate ground water is low (375 and 452 uS/cm) compared with the two inflows, gathering water from some distance away. The conductivity of the inflow that drains catchment close to the motorway is higher (863) than that of the other inflow to Tabley Mere (652) and carries about double the chloride concentration though a lesser alkalinity. The source of the chloride may be road salt. The conductivity and chloride concentrations of the mere are consonant with a simple mixing of the two inflow waters but there is a lower alkalinity in the mere than in either inflow. Alkalinity is not fully conservative and some carbonate ions thus seem to be precipitating in the mere. The moat has a slightly lower conductivity and higher alkalinity than the mere suggesting either an additional small source of water (perhaps the inflow that did not flow this year) or chemical changes in the water passing through the wet woodland that separates the mere and the moat. Much of this water passes by seepage.

The local ground water is moderately rich in phosphorus and low in nitrate as measured in the pond but the existence of moderately high ammonium levels in this pond suggest that its water chemistry may be modified by cattle and that some of the phosphorus may be derived from cattle excreta. Ground water is unlikely to be a major nutrient source for this system however. The field drain was markedly less rich in phosphorus, and had much greater nitrate concentrations. It probably reflected the composition of surface run off after some soil contact rather than deep ground water composition.

The major inflow streams are both very rich in soluble reactive and total phosphorus, and nitrate. The eastern stream is also very rich in ammonium. The phosphorus concentrations could be natural in the motorway stream but the chances are that there is contamination by farm effluent and this is certainly the case for the eastern inflow. The motorway inflow carried 7315 kgN and 384 kgP per year; the eastern inflow carried 5891 kgN and 439 kgP per year. The combined load on Tabley Mere was a very high 4.32 gP per square metre and 68 gN per square metre.

Concentrations of phosphorus in both the mere and moat were consequentially high and inorganic nitrogen concentrations were also generally higher than in most other mere sites. Inorganic nitrogen availability, however was very low in both for a period during the summer.

(iv) Phytoplankton and zooplankton

Although there was a distinct and prolific spring peak of phytoplankton, concentrations during the rest of the year in Tabley Mere were low and numbers of ***Daphnia*** were high. The spring peak was of small diatoms and diatoms were important components of the community. Nitrogen-fixing blue-green algae were present in summer but were not prominent, though occasionally they aggregated as blooms in the southern part of the lake. Tabley Moat was similar but additionally sustained a large population of flagellate green algae in autumn. ***Daphnia*** grazing was also likely to have been very important in the Moat.

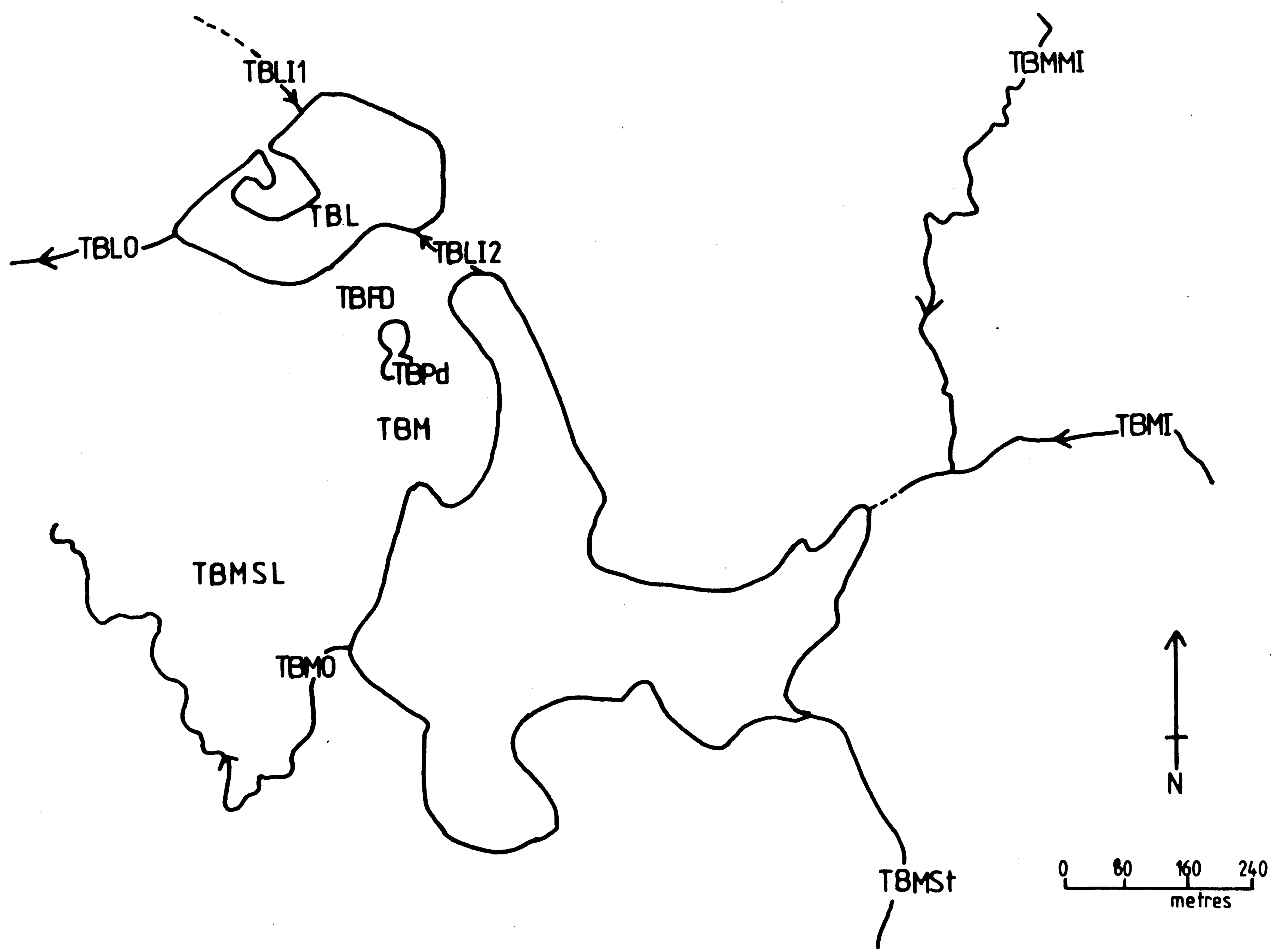
(v) Aquatic plants

Both mere and moat were rich in aquatic plant diversity and biomass. ***Callitriche hermaphroditica*** dominated the mere with

Potamogeton berchtoldii. Hydrodictyon and filamentous algae were common and four other species of vascular plant were present. The moat has a classic Phase 2 community with abundant ***Ceratophyllum demersum*** and other submerged species with extensive beds of ***Nuphar lutea*** with ***Nymphaea alba***.

(vi) Overall assessment

Both the moat and the mere are in Phase 2 states. They have been undoubtedly eutrophicated by the farm effluent entering through the surface streams and it is this which presently maintains the high plant biomass. Such communities are stabilised by mechanisms such as ***Daphnia*** grazing. The plants provide refuges and allow coexistence of abundant grazer Cladocera with normal fish communities. There is an active fishing club on both mere and moat. The danger for such sites is that their nutrient loading is high enough for only small changes in additional switch mechanisms to cause a loss of plants and an establishment of phytoplankton dominance. Switch mechanisms are various and can include mechanical damage to the plants, decrease in water level giving increased access of birds to the plants, increases in alien bird grazers, like Canada geese, and use of herbicides on surrounding areas. They can also include mechanisms that eliminate the Cladocera for a period, such as pesticide drift, severe winter icing that kills piscivorous fish and favours zooplanktivorous fish or severely increased salinity. There are dangers of some of these mechanisms operating at Tabley Mere and the results could be precipitous and dramatic. It would be highly desirable to restrict the nutrient input coming through both inflows as soon as possible. Arablisation should also be avoided on the immediately surrounding land and the present flock of Canada geese should be reduced as much as possible.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Sat, Sep 5, 1992 4:44 pm

Tabley Mere Motorway Inflow

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	Oct 16 1991	520	0.00	2.15	7.17	49.0	1331.0	1870	522	2393	3.85	357	4.10	0.014	35.600		20.300	
2	Nov 6 1991	831	0.05	3.15	7.54	116.0	160.0			184	4.35	763	4.89	0.028	86.600		3.100	
3	Nov 27 1991	778	0.15	2.75	7.62	106.0	157.0	358	0	358	4.32	437	3.66	0.019	54.700		4.100	
4	Jan 8 1992	845	0.00	2.45	7.41	88.0	119.0	134	50	184	3.91	358	4.88	0.029	74.900		3.200	
5	Jan 29 1992	1257	0.00	2.10	8.14	255.6	147.0	224	33	258	8.05	430	4.28	0.013	66.700		2.030	
6	Feb 26 1992	868	0.35	3.05	7.61	108.0	136.0	196	75	271	15.22	1077	3.88	0.016	157.700		2.620	
7	Mar 17 1992	840	0.10	3.00	7.56	98.4	87.9	214	253	467	14.21	378	4.21	0.069	609.000		19.500	
8	April 8 1992	840	0.30	2.15	7.49	105.0	180.0	180	144	324	15.00	700	3.72	0.022	209.000		4.300	
9	May 6 1992	991	0.00	2.65	7.34	156.0	731.0	731	929	1659	10.30	262	5.80	0.018	115.000		18.100	
10	May 27 1992	839	0.00	2.10	7.68	128.0	298.0	428	0	428	13.42	158	3.99	0.009	73.900		2.330	
11	June 17 1992	882	0.00	2.20	7.71	129.0	305.0	373	26	399	15.11	101	4.31	0.007	64.400	7316.000	1.690	384.000
12																		
13	Winter mean	916	0.11	2.70	7.66	135.0	144.0			251	7.17	613	4.32	0.021				
14	SD	194	0.15	0.40	0.28	68.0	17.0			72	4.80	303	0.56	0.007				
15	Growth mean	819	0.07	2.38	7.49	111.0	489.0			945	11.98	326	4.36	0.023				
16	SD	158	0.12	0.37	0.20	37.0	468.0			870	4.40	213	0.74	0.023				
17	Annual mean	863	0.09	2.52	7.57	122.0	332.0			630	9.80	457	4.34	0.022				
18	SD	173	0.13	0.41	0.25	52.0	377.0			716	5.00	286	0.63	0.017				

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	Jul 31 1991	593	0	2.32	7.17	73.5	404	423	107	530	0.71	1036	5.55	+	0.420		0.130	
2	Aug 21 1991	*	*	*	*	*	*	*	*	*	*	*	*	0	0.000		0.000	
3	Sept 11 1991	*	*	*	*	*	*	*	*	*	*	*	*	0	0.000		0.000	
4	Oct 16 1991	*	*	*	*	*	*	*	*	*	*	*	*	0	0.000		0.000	
5	Nov 6 1991	*	*	*	*	*	*	*	*	*	*	*	*	0	0.000		0.000	
6	Nov27 1991	788	0.25	4.45	7.45	71	250	386	273	659	2.55	1478	3.420	0.001	2.440		0.400	
7	Jan 8 1992	787	0	2.15	7.33	76	105	123	58	182	7.53	561	4.97	0.012	58.720		1.320	
8	Jan 29 1992	785	0.1	3.5	8.36	77.8	123	123	5	128	7.68	616	4.91	0.003	15.050		0.230	
9	Feb 26 1992	838	0	3.3	7.63	88	164	203	150	353	10.98	1127	4.67	0.001	7.320		0.210	
10	Mar 17 1992	756	0	2.6	7.29	73	64	74	60	135	17.87	277	4.59	0.009	98.800		0.740	
11	April 8 1992	*	*	*	*	*	*	*	*	*	*	*	*	0	0.000		0.000	
12	May 6 1992	769	0	4.0	7.3	72	202	203	0	203	5.45	590	4.83	0.003	10.960		0.370	
13	May 27 1992	876	0.1	5.85	7.93	72	533	547	867	1414	0.86	3072	5.8	+	0.950		0.340	
14	June 17 1992	804	0	4.6	8.04	72.7	14	14	277	291	4.4	211	5.13	0.0008	2.230	731.000	0.140	14.400
15																		
16	Winter mean	800	0.09	3.35	7.69	78.2	161			331	7.19	946	4.49	0.003				
17	SD	26	0.19	0.94	0.46	7.1	65			239	3.48	437	0.73	0.004				
18	Growth mean	760	0.02	3.87	7.55	72.6	243			515	5.86	1057	5.18	0.0015				
19	SD	104	0.04	1.46	0.41	0.65	221			524	7.0	1167	0.5	0.003				
20	Annual mean	777	0.05	3.64	7.61	75.1	207			433	6.45	1008	4.87	0.002				
21	SD	78	0.09	1.2	0.41	5.3	167			410	5.46	869	0.67	0.004				

Tabley Fd Drain to TBL TBFD

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/year	kg P/year
1	Nov 27 1991	458	0	2.2	6.60	69	13	20	11	31	4.26	109	4.91	0.0001		
2	Jan 8 1992	419	0	1.9	6.79	30	108	118	50	168	4.46	112	3.91	0.0001		
3	Jan 29 1992	*	*	*	*	*	*	*	*	*	*	*	*	0		
4	Feb 26 1992	479	0	2.9	7.01	28	23	23	11	35	4.66	155	4.01	0.0002		
5	Mar 17 1992	*	*	*	*	*	*	*	*	*	*	*	*	0		
6	April 8 1992	*	*	*	*	*	*	*	*	*	*	*	*	0		
7																
8	Winter mean	452	0	2.3	6.8	42	48			78	4.46	125	4.3	0.00006	8.700	0.150
9	SD	30	0	0.5	0.2	23	52			78	0.2	26	0.6	0.00008		

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate SI	Discharge
1	Jul 31 1991	722	0.0	2.46	8.00	118	526	530	100	630	0.430	494.0	5.95	0.0026
2	Aug 21 1991	681	0.6	2.50	9.14	119	359	425	48	473	0.078	61.7	1.71	*
3	Sept 11 1991	*	*	*	*	*	*	*	*	*	*	*	*	0
4	Oct 16 1991	625	0.4	2.4	8.67	98	481	571	126	697	0.18	179	1.19	0.023
5	Nov 6 1991	642	0.1	2.35	7.82	80	454	473	78	551	0.52	703	1.8	0.028
6	Nov 27 1991	717	0.2	2.7	8.01	82.4	280	309	119	427	1.7	1533	2.3	0.034
7	Jan 8 1992	691	0	2.1	7.78	92	180	208	99	307	2.71	448	4.15	0.085
8	Jan 29 1992	732	0	2.4	8.27	90.7	160	160	0	160	11.31	300	4.21	0.043
9	Feb 26 1992	853	0.4	2.6	8.78	128	13	52	106	158	7.59	92	2.69	0.035
10	Mar 17 1992	781	0.25	2.35	8.86	114	3	35	45	80	5.97	47.4	0.26	0.184
11	April 8 1992	712	0.3	3.15	8.66	95	8	38	35	72	7.62	48	0.19	0.038
12	May 6 1992	686	0.25	2.6	8.73	94	59	89	21	111	2.8	89	0.99	0.027
13	May 27 1992	707	0.45	2.2	9.27	120	106	120	199	319	0.39	93	3.58	0.021
14	June 17 1992	No flow												
15														
16	Winter mean	727	0.14	2.43	8.13	94.6	217			321	4.77	615	3.03	0.045
17	SD	78	0.17	0.23	0.4	19	163			171	4.54	559	1.1	0.023
18	Growth mean	702	0.32	2.5	8.76	108	220			340	2.5	145	1.98	0.049
19	SD	47	0.19	0.3	0.41	12	228			265	3.1	161	2.1	0.067
20	Annual mean	712	0.27	2.48	8.5	103	229			332	3.44	341	2.42	0.047
21	SD	60	0.19	0.27	0.51	16	194			222	3.76	432	1.76	0.05

Tabley Mere stream TBMI1/TBMI

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Total Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge	kg N/week	kg N/year	kg P/week	kg P/year
1	Jul 31 1991	615	0.00	3.68	7.41	36.7	583	624	473	1097	2.32	4920	9.01	0.0003	1.300		0.200	
2	Aug 21 1991	658	0.00	2.00	7.35	85.0	460	582	0	582	6.25	2024	3.25	0.0050	25.000		1.760	
3	Nov 6 1991	598	0.00	1.30	7.47	79.0	247			265	5.92	123	3.12	0.0190	69.400		3.050	
4	Nov 27 1991	740	0.25	4.45	7.27	62.8	504	740	123	863	2.91	8332	5.08	0.1670	1135.500		87.200	
5	Jan 8 1992	595	0.00	2.60	7.24	46.0	140	233	0	233	5.77	684	4.36	0.0090	35.100		1.270	
6	Jan 29 1992	627	0.10	4.10	8.30	64.8	547	559	65	624	7.88	1925	4.92	0.0010	5.900		0.380	
7	Feb 26 1992	673	0.00	3.70	7.50	56.0	273	327	46	373	5.15	1188	4.07	0.0060	23.000		1.350	
8	Mar 17 1992	607	0.05	3.25	7.45	44.5	130	174	56	230	6.81	441	3.84	0.0130	57.000		1.800	
9	April 8 1992	713	0.10	2.85	7.38	62.1	866	1483	211	1694	2.97	2018	3.58	0.0020	6.030		3.400	
10	May 6 1992	696	0.00	4.85	7.09	52.0	1205	1249	1898	3146	0.50	2619	3.26	0.0006	1.130		1.140	
11	May 27 1992													0.0000	0.000		0.000	
12	June 17 1992													0.0000	0.000	5891.000	0.000	439.000
13																		
14	Winter mean	647	0.07	3.23	7.56	61.7	342			496	5.53	2450	4.31	0.0400				
15	SD	61	0.11	1.28	0.43	12.0	175			302	1.78	3354	0.78	0.0700				
16	Growth mean	658	0.03	3.30	7.34	56.1	649			1350	3.77	2404	4.59	0.0030				
17	SD	47	0.04	1.05	0.14	18.7	408			1146	2.68	1622	2.48	0.0050				
18	Annual mean	652	0.05	3.30	7.45	58.9	496			911	4.65	2427	4.45	0.0186				
19	SD	52	0.08	1.10	0.32	15.0	337			911	2.34	2484	1.74	0.0470				

Tabley Moat Outflow TBLO

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge
1	Jul 31 1991	642	0.00	3.12	7.75	79.6	924	1030	25.0	1055	0.050	217.0	1.68	0.0010
2	Aug 21 1991	648	0.00	3.40	7.74	85.0	1127	1459		1238	0.120	165.0	1.86	0.0012
3	Sept 11 1991	688	0.10	3.60	7.90	85.0	126			1542	0.084	170.0	1.95	0.0006
4	Oct 16 1991	633	0.30	3.60	7.79	71.7	821	1187	292.0	1479	0.090	96.4	4.66	0.0020
5	Nov 6 1991	638	0.20	3.10	7.59	76.0	806	978	6.7	985	0.230	248.0	6.30	0.0040
6	Nov 27 1991	597	0.25	3.20	7.76	57.0	563	609	70.0	679	0.780	795.0	3.55	0.0030
7	Jan 8 1992	612	0.00	2.20	7.73	66.0	20	327	0.0	327	4.020	455.0	5.31	0.0110
8	Jan 29 1992	639	0.00	2.70	8.22	63.0	153	153	0.0	153	7.580	264.0	5.87	0.0100
9	Feb 26 1992	676	0.00	2.50	8.01	80.0	40	53	30.0	82	4.720	143.0	3.72	0.0100
10	Mar 17 1992	650	0.30	2.40	8.86	76.2	2	19	74.0	93	3.150	82.0	0.45	0.0190
11	April 4 1992	630	0.35	2.60	8.29	68.0	3	25	59.0	85	4.140	42.0	0.42	0.0170
12	May 6 1992	620	0.10	3.10	7.77	66.0	154	179	3.0	182	0.740	479.0	2.75	0.0040
13	May 27 1992	668	0.00	3.95	7.59	56.0	404	404	0.0	404	1.940	53.0	4.52	0.0003
14	June 17 1992	687	0.00	4.15	7.63	48.5	351	351	0.0	351	2.080	4.0	4.52	0.0001
15														
16	Winter mean	632	0.09	2.74	7.86	68.4	316			445	3.470	381.0	4.95	0.0080
17	SD	30	0.12	0.40	0.25	9.0	351			380	3.020	257.0	1.25	0.0040
18	Growth mean	652	0.14	3.32	7.92	70.7	435			714	1.380	145.0	2.53	0.0001
19	SD	24	0.15	0.58	0.41	12.5	422			608	1.530	143.0	1.69	0.0080
20	Annual mean	645	0.11	3.12	7.90	69.9	392			618	2.120	230.0	3.39	0.0060
21	SD	27	0.14	0.59	0.35	11.2	388			538	2.300	216.0	1.92	0.0060

Tabley Pond TBPd

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si
1	Jul 31 1991	402	0.0	2.16	7.58	53.0	432.0	432	222	645	0.29	1866	2.94
2	Aug 21 1991	421	0.0	2.50	7.34	60.0	382.0	504	153	657	0.14	2970	3.53
3	Sept 11 1991	410	0.0	2.35	7.47	55.4	65.0			307	0.41	376	2.96
4	Oct 16 1991	401	0.0	2.35	7.41	53.0	171.0	274	25	299	0.24	1226	4.13
5	Nov 6 1991	386	0.0	1.80	7.35	76.0	81.3	122	58	180	0.28	975	4.37
6	Nov 27 1991	353	0.1	1.90	7.36	56.9	40.0	73	50	123	0.24	513	3.48
7	Jan 8 1992	362	0.0	1.60	7.59	54.0	69.0	98	31	128	0.45	195	3.71
8	Jan 29 1992	385	0.0	1.60	7.98	44.4	49.0	49	73	122	0.55	158	4.16
9	Feb 26 1992	350	0.0	1.50	8.09	56.0	16.0	57	35	91	0.19	42	3.33
10	Mar 17 1992	347	0.1	1.50	8.33	54.0	10.0	51	89	149	0.12	35	4.04
11	April 4 1992	343	0.1	1.80	7.79	56.3	6.0	27	204	231	0.13	11	2.52
12	May 6 1992	349	0.0	1.55	7.99	54.0	2.0	75	145	220	0.02	75	1.93
13	May 27 1992	368	0.0	1.75	7.62	56.0	35.0	102	219	321	0.00	3	1.95
14	June 17 1992	376	0.0	1.85	7.73	56.6	103.0	195	405	600	0.03	36	1.93
15													
16	Winter mean	367	0.0	1.68	7.67	57.5	51.0			129	0.34	377	3.81
17	SD	17	0.0	0.16	0.35	11.5	25.0			32	0.15	377	0.44
18	Growth mean	380	0.0	1.98	7.70	55.4	134.0			381	0.15	733	2.88
19	SD	30	0.0	0.37	0.31	2.2	164.0			197	0.14	1067	0.88
20	Annual mean	375	0.0	1.87	7.69	56.1	104.0			291	0.22	606	3.21
21	SD	26	0.0	0.34	0.31	6.7	136.0			200	0.17	881	0.86

Tabley Mere TBM

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Total Sol P	Partic P	Total P
1	Jul 31 1991	702	0.00	2.48	7.73	73.5	549	455	163	618
2	Aug 21 1991	681	1.00	2.50	9.44	123.4	279	335	26	361
3	Sept 11 1991	687	1.00	2.40	9.71	126.0	183			250
4	Oct 16 1991	653	0.40	2.90	8.53	94.4	597	711	137	848
5	Nov 11 1991	641	0.10	2.40	8.13	96.0	396	396		396
6	Nov 27 1991	714	0.15	2.95	7.86	118.0	251	312	38	350
7	Jan 8 1992	685	0.00	2.10	7.82	92.0	154	182	86	267
8	Jan 29 1992	Frozen								
9	Feb 26 1992	848	0.30	2.60	8.75	132.0	14	48	103	151
10	Mar 17 1992	769	0.30	2.30	8.93	120.7	7	34	92	126
11	April 8 1992	712	0.40	2.40	8.84	89.3	1	31	82	112
12	May 6 1992	663	0.35	2.50	9.01	52.0	50	84	0	84
13	May 27 1992	711	0.25	2.20	9.03	118.0	161	209	57	265
14	June 17 1992	643	0.95	2.15	10.22	111.0	188	238	126	364
15										
16	Winter mean	722	0.14	2.51	8.14	110.0	204			291
17	SD	89	0.13	0.36	0.43	19.0	161			108
18	Growth mean	691	0.52	2.43	9.05	101.0	224			336
19	SD	38	0.37	0.22	0.71	25.6	218			253
20	Annual mean	701	0.40	2.45	8.77	104.0	218			323
21	SD	56	0.36	0.26	0.76	23.0	196			215

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.080	747.0	4.83	10.60	8.30	0.86	1.10	>	124.00
2	0.009	128.0	0.91	2.69	4.00	1.50	1.17	>	10.04
3	0.000	30.0	2.01	1.35	3.33	2.50	0.83	>	50.74
4	0.007	89.0	1.78	6.70	2.70	0.04	0.89	>	26.30
5	0.400	656.0	1.93	10.40	12.70	1.23	0.96	>	16.64
6	1.450	1444.0	0.89	7.70	11.30	1.62	0.82	>	0.18
7	3.770	444.0	3.26	4.40	13.00	3.25	0.81	>	0.20
8									
9	6.740	58.0	2.34	86.90	116.00	1.47	1.67	>	0.18
10	5.260	62.0	0.23	45.10	53.00	1.29	1.20	>	3.06
11	8.170	9.5	0.18	37.80	44.00	1.28	1.20	>	3.60
12	2.200	73.0	1.28	0.40	2.30	7.00	0.69	>	41.20
13	0.250	236.0	3.66	12.10	15.00	1.36	0.98	>	1.89
14	0.000	14.0	1.83	3.30	8.30	2.78	0.91	>	94.40
15									
16	3.090	651.0	2.11	27.40					4.30
17	2.810	584.0	0.98	39.70					8.20
18	1.780	154.0	1.86	13.30					39.50
19	2.980	233.0	1.53	16.50					43.80
20	2.180	284.0	1.93	17.60					28.60
21	2.880	410.0	1.35	25.00					39.70

	Organism	July 31 1991	Aug 21 1991	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 27 1992	June 17 1992
1	Amph comm	-	-	-	-	-	-	94	-	-	-	-	-
2	Amphora sp	20	-	-	27	94	-	40	200	-	-	13	-
3	Amphora ov	-	40	107	-	-	134	-	-	-	-	-	-
4	Cyclo chaet	-	-	-	-	-	-	-	-	3217	-	-	-
5	Cyclotella sp	-	27	-	40	-	13	27	41600	-	-	-	-
6	Cyclo menegh	-	-	-	-	-	-	-	-	8847	44997	-	-
7	Cocconeis	-	13	13	94	27	134	188	-	67	-	-	-
8	Cymb vent	-	-	-	54	-	27	-	-	-	-	-	-
9	Fragilaria	-	27	201	40	-	-	-	-	-	-	-	-
10	Frag constr	-	-	-	-	13	161	107	-	-	-	121	-
11	Gomphonema	20	67	-	-	-	67	67	-	-	-	-	40
12	Gomph vent	-	-	13	-	-	-	-	-	-	-	-	-
13	Diatoma	-	-	-	-	-	13	-	-	-	-	-	-
14	Caloneis	-	-	-	-	-	13	-	-	-	-	-	-
15	Hantzschia	-	-	-	-	-	-	13	-	-	-	-	-
16	Frag crot	-	-	-	-	-	-	-	-	-	-	13	-
17	Gyrosigma	-	-	-	-	-	-	-	-	-	-	13	-
18	Navicula	322	13	13	-	27	94	121	-	-	-	27	27
19	Nitzschia	281	683	-	-	-	-	-	200	-	-	27	-
20	Pinn virid	-	-	-	-	-	-	-	-	-	-	13	-
21	Pinn sp	-	13	-	-	-	-	-	-	-	-	-	-
22	Synedra ulna	-	13	-	-	-	-	13	-	-	-	-	-
23	Synedra sp	-	-	-	54	-	-	-	-	268	-	13	1635
24	Rhoicosphenia	-	13	-	-	-	-	-	-	-	-	-	-
25	Stephanod sp	-	-	13	-	-	-	-	-	-	-	-	-
26	Cymbella sp	-	-	-	27	-	-	-	-	-	-	-	-
27	*	-	-	-	-	-	-	-	-	-	-	-	-
28	*	-	-	-	-	-	-	-	-	-	-	-	-
29	*	-	-	-	-	-	-	-	-	-	-	-	-
30	*	-	-	-	-	-	-	-	-	-	-	-	-
31	Ankistrod sp	-	40	-	-	-	-	-	-	-	-	-	-
32	Ank conv	-	-	-	-	-	-	-	-	201	-	-	-
33	Chlamydo sp	40	-	27	161	-	-	134	1800	2212	2825	80	161
34	Chlamydo ang	60	-	-	-	-	-	-	-	-	-	-	-
35	Chlamydo ep	362	-	-	-	-	-	-	-	-	-	-	-
36	Chlamydo glob	-	-	-	-	-	-	-	2400	-	-	-	-
37	Chlorella sp	-	308	-	-	-	-	-	-	-	1009	-	-
38	Lobomonas sp	-	-	-	-	-	-	-	200	-	-	-	-
39	Micract pus	-	-	-	-	-	-	-	-	402	-	-	-
40	Oocystis sp	-	-	-	-	-	-	-	-	-	-	-	-
41	Scened acum	-	-	-	-	13	-	-	-	-	-	-	-
42	Scened quad	-	-	-	-	-	-	-	-	201	-	-	-
43	Scened bij	-	-	-	-	27	40	27	-	-	-	-	13
44	Scened quad	-	13	-	-	-	-	-	-	-	-	13	-
45	Schroed jud	462	-	-	-	-	-	-	-	-	-	-	-
46	Schroed setig	-	80	-	-	-	-	-	-	-	202	67	27
47	Selenast west	-	13	-	-	-	-	13	200	134	202	-	-
48	Selenast min	-	-	-	-	-	-	-	-	-	202	-	-
49	Tetrast staur	-	-	-	-	-	-	-	-	-	404	-	-
50	Closterium	-	-	-	-	-	-	-	-	-	-	-	13
51	*	-	-	-	-	-	-	-	-	-	-	-	-
52	*	-	-	-	-	-	-	-	-	-	-	-	-
53	*	-	-	-	-	-	-	-	-	-	-	-	-
54	Euglena sang	-	-	-	-	-	-	-	-	-	202	-	-
55	Euglena sp	-	13	-	-	-	-	13	-	335	-	-	-
56	Trachelomonas	40	13	-	-	-	13	-	-	67	-	13	-
57	*	-	-	-	-	-	-	-	-	-	-	-	-
58	*	-	-	-	-	-	-	-	-	-	-	-	-
59	Crypto erosa	-	-	-	-	-	-	-	-	201	-	-	-
60	Crypto acuta	-	-	-	-	-	-	13	2000	469	-	-	-
61	Crypto ovata	60	-	-	-	-	-	-	-	-	807	-	-
62	Rhodo min	3477	-	134	563	188	590	161	1400	201	807	442	121
63	*	-	-	-	-	-	-	-	-	-	-	-	-
64	*	-	-	-	-	-	-	-	-	-	-	-	-
65	*	-	-	-	-	-	-	-	-	-	-	-	-
66	Chloromonas	-	241	-	-	-	-	-	-	-	404	-	-
67	*	-	-	-	-	-	-	-	-	-	-	-	-
68	*	-	-	-	-	-	-	-	-	-	-	-	-
69	*	-	-	-	-	-	-	-	-	-	-	-	-
70	*	-	-	-	-	-	-	-	-	-	-	-	-
71	Anab circ	-	13	-	-	-	-	-	-	-	-	-	-
72	Anab aff	-	-	-	-	-	-	-	-	-	-	-	-
73	Anab sp	1307	-	-	-	-	-	-	-	-	-	-	-

Tabley Mere Phytopl 1991/92

	Organism	July 31 1991	Aug 21 1991	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 27 1992	June 17 1992
74	Aph fl aq	-	174	-	-	-	-	-	-	-	-	456	817
75	Coelosphaer	-	-	-	-	-	-	-	-	-	-	-	-
76	Lyngbya sp	-	-	-	-	-	-	-	-	-	-	67	-
77	Merismo sp	-	-	-	-	-	13	-	-	-	-	-	-
78	Phormidium sp	20	-	-	-	-	-	-	-	-	-	-	-
79	Osc sp	-	40	27	27	-	-	-	-	-	-	-	-
80	Osc ten	-	1072	-	-	-	-	-	-	-	-	27	-
81													
82	Total diatoms	643	909	360	417	161	656	670	42000	12399	44997	240	1672
83	Total greens	924	454	27	161	40	40	174	4600	3150	4844	160	214
84	Total others	3577	267	134	563	188	603	187	3400	1273	2220	455	121
85	Total blue grns	1327	1299	27	27	0	013	0	0	0		550	817
86	TOTAL	6471	2929	548	1168	389	1312	1031	50000	16822	52061	1405	2824
87													
88	Diatoms %	9.9	31	65.7	35.7	41.4	50	65	84	73.7	86.4	17.1	59.2
89	Greens %	14.3	15.5	4.9	13.8	10.3	3	16.9	9.2	18.7	9.3	11.4	7.6
90	Others %	55.3	9.1	24.5	48.2	48.3	46	18.1	6.8	7.6	4.3	32.4	4.3
91	Blue greens%	20.5	44.3	4.9	2.3	0	1	0	0	0	0	39.1	28.9
92													
93													
94	Winter mean	60.1(18.7)	9.9(5.7)	29.8(20.6)	0.25(0.5)								
95	Growth mean	47.3(27.8)	11.9(4.5)	23.2(20.3)	17.5(18.2)								
96	Annual mean	51.6(25.0)	11.2(4.8)	25.4(19.7)	12.8(17.2)								

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 31 1991	721	0.00	2.50	7.92	127.0	519	511	85	596
2	Aug 21 1991	692	0.55	2.60	9.07	119.0	367	444	31	475
3	Sept 11 1991	687	0.55	2.55	9.27	115.0	395			449
4	Oct 16 1991	640	0.30	2.50	8.66	94.0	469	628	0	628
5	Nov 11 1991	641	0.20	2.40	7.76	114.0	439	495	67	562
6	Nov 27 1991	719	0.35	2.85	7.81	80.0	277	341	5	347
7	Jan 8 1992	691	0.00	2.05	7.71	92.0	181	208	99	307
8	Jan 29 1992	727	0.00	2.30	8.18	90.7	160	160	23	183
9	Feb 26 1992	847	0.35	2.65	8.76	132.0	15	37	133	170
10	Mar 17 1992	778	0.30	2.30	8.94	118.0	5	31	82	112
11	April 8 1992	713	0.40	2.60	8.64	93.2	5	40	37	77
12	May 6 1992	687	0.25	2.65	8.70	92.0	63	93	6	99
13	May 27 1992	703	0.45	2.20	9.24	116.0	113	146	56	202
14	June 17 1992	656	0.65	2.35	9.69	105.0	234	315	39	354
15										
16	Winter mean	725	0.23	2.45	8.04	102.0	214			314
17	SD	76	0.17	0.31	0.44	21.0	157			159
18	Growth mean	697	0.38	2.47	8.90	109.0	241			332
19	SD	40	0.20	0.15	0.50	13.0	203			217
20	Annual mean	707	0.31	2.46	8.60	106.0	232			326
21	SD	54	0.21	0.21	0.60	16.0	182			192

Tabley Mere near sluice TBMSL

Sat, Sep 5, 1992 6:03 pm

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoid	480:663	430:410	Secchi	Total Daphnia
1	0.400	681.0	5.55	4.40	4.3	1.08	1.11	>	3.080
2	0.074	113.0	1.91	5.05	5.0	1.00	1.11	>	0.370
3	0.005	44.5	1.35	26.30	45.0	1.73	1.36	>	47.460
4	0.190	192.0	1.30	4.00	9.0	2.25	0.94	>	0.400
5	0.540	726.0	1.88	0.34	4.0	12.00	0.72	>	5.000
6	2.080	1039.0	1.82	1.80	4.3	2.60	0.90	>	0.800
7	2.710	448.0	4.15	2.20	10.0	5.00	0.69	>	0.000
8	10.370	367.0	4.42	1.80	9.3	5.60	0.67	>	0.000
9	7.970	175.0	2.87	78.50	77.7	1.09	1.26	>	0.000
10	6.020	32.0	0.21	56.80	64.0	1.24	1.21	>	0.180
11	7.250	55.0	0.27	7.70	9.3	1.33	0.98	>	15.100
12	3.050	137.0	1.05	1.50	7.0	5.25	0.86	>	14.400
13	0.250	121.0	3.41	15.00	19.3	1.41	1.02	0.6	14.300
14	0.000	19.0	2.84	57.90	60.3	1.15	1.30	>	
15									
16	4.730	551.0	3.03	16.90					1.160
17	4.200	337.0	1.22	34.40					2.170
18	1.920	155.0	1.99	19.90					11.900
19	2.860	205.0	1.71	22.60					15.900
20	2.920	296.0	2.36	18.80					7.780
21	3.530	316.0	1.59	26.10					13.400

	Organism	July 31 1991	Aug 21 1992	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 27 1992	June 17 1992
1	Amphora sp	-	147	-	-	-	-	13	-	-	-	-	-	-
2	Amphora ov	-	-	134	-	-	13	-	-	-	-	-	13	-
3	Cocconeis	-	27	-	27	-	-	13	-	-	-	-	-	20
4	Cyclotella sp	-	13	-	13	-	54	-	-	1240	13712	8042	13	-
5	Cymbella sp	-	-	-	27	-	-	-	-	-	-	-	-	-
6	Frag sp	20	-	-	13	-	-	13	-	-	-	-	-	-
7	Gomphon sp	20	27	-	-	-	-	-	-	-	-	67	-	-
8	Gyrosig sp	-	-	-	-	-	-	-	-	-	-	-	13	-
9	Frag crot	-	-	-	-	-	-	-	-	-	-	-	13	-
10	Navic sp	121	-	-	27	-	-	27	-	80	40	-	13	-
11	Nitzch sp	-	40	469	-	-	-	-	-	40	-	-	-	-
12	Pinn sp	-	-	-	-	-	-	-	-	-	-	-	13	-
13	Rholcosph sp	-	-	-	-	-	-	-	-	40	-	-	-	-
14	Synedra sp	-	13	-	-	-	-	-	-	-	40	134	-	241
15	Surirella sp	-	-	-	-	-	-	-	-	-	-	-	-	-
16	*	-	-	-	-	13	-	-	-	-	-	-	-	-
17	*	-	-	-	-	-	-	-	-	-	-	-	-	-
18	*	-	-	-	-	-	-	-	-	-	-	-	-	-
19	*	-	-	-	-	-	-	-	-	-	-	-	-	-
20	Ankist falc	-	-	67	-	-	-	-	-	40	-	-	-	-
21	Ank conv	-	-	-	40	-	-	-	-	-	-	201	-	-
22	Chlamydo pseu	-	-	-	-	-	-	-	-	120	-	-	-	-
23	Chlamydo sp	-	67	-	27	-	-	94	117	2440	1890	1005	40	40
24	Chlamydo sp	321	-	-	-	147	-	-	-	-	-	-	-	-
25	Chlamydo glob	-	-	67	-	-	-	-	-	-	-	-	-	-
26	Chlorella sp	-	-	-	-	-	-	-	26	-	-	-	-	-
27	Chlamydo spha	-	-	-	-	13	-	13	-	160	-	536	-	-
28	Chlorogon sp	-	-	-	-	-	-	-	39	200	-	-	-	-
29	Carteria sp	-	-	-	-	-	-	-	-	-	-	67	-	-
30	Closterium sp	-	-	-	-	-	-	-	-	-	-	67	-	-
31	Crucig tetra	-	-	-	-	-	-	-	13	-	-	-	-	-
32	Crucig quad	-	-	-	-	-	-	-	-	-	402	-	-	-
33	Oocystis sp	20	-	-	-	-	-	-	-	-	-	-	-	-
34	Scened quad	-	-	-	-	-	-	-	-	-	40	-	13	20
35	Scened bij	-	-	-	-	-	-	-	-	41	-	-	-	-
36	Scened acum	-	-	-	-	-	-	-	-	-	40	-	-	-
37	Scened dim	-	-	-	-	-	-	-	-	-	-	134	-	-
38	Schroed jud	322	-	-	-	-	-	-	-	-	-	67	-	-
39	Schroed setig	-	724	-	-	-	-	-	-	-	-	-	54	40
40	Selenast west	-	-	-	-	-	-	-	-	-	563	-	-	-
41	Tetraed sp	-	13	-	-	-	-	-	-	-	-	-	-	-
42	Tetras staur	-	-	-	-	-	-	-	-	-	-	134	-	-
43	*	-	-	-	-	-	-	-	-	-	-	-	-	-
44	*	-	-	-	-	-	-	-	-	-	-	-	-	-
45	*	-	-	-	-	-	-	-	-	-	-	-	-	-
46	*	-	-	-	-	-	-	-	-	-	-	-	-	-
47	*	-	-	-	-	-	-	-	-	-	-	-	-	-
48	*	-	-	-	-	-	-	-	-	-	-	-	-	-
49	Euglena sang	-	-	-	-	-	-	-	-	-	-	-	27	-
50	Eugl sp	-	-	67	54	-	-	67	13	40	40	67	-	-
51	Trachelo sp	-	-	-	13	-	-	-	-	40	40	-	-	-
52	Crypto arc	-	-	-	-	-	-	-	-	-	-	-	13	-
53	Crypto marss	-	-	-	-	-	-	-	26	-	-	-	-	-
54	Crypto acuta	-	-	-	-	-	-	13	-	4640	201	-	-	-
55	Crypto erosa	-	-	-	-	-	13	-	-	-	241	871	-	-
56	Crypto ov	80	-	67	-	27	-	-	39	-	-	-	-	-
57	Rhodo min	2211	-	871	228	161	188	94	156	360	40	1005	415	60
58	*	-	-	-	-	-	-	-	-	-	-	-	-	-
59	*	-	-	-	-	-	-	-	-	-	-	-	-	-
60	*	-	-	-	-	-	-	-	-	-	-	-	-	-
61	Chlorochr min	-	335	-	-	-	-	-	-	-	-	-	-	-
62	Chloromonas	-	-	-	-	-	-	-	-	-	-	67	-	-
63	Coccomonas	-	-	-	-	-	-	-	-	-	-	134	-	-
64	*	-	-	-	-	-	-	-	-	-	-	-	-	-
65	*	-	-	-	-	-	-	-	-	-	-	-	-	-
66	Glenodinium	-	-	-	-	-	-	-	-	40	-	-	-	-
67	*	-	-	-	-	-	-	-	-	-	-	-	-	-
68	*	-	-	-	-	-	-	-	-	-	-	-	-	-
69	Anabaena sp	442	-	-	-	-	-	-	-	-	-	-	-	-
70	Aphan flos aq	-	-	7238	764	-	-	13	-	-	-	-	241	3558
71	Aphan iz sp	-	-	-	-	27	-	-	-	-	-	-	-	-
72	Calothrix sp	-	-	-	-	-	-	-	-	-	-	67	-	-
73	Coelosph sp	20	-	-	-	-	-	-	-	-	-	-	-	-

Tabley Mere Sluice Phytopl 91/2

	Organism	July 31 1991	Aug 21 1992	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 27 1992	June 17 1992
74	Gloeocap rup	-	-	-	-	-	-	-	-	-	121	67	-	-
75	Lyngbya sp	-	-	-	-	-	-	-	-	-	-	-	94	40
76	Merismo punc	-	-	-	-	-	-	13	-	-	-	-	-	-
77	Osc sp	-	27	-	-	-	-	-	-	-	-	-	27	-
78	Osc ten	-	335	-	-	-	-	-	-	-	-	-	-	-
79	Stigonema sp	-	-	-	-	-	-	-	13	-	-	67	-	-
80														
81	Total diatoms	161	267	603	107	13	67	66	0	1400	13792	8243	91	261
82	Total greens	663	804	134	67	160	0	107	195	3001	2975	2211	107	100
83	Total others	2291	335	1005	295	188	201	174	234	5120	562	2144	455	60
84	Total blue grns	462	362	7238	764	27	0	26	13	0	121	201	762	3598
85	TOTAL	3577	1768	8980	1233	388	268	347	442	9521	17270	12799	1415	4019
86														
87	Diatoms %	4.5	15.1	6.7	8.7	3.4	25	19	0	14.7	79.9	64.4	6.4	6.5
88	Greens %	18.5	45.5	1.5	5.4	41.2	0	30.8	44.1	31.5	16.2	17.3	7.6	2.5
89	Others %	64	19	11.2	23.9	48.5	75	50.1	52.9	53.8	3.3	16.8	32.1	1.5
90	Blue greens %	12.9	20.5	80.6	62	7.0	0	7.5	2.9	0	0.7	1.6	25.6	89.5
91														
92		Diatoms	Greens	Others	Blue greens									
93	Winter mean	12.4(10.5)	29.5(17.5)	56.1(11)	3.5(3.6)									
94	Growth mean	24(30)	14.3(14.3)	21.5(20)	36.7(35.5)									
95	Annual mean	19.6(24.5)	20.2(16.8)	34.8(24)	23.9(32)									

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 31 1991	646	0.00	3.04	7.43	77.6	1096	1181	0	1181
2	Aug 21 1991	667	0.00	3.40	7.41	85.0	1275	1480	48	1528
3	Sept 11 1991	680	0.00	3.70	7.73	85.0	1157			1409
4	Oct 16 1991	618	0.40	3.80	7.66	71.7	1010	1276	0	1276
5	Nov 6 1991	627	0.00	3.00	7.78	80.0	669	797	0	797
6	Nov 27 1991	596	0.10	3.50	7.59	74.5	391	494	109	603
7	Jan 8 1992	615	0.00	2.30	7.67	64.0	154	190	48	239
8	Jan 29 1992	591	0.00	2.80	8.52	29.6	135	135	0	135
9	Feb 26 1992	668	0.10	2.70	8.01	84.0	111	118	60	177
10	Mar 17 1992	666	0.25	2.75	8.68	79.4	2	32	74	105
11	April 8 1992	625	0.20	2.90	8.48	75.7	2	27	56	83
12	May 6 1992	596	0.35	3.00	8.59	70.0	64	87	135	222
13	May 27 1992	642	0.00	3.70	7.57	70.0	891	1093	0	1093
14	June 17 1992	612	0.00	4.35	7.47	64.6	942	942	285	1227
15										
16	Winter mean	619	0.04	2.86	7.90	75.6	292			390
17	SD	31	0.05	0.44	0.37	8.7	239			293
18	Growth mean	639	0.13	3.40	7.89	75.4	715			903
19	SD	284	0.17	0.52	0.53	7.0	532			589
20	Annual mean	632	0.10	3.21	7.90	75.5	564			720
21	SD	30	0.14	0.55	0.47	7.0	486			552

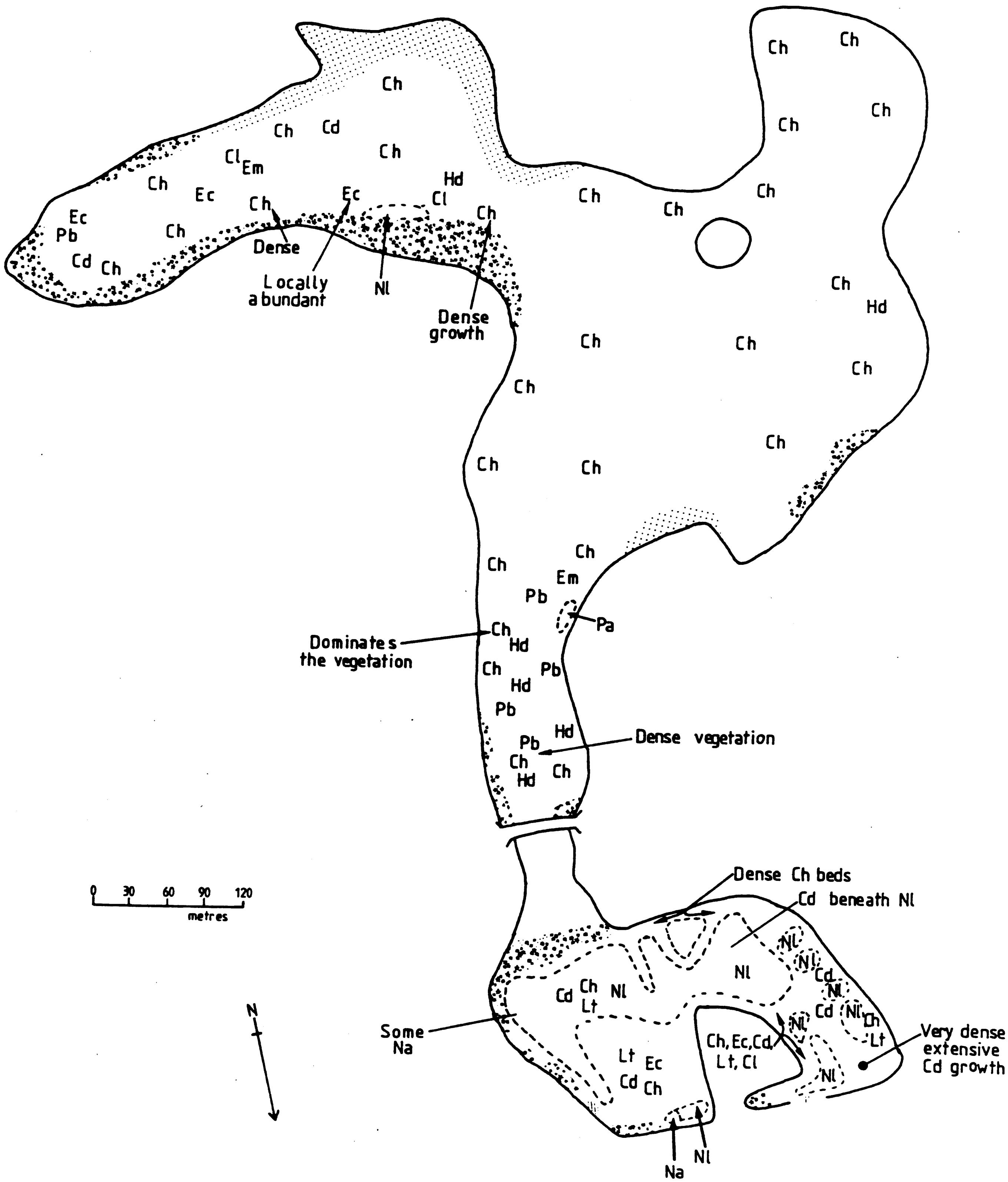
Tabley Moat TBL

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.040	393.0	2.37	0.00	5.3	>	0.87	>	160.70
2	0.022	187.0	1.87	1.40	2.0	1.5	0.84	>	51.86
3	0.000	25.0	1.79	4.00	7.0	1.75	0.87	>	224.40
4	0.004	57.2	4.87	34.30	40.0	1.18	1.19	>	6.15
5	0.150	119.0	6.59	194.00	218.0	1.14	0.36	>	0.42
6	0.610	748.0	4.87	63.80	61.3	1.06	1.28	>	13.86
7	3.930	622.0	5.05	3.70	8.0	2.4	0.78	>	0.62
8	7.580	670.0	5.88	4.80	10.3	2.38	0.92	>	2.87
9	4.830	77.0	3.68	12.80	24.0	2.06	1.01	>	1.15
10	3.800	63.0	0.51	61.20	67.7	1.22	1.24	>	3.64
11	4.720	21.0	0.38	26.80	32.7	1.34	1.17	>	3.78
12	0.130	28.0	2.31	60.50	56.0	1.02	1.21	>	1.95
13	0.140	1004.0	4.01	3.70	8.0	2.4	0.85	>	98.70
14	0.680	265.0	5.04	0.70	1.0	1.5	0.81	>	2.00
15									
16	3.420	447.0	5.20	21.30					3.78
17	3.090	322.0	1.10	28.60					5.70
18	1.060	227.0	2.57	21.40					61.50
19	1.840	319.0	1.72	25.50					82.70
20	1.900	306.0	3.52	21.40					40.90
21	2.530	326.0	1.98	25.30					71.00

	Organism	July 31 1991	Aug 21 1991	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 6 1992	May 27 1992	June 17 1992
1	Achnanthes	-	-	-	20	-	-	-	-	-	-	-	-	-	-
2	Cyclo chaetoc	-	-	-	-	-	-	-	-	-	2252	-	-	-	-
3	Cyclo menegh	-	27	-	-	-	-	-	-	-	11460	4584	-	-	-
4	Cyclo sp	-	-	13	-	-	40	67	-	377	-	-	101	27	67
5	Cocconeis	-	-	-	40	40	40	27	13	39	-	-	-	-	-
6	Cymbella vent	-	-	-	-	-	-	-	-	-	-	-	101	-	-
7	Cymbella	13	-	13	-	-	-	-	-	-	-	-	-	-	-
8	Cymatopleura	-	13	-	-	-	-	-	-	-	-	-	-	-	-
9	Frag viresc	-	-	-	-	-	-	-	26	-	-	-	-	-	-
10	Frag crot	-	-	134	-	-	-	-	-	-	-	-	-	-	-
11	Frag construe	-	-	-	-	-	-	-	130	-	-	40	201	-	-
12	Frag constric	27	-	-	-	-	-	-	-	-	-	-	-	-	-
13	Frag sp	214	-	-	-	161	-	-	-	-	40	40	-	13	-
14	Gomph acum	-	-	13	-	-	-	-	-	-	-	-	-	-	-
15	Gomph vent	- -	27	-	-	-	-	-	-	-	-	-	-	-	-
16	Gomph sp	54	-	-	-	40	-	-	-	-	-	-	-	-	-
17	Hantzschia	-	40	-	-	-	-	-	-	-	-	-	-	-	-
18	Melosira dist	-	-	-	-	-	-	-	-	-	40	-	-	-	-
19	Melosira sp	-	-	-	-	-	-	-	-	-	-	121	-	-	-
20	Nitsch sig	-	-	-	-	-	-	-	-	-	40	-	-	-	-
21	Nitsch sp	-	-	13	-	-	-	-	-	26	-	-	-	-	-
22	Navicula	121	80	13	80	-	-	94	143	52	121	161	-	13	-
23	Nav hung	-	13	13	-	-	-	-	-	-	-	-	-	-	-
24	Pinnularia	13	-	-	-	-	-	-	-	-	-	-	-	-	-
25	Stephan astr	-	-	-	-	-	-	-	-	-	-	40	-	-	-
26	Synedra	80	189	-	-	-	-	-	13	26	40	201	-	-	107
27	Synedra aff	-	40	-	-	-	-	-	-	-	-	-	-	-	-
28	Synedra uln	-	-	13	20	20	-	-	-	-	-	-	-	-	-
29	Navic capitat	-	-	-	-	-	-	-	-	-	-	-	-	-	13
30	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	Ank conv	-	40	-	-	-	-	-	-	-	-	40	-	-	-
35	Chlamyd sphag	- -	-	-	-	-	-	-	-	-	40	643	-	-	-
36	Chlamyd glob	-	-	13	-	-	-	-	-	-	-	-	402	-	-
37	Chlamyd poly	-	-	54	-	-	-	-	-	-	-	-	-	-	-
38	Chlamyd snow	-	13	-	-	-	-	-	-	-	-	-	-	-	-
39	Chlamyd ang	74	-	-	-	-	-	-	-	-	-	-	-	-	-
40	Chlamyd ep	54	107	-	101	-	-	-	-	-	-	-	-	40	-
41	Chlamyd sp	54	-	121	101	101	201	161	104	338	2212	-	-	54	188
42	Characiopsis	-	27	-	-	-	-	-	-	-	-	-	-	-	-
43	Carteria	-	-	-	2271	-	-	-	-	-	-	-	-	-	-
44	Chlorella	-	-	-	-	-	-	-	26	-	40	-	-	13	-
45	Chlorogonium	-	-	-	-	-	-	-	-	195	-	-	-	-	-
46	Elakatothrix	-	-	-	20	-	-	-	-	-	-	-	-	-	-
47	Carteria cord		-	-	-	2191	3035	-	-	-	-	-	15483	40	-
48	Oocystis pus	-	27	-	-	-	-	-	-	-	-	-	-	-	-
49	Ped bory	-	-	13	-	-	-	-	-	-	-	-	-	-	-
50	Polytoma	-	-	-	-	-	-	-	-	-	40	-	-	-	-
51	Scened bijug	13	-	-	-	-	-	-	-	-	80	-	-	-	-
52	Scened qu long	-	13	-	-	-	-	-	-	-	-	-	-	-	-
53	Schroed setig	-	-	13	-	-	-	-	-	-	-	-	-	121	13
54	Tetraed min	-	-	-	-	-	20	-	-	-	-	-	-	-	-
55	Ulothrix	-	27	-	-	-	-	-	-	-	-	-	-	-	-
56	Characium am	-	-	-	-	-	-	-	-	-	-	-	-	-	54
57	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
58	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
59	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
60	Phacus	-	-	-	-	-	141	-	-	-	-	-	-	-	13
61	Phacus long	-	-	-	221	-	-	-	-	13	-	-	-	-	-
62	Eugl sang	-	-	27	-	-	-	-	-	65	161	-	-	-	-
63	Trachelo sp	-	-	13	-	20	60	-	-	-	121	40	-	-	13
64	Euglena sp	-	-	-	40	60	20	40	-	-	-	-	-	-	13
65	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
66	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
67	Crypto acut	-	-	-	-	-	-	-	13	533	201	-	-	-	67
68	Crypto reflex	-	-	-	-	-	-	134	-	39	-	80	-	-	-
69	Crypto ov	-	-	40	201	20	422	-	13	26	282	-	-	-	-
70	Crypto eross	-	-	-	302	-	-	-	-	-	-	402	-	-	-
71	Rhodo min	-	67	27	40	-	60	-	-	3107	201	80	101	107	134
72	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Organism	July 31 1991	Aug 21 1991	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 6 1992	May 27 1992	June 17 1992
74	Chlorochr min	-	40	-	-	-	-	-	-	-	-	-	-	-	-
75	Gonyostomum	-	-	-	362	-	-	-	-	-	-	-	-	-	-
76	Mallomonas	-	-	-	-	-	60	-	-	-	-	80	-	-	-
77	Chloromonas	-	-	-	-	-	-	-	-	-	-	201	-	-	-
78	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
79	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80	Anabaena sp	27	-	-	-	-	-	-	-	-	-	-	-	-	-
81	Anab fl aq	-	-	-	-	-	-	-	-	-	-	-	-	-	-
82	Cylindrosperm	-	-	-	-	-	-	-	-	-	-	40	-	-	-
83	Dact raph	-	-	-	-	-	-	-	-	-	-	80	-	-	-
84	Gloeocaps rup	-	13	-	-	-	-	-	-	-	-	-	-	-	-
85	Merismop sp	-	-	-	-	-	-	54	-	-	-	-	-	-	-
86	Microcystis	-	-	-	-	-	-	-	13	-	-	-	-	-	-
87	Synech aerug	-	-	-	-	-	-	-	-	-	-	-	-	13	-
88	Osc sp	-	-	-	-	-	-	-	-	26	-	-	-	-	-
89															
90	Total diatoms	522	429	225	160	261	80	188	325	520	13973	5187	403	53	187
91	Total greens	195	254	214	2493	2292	3256	161	130	533	2412	683	15885	268	255
92	Total others	0	107	107	1165	100	763	174	26	3783	966	883	101	107	240
93	Total blue grns	27	13	0	0	0	0	54	13	26	0	120	0	13	0
94	TOTAL	744	803	546	3818	2653	4099	577	494	4862	17351	6873	16389	441	682
95															
96	Diatoms %	70.2	53.4	41.2	4.2	9.8	1.95	32.6	65.8	10.7	80.5	75.5	2.5	12	27.4
97	Greens %	26.2	31.6	39.2	65.3	86.4	79.4	27.9	26.3	11	13.9	9.9	96.9	60.8	37.4
98	Others %	0	13.3	19.6	30.5	3.8	18.6	30.2	5.3	77.8	5.6	12.8	0.6	24.3	35.2
99	Blue greens %	3.6	1.6	0	0	0	0	9.4	2.6	0.5	0	1.7	0	2.9	0
100															
101		Diatoms	Greens	Others	Blue greens										
102	Winter mean	24.2(25.9)	46.2(34.2)	27.1(30.3)	2.5(4.0)										
103	Growth mean	40.8(30.9)	42.4(27.6)	15.8(12.6)	1.09(1.42)										
104	Annual mean	34.8(29.3)	43.7(28.9)	19.8(20.3)	1.59(2.58)										

Tabley Mere



Tabley Moat

(t) TATTON MERE

(i) Morphometry and water budget

Tatton is a largish mere of 31.7ha with a maximum depth of around 11m. It has inflows through wetland to the south where the town of Knutsford lies close to it and a single outflow to the north. A small mere, Melchett Mere lies close to its outflow and appears to be fed entirely from ground water plus diffuse run off from the parkland that surrounds the mere. The flushing rates, based on gauging of the outflow, on annual, winter and growth season bases were 1.1,1.45, and 1 per year with corresponding retention times of 46,36 and 54 weeks. Water is thus held in the basin for a relatively long period with little seasonal variation.

(ii) Changes in land use

The catchment of Tatton Mere lies within the parishes of Tatton and Knutsford for which the land use changes have been as follows:

	1931	1987
Cattle(head)	556	496
nutrient units	6728	6002
Pigs(head)	154	0
nutrient units	739	0
Sheep(head)	1269	321
nutrient units	1814	482
Poultry(head)	2408	23
nutrient units	337	3
Total nutrient units	9618	6487
Permanent grass(ha)	851	214
Temporary grass(ha)	47	28

Arable(ha)	147	318
Woodland(ha)	3	25
Rough grazing(ha)	0	0
Total hectarage	1048	585

These parishes are unusual in showing a decline in stock keeping, a familiar drift to arable from grassland but a very marked loss of land to non agricultural uses as the local town has expanded.

(iii) Major ions and nutrient loads

The local ground water ,as reflected in Melchett Mere, is moderately rich in ions with quite high alkalinity. It is also low in phosphorus and in nitrate. Tatton Mere has slightly greater conductivity and lesser alkalinity reflecting local heterogeneity but confusing the interpretation of Tatton's rather high soluble reactive and total phosphorus concentrations. These may be natural but equally may be derived from old effluent inputs fom Knutsford. The town is mains sewered but the effluent is discharged elsewhere. With such high phosphorus concentrations it might be expected that inorganic nitrogen would build up also in winter if there is an ultimate excretal source and there is a small but distinct increase. The inflow comes through areas of wetland that would mute such increase even in winter. The nutrient status of the mere thus remains problematic with some reason for suspicion of effluent entry.

(iv) Phytoplankton and zooplankton

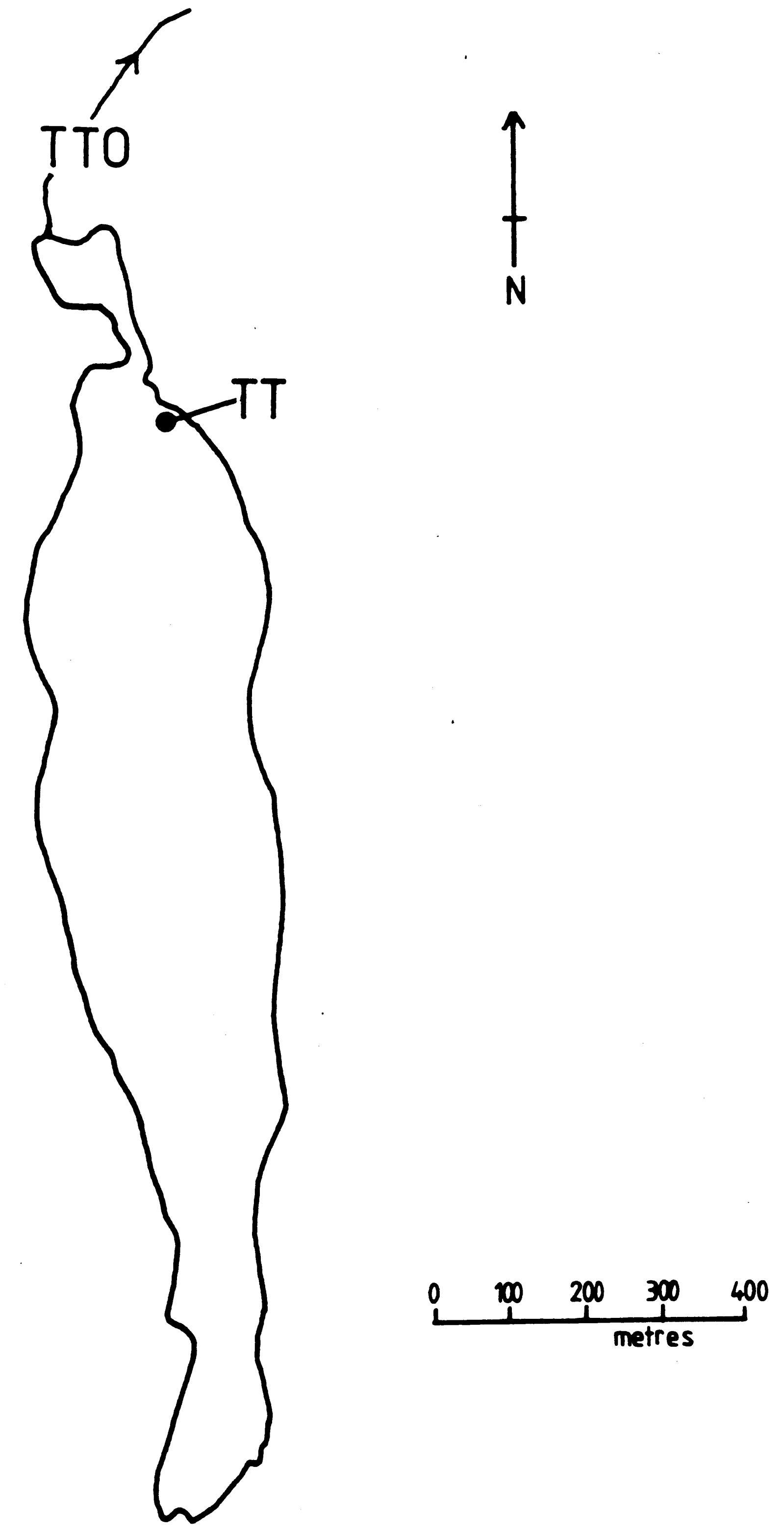
Apart from a spring peak of diatoms, chlorophyll a concentrations were low, whilst ***Daphnia*** populations were very modest. Blue-green algae were also scarce. The algal crop thus seems to be controlled by the low nitrogen availability and it is surprising, considering the long retention time and high alkalinity that nitrogen fixing blue-green algae were scarce.

(v) Aquatic plants

A full survey could not be carried out because of the prohibition of powered boats on the mere but it was clear from a littoral survey that aquatic plants were relatively abundant and diverse with nine submerged vascular plants plus one species of ***Chara*** being recorded. ***Myriophyllum spicatum, Elodea canadensis*** and ***Potamogeton pectinatus*** were particularly plentiful. These are all highly tolerant species. The trophic score was 8.8, alittle higher than those recorded in 1979 and 1987 (8.5,8.6) but probably not significantly so. The DAFOR score remains high at 27, with 1979 and 1987 values having been 24 and 17.5 respectively.

(vi) Overall assessment

Despite a suspicion of effluent contamination, which may eventually prove to be unfounded, Tatton Mere is in a reasonable state with low algal crops, that are nutrient controlled, and a rich aquatic plant assemblage. It is desirable that the issue of nutrient source be further investigated but it is likely to be one that will decrease rather than increase as old septic tank systems are replaced by mains sewerage. On balance the phosphorus levels are so high that any such source should be very obvious. That it is not makes it likely that the high phosphorus concentration is natural and that the drift to the south of the mere is phosphorus rich. No immediate action seems necessary at Tatton mere.


TTO
TT
N
0
100
200
300
400
metres

Tatton Mere Outflow TTO

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si	Discharge
1	Jul 31 1991	505	0.17	2.24	8.29	57.0	171	184	39.0	223	0.00	58	1.24	0.0040
2	Aug 21 1991	517	0.40	2.20	9.05	59.6	157	205		187	0.00	236	0.89	0.0430
3	Sept 11 1991	507	0.20	2.40	8.78	59.6	154			181	0.00	32	0.38	0.1000
4	Oct 16 1991	528	0.40	1.90	8.08	67.9	272	319	0.0	319	0.23	111	0.69	0.0660
5	Nov 6 1991	527	0.10	2.50	7.92		269	292	18.0	311	0.20	162	1.74	0.1330
6	Nov 27 1991	449	0.25	2.95	8.25	55.0	251	285	26.5	312	0.34	189	2.23	0.0790
7	Jan 8 1992	523	0.10	2.50	8.22	58.0	267	271	237.0	508	0.55	391	2.79	0.1700
8	Jan 29 1992	441	0.15	2.75	8.40	51.9	298	299	34.0	333	0.42	285	2.87	0.0360
9	Feb 26 1992	507	0.20	2.40	9.28	56.0	71	104	182.0	286	0.09	153	0.72	0.0003
10	Mar 17 1992	507	0.50	2.70	9.17	57.2	125	125	205.0	330	0.42	67	0.27	0.0150
11	April 8 1992	511	0.35	3.10	8.65	54.4	126	139	41.0	180	0.34	91	0.70	0.1080
12	May 6 1992	507	0.20	2.65	8.80	58.0	62	62	66.0	129	0.01	11	0.58	0.0900
13	May 27 1992	507	0.30	2.75	9.06	60.0	125	150	130.0	279	0.00	27	0.40	0.0260
14	June 17 1992	484	0.30	2.40	8.99	56.6	154	176	0.0	176	0.00	53	0.99	0.0530
15														
16	Winter mean	489	0.16	2.62	8.40	55.2	231			250	0.32	236	2.07	0.0840
17	SD	41	0.07	0.23	0.51	2.5	91			137	0.18	101	0.88	0.0690
18	Growth mean	508	0.31	2.48	8.76	58.9	150			223	0.11	76	0.68	0.0560
19	SD	12	0.11	0.36	0.37	3.8	53			70	0.17	68	0.32	0.0400
20	Annual mean	501	0.26	2.53	8.64	57.8	177			268	0.19	133	1.18	0.0660
21	SD	26	0.12	0.31	0.44	3.8	76			98	0.20	111	0.88	0.0500

Tatton-Melchett Mere TTMM

	Date	Conductivity	Phenolph Alk	Total alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P	Nitrate N	Ammonium N	Silicate Si
1	Jan 8 1992	454	0.20	2.90	8.12	32.0	24	24	12	36	0.23	90	3.64
2	Jan 29 1992	445	0.15	3.95	8.35	33.3	11	22	12	34	0.33	151	3.43
3	Feb 26 1992	457	0.20	2.90	8.20	32.0	9	10	16	25	0.28	83	3.14
4	Mar 17 1992	445	0.15	2.95	8.53	31.8	4	11	17	27	0.25	20	2.69
5	April 8 1992	434	0.30	2.90	8.37	31.1	6	10	16	36	0.08	24	2.13
6	May 6 1992	440	0.15	2.90	8.11	30.0	0	35	0	35	0.00	150	1.66
7	May 27 1992	428	0.25	2.85	8.56	36.0	7	20	0	20	0.00	0	1.22
8	June 17 1992	406	0.20	2.65	8.66	28.3	12	12	0	12	0.00	0	1.19
9													
10	Winter mean	452	0.18	3.25	8.22	32.4	15			32	0.28	108	3.40
11	SD	6	0.03	0.60	0.12	0.8	8			6	0.05	37	0.25
12	Growth mean	431	0.21	2.85	8.45	31.4	6			26	0.07	39	1.78
13	SD	15	0.07	0.12	0.21	2.9	4			10	0.11	63	0.64
14	Annual mean	439	0.20	3.00	8.36	31.8	9			28	0.15	65	2.39
15	SD	16	0.05	0.39	0.21	2.3	7			9	0.14	63	0.98

Tatton Mere TT

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 31 1991	516	0.20	2.24	8.47	57.0	114	146	3.0	149
2	Aug 21 1991	508	0.50	2.30	8.94	63.8	151	193		162
3	Sept 11 1991	519	0.40	2.45	8.64	59.6	131			170
4	Oct 16 1991	533	0.20	2.90	8.15	52.8	255	351	45.0	396
5	Nov 6 1991	534	0.10	2.50	8.07	76.0	291	354	24.0	378
6	Nov 27 1991	500	0.25	2.85	8.31	54.9	256	308	8.0	317
7	Jan 8 1992	527	0.10	2.60	8.14	56.0	277	332	0.0	332
8	Jan 29 1992	534	0.10	2.90	8.39	57.4	298	298	0.0	298
9	Feb 26 1992	530	0.55	2.85	8.93	56.0	179	179	109.0	288
10	Mar 17 1992	513	0.45	2.75	9.21	57.2	123	145	57.0	202
11	April 8 1992	519	0.45	2.15	8.46	58.2	139	161	8.9	170
12	May 6 1992	519	0.20	2.75	8.62	56.0	71	71	51.0	122
13	May 27 1992	514	0.20	2.70	8.78	56.0	76	92	8.0	100
14	June 17 1992	496	0.50	2.50	9.13	56.6	134	178	0.0	178
15										
16	Winter mean	525	0.22	2.74	8.37	60.1	260			323
17	SD	14	0.20	0.18	0.34	9.0	48			35
18	Growth mean	515	0.34	2.53	8.71	57.5	139			183
19	SD	10	0.14	0.26	0.34	3.0	54			85
20	All year mean	518	0.30	2.60	8.59	58.4	183			233
21	SD	13	0.17	0.25	0.37	5.6	78			98

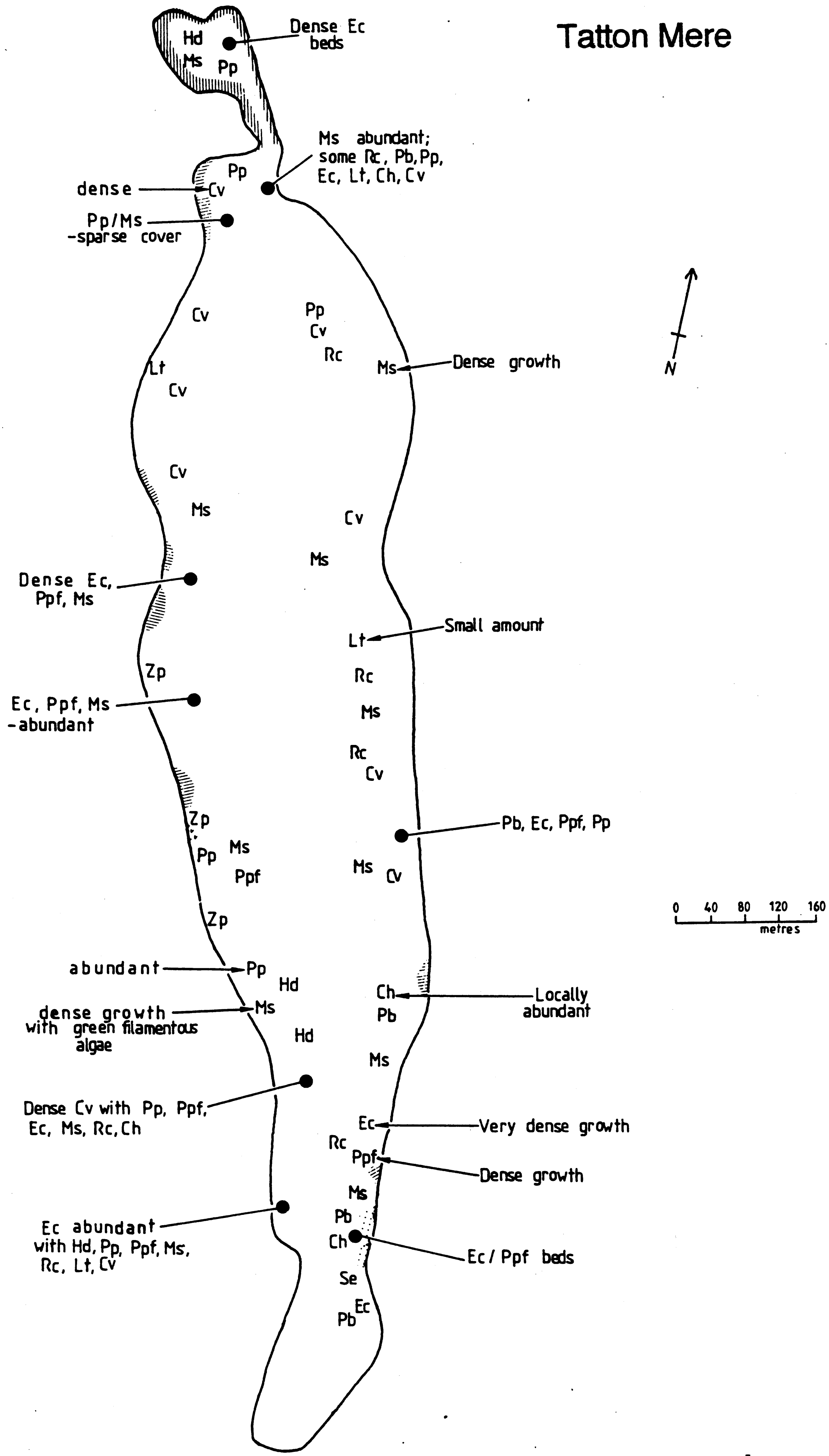
	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.02	51	1.58	4.00	5.0	1.36	1.00	>	0.32
2	0.00	42	2.03	11.45	11.3	1.38	1.23	>	1.10
3	0.00	12	1.23	19.90	27.3	1.39	1.14	>	2.52
4	0.09	130	0.48	6.40	12.7	2.00	1.42	>	34.00
5	0.27	194	1.54	7.41	14.0	1.91	1.00	>	0.50
6	0.41	269	1.71	1.83	4.0	2.40	1.04	>	0.50
7	0.55	285	2.58	3.30	8.0	2.67	0.88	>	0.06
8	0.73	257	2.83	1.50	15.3	11.50	0.86	>	0.17
9	0.76	92	1.66	64.50	128.0	2.18	1.07	>	0.11
10	0.68	91	0.32	33.40	42.0	1.38	1.19	>	0.24
11	0.76	74	0.33	2.60	3.3	1.43	0.91	>	30.42
12	0.14	66	0.88	4.00	7.3	2.00	1.03	>	3.96
13	0.08	173	1.64	5.50	9.7	1.93	0.98	>	0.88
14	0.09	28	2.00	3.30	7.0	2.33	0.95	>	3.91
15									
16	0.54	219	2.06	15.70					0.27
17	0.21	79	0.60	27.30					0.22
18	0.21	74	1.17	10.10					8.60
19	0.30	51	0.69	10.30					13.50
20	0.33	125	1.49	12.10					5.62
21	0.31	94	0.78	17.40					11.40

Tatton Mere Phytopl. 1991/92

Sat, Sep 5, 1992 10:26 am

	Organism	July 31 1991	Aug 21 1991	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 6 1992	May 27 1992	June 17 1992
1	Aster form	-	13	-	80	-	-	40	-	1640	1099	67	-	-	-
2	Amph ov	-	-	-	13	-	-	40	-	-	-	-	-	-	-
3	Cyclo menegh	-	269	-	-	-	-	-	-	-	-	188	-	-	-
4	Cyclo ocell	-	-	-	-	-	-	-	-	-	724	-	-	-	-
5	Cyclo sp	13	590	462	13	-	-	80	13	24440	-	-	-	13	-
6	Cymb vent	-	-	-	-	13	-	-	-	-	-	-	-	-	-
7	Cymbella sp	13	-	-	-	27	-	-	-	-	-	-	-	-	-
8	Cymb prost	13	-	-	-	-	-	-	-	-	13	-	-	-	-
9	Cocconeis sp	80	13	-	40	13	-	-	-	40	-	-	-	-	-
10	Caloneis sp	-	-	-	13	-	-	-	-	-	13	-	-	-	-
11	Diatoma sp	13	94	-	13	-	-	-	-	-	-	-	-	-	-
12	Cymb turg	-	-	-	-	-	-	-	26	-	-	-	-	-	-
13	Frag crot	-	-	-	-	-	-	40	-	-	-	13	20	-	-
14	Frag virasc	-	-	-	-	-	13	-	-	-	-	-	-	-	-
15	Frag sp	54	-	-	-	40	-	-	-	-	-	-	-	13	-
16	Frag const	-	13	20	13	-	-	-	-	-	-	-	-	-	-
17	Gomphonema	147	-	-	27	40	-	-	-	120	27	13	-	-	-
18	Gomph constr	-	-	-	27	-	-	-	-	-	-	-	-	-	-
19	Gomph oliv	-	-	-	13	-	-	-	-	-	-	-	-	-	-
20	Gyrosigma	-	-	-	-	-	-	-	-	-	54	-	-	-	-
21	Melos sp	-	-	-	-	27	-	-	-	-	-	-	-	-	-
22	Melos gran	-	40	161	67	-	13	3579	-	-	-	-	-	-	-
23	Melos ital	-	-	-	-	-	-	-	-	-	-	13	-	-	-
24	Neidium sp	-	-	-	-	13	-	-	-	-	-	-	-	-	-
25	Navicula sp	442	80	-	54	94	80	-	130	280	107	40	-	-	13
26	Nitzschia sp	496	-	-	-	-	-	-	-	40	-	-	-	-	-
27	Nitzschia sig	-	-	-	-	-	-	-	-	-	13	-	-	-	-
28	Pinnularia sp	13	-	-	-	-	-	-	13	-	-	-	-	-	-
29	Rhoicoeph sp	-	13	-	-	13	54	-	-	-	-	-	-	-	13
30	Surirella sp	13	-	-	-	-	-	-	-	-	-	-	-	-	-
31	Synedra ulna	67	-	-	-	-	13	-	-	-	-	-	-	-	-
32	Stephan ast	-	-	-	-	-	27	-	-	-	13	-	-	-	-
33	Cymb cist	-	-	-	-	-	-	-	-	-	-	-	13	-	-
34	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	Actinast hant	-	-	60	-	-	-	-	-	-	-	-	-	-	-
39	Ank falc	-	54	-	-	-	-	-	-	-	-	-	-	-	-
40	Ank conv	-	-	141	-	-	-	-	-	-	13	-	-	-	-
41	Carteria cord	-	-	-	-	-	-	-	-	-	-	-	1018	-	-
42	Chlorogonium	-	-	-	-	-	-	-	169	40	27	-	-	-	-
43	Chlorella	-	-	-	-	-	-	-	78	-	13	13	-	27	-
44	Chlamydo glob	-	-	281	27	-	-	-	-	-	-	-	-	-	27
45	Chlamydo sp	94	134	-	-	-	-	40	91	960	456	67	54	54	-
46	Chlamydo poly	-	-	945	-	-	-	-	-	-	-	-	-	-	-
47	Chlamydo sph	-	-	40	-	-	-	-	-	-	13	-	-	-	-
48	Crucig tetra	-	-	-	-	-	-	282	-	-	-	-	-	-	-
49	Coelast sphaer	-	-	-	-	-	-	-	-	-	-	27	-	-	-
50	Dictyosph ehr	-	-	503	-	-	-	-	-	-	-	-	-	-	-
51	Dictyo pulch	-	-	161	-	-	-	-	-	-	-	-	-	-	-
52	Lobomonas	-	-	-	-	-	-	-	-	-	13	-	-	-	-
53	Oocystis borg	-	-	-	-	-	-	-	-	-	-	-	-	40	-
54	Oocystis pus	-	-	20	-	-	-	-	-	40	-	-	-	-	-
55	Oocystis cras	-	-	-	-	-	-	-	-	-	-	-	-	107	-
56	Pediast bory	-	-	-	-	27	-	-	-	-	-	-	-	-	-
57	Pediast dupl	-	-	-	-	-	-	40	-	-	-	-	-	-	-
58	Quadrig lac	-	-	60	-	-	-	-	13	-	-	-	-	-	-
59	Scened quad	-	-	141	27	-	-	442	-	-	13	13	-	13	-
60	Scened bij	-	-	-	-	-	-	40	-	-	-	-	-	13	-
61	Selenast sp	-	-	101	-	-	-	-	-	-	-	-	-	-	-
62	Selenast min	-	-	-	-	13	-	-	-	-	-	-	-	-	-
63	Selenast west	-	-	-	-	-	-	-	-	-	13	-	-	-	-
64	Schroed setig	-	13	20	-	-	-	-	13	160	-	-	-	107	121
65	Schroed jud	-	-	-	-	-	-	-	-	-	-	40	27	13	65
66	Sphaerocystis	-	-	-	-	-	-	-	-	-	-	-	40	-	-
67	Tetraed min	-	-	-	-	-	-	40	-	-	-	-	-	-	-
68	Ulothrix	13	-	-	-	-	-	40	-	-	-	-	-	-	-
69	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71	*	-	-	-	40	-	-	-	-	-	-	-	-	-	-
72	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
73	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Organism	July 31 1991	Aug 21 1991	Sept 11 1991	Oct 16 1991	Nov 6 1991	Nov 27 1991	Jan 8 1992	Jan 29 1992	Feb 26 1992	Mar 17 1992	April 8 1992	May 6 1992	May 27 1992	June 17 1992
74	Euglena sp	-	-	-	-	-	13	-	-	80	-	13	-	-	-
75	Trachelo sp	-	13	60	13	-	-	161	13	-	27	-	-	13	-
76	Crypto marss	-	-	-	-	-	-	-	102	-	-	-	-	-	-
77	Crypto sp	-	-	40	-	-	-	-	-	-	-	-	-	-	-
78	Crypto erosa	-	107	-	67	-	-	-	-	280	-	-	-	147	147
79	Crypto ovata	94	13	-	40	107	322	523	78	420	268	54	27	-	-
80	Crypto acuta	-	-	-	-	-	-	-	-	160	-	-	20	-	-
81	Rhodo min	214	-	2090	188	27	214	-	195	40	-	-	54	375	255
82	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
83	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
84	Chlorochr min	-	13	-	-	-	-	-	-	-	-	-	-	-	-
85	Mallomonas	-	-	20	-	-	-	-	-	-	-	-	-	-	-
86	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
87	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
88	Glenodinium	-	-	-	-	-	-	-	-	40	-	-	-	-	-
89	Peredinium	-	-	40	-	-	-	-	-	-	-	-	-	-	-
90	Ceratium hir	-	-	20	-	-	-	-	-	-	-	-	-	-	-
91	Gymnodinium	-	-	-	-	-	-	-	-	-	13	-	-	-	-
92	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
93	Gloeocystis	-	-	-	-	-	-	-	-	-	-	-	-	-	94
94	Anab circ	27	-	-	-	-	-	-	-	-	-	-	67	13	13
95	Anabaena sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-
96	Anab spir	-	-	181	-	67	-	-	-	-	-	-	-	-	-
97	Aphan fl aq	-	-	583	-	-	-	-	-	-	-	54	-	40	40
98	Dact raphid	-	-	-	-	-	-	-	-	-	13	-	-	-	-
99	Oscillatoria	-	-	-	-	-	-	-	-	-	13	-	-	-	-
100	Phormidium	80	-	-	-	-	-	-	-	-	-	-	-	-	-
101	Stigonema	-	-	-	-	-	-	-	52	-	-	-	-	-	-
102															
103	Total diatoms	1364	1125	643	373	280	200	3779	182	26540	2063	334	33	26	26
104	Total greens	107	201	2473	94	40	0	924	364	1200	561	160	1139	374	213
105	Total others	308	146	2210	308	134	549	684	388	980	295	67	101	535	402
106	Total bga	107	0	824	0	67	0	0	52	40	39	54	67	53	147
107	TOTAL	1886	1472	6150	775	521	749	5387	986	28760	2958	615	1340	988	788
108															
109	% diatoms	72.3	76.4	10.5	48.1	53.7	26.7	70.2	18.5	92.3	69.7	54.3	2.5	2.6	3.3
110	% greens	5.7	13.7	40.2	12.1	7.7	0	17.2	36.9	4.2	19	26.0	85	37.9	27.0
111	%others	16.3	9.9	35.9	39.7	25.7	73.3	12.7	39.4	3.4	10	10.9	7.5	54.1	51.0
112	%bga	5.7	0	13.4	0	12.9	0	0	5.3	0.1	1.3	8.8	5	5.4	18.7
113															
114		Diatoms	Green algae	Others	Blue greens										
115	Winter mean%	53.5	13.2	30.9	3.7										
116	SD	30.5	14.7	27.3	5.7										
117	Growth mean%	37.7	29.6	26.1	6.5										
118	SD	32.6	23.8	19	6.3										
119	Allyear mean%	42.9	23.8	27.8	5.9										
120	SD	31.5	21.9	21.4	6.0										


Tatton Mere
Dense Ec beds
Hd
Ms
Pp
Ms abundant; some Rc, Pb, Pp, Ec, Lt, Ch, Cv
Pp
dense
Cv
Pp/Ms -sparse cover
Cv
Pp
Cv
Rc
Ms
Dense growth
N
Lt
Cv
Cv
Ms
Cv
Ms
Dense Ec, Ppf, Ms
Small amount
Lt
Rc
Zp
Ec, Ppf, Ms -abundant
Ms
Rc
Cv
Zp
Pb, Ec, Ppf, Pp
Pp
Ms
Ppf
Ms
Cv
0 40 80 120 160
metres
Zp
abundant
Pp
Hd
dense growth with green filamentous algae
Ms
Ch
Locally abundant
Pb
Hd
Ms
Dense Cv with Pp, Ppf, Ec, Ms, Rc, Ch
Ec
Very dense growth
Rc
Ppf
Dense growth
Ms
Pb
Ec abundant with Hd, Pp, Ppf, Ms, Rc, Lt, Cv
Ch
Ec / Ppf beds
Se
Pb
Ec

(u) WHITE MERE

(i) Morphometry and water budget

White Mere is an isolated basin with no apparent permanent surface inflows and is probably fed almost entirely by ground water. It is deep (13.8m) and 25.5ha in area.

(ii) Changes in land usage

Whitemere has a catchment area that is probably contained within the Ellesmere Rural Parish for which the land use changes have been:

	1931	1987
Cattle(head)	8569	12501
nutrient units	103685	151262
Pigs(head)	4434	5774
nutrient units	21283	29715
Sheep(head)	7721	10658
nutrient units	11582	15987
Poultry(head)	37706	2927
nutrient units	5279	410
Total nutrient units	141829	195374
Permanent grass(ha)	6124	3502
Temporary grass(ha)	457	1314
Arable(ha)	580	1706
Woodland(ha)	3	141
Rough grazing	28	118
Total hectarage	7192	6781

There has thus been an increase in stock keeping and a loss of grassland to arable and non-agricultural uses.

(iii) Major ion chemistry and nutrient loads

White Mere has only modest conductivity and alkalinity compared with other of the meres but it has among the highest soluble reactive and total phosphorus concentrations with the rather staggering mean annual value for total P of 1456ug/l. Its inorganic nitrogen concentrations are however low and nitrogen is very scarce in summer. It seems likely that the high phosphorus is a natural phenomenon.

(iv) Phytoplankton and zooplankton

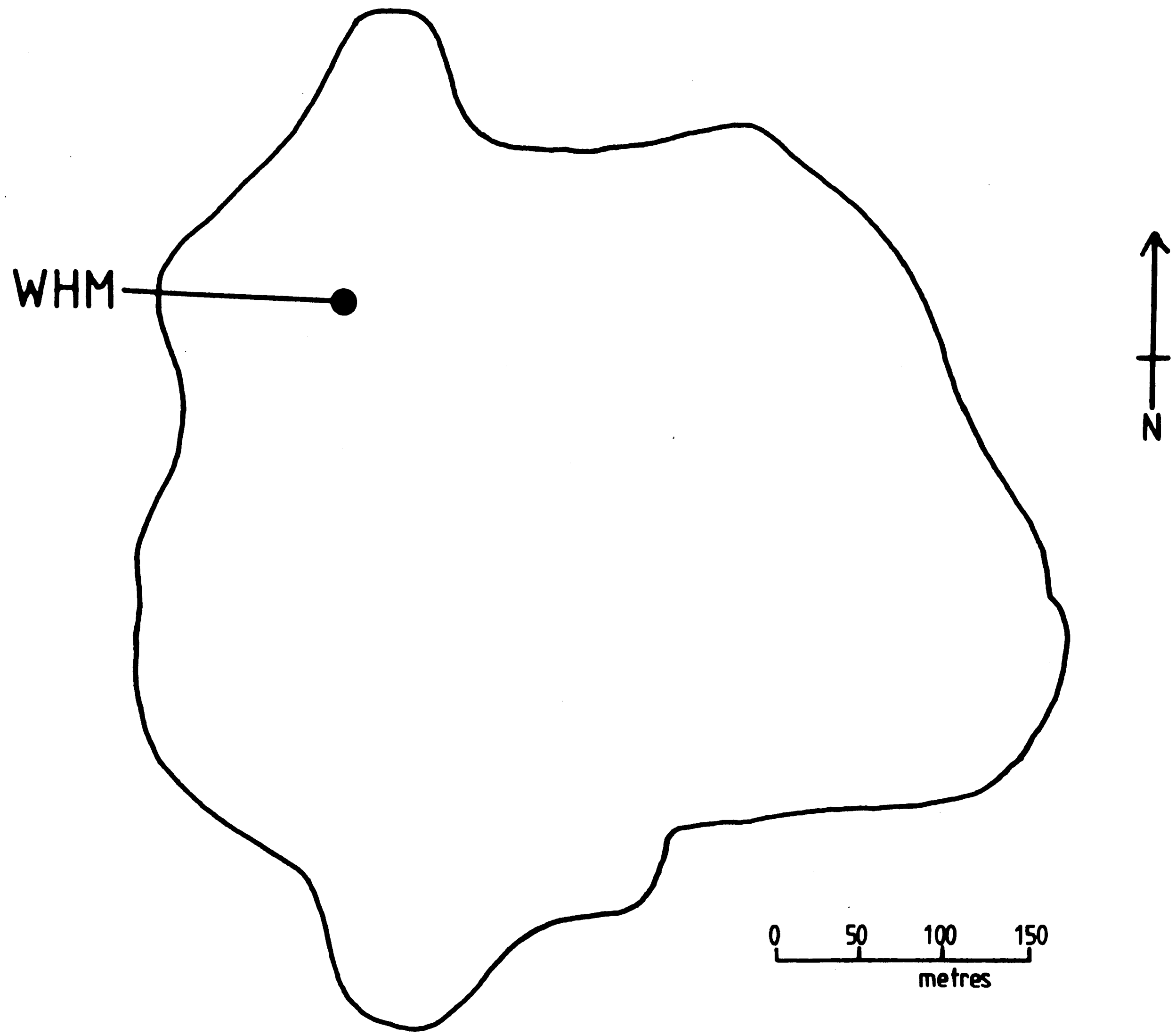
Chlorophyll a concentrations were modest and the community contained a significant proportion of blue-green algae. ***Daphnia*** numbers were moderately high but fluctuated greatly. White Mere is stratified in summer and vertical migrations may have confounded the sampling strategy used, on some occasions. Both grazing and shortage of nitrogen are likely to be important determinants of the algal crops.

(v) Aquatic plants

At appropriate depths, aquatic plants were abundant with ***Elodea canadensis*** particularly so and ***Ranunculus circinatus*** frequent. The trophic score was 8.2, compared with similar values of 8.1 and 8.6 in 1979 and 1987. The DAFOR score has fallen from 18.5 in1987 to 11 but this index is so observer-dependent that even such an apparently large change may mean little.

(vi) Overall assessment

There appear to be no particular problems at White Mere from the eutrophication point of view. It seems to be a 'classic' high phosphorus mere that has undoubtedly undergone some eutrophication as aresult of agricultural changes in its catchment but these changes have not led to severe symptoms of eutrophication. The water remains clear and there is as much plant development as might be expected in such a site. No immediate management is required.


WHM
N
0 50 100 150
metres

White Mere WHM

	Date	Conductivity	Phenolph Alk	Total Alk	pH	Chloride	Sol React P	Tot Sol P	Partic P	Total P
1	Jul 24 1991	336	0.20	1.85	9.06	38.8	883	844	243	1087
2	Aug 14 1991	300	0.25	1.80	8.93	44.9	1015	1296	179	1475
3	Sept 4 1991	325	0.08	1.20	8.56	36.7	1415	1619	71	1689
4	Oct 9 1991	320	0.00	2.10	7.74	43.5	1447			1686
5	Oct 30 1991	324	0.10	2.15	7.43	60.6	1225	1629	203	1833
6	Nov 20 1991	291	0.15	2.00	7.67	-	1086	1226	158	1384
7	Dec 18 1991	334	0.00	2.15	7.60	36.4	1402	1896	0	1896
8	Jan 22 1992	318	0.00	2.00	7.92	38.5	1312	1601	0	1601
9	Feb 19 1992	311	0.30	1.90	8.10	39.2	1256	1256	0	1256
10	Mar 11 1992	299	0.20	2.05	8.38	43.5	1313	1313	0	1313
11	April 1 1992	293	0.35	1.85	9.04	35.3	844	1606	0	1606
12	April 29 1992	286	0.30	1.80	9.02	40.0	831	831	418	1249
13	May 20 1992	297	0.10	1.80	8.60	40	1042	1042	0	1042
14	June 10 1992	286	0.15	1.65	8.98	37.3	1031	1031	0	1031
15										
16	Winter mean	314	0.11	2.00	7.82	38.0	1264			1534
17	SD	18	0.14	0.10	0.23	1.5	133			280
18	Growth mean	307	0.17	1.83	8.57	42.1	1105			1427
19	SD	18	0.11	0.27	.0.58	7.2	231			295
20	Annual mean	309	0.17	1.88	8.36	41.1	1150			1456
21	SD	18	0.11	0.25	0.61	6.5	216			285

White Mere WHM

	Nitrate N	Ammonium N	Silicate Si	Chlorophyll	Carotenoids	480:663	430:410	Secchi	Total Daphnia
1	0.22	211	0.51	13.20	20.00	1.67	1.16	1.65	8.68
2	0.00	374	0.95	30.60	38.70	1.27	1.24	0.80	2.79
3	0.00	238	0.68	13.80	23.00	1.68	1.32	1.75	25.70
4	0.00	414	1.19	16.20	23.70	1.48	1.10	2.10	22.70
5	0.09	742	1.40	5.70	9.00	1.59	1.04	>	24.00
6	0.54	587	0.44	8.12	12.00	1.64	1.05	3.0	11.20
7	0.12	719	0.45	3.30	5.30	1.78	0.86	2.5	13.20
8	0.25	565	0.56	34.80	47.70	1.51	1.26	>	0.30
9	0.30	574	0.74	0.73	2.33	3.50	1.26	3.7	1.22
10	0.43	250	0.27	11.40	11.70	1.13	1.16	2.75	1.39
11	0.31	0	0.12	19.40	22.00	1.25	1.05	2.0	6.82
12	0.05	24	0.49	30.40	27.70	1.00	1.18	1.6	55.06
13	0.01	229	0.83	4.00	7.00	1.91	1.03	>3.55	19.13
14	0.00	0	0.45	22.40	30.00	1.48	1.04	2.1	2.00
15									
16	0.30	611	0.55	11.70					6.50
17	0.18	72	0.14	15.70					6.70
18	0.11	248	0.69	16.70					16.80
19	0.16	227	0.40	9.10					16.50
20	0.17	352	0.65	15.30					13.90
21	0.18	256	0.35	10.90					14.90

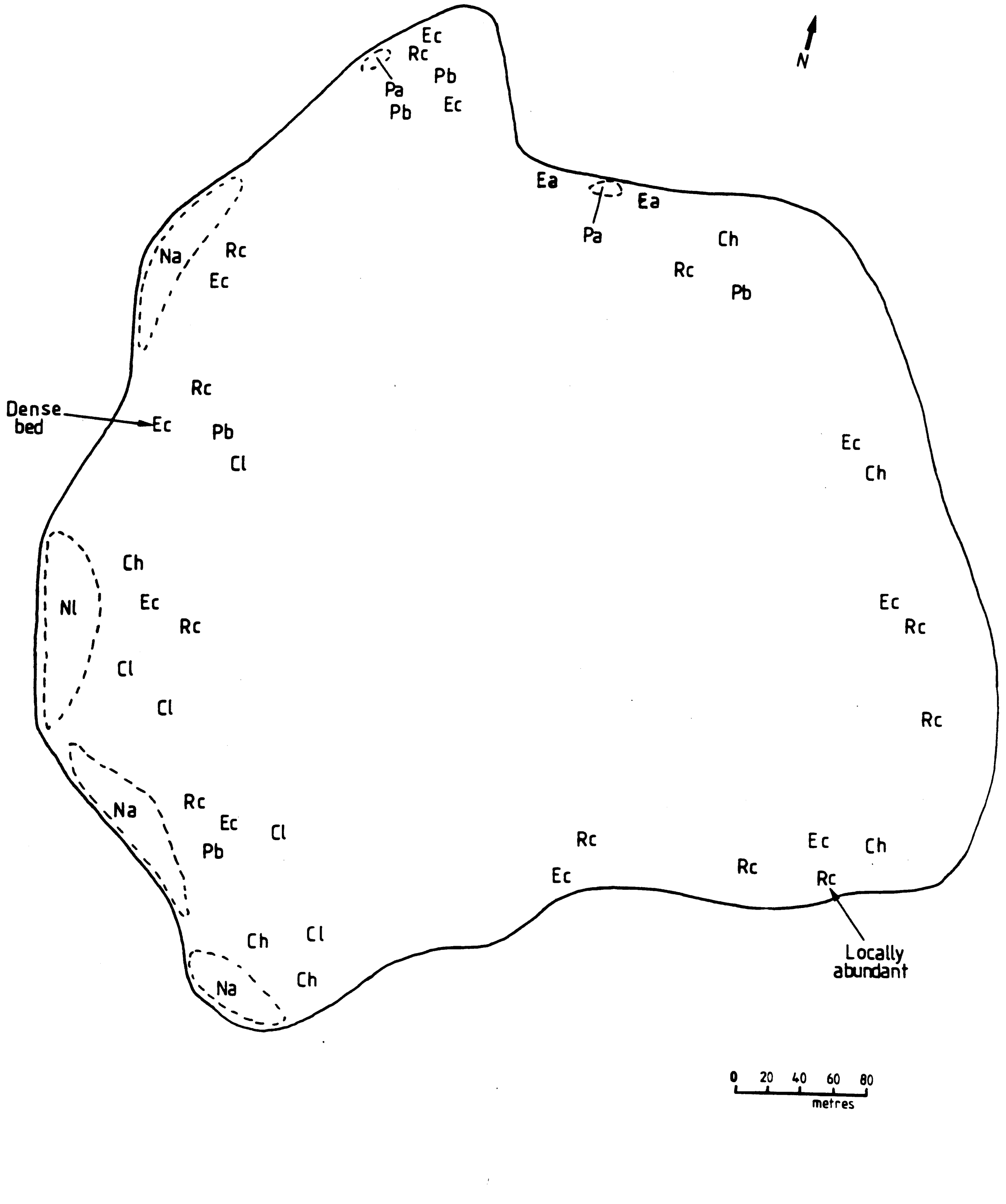
White Mere Phytopl. 1991/92

Sat, Sep 5, 1992 7:36 pm

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	Mar 11 1992	April 1 1992	Aug 28 1992	May 20 1992	June 10 1992
1	Aster form	22	-	-	26	1394	107	27	13	121	-	-	-	-
2	Cyclotella sp	22	-	22	-	-	27	-	1066	6675	804	-	-	13
3	Cocconeis sp	-	-	-	-	-	-	-	13	40	-	-	-	-
4	Cymatopl sol	-	-	-	-	-	-	-	-	40	-	-	-	-
5	Diatoma sp	-	67	-	-	-	-	-	-	-	-	-	-	-
6	Frag crot	-	-	-	-	-	-	-	-	-	22	-	-	94
7	Frag sp	22	-	45	-	-	-	-	-	-	-	-	-	-
8	Gomphonema	-	-	-	-	-	-	-	-	-	-	-	-	-
9	Melosira sp	-	-	-	-	-	-	-	13	-	-	-	-	-
10	Melosira gran	-	-	-	13	13	-	-	-	-	-	-	-	-
11	Navicula sp	-	67	-	-	-	27	-	-	40	67	-	-	-
12	*	-	-	-	-	-	-	-	-	-	-	-	-	-
13	*	-	-	-	-	-	-	-	-	-	-	-	-	-
14	*	-	-	-	-	-	-	-	-	-	-	-	-	-
15	Ankistro sp	-	-	-	-	-	-	-	-	-	-	-	-	-
16	Ank conv	-	-	-	-	-	-	-	-	80	-	-	-	-
17	Ank falc	-	-	-	-	-	-	-	-	40	-	-	-	-
18	Brachiomonas	22	-	-	-	-	-	-	-	-	-	-	-	-
19	Carteria	-	-	-	-	-	-	-	-	-	-	-	-	54
20	Chlorella vulg	-	-	-	-	-	-	-	-	-	-	-	-	496
21	Chlorogonium	-	-	-	-	-	-	27	182	-	-	-	-	-
22	Chlamydo sp	246	-	134	-	255	13	27	208	362	-	-	40	54
23	Chlamydo glob	201	-	-	-	-	-	-	-	-	-	-	-	13
24	Chlamydo ang	-	-	22	-	-	-	-	-	-	-	-	-	13
25	Closterium sp	-	-	-	-	-	-	-	-	-	-	-	-	-
26	Clost cynth	-	-	-	13	-	-	-	-	-	-	-	-	13
27	Crucigenia sp	-	-	-	13	-	-	-	-	-	-	-	-	-
28	Elakatothrix	-	-	22	-	-	-	-	-	-	-	-	-	-
29	Eudorina eleg	-	67	-	-	-	-	-	-	-	-	-	-	-
30	Dictyo pulch	-	-	-	13	-	-	-	-	-	-	-	-	-
31	Micract pus	-	-	-	-	-	-	-	-	-	-	-	-	27
32	Crucigenia fen	-	-	-	-	-	13	-	-	-	-	-	-	-
33	Oocystis borg	-	-	-	-	-	-	-	-	-	67	-	-	-
34	Oocystis pus	-	-	-	-	-	-	-	13	-	-	348	-	-
35	Oocystis cras	-	-	-	-	-	-	-	-	-	-	54	13	-
36	Pandor morum	-	-	-	-	-	-	-	-	40	-	54	13	13
37	Pediast bory	22	-	-	-	-	13	-	-	-	-	-	13	-
38	Plankto gelat	-	-	-	-	-	-	-	-	-	-	-	27	-
39	Scened bijug	-	-	-	-	-	-	-	-	-	45	-	-	-
40	Selenast west	-	-	-	-	-	-	-	-	80	112	-	-	-
41	Schroed sp	-	-	-	-	40	-	-	-	-	-	-	-	-
42	Schroed jud	36	-	-	-	-	-	-	-	40	-	-	-	27
43	Schroed setig	-	67	22	-	-	-	-	39	-	-	27	335	27
44	Sphaerocyst	-	-	-	-	-	-	-	-	-	-	-	13	-
45	Staurastrum	-	-	-	13	-	-	13	-	-	-	-	27	13
46	Staurast ping	67	-	-	-	-	-	-	-	-	-	-	-	-
47	Ulothrix var	-	402	-	-	-	-	-	-	-	-	-	-	-
48	*	-	-	-	-	-	-	-	-	-	-	-	-	-
49	*	-	-	-	-	-	-	-	-	-	-	-	-	-
50	*	-	-	-	-	-	-	-	-	-	-	-	-	-
51	Euglena sp	-	-	-	-	-	-	13	-	40	22	13	-	-
52	Euglena grac	-	-	-	-	-	-	-	-	-	-	-	-	-
53	Euglena poly	-	-	22	-	-	-	-	-	-	-	-	-	-
54	Phacus sp	-	-	22	-	-	-	-	-	-	-	-	-	-
55	Trachelo sp	-	-	45	-	-	-	-	-	161	-	-	27	40
56	*	-	-	-	-	-	-	-	-	-	-	-	-	-
57	Crypto erosa	-	-	-	-	-	-	-	13	-	-	13	-	214
58	Crypto reflex	-	-	-	-	-	-	13	-	-	-	-	-	-
59	Crypto ov	89	67	89	107	121	27	-	-	603	246	40	-	523
60	Rhodo min	1273	-	223	-	13	-	1166	91	1850	201	-	147	268
61	Crypto acuta	-	-	-	-	-	-	-	-	80	89	-	94	-
62	*	-	-	-	-	-	-	-	-	-	-	-	-	-
63	*	-	-	-	-	-	-	-	-	-	-	-	-	-
64	Mallomonas	-	-	-	-	-	-	-	-	-	-	40	-	27
65	Gonyostomum	-	-	-	-	-	-	-	-	80	-	-	-	-
66	Merotrichia	-	-	-	-	-	-	-	-	-	45	-	-	-
67	Trachychloron	-	-	-	-	-	-	-	-	-	45	-	-	-
68	*	-	-	-	-	-	-	-	-	-	-	-	-	-
69	*	-	-	-	-	-	-	-	-	-	-	-	-	-
70	Gonyaulax	-	-	-	-	-	-	-	-	-	-	-	-	-
71	Cerat hirund	22	134	156	-	-	-	-	-	-	-	-	-	13
72	Glenodinium	-	-	-	-	-	-	-	-	80	-	-	-	-
73	Gyrodin pus	-	-	-	-	-	-	-	-	-	89	-	-	-

	Organism	July 24 1991	Aug 14 1991	Sept 4 1991	Oct 9 1991	Nov 20 1991	Dec 18 1991	Jan 22 1992	Feb 19 1992	Mar 11 1992	April 1 1992	Aug 28 1992	May 20 1992	June 10 1992
74	*	-	-	-	-	-	-	-	-	-	-	-	-	-
75	*	-	-	-	-	-	-	-	-	-	-	-	-	-
76	Anab fl aq	-	-	-	-	-	-	-	-	-	-	-	-	-
77	Anab sp	22	-	-	-	-	-	-	-	40	-	-	-	-
78	Anab spir	-	871	-	-	-	-	616	-	-	-	-	-	-
79	Anab aff	-	-	-	-	-	-	-	-	-	-	-	-	-
80	Anab circ	-	-	22	27	-	-	-	-	-	223	1166	-	-
81	Aphanocap el	89	134	-	-	-	-	-	-	-	-	-	-	-
82	Aphaniz fl aq	-	-	-	-	-	-	134	-	-	45	-	-	-
83	Aphanocapsa	-	-	-	-	-	-	-	-	-	134	-	-	-
84	Coelosph naeg	-	-	112	-	-	-	-	-	-	-	-	-	-
85	Dact fasc	89	-	-	-	-	-	-	-	-	-	-	-	-
86	Gloeocystis	-	-	-	-	-	-	-	-	-	-	-	-	-
87	Gomphos lac	-	-	-	-	-	-	-	-	-	-	-	-	-
88	Gomphos apon	-	-	-	-	-	-	-	-	-	-	13	-	-
89	Microcyst aer	45	-	22	-	-	-	-	-	-	-	-	-	-
90	Oscillatoria	-	-	-	-	-	13	-	-	-	-	-	-	-
91	Osc ten	-	-	-	-	-	-	-	-	-	-	-	-	-
92	Phormidium	69	-	-	-	-	-	-	-	-	-	-	-	-
93														
94	Total diatoms	66	134	67	39	1407	161	27	1105	6916	893	0	0	107
95	Total greens	594	536	200	52	295	39	67	442	642	224	483	481	750
96	Total others	1384	201	557	107	134	27	1194	104	2894	737	106	268	1085
97	Total blue grns	314	1005	156	27	0	13	750	0	40	602	1179	0	0
98	TOTAL	2358	1876	980	225	1836	240	2038	1651	10492	2456	1768	749	1942
99														
100	Diatoms %	2.8	7.1	6.8	17.3	76.6	67.1	1.3	66.9	65.9	36.4	0	0	5.5
101	Greens%	25	28.6	20.4	23.1	16.1	16.2	3.3	26.8	6.1	9.1	27.3	64.2	38.6
102	Others %	58.7	10.7	56.8	47.6	7.3	11.2	58.6	6.3	27.6	30.0	6.0	35.8	55.9
103	Blue greens %	13.3	53.6	15.9	12.0	0	5.4	36.8	0	.38	24.5	66.7	0	0
104														
105		Diatoms	Greens	Others	Blue greens									
106	Winter mean	53(35)	15.6(9.6)	20.9(25.2)	10.6(17.7)									
107	Growth mean	17.7(22.6)	26.9(17.1)	36.6(19.8)	20.7(24)									
108	Annual mean	29.5(30.9)	23.5(15.7)	31.7(21.8)	17.6(22)									

WHITE MERE


N
Ec
Rc
Pb
Ec
Pa
Pb
Ea
Pa
Ea
Ch
Rc
Pb
Na
Rc
Ec
Rc
Dense bed
Ec
Pb
Cl
Ec
Ch
Nl
Ch
Ec
Rc
Cl
Cl
Ec
Rc
Rc
Na
Rc
Ec
Pb
Cl
Rc
Ec
Rc
Ec
Ch
Rc
Locally abundant
Ch
Cl
Na
Ch
0 20 40 60 80
metres

SECTION 1 SUMMARY OF STATE OF THE MERES AND REMEDIAL MEASURES REQUIRED

Mere	State	Measures suggested			
		None	Nutrient control	Reduce fish	No re-stocking
Berrington	+	+	-	-	-
Betley	+/-	-	+	+	+
Betton	+	+	-	-	-
Bomere	+	+	-	-	-
Chapel	+/-	-	+	-	+
Cole	+	+	-	-	-
Comber	+/-	-	+	-	+
Cop	+/-	-	+	+	+
Crose	+	+	-	-	-
Fene	-	-	-	+	+
Hatch	+	+	-	-	-
Little	+/-	-	+	-	+
Mere	+	+	-	-	-
Oak	+	+	-	-	-
Oss	+	+	-	-	-
Petty	-	-	+	+	-
Quoisley L	+/-	+	-	-	+
Quoisley B	+/-	+	-	-	+
Rostherne	+/-	-	+	-	-
Tabley Mr	+/-	-	+	-	-
Tabley Mt	+/-	-	+	-	-
Tatton	+	+	-	-	-
White	+	+	-	-	-

Of the twenty-three sites considered, 11 are believed to be in a satisfactory state (+) from the point of view of eutrophication. They may have undergone some increase in loading during the past few decades but there is probably little that can be immediately and practicably done to reduce this for the sources are diffuse and reduction would require major changes in agricultural policy.

Twelve sites are considered to be in a seriously threatened state(+/-) or have been severely altered by eutrophication(-). Of these sites, nutrient control alone is needed in three, some manipulation of the fish stock or avoidance of re-stocking in three and both measures in a further six. The nutrient control has already been put in place at two sites (Little Mere and Rostherne Mere) by diversion of sewage effluent. Apart from a domestic effluent problem at Chapel Mere, and additionally even there, the problem at the other sites is farm effluent and nutrient control should be diversion of the effluent so that both N and P are removed. It is likely that phosphorus availability is naturally high in the area and that eutrophication may have been nitrogen-driven in many instances. In this respect it is important that, as a general precautionary measure, all wet meadow and wetland areas adjacent to the lakes should be maintained with high water tables. Denitrification, which is favoured in soils of high but fluctuating water table, is likely to be currently very imprtant in reducing the immediate nitrogen loads to the lakes. The surface water streams are often very rich in nitrate.

SECTION 2 REGIONAL LIMNOLOGY OF THE WEST MIDLAND MERES

1. The first step in comprehending natural phenomena is the recognition of pattern. Once recognised, pattern needs to be explained and in explanation comes understanding. Following understanding there can be sensible prescriptions for management. An approach to the recognition of pattern is correlation among sets of data and this is applied here to discern common relationships among the meres. Only experiment can reveal the mechanisms that constitute understanding and this must be left to future projects. However prescriptions for management can be made from analogous experience elsewhere and the suggestions given in the first section are of this nature. It is desirable, however that more detailed studies are made on selected sites to confirm the prescriptions. in the meantime some understanding can come from a wide overview of the entire data set.

2. By the very collective term of the West Midland Meres there is an implication of a certain commonality and it is not uncommon to find generalisations that imply a uniformity among them as naturally eutrophic kettle hole lakes. Although most are probably ancient natural basins, they may have a variety of origins (Reynolds 1979) and they certainly have a wide variety of water chemistries. Reynolds recognised that the lakes were not uniformly distributed and was able to show, by nearest neighbour analysis that they were for the most part clumped. The reason for the clumping is not obvious but perhaps related to the dropping of morainic material or of particular washout regions from the melting glaciers. Using conductivity data Reynolds showed that the groups of meres had characteristic ranges of values but that there was a great deal of overlap between groups. There was, perhaps surprisingly, a tendency for the groups with the higher conductivities to be associated with sandy and gravelly drift and for the least

Meres Summary Table

	%grns(grow)	%bga(grow)	Daphnia(ann)	Daphnia (grow)	Bos/Daph	Daph lg/sm	%Lg Daph	Grazing	Ln Cphyll grow
1	49.600	31.700	0.090	0.120	0.596	0.350	0.000	0.090	3.016
2	38.300	4.200	1.790	2.010	0.550	0.038	0.000	1.790	4.383
3	23.400	18.900	1.050	1.470	0.710	0.110	4.800	1.200	2.625
4	51.400	21.900	10.000	13.900	0.350	0.007	0.000	10.000	2.632
5	18.300	13.300	71.800	100.100	0.003	0.040	3.700	79.800	2.565
6	26.700	47.100	48.600	24.800	0.002	0.002	0.000	48.600	3.391
7	15.200	15.200	23.400	33.700	0.006	0.003	0.000	23.400	3.020
8	16.200	23.000	3.600	4.050	0.019	0.860	46.200	8.600	4.011
9	17.600	5.400	22.800	31.700	0.003	0.700	41.100	50.900	2.219
10	53.400	16.900	19.060	26.700	0.250	0.008	0.420	19.300	3.285
11	28.200	4.170	0.380	0.530	86.100	0.210	5.050	0.440	3.418
12	33.100	2.300	22.500	26.000	0.070	2.900	74.400	72.700	2.573
13	43.100	24.300	41.800	58.000	0.002	0.007	0.490	42.400	3.456
14	47.700	4.400	7.900	12.200	0.110	0.009	0.000	7.900	3.965
15	45.900	11.100	65.900	84.000	0.003	0.001	0.000	65.900	2.398
16	42.700	3.900	94.700	108.300	0.001	0.304	23.300	161.000	2.351
17	13.500	34.000	8.200	8.600	0.012	0.104	9.000	10.400	3.118
18	11.900	17.500	28.600	39.500	0.010	9.970	90.900	107.000	2.588
19	14.300	36.700	7.780	11.900	0.125	2.340	70.430	24.200	2.988
20	42.400	1.090	40.900	61.500	0.003	0.680	40.400	90.500	3.063
21	29.600	6.500	12.100	10 100	0.028	0.020	0.780	12.400	2.313
22	26.900	20.700	13.900	16.800	0.005	0.007	0.170	14.000	2.815
23	9.600	16.200	7.400	9.300	0.200	0.003	0.340	7.390	3.001
24	82.900	0.000	11.800	16.800	2.490	0.000	0.000	11.800	2.128

	Total P (wint)	Total P(grow)	Total N(grow)	SRP (grow)	Chlorophyll(an)	Chlorophyll(gr)	%diat(ann)	%grns(ann)	%bga(ann)	%diat(grow)
1	183.000	83.000	0.250	28.000	16.600	20.400	12.600	41.500	32.000	3.400
2	274.000	609.000	0.710	360.000	62.900	80.100	41.800	30.800	2.900	13.700
3	178.000	88.000	0.360	52.000	11.200	13.800	17.000	17.900	13.400	8.400
4	112.000	49.000	0.260	15.000	12.000	13.900	8.250	50.800	15.600	6.400
5	1241.000	1278.000	0.586	1052.000	12.000	13.000	33.400	20.400	10.000	39.000
6	513.000	355.000	0.520	244.000	21.700	29.700	9.800	23.800	34.100	2.500
7	507.000	298.000	0.810	188.000	14.700	20.500	21.700	20.500	11.100	24.200
8	166.000	382.000	1.650	248.000	59.600	55.200	52.800	13.500	18.200	39.800
9	298.000	180.000	0.235	124.000	9.830	9.200	26.100	14.300	4.040	12.100
10	359.000	539.000	0.610	413.000	19.060	26.700	25.400	47.600	12.500	19.800
11	72.000	90.000	1.760	15.000	29.500	30.500	28.100	25.100	3.700	14.400
12	980.000	1686.000	3.030	1541.000	11.400	13.100	21.400	33.700	2.200	28.600
13	232.000	321.000	0.270	199.000	35.400	31.700	19.700	38.000	18.500	9.900
14	121.000	339.000	0.440	150.000	60.500	52.700	41.300	42.800	3.100	32.900
15	319.000	439.000	0.295	364.000	8.400	11.000	19.500	48.700	8.030	21.400
16	273.000	260.000	1.080	186.000	14.200	10.500	24.700	41.500	3.740	26.800
17	520.000	370.000	0.740	296.000	16.300	22.600	14.600	13.600	32.400	19.100
18	291.000	336.000	1.930	224.000	17.600	13.300	51.600	11.200	12.800	47.300
19	314.000	332.000	2.080	241.000	18.800	19.850	19.600	20.200	23.900	24.000
20	390.000	903.000	1.287	715.000	21.400	21.400	34.800	43.700	1.590	40.800
21	323.000	183.000	0.280	139.000	12.100	10.100	42.900	23.800	5.900	37.700
22	1534.000	1427.000	0.360	1105.000	15.300	16.700	29.500	23.500	17.600	17.700
23	46.000	56.000	0.850	3.000	15.500	20.100	24.600	10.500	13.000	21.400
24	73.000	56.000	0.100	5.000	7.400	8.400	4.300	84.200	0.050	6.100

	Mere	Area	Max. depth	Conduct(ann)	Phen Alk(ann)	Tot Alk(ann)	Chloride(ann)	Total P (ann)	Total N (wint)	SRP (wint)
1	Berrington Pl	2.500	12.200	392.000	0.170	1.800	60.900	113.000	0.720	126.000
2	Betley Mere	9.300	1.800	659.000	0.440	3.930	47.600	506.000	1.850	197.000
3	Betton Pool	6.400	10.900	356.000	0.150	2.080	43.500	113.000	0.640	143.000
4	Bomere	10.300	15.200	132.000	0.020	0.670	23.700	67.000	0.600	81.000
5	Chapel Mere	6.500	2.400	721.000	0.540	4.680	37.400	1267.000	0.650	957.000
6	Colemere	27.600	11.500	239.000	0.200	1.490	25.300	400.000	1.270	450.000
7	Combermere	51.500	11.800	513.000	0.340	3.000	43.200	362.000	0.900	411.000
8	Cop Mere	16.800	2.700	457.000	0.510	2.950	29.500	315.000	2.340	102.000
9	Crosemere	15.200	9.300	474.000	0.290	3.050	36.000	214.000	0.600	237.000
10	Fenemere	9.400	2.200	756.000	0.430	4.760	78.400	487.000	2.800	169.000
11	Hatchmere	4.700	3.800	484.000	0.130	2.360	48.100	85.000	1.320	7.000
12	Little Mere	2.500	1.700	523.000	0.008	1.760	73.200	1510.000	1.910	746.000
13	Oss Mere	9.500	3.000	491.000	0.410	3.020	40.300	296.000	0.147	132.000
14	Petty Pool	11.700	3.100	465.000	0.190	2.350	50.400	261.000	1.030	50.000
15	Quoisley Big M	4.000	2.400	611.000	0.360	4.690	41.900	404.000	1.540	314.000
16	Quoisley Lt M	2.200	1.800	639.000	0.250	5.020	38.600	264.000	2.130	179.000
17	Rostherne Mr	48.700	27.500	523.000	0.260	2.650	44.700	419.000	0.840	431.000
18	Tabley Mere	19.400	4.400	701.000	0.400	2.450	104.000	323.000	3.740	204.000
19	Tabley M(sl)	19.400	4.400	707.000	0.310	2.460	106.000	326.000	5.280	214.000
20	Tabley Moat	2.000	1.500	632.000	0.100	3.210	75.500	720.000	3.870	292.000
21	Tatton Mere	31.700	11.000	518.000	0.300	2.600	58.400	233.000	0.750	260.000
22	White Mere	25.500	13.800	309.000	0.170	1.880	41.100	1456.000	0.910	1264.000
23	Mere mere	15.800	8.100	523.000	0.030	1.510	75.600	54.000	1.010	18.000
24	Oakmere	18.300	5.600	188.000	0.000	0.028	23.200	61.000	0.330	17.000

conductive to be on boulder clay, but the relationship was very weak. One problem might have been the paucity of data, for many meres in the analysis had only a single measurement to characterise them. Using principal components analysis, Beales(1976) recognised six categories. These were pools of high alkalinity (>4 mequiv/l), pools of moderate alkalinity (2-4 mequiv/l), shallow pools of moderate to high alkalinity, small pools of low alkalinity, bog pools, and deeper meres of low to moderate alkalinity (<4 mequiv/l). With all due respect to the powers of modern multivariate statistical analysis, this is not a very informative classification for understanding how the ecosystems work and what drives their functioning.

3. The approach used here has been stepwise. First, synoptic diagrams have been constructed using the fuller data now available. Then secondly, a regression analysis has been carried out to investigate factors determining the algal crop size in the meres examined in detail. Finally this analysis has been extended to sub-groups of the meres determined on good limnological grounds.

4. Figure 1 shows the distribution of conductivity. Mean annual data recorded in this survey have been used and supplemented with data from Reynolds(1979) for meres not included in the survey. Comparison of Reynold's data taken in the nineteen seventies, NCC data taken in the nineteen eighties (Wigginton & Palmer 1987) and current 1991/92 data shows a steady increase in most sites, which is probably related to the tendency for summers to be drier in the last decade. Some comparisons are shown in Table 1. For comparability, Reynolds' data have been increased by a factor of 1.2, the average increase among all the meres for which data are available. Tabley Mere has been excluded because its high conductivity may be linked to the leaching of salt from deicing treatment of the motorway that runs close to one of its main inflows.

Table 1. Changes in conductivity of some of the West Midland Meres between the 1970s and the early 1990s

Mere	1976 (Reynolds)	1979 (NCC)	1987 (NCC)	1991/2
Berrington	292	290	415	392
Betton	256	243	315	356
Bomere	94	100	145	132
Cole	289	303	310	239
Crose	373	340	390	474

Fene	570	507	690	756
Hatch	406	380	460	484
Oss		310	460	491
Quoisley Big	522	450	600	611
Tatton	496	400	515	518
Tabley	769	540	1020	701
Quoisley Lt	571			639
Petty	337			465
Cop	404			457
Comber	400			513
Chapel	559			721
Betley	609			713

5. Figure 1 confirms that there is no simple pattern to conductivity. Each group of meres has awide range and although the North Cheshire group has some of the highest values, there is little to suggest that this may be linked to the existence of the Triassic salt field. Values, even at their highest are much lower than those of brines and some quite low values are also found. Conductivity in the meres is closely linked to alkalinity. the regression equation is:

$$\text{Alkalinity} = 0.006\ \text{Conductivity} - 0.297 \quad r= 0.79,\ P < 0.0001$$

A plot of alkalinity thus gives a similar picture to that of conductivity.

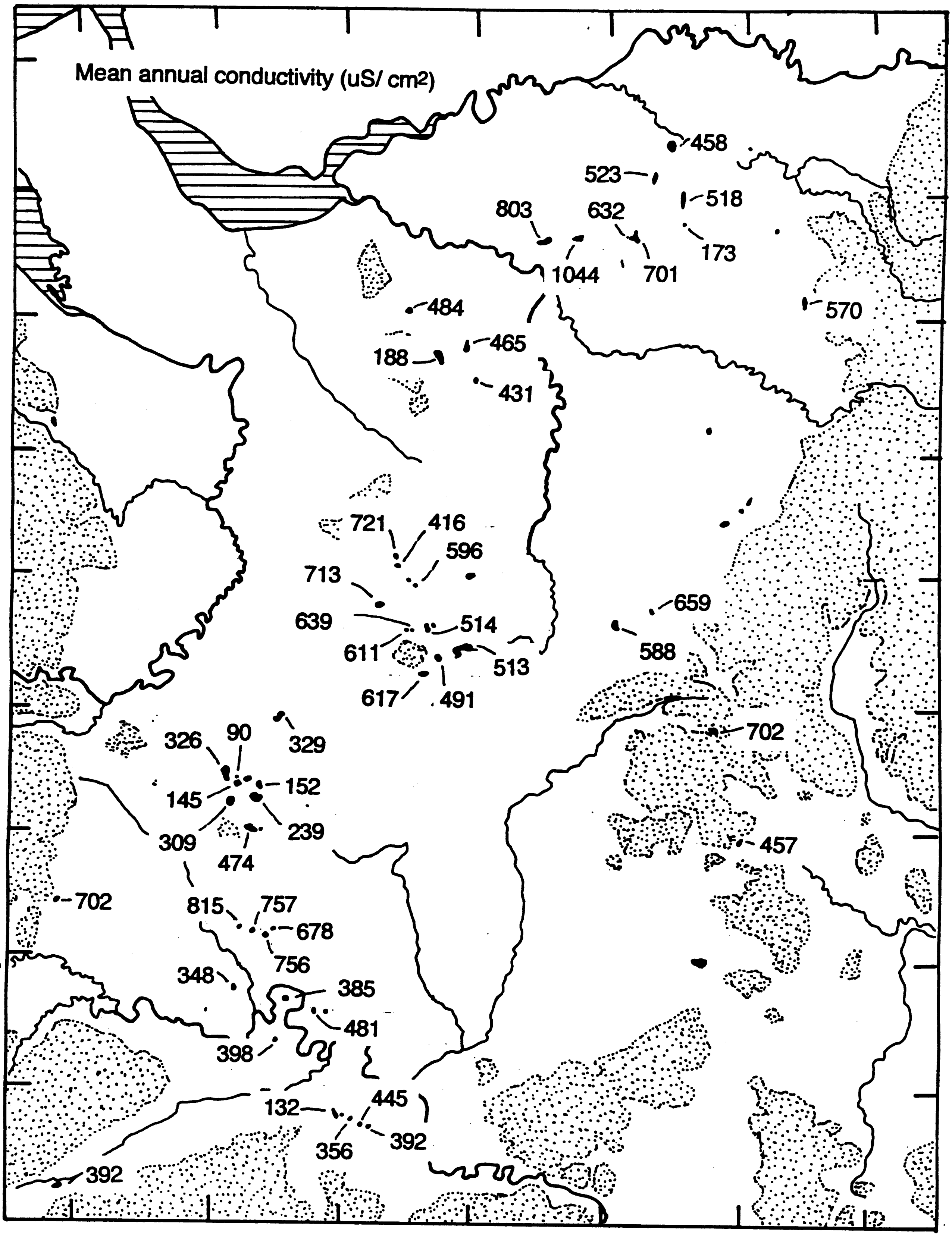
6. Chloride is not so closely linked with alkalinity as chloride is derived from rain whereas most of the ions which dominate the conductivity, including the bicarbonate ions that dominate the alkalinity, are soil derived. The chloride /conductivity regression was:

$$\text{Chloride} = 0.086\ \text{Conductivity}\ 8.856 \quad (r = 0.63.\ P < 0.005)$$

A synoptic plot of chloride, however also shows great variation over limited areas and no particular trend pattern (Fig 2). This diagram also includes data from Reynolds that have been corrected for the weather-linked increases since the 1970s.

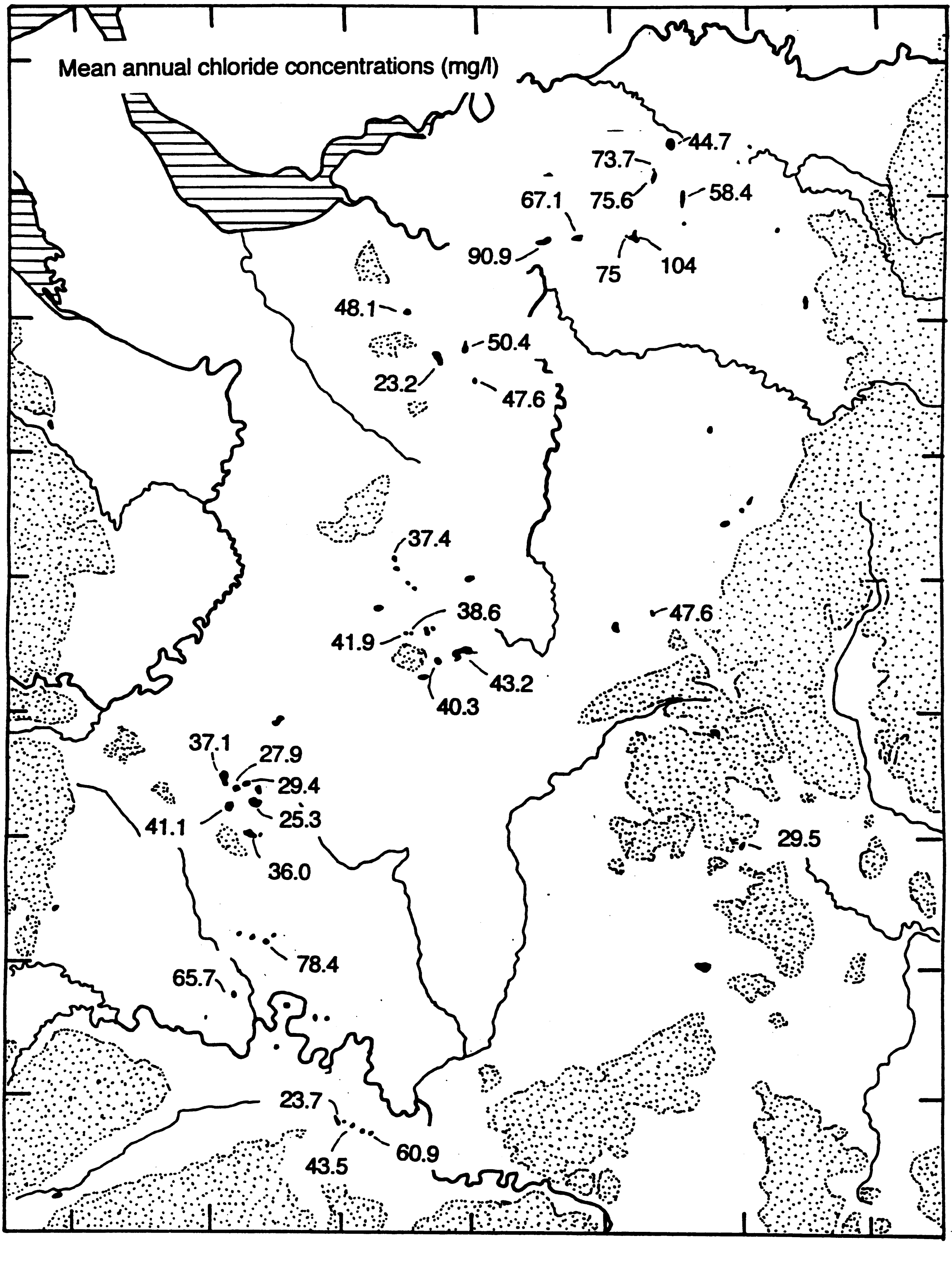
7. The relatively high phosphorus concentrations measured in some of the meres by Reynolds (1979) have been attributed to the existence of phosphorus-rich minerals such as apatite in the surrounding drift. If this is so there might be a relationship between total phosphorus and either alkalinity or conductivity. Examination of the current data revealed no significant relationship between total phosphorus and either of these variables with no correlation coefficient greater than 0.22. Nor was there any geographical pattern (Fig.3) in the distribution of total phosphorus concentrations, although it is confirmed that some very high values exist in a set that is generally high. In Fig.3 lakes that are known to have pollutant sources of phosphorus are distinguished from lakes

Fig 1



Mean annual conductivity (uS/ cm2)
458
523
518
803
632
173
1044
701
570
484
465
188
431
721
416
596
713
659
639
514
588
611
513
617
491
702
326
90
329
152
145
239
309
474
457
702
815
757
678
756
348
385
481
398
132
445
356
392
392

Fig 2



Mean annual chloride concentrations (mg/l)
44.7
73.7
67.1
75.6
58.4
90.9
75
104
48.1
50.4
23.2
47.6
37.4
38.6
41.9
43.2
40.3
47.6
37.1
27.9
29.4
41.1
25.3
36.0
29.5
78.4
65.7
23.7
43.5
60.9

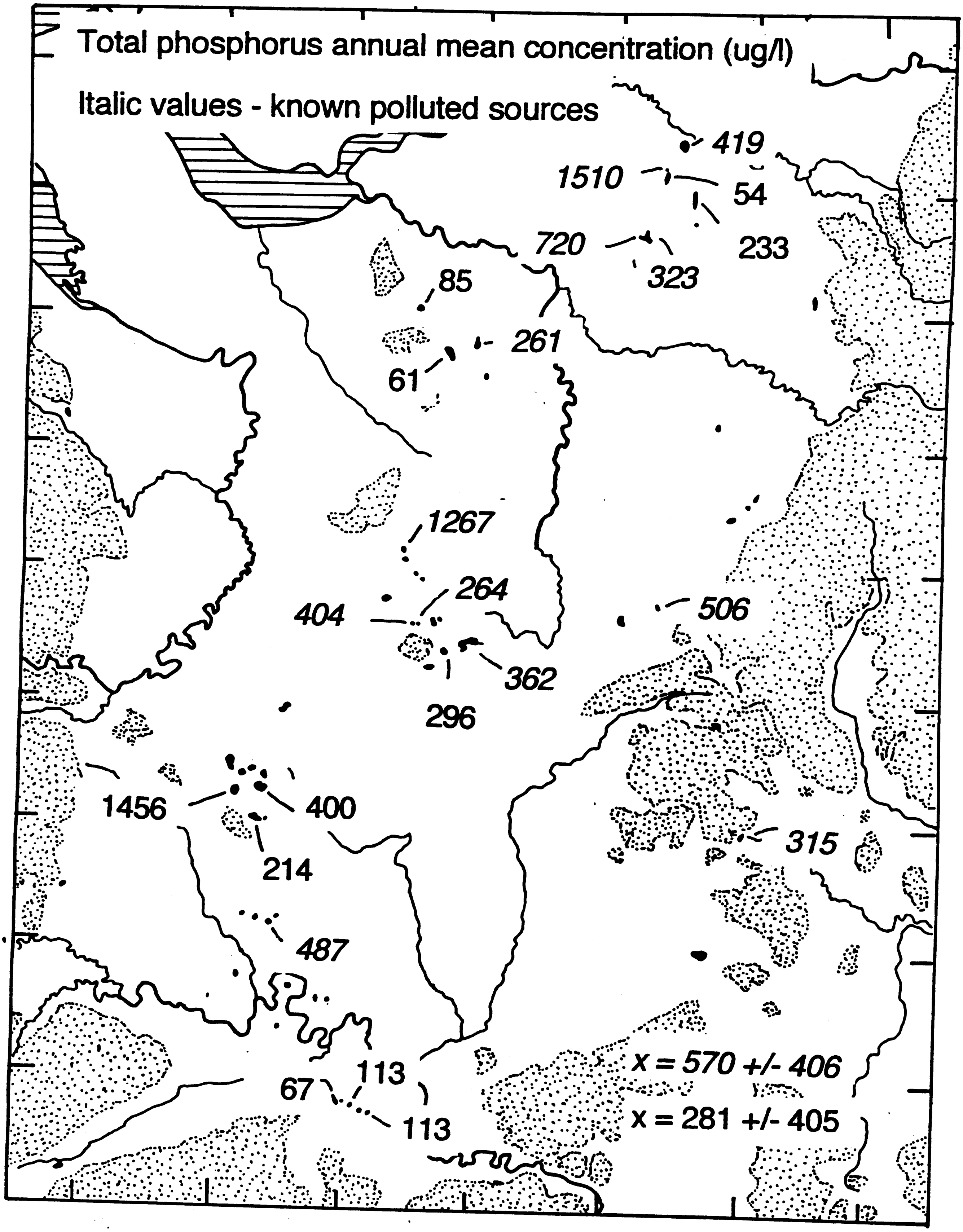
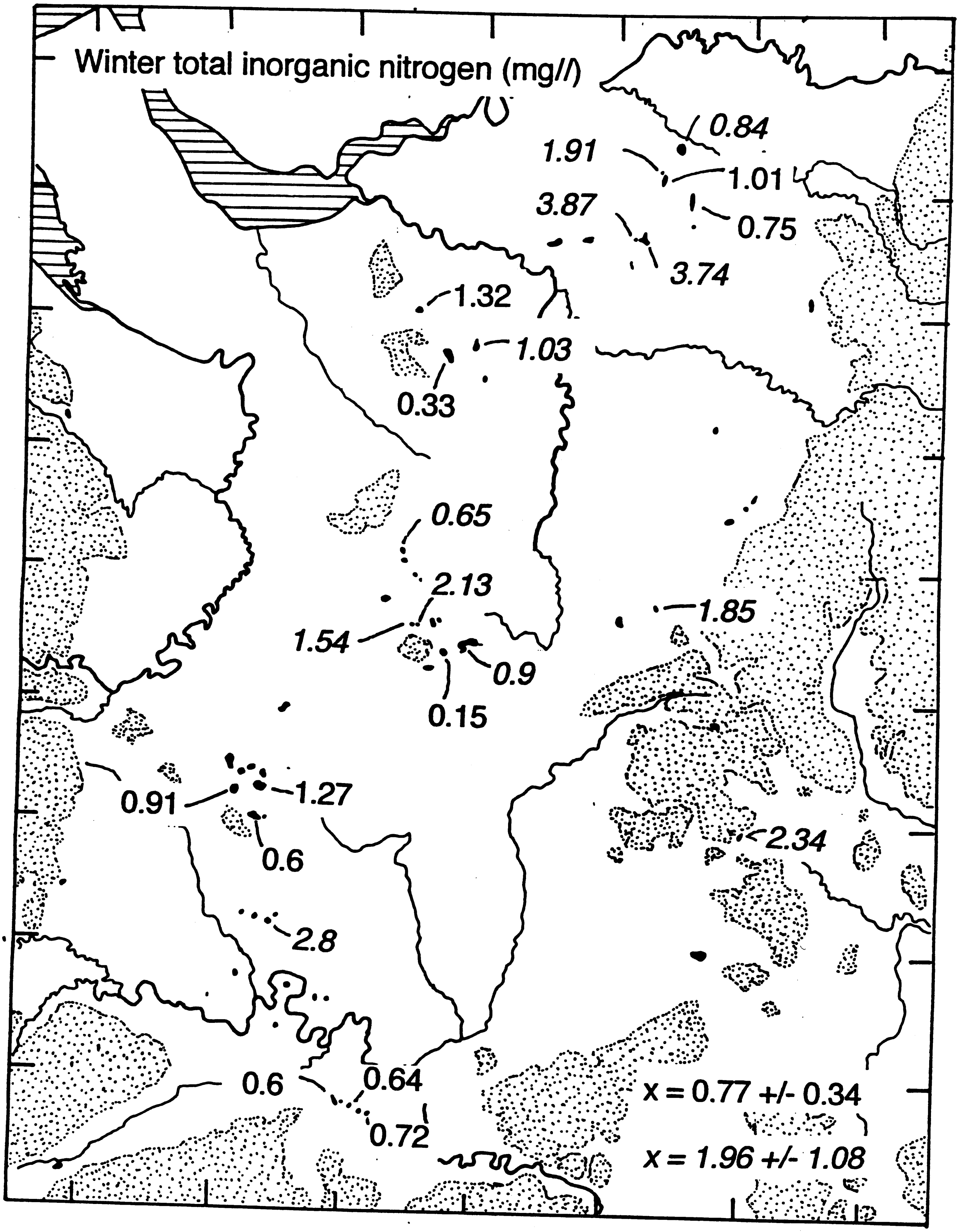

Total phosphorus annual mean concentration (ug/l)
Italic values - known polluted sources
419
1510
54
233
720
323
85
261
61
1267
264
404
506
362
296
1456
400
315
214
487
113
67
113
x = 570 +/- 406
x = 281 +/- 405

Fig 3



Italic numerals- known polluted sources

Fig 4

where no such source could be discovered. On average the former group has higher total phosphorus concentrations but the largest value of all (White Mere) lies in the latter group.

8. A synoptic plot of winter inorganic nitrogen concentrations (Fig. 4) also shows no geographical pattern. Lakes with known pollutant sources have the higher values but overall the values are low for an agricultural area. The streams are not necessarily deficient in nitrogen and the low values in the lakes probably reflect denitrification in the wetlands surrounding many of the lakes. Comparable values in East Anglia would be nearly an order of magnitude larger.

9. The synoptic approach to detection of pattern among the meres has thus failed to demonstrate any simple spatial pattern. This may reflect a non-systematic influence of human activities coupled with the marked heterogeneity of glacial drift. An underlying pattern must exist but to reveal it would require very detailed soil sampling.

10. The second approach taken was to carry out regressions to see which variables might best predict the algal biomass as measured by mean chlorophyll a concentrations during the growing season. A summary table was compiled of those variables likely to be important. These included key major ion variables such as conductivity, and total alkalinity. Phenolphthalein alkalinity was also included but may often be derivative of high chlorophyll a concentrations following intense photosynthesis. A range of phosphorus and nitrogen variables was included, and also variables related to potential grazing of the algae. Some of these were straightforward, such as ***Daphnia*** numbers. Others were designed to give a better index of potential grazing and included the percentage of large(>2mm) ***Daphnia***, the ratio of large to small ***Daphnia*** and a grazing index in which large ***Daphnia*** were weighted at four times the value of small ***Daphnia***. Grazing rate of daphnids is proportional to the second or third power of size. The ratio of ***Bosmina*** to ***Daphnia*** increases as fish predation increases and this ratio was also included. Simple regressions between each variable and either chlorophyll a concentration or ln chlorophyll a concentration were carried out with the following results (Table 2):

Table 2 Simple regressions between growth season mean chlorophyll a concentrations and environmental variables in 23 meres

	Chlorophyll a		Ln chlorophyll a	
Variable	r^2	**P**	r^2	**P**

Area	**0.002**	**ns**	**0.0001**	**ns**
Depth	**0.058**	**ns**	**0.025**	**ns**
Conductivity	**0.058**	**ns**	**0.014**	**ns**
Total alkalinity	**0.024**	**ns**	**0.013**	**ns**
Chloride	**0.008**	**ns**	**0.00008**	**ns**
Ann Tot P	**0.005**	**ns**	**0.004**	**ns**
Wint Tot P	**0.044**	**ns**	**0.041**	**ns**
Wint SRP	**0.051**	**ns**	**0.019**	**ns**
Wint N	**0.008**	**ns**	**0.00004**	**ns**
Grow Tot P	**0.00007**	**ns**	**0.00004**	**ns**
Grow SRP	**0.009**	**ns**	**0.014**	**ns**
Grow N	**0.002**	**ns**	**0.014**	**ns**
Ann *Daphnia*	**-0.109**	**<0.25**	**-0.124**	**<0.1**
Grow *Daphnia*	**-0.096**	**<0.25**	**-0.109**	**<0.25**
Bos/Daph	**0.007**	**ns**	**0.024**	**ns**
***Daph* lge/sm**	**-0.024**	**ns**	**-0.026**	**ns**
***Daph* % lge**	**-0.02**	**ns**	**-0.023**	**ns**
Grazing	**-0.134**	**<0.1**	**-0.162**	**<0.05**

11. The results of this analysis indicated that major ion and nutrient variables had very little influence on algal crops but that grazing had some significant effect. The amount of variation explained was small however and so multiple regressions using several variables were attempted. The variables having the greatest correlation coefficients in the above table were used with the stipulation that only one major ion related, one phosphorus, one nitrogen and one grazing related variable were used. Depth was also included.

12. The results were as follows:

	Chlorophyll a		**Ln Chlorophyll a**	
Variable	**Sequential r^2**	**P**	**Sequential r^2**	**P**
Grazing index	**0.134**	**<0.1**	**0.162**	**<0.05**
Depth	**0.311**	**<0.25**	**0.281**	**<0.05**
Conductivity	**0.338**	**<0.05**	**0.325**	**<0.05**
Winter N	**0.339**	**<0.1**	**0.337**	**<0.1**
Winter SRP	**0.341**	**<0.25**	**0.338**	**<0.25**

With these, the most predictive regressions, grazing and depth were most effective at accounting for the variance in the data but at best accounted for only 31.1% of the variance, Addition of conductivity, winter N and winter SRP added only a further few per cent. A total of at most 34% of the variance could be accounted for suggesting that other factors were much more important.

13. Low predictability in regressions, however, can arise from selection of too heterogeneous a data set. In this case the lakes may have been of very different kinds with different variables controlling algal crops in different types. The lake set was therefore divided on the basis of depth. The basis for this decision was that the ecosystems of shallow lakes are potentially dominated by submerged plants whilst in deep lakes, although plants may grow prolifically in a narrow littoral zone at the edge, their influence on the ecosystem overall is subordinate to that of the plankton. Submerged plant dominance can only occur if a substantial part of the bottom is colonisable by plants. This will depend essentialy on the light climate at the sediment surface and hence on turbidity. However the criterion adopted for shallowness here is potential dominance by submerged plants rather than actual dominance and extensive work in Denmark (Jeppesen et al 1991)suggests that 3m is a sensible depth at which to make a separation between deep and shallow lakes.

14. Only maximum depths are available for the meres and this can give problems in lakes whose maximum depth is close to the critical depth for separation. A lake may have a maximum depth above the critical but have mostof its bottom covered with plants except for a small area at the maximum depth. Another lake with a similar maximum depth may have steep sides and most of its bottom may be at the maximum depth and potentially uncolonisable. In the meres' data set, most separate easily into the deep or shallow category. Two meres, however,pose problems. Tabley Mere has a maximum depth of 4.4m but is manifestly covered with aquatic plants and was included in the shallow category. On logical grounds, Hatchmere at 3.8 m should then also be included in the shallow category. But Hatch Mere has steep sides and despite clear water has only a narrow littoral zone with plants. Hence it was retained in the deep category in which its maximum depth places it.

15. A comparison between key variables in the two categories gave the following results (Table 3):

Table 3 Comparison between characteristics of deep and shallow meres. Statistical comparison was made using a t test.

	Shallow	Deep

	Mean	SD	Mean	SD	P
Area	9.4	6.4	21.5	16.2	<0.02
Depth	2.6	0.97	11.7	5.9	<0.0001
Conductivity	614	105	388	142	<0.002
Phenolph alk	0.33	0.16	0.17	0.11	<0.02
Total alk	3.44	1.13	1.93	0.91	<0.002
Chloride	60.2	26.4	43.6	15.9	ns
Ann Tot P	557	413	298	389	ns
Wint Tot P	413	338	363	409	ns
Growth Tot P	619	447	270	383	ns
Wint SRP	296	273	287	348	ns
Growth SRP	474	425	185	307	ns
Wint total N	2.27	1.47	0.82	0.28	<0.01
Growth total N	1.16	0.86	0.54	0.46	<0.05
Ann chlorophyll	28.4	20.8	15.2	5.9	ns
Growth c'phyll	29.0	22.2	18.0	7.4	ns
Ann % diatoms	32.1	12.4	20.0	11.0	<0.05
Ann % Greens	32.7	13.3	29.1	20.8	ns
Ann % blue grns	9.8	7.5	15.2	11.8	ns
Growth % diats	28.7	11.6	14.5	10.3	<0.01
Growth % grns	33.9	14.8	31.2	20.8	ns
Growth % bl gr	13.2	11.0	18.5	13.9	ns
Ann *Daphnia*	33.9	30.1	13.3	13.5	<0.05
Growth *Daphnia*	44.5	37.4	14.0	11.4	<0.02

Bosm/Daph	**0.095**	**0.162**	**7.5**	**24.7**	**ns**
***Daph* lg/sm**	**1.43**	**2.86**	**0.13**	**0.21**	**ns**
% lge *Daphnia*	**29.2**	**34.2**	**5.1**	**11.7**	**<0.05**
Grazing index	**56.8**	**48.4**	**15.9**	**17.1**	**<0.02**

16. There were several significant differences between the two categories. The deep lakes were larger, with lower conductivities, lower total alkalinities and lower phenolphthalein alkalinities. The latter is probably not derivative of differences in chlorophyll a concentrations as these were not significantly different between the two categories. Phenolphthalein alkalinity was detectable in many stream waters and in the meres even in winter and appears to be a function of the high total alkalinities. It probably means that the local drift is leaching significant quantities of carbonate as well as bicarbonate, the major component of alkalinity. Chloride did not differ between categories nor did total phosphorus nor soluble reactive phosphorus. There were, however, significant differences in nitrogen availability with the shallow lakes having greater supplies. This probably is because they are more likely to be fed by surface water streams that may pick up nitrate or ammonium from close-by farming operations. The deep meres are more likely to be ground water fed and although ground water in the east of England is very rich in nitrate it is not necessarily so in the west midlands where less permeable drift and waterloggged soils may give greater potentiality for soil denitrification.

17. Among the algal community the only significant difference found was in the percentage of diatoms, which was greater in the shallow lakes. This might reflect a greater degree of mixing in these lakes. The stratification of the deeper lakes tends to disfavour diatoms somewhat and to favour flagellates and blue green algae. However, although the deep lakes had greater proportions, on average, of blue green algae in their communities, the difference was not statistically significant. It may be that significant differences might be seen if biomass rather than numerical indicators were used.

!8. Prominent differences were found in the zooplankton communities. Shallow lakes had significantly more ***Daphnia***, of larger size and of greater potential grazing activity than deep ones. Deep lakes also had a greater proportion of ***Bosmina*** in their communities. Collectively this suggests greater effective fish predation in the deeper lakes. Many of the shallow lakes had substantial beds of aquatic plants to provide refuges against predation which are absent in the deeper lakes. Large ***Daphnia*** are more readily eaten than small and ***Bosmina*** often persists when all the ***Daphnia*** have been eaten. There is a greater chance also that shallow lakes may have lost their fish communities due to past winter kills under ice or summer kills due to night time respiration by the large aquatic plant biomass. On the other hand the stream connections of most of these lakes might also favour ready recolonisation after such a kill.

19. A pattern thus emerges among the meres based on depth. This has no geographical basis because the original depth of a glacially formed basin in drift deposits is presumably often randomly determined. The differences in nitrogen, diatom representation and zooplankton activity are all readily explained but the differences in conductivity and alkalinity are not. This is particularly so as there is no systematic difference in phosphorus concentration. Phosphorus is presumed to be derived from drift deposits rich in appropriate minerals and hence might be expected to be more abundant in the ground water-fed deep meres. Surface pollutant sources are,however commoner in the shallow category and may have increased the concentrations in this group so that they are no longer different from those of the deep meres. What is puzzling therefore is that conductivities and alkalinities in the shallow group are higher than in the deep group. If ground water is the major source for the latter it might be expected that the higher conductivities would be found in the deep group.

20. The next step in the analysis was to attempt to determine what controlled algal crops in the two groups separately. The significant differences in nitrogen, conductivity , alkalinity and zooplankton were possible clues to this. Note that overall algal crops were similar on average between the two groups. Regression analyses were thus carried out on the data for the two groups with growth season mean chlorophyll a as the dependent variable.

21. Results for the shallow lake group were as follows (Table 4):

Table 4. Simple regression analyses between growth season mean chlorophyll a and ln chlorophyll a in a group of shallow meres.

	Chlorophyll a		Ln Chlorophyll a	
Variable	r^2	P	r^2	P
Area	0.08	ns	0.12	ns
Depth	0.01	ns	0.001	ns
Conductivity	0.12	ns	0.15	ns

Total alk	**0.02**	**ns**	**0.05**	**ns**
Chloride	**0.11**	**ns**	**0.002**	**ns**
Ann totP	**0.09**	**ns**	**0.11**	**ns**
Wint totP	**0.19**	**ns**	**0.23**	**ns**
Growth totP	**0.06**	**ns**	**0.08**	**ns**
Wint SRP	**0.2**	**ns**	**0.26**	**ns**
Growth SRP	**0.11**	**ns**	**0.13**	**ns**
Winter N	**0.04**	**ns**	**0.23**	**ns**
Growth N	**0.07**	**ns**	**0.07**	**ns**
Ann *Daphnia*	**-0.44**	**<0.025**	**-0.54**	**<0.01**
Growth *Daphnia*	**-0.45**	**<0.025**	**-0.53**	**<0.01**
Bosm/Daphnia	**0.5**	**<0.01**	**0.38**	**<0.05**
***Daphnia* lg/sm**	**-0.09**	**ns**	**-0.1**	**ns**
% lge *Daphnia*	**-0.12**	**ns**	**-0.11**	**ns**
Grazing index	**-0.533**	**<0.01**	**-0.65**	**<0.005**

22. No significant correlations were obtained with any chemical variables but very strong inverse relationships were found with zooplankton related variables. Figs 5 &6 demonstrate this graphically. The most important feaure determining the algal crops in the shallow lakes was therefore grazing. Multiple regressions using grazing and conductivity were able to account for a total of up to 56.2% of the total variance in chlorophyll a before the significance fell below 0.05. For ln chlorophyll a, 65% of the variance was determined by grazing alone; this was increased to 68.8% by addition of conductivity, and 76.7% by addition of winter SRP. Winter N had no additional effect.

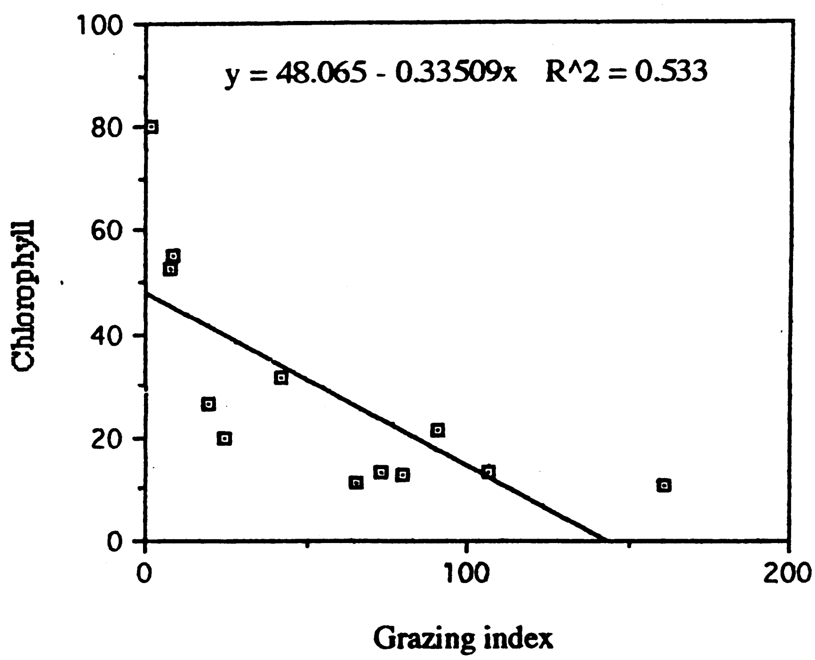
23. The same analysis was applied to the deep lake group with the following results for simple regressions:

	chlorophyll a		ln chlorophyll a	

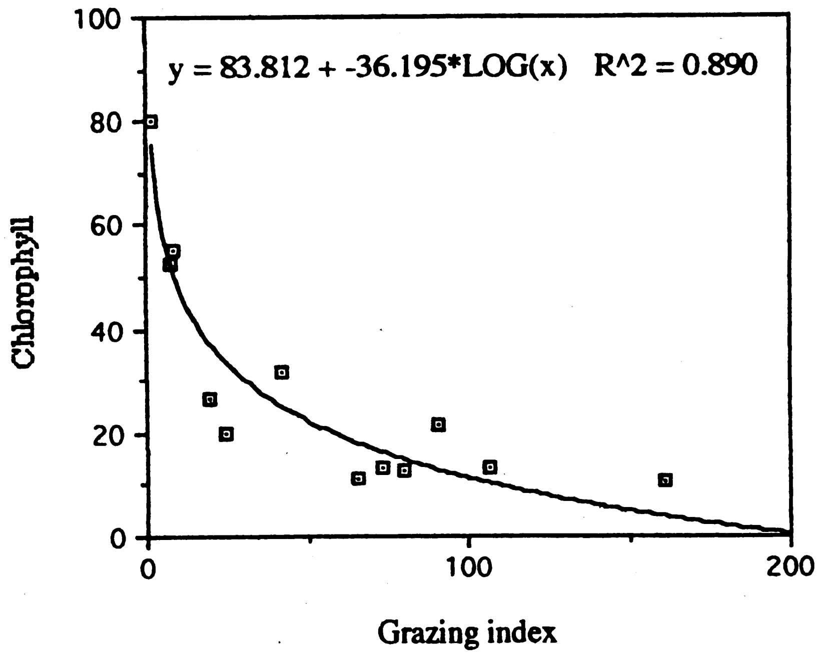
Variable	r^2	P	r^2	P
Area	0.007	ns	0.013	ns
Depth	0.006	ns	0.03	ns
Conductivity	0.034	ns	0.042	ns
Phenolph alk	0.005	ns	0.006	ns
Total alk	0.03	ns	0.04	ns
Chloride	0.02	ns	0.05	ns
Ann totP	0.004	ns	0.014	ns
Wint totP	0.004	ns	0.014	ns
Growth totP	0.004	ns	0.014	ns
Wint SRP	0.004	ns	0.015	ns
Growth SRP	0.002	ns	0.009	ns
Winter N	0.81	<0.0001	0.759	<0.005
Growth N	0.56	<0.01	0.51	<0.01
Ann *Daphnia*	-0.038	ns	-0.016	ns
Growth *Daphnia*	-0.031	ns	-0.043	ns
Bosm/Daphnia	0.273	ns	0.187	ns
Daphnia lg/sm	-0.03	ns	-0.04	ns
% lge *Daphnia*	-0.09	ns	-0.12	ns
Grazing index	-0.0003	ns	-0.009	ns

24. The results were thus clear cut (Figs 7 & 8) and very different from those obtained in the shallow lakes. Nitrogen supply determined the algal crops in the deep lakes. The winter N concentration is a good surrogate for the nitrogen loading to a temperate lake. Multiple regressions using chlorophyll a as the independent variable were able to explain only a further 4% to the 80.6% of the variance explained by winter nitrogen, with ***Bosmina***

Fig 5

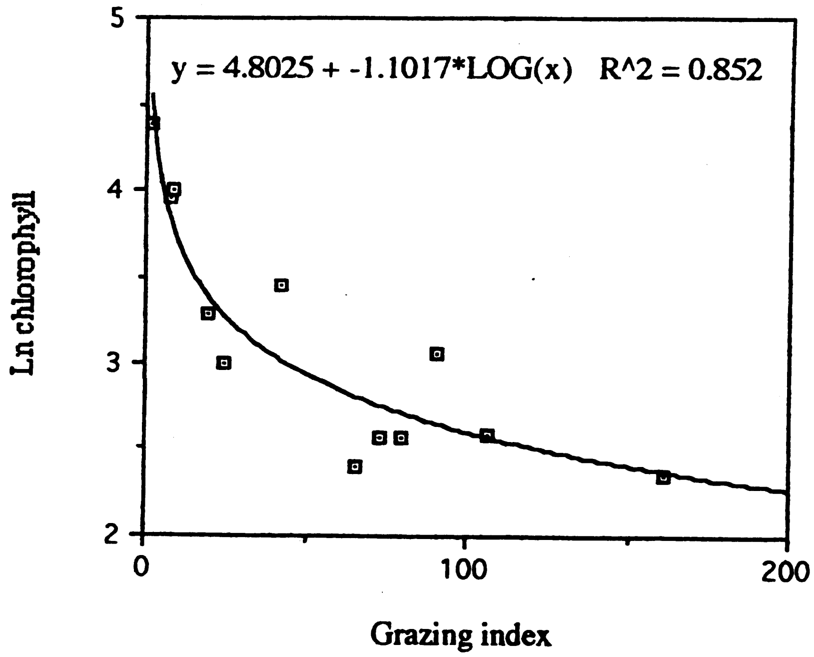


y = 48.065 - 0.33509x R^2 = 0.533
Chlorophyll
Grazing index
100
80
60
40
20
0
0
100
200



y = 83.812 + -36.195*LOG(x) R^2 = 0.890
Chlorophyll
Grazing index
100
80
60
40
20
0
0
100
200

Fig 6


y = 4.8025 + -1.1017*LOG(x) R^2 = 0.852
Ln chlorophyll
5
4
3
2
0
100
200
Grazing index

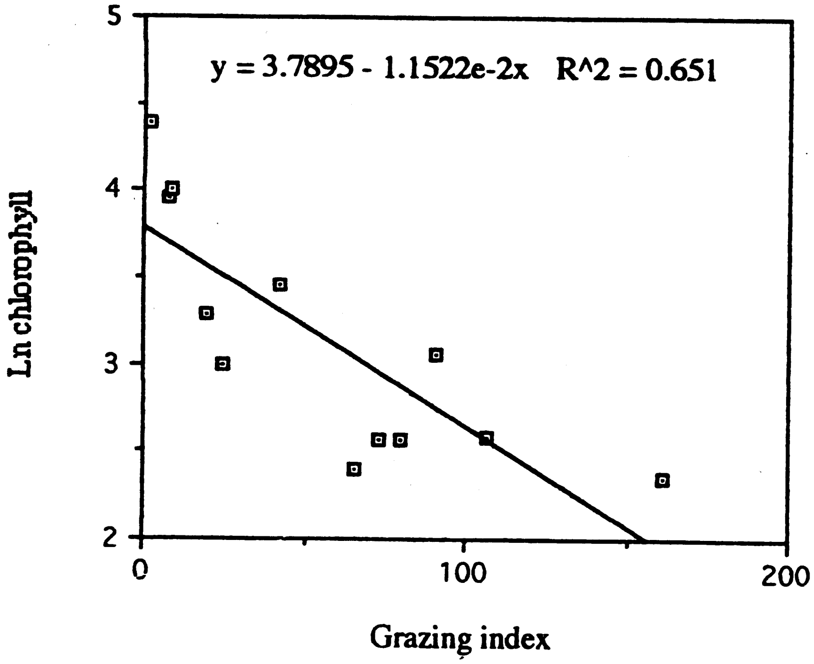
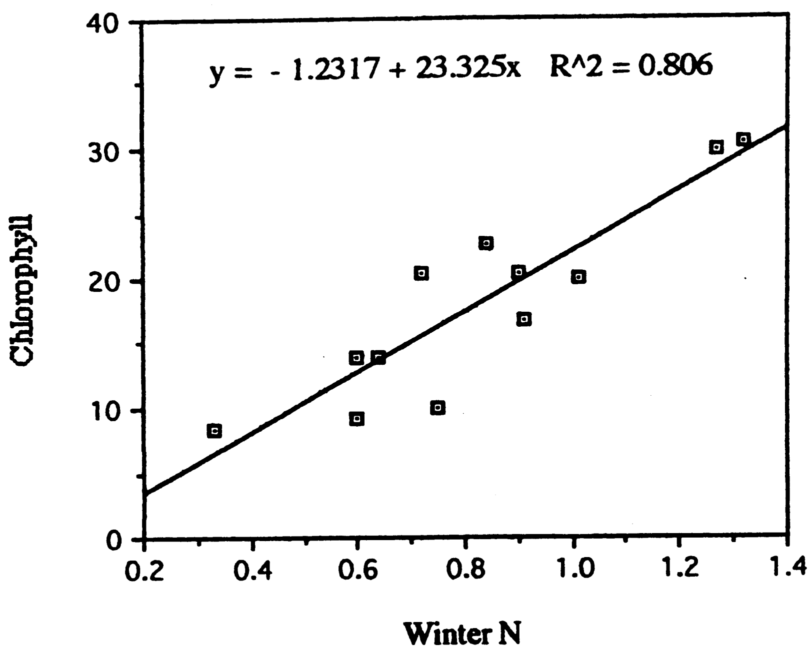
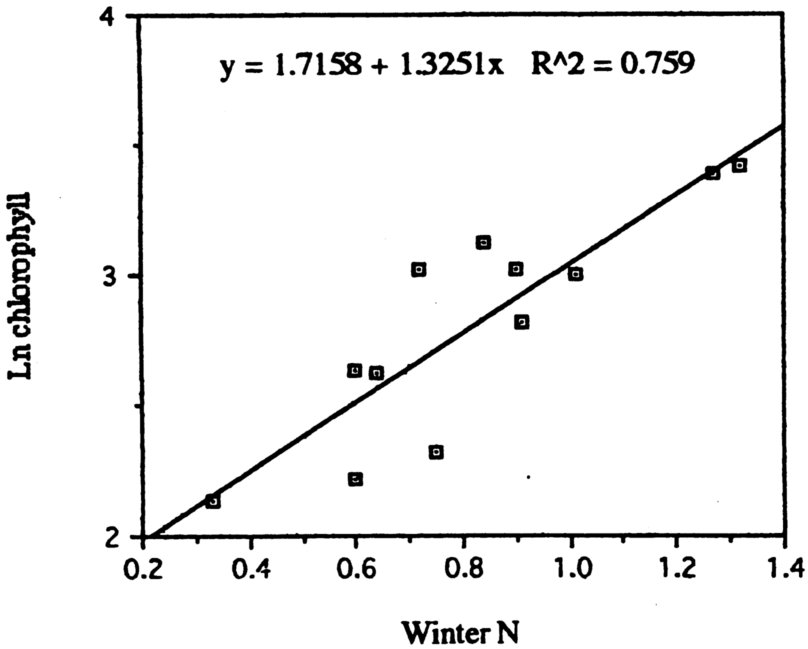

y = 3.7895 - 1.1522e-2x R^2 = 0.651
Ln chlorophyll
5
4
3
2
0
100
200
Grazing index

Fig 7



y = - 1.2317 + 23.325x R^2 = 0.806
Chlorophyll
40
30
20
10
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Winter N



y = 1.7158 + 1.3251x R^2 = 0.759
Ln chlorophyll
4
3
2
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Winter N

Fig 8

to ***Daphnia*** ratio, conductivity, winter SRP and grazing index each contributing a very small increment.

25. **These data not only give pattern to the data set, they also provide general guides for conservation management if the aim is to maintain minimal algal crops and a good light climate for aquatic plants. For shallow lakes (<3m) attention must be given to maintenance of the zooplankton grazers through control of fish stocking and factors like pesticide use which may destroy grazing potential. And for deep lakes control of the nitrogen input is crucial. In contrast to most other temperate lakes, the phosphorus concentrations are immaterial because of the general abundance of this element in the catchments of the area.**

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APPENDIX

NPo-forskning fra Miljøstyrelsen

Conference Contributions

International Conference on N, P and Organic Matter

Contributions by Invited International Experts

1991.

Miljøministeriet
Miljøstyrelsen

The role of nutrients in determining the structure of lake ecosystems and implications for the restoration of submerged plant communities to lakes which have lost them

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1. The balance between plants and plankton in shallow lakes

All significant cities house great art. Lisbon is no exception and in the middle of the city is the Musea Caloust Gulbenkian with its sculpture garden, graced and integrated by a network of pools and streams. An inspection of the water supply to the garden showed me that all had a common source, yet some pools had clear water and communities of Chara and other submerged plants, whilst others had dense green algal phytoplankton and only nymphaeids and emergents among the plants. The distinction between the two groups of ponds was that the former lacked fish, whilst the latter had shoals of goldfish (Carassius auratus) so abundant as to be obvious even in the deep-green water. It was a dramatic illustration that the operation of aquatic ecosystems is a function not only of the nutrients, held as of prime importance by much conventional wisdom, but also of the interwoven effects of predation and other biological relationships.

Nearly twenty years ago I began work on a group of about forty lakes in eastern England, the Norfolk Broads. They are not natural lakes, but shallow (1-2m) flooded peat diggings, whose origin has been traced back to the technique of peat excavation introduced by the invading Danes in centuries just prior to the turn of the first millenium A.D. In the fourteenth century, the pits, which range in area from 1 to 120 ha, were flooded during a climatically wet period and connected by channels to the nearby rivers. They lie close to the rivers at the heads of the valleys but at greater distances at the feet of the valleys. The former pits were located close to villages on the upland at valleys' edges. All are riverine lakes, but the consequences of their location at the edges of widening valleys mean that the upstream ones are flushed much more rapidly than the downstream ones (Moss et al. 1989).

The river and Broad system is small in volume yet takes the effluent from a large number of small sewage treatment works, and the run off from one of the most intensive arable catchments in Britain. In consequence it is eutrophic and dominated by phytoplankton algae, whereas until the 1960s it bore rich communities of submerged plants and formerly had very clear water. Palaeolimnological and anecdotal evidence suggest that the system has passed from an original phase with clear water and low growing plants like Naias marina and charophytes to dominance by tall growing plants (Potamogeton, Myriophyllum, Ceratophyllum before finally losing almost all of the plant communities and becoming turbid with planktonic algae. This sequence correlates with steadily increasing loading of nitrate and phosphate on the system. Consequently, my earliest overall view of restoration of the system was that reduction in nutrient loading would result in a linear reversal from the planktonic phase 3 back to the tall plant phase 2 and perhaps even to the short-plant phase 1. Subsequent investigations were to show that this was too simple.

A pair of small Broads at Brundall on the R. Yare provided a first insight (Leah, Moss & Forrest 1980). They were connected by a channel like the two cups of a brassiere. One cup was freely connected with the river, whilst the connections that the other had had both with the river and the first cup were blocked with earth dams. The R. Yare carries large quantities of sewage effluent and is a very eutrophic river. The hypothesis was that the cup connected to the river would remain hypereutrophic and dominated by planktonic algae whilst the isolated cup would become nutrient poor and plants would re-establish. This latter is what happened, but inconveniently for the hypothesis, the nutrient levels in the isolated Broad were just as high as in the control Broad. Under the strong tidal regime of the river at Brundall, the earthworks had leaked and river water was being injected into both Broads on each tide. Nonetheless, large stands of Nitella flexilis established in the 'isolated' broad whilst the open Broad indeed was plankton dominated.

A second set of observations contravening the simple relationship believed to exist between ecosystem structure and nutrient loading was made at Hoveton Great Broad on the R. Bure (Timms & Moss 1984). Hoveton Great Broad has large algal populations, with a few small patches of nymphaeids (Nuphar lutea and Nymphaea alba). It has a subsidiary basin, Hudsons Bay, which has only a small area of open water adjacent to large stands of nymphaeids. Both basins are freely connected with each other and with the river and, on twice-daily tides, received injections of effluent rich water. The open water in Hudsons Bay, however, remained very clear and virtually free of phytoplankton in summer, whilst the main basin of Hoveton Great Broad was turbid with more than 100 $\mu g\ l^{-1}$ of chlorophyll a.

An attempt to reproduce the changes believed to occur in plant-dominated lakes on eutrophication was the subject of the third set of disturbing observations (Balls et al. 1989; Irvine et al. 1989). We built a set of twenty 10m x 4 m experimental ponds by sub-dividing a long straight channel in one of the Bure valley wetlands with wooden dams. The channel had been isolated sometime previously from the river and had a phase 2 aquatic plant community with Ceratophyllum demersum, Stratiotes aloides, Hydrocharis morsus-ranae, Lemna minor and L. trisulca. We removed the existing fish stock - a sparse population mostly of pike and eels and restocked each pond with a standard mixture of small (<10 cm) roach (Rutilus rutilus), perch (Perca fluviatilis) and bream (Abramis brama) with some small carp (Cyprinus carpio).

Prior to this, some of the ponds were cleared manually of aquatic plants to create open water whilst the remaining ponds were allowed to retain their plants. All the ponds received additions of ammonium nitrate and also one of a series of phosphorus loadings given at two-weekly intervals. The higher phosphorus loadings were greater than those received by the Broads themselves.

Even at very high loadings the plant-dominated ponds retained their plants and neither phytoplankton nor high phosphorus concentrations were established in the water. In the cleared ponds at the higher loadings, however, large phytoplankton populations were established. In this experiment, therefore, eutrophication did not displace the aquatic plants, and phytoplankton was only established when the plants had previously been removed by other means.

In each of these examples the reason why the water became or remained clear was that grazing by large Cladocera was intense. In the Brundall experiment, the fish stock in the 'isolated' broad was depleted, probably by cormorant predation and Daphnia longispina became very abundant. In the observations on Hoveton Great Broad, a very large community of large Cladocera of several genera was harboured in the beds of nyphaeids; many animals moved out at night to graze in the open water and kept the phytoplankton population from increasing. These animals were probably eaten after dawn by the fish, but were replaced the next night from the huge stocks in the plant refuges. And in the ponds experiment the plants again provided refuges for Daphnia and Simocephalus, which kept phytoplankton from developing. In the cleared ponds, such refuges were absent and there was much potential for fish predation on the Cladocera.

The three examples quoted had the common feature that either phytoplankton- or plant-dominance could be established at the same high nutrient loadings or concentrations or both. This suggested that two alternative stable states might exist over a range of high nutrient conditions. In turn this posed three problems. First, because nutrient addition alone did not displace the plants (ponds experiment) what factors might cause this change and secondly what might be necessary to switch the phytoplankton dominated state back to plant dominance? Observations elsewhere in Broadland had shown (Moss & Leah 1982) that simple nutrient reduction did not necessarily result in clearing of the water and reestablishment of plants. The third problem was interlinked - what mechanisms stabilize the plant-dominated system in the face of increased nutrient loading and conversely what stabilizes the plankton dominated state when nutrient loading is reduced?

There are undoubtedly many mechanisms acting as stabilizers or buffers. Grazing by Cladocera finding refuge in the plant beds is clearly important and grazing by chironomids and snails on the periphyton may be equally so in stabilizing the plant community. Oxygen depletion in the plant beds may discourage entry of potentially predatory or even herbivorous fish. Weed-bed snails, by acting as intermediate hosts for trematodes parasitic on fish, may in subtle ways alleviate the potential fish predation on grazers. Plants may produce allelopathic substances which inhibit phytoplankton, though I have been unable to demonstrate this in experiments using plankton populations contained within dialysis bags close to weedbeds.

Mechanisms stabilizing phytoplankton dominance include the absence of cladoceran grazers through lack of refuges and the ability of phytoplankton to develop early in the year and to compete successfully for CO_2 and nutrients because of the shorter diffusion pathways into the organism. Other mechanisms may be a shift in the age-structure of predatory fish from one with much of the biomass in older fish, which need large invertebrates for their food, to one in which most of the biomass is in young zooplanktivorous fish. These may fail to grow large through lack of plant-associated large invertebrate food.

A further feature, of the three examples of alternative plant and phytoplankton-dominated states given above, was that the phytoplankton communities were dominated by diatoms or small flagellates and not by large flagellates like Ceratium or filamentous or colonial cyanophytes. This was perhaps because of the high flushing rates in the Brundall and Hoveton Great Broad examples. In the experimental ponds, the large contact area of organic sediments in relation to the water volume may have established such an abundance of free CO_2 that cyanophytes were not favoured (Shapiro 1990). There are, however, Broads which are dominated by cyanophytes for much of the year (Moss & Balls 1989). They are those Broads which lie at some distance (1-2 km) from the main river and which are the least flushed and have theoretical retention times of nearly two months, which are lengthy for this system.

Experiments in one such lake, using netting enclosures to exclude both fish and fish fry but allowing free movement of phytoplankton through the enclosures, showed that large Cladocera did not develop during the summer. In control enclosures in a diatom-dominated lake in the same river system, very large numbers of three species of large Cladocera, including the very large Daphnia magna and Daphnia pulex, were found (Moss, Stansfield & Irvine 1991). This suggests that a planktonic state, which is not an alternative to a plant-dominated state stabilized by Cladocera grazing, may exist at high effective nutrient loadings. The word effective is used to express the importance of relatively low flushing rate in allowing the loading to support the build up of large populations of large algae.

These results collectively changed my concept of the effects that eutrophication had had on the structure of the Broads ecosystem. A linear change from Phase 1 (short plants) to phase 2 (tall plants) to phase 3 (phytoplankton) with increased loading clearly did not describe the situation. Instead, four phases seemed to be needed with the phase 1 community being changed to phase 2 by increased loading but phase 2 and phase 3 being alternatives over similar loadings with each switchable to the other by mechanisms which could not be nutrient-linked. In turn, at very high effective loadings, (determined by low flushing rates), a phase 4 phytoplankton community develops which is not controllable by zooplankton grazers because of the inedibility of the species concerned. The implication of this is that for restoration of clear water and aquatic plants a combination of nutrient reduction (to move the system from phase 4 to phase 2/3) and other biomanipulative measures (to move phase 3 to phase 2) will be necessary. In turn this demands an understanding of what mechanisms switch phase 2 to phase 3 (loss of plants) or the converse, phase 3 to phase 2 (reestablishment of plants).

Clearly the switch from plants to plankton and vice versa cannot inevitably involve changes in nutrient status in the range over which these communities exist as alternative stable states. This does not preclude the possibility that such a switch might not be nutrient-mediated at very high loadings or concentrations and this issue is discussed below.

There may be many non-nutrient mediated switch mechanisms operating singly or together in different situations. Examples might be mechanical disturbance of plants through severe boat damage or repeated cutting, or over-grazing by mammals such as the coypu (Myocaster coypus) or birds such as swans or geese. This is likely to have occurred where human activities (introduction as an exotic, or artificial feeding in summer by tourists) have unnaturally increased the sizes of local populations. Disturbance of grazing invertebrate populations may also allow competitive build-up of periphyton or phytoplankton. Such disturbance might result from incidental pesticide (Stansfield et al. 1989) or salinity pollution (Moss 1990) or deliberate molluscicide use, for example in control of mollusc-borne trematode diseases. It may also arise from alterations in fish communities through deoxygenation under ice which favour zooplankivorous or benthivorous fish over their own piscivores (C. Bronmark pers. comm.). Finally the plants themselves may be poisoned through herbicide run-off or deliberate application to control their biomass. Once such a switch has been enacted, it does not necessarily follow that reversal of the process will occur through operation of the same switch in the reverse direction, though the causative factor must obviously be removed as part of the treatment. Where the refuges provided for zooplankton grazers by plants have obviously been lost, artificial refugia (Irvine et al. 1990; Moss 1990) may have to be provided to reinstate sufficient grazers even if the original mechanism destroying the plants did not directly act on the grazer community. This is because fish will have eliminated the large Cladocera in the phytoplankton-dominated state.

A switch from phase 2 or 3 to phase 4 (production of inedible phytoplankton) is a nutrient mediated one but there may be other nutrient mediated mechanisms also. These might include stimulation of blanketing filamentous algae or epiphytes, particularly where nitrogen loadings as well as phosphorus loadings are high (Fitzgerald 1969). Increased epiphyte burdens might alter the balance of photosynthesis and respiration in the host plant by shading, competition for CO_2 or inhibition of plant photosynthesis by other means. Vigorous plant growth may itself inhibit further plant regeneration if the environment at the sediment surface through decomposition of the plants disfavours seed germination or turion development. This latter appears to be the best explanation for the cyclical growth and demise of aquatic plants in Alderfen Broad (Moss et al., 1990).

2. Community changes in the context of different lakes

Finally these processes of loss of plants through non-nutrient and nutrient-mediated mechanisms must be put in the contexts of different sorts of lakes. Figures 1-3 give hypotheses which seem to fit the information at present available in lakes with negligible (Fig. 1), significant but not dominant (Fig. 2) and dominant littoral development (Fig. 3). The littoral is defined as that part of the lake capable of supporting net photosynthesis at the sediment surface.

The horizontal axes show effective phosphorus loading, which takes into account the fact that flushing rate has a major influence on the extent to which loading can be converted into actual standing crop of plants or algae. The vertical axes show phytoplankton chlorophyll a and plant biomass per m^2 averaged over the entire lake area. Available N to available P ratio in the water is also shown and P 1-4 represent phases 1 to 4 as discussed above.

In relatively deep lakes (Fig. 1) aquatic plants are unlikely to have a major role in the lake system overall. Their biomass may be stimulated a little as nutrient loadings increase but they never acquire an abundance sufficient for them to have major effects on the dominant pelagic area of the lake. Increasing eutrophication is thus likely to lead to a build up in phytoplankton and a restriction or loss of most of the aquatic plants simply through nutrient-mediated shading. At extreme phosphorus loadings, the phytoplankton will become limited by nitrogen or ultimately, if nitrogen fixers can develop, by self-shading.

In an intermediately deep lake (Fig. 2) where the littoral zone occupies a significant part of the lake - say up to a third or so - the effects of increased loading will be reflected initially in growth of both the phytoplankton and of the littoral plant-periphyton communities. The relationship between phytoplankton chlorophyll a and phosphorus will show a lower ratio than in the deep lake as the plant-periphyton complex takes up some of the available nutrient from the water, as well as exploiting the sources in the sediment. However, as loading increases, the phytoplankton, with its advantages in competition for light energy, will eventually start to restrict the plant growth and a nutrient-mediated switch to phytoplankton dominance will occur. A non-nutrient mediated loss of plants may, of course, occur at a lower loading but restoration of the plants should be possible by removal of the cause of destruction alone.

Where the lake is dominated by its littoral zone, perhaps with more than half of its area capable of supporting submerged and rooted plant growth, a much more complicated situation ensues. The plants will increase their biomass (with changes also in species) as loading increases and phase 1 plants will be replaced by phase 2 (tall, rank) plants. Phytoplankton will fail to develop because the mechanisms which stabilize the dominant plant community will prevent it from doing so. The decomposition of the plants in their abundant beds will result in deoxygenated condition at the sediment surface which favour phosphate release and denitrification and the N:P ratio will consequently fall more sharply than in the previous cases. Increased nutrient loading, which may require concomitant increases in nitrogen load may result in a direct shift from phase 2 to phase 4 if large phytoplankters begin to be produced which the zooplankton grazers cannot control. These events are shown in the upper panel of Fig. 3.

Shallow lakes are likely to be situated in areas where non-nutrient mediated mechanisms, involving mechanical damage, agricultural pesticide pollution or salinification through pumped drainage of low-lying land near the sea are likely to occur. Their morphometry also favours deoxygenation under winter ice or at night in summer with consequent effects on the fish community. If one of these mechanisms begins to operate, the situation shown in the lower panel of Fig. 3 may occur. In this, the plants are lost through a non-nutrient mediated mechanism at relatively low loadings and phytoplankton takes over dominance as phase 2 is replaced by phase 3. At this stage restoration of phase 2 is possible through biomanipulation because the phytoplankton species establishing at these relatively low effective loadings are edible to zooplankters. If loading then increases further, phase 3 may be replaced by phase 4 and restoration of plants will require loading reduction as well as biomanipulation.

In conclusion, the simple relationships between nutrient state and the structure of aquatic ecosystems which were formerly thought to prevail seem as unlikely to exist as any simple relationship between the great art, with which this paper began, and the conception of it in the mind of the artist.

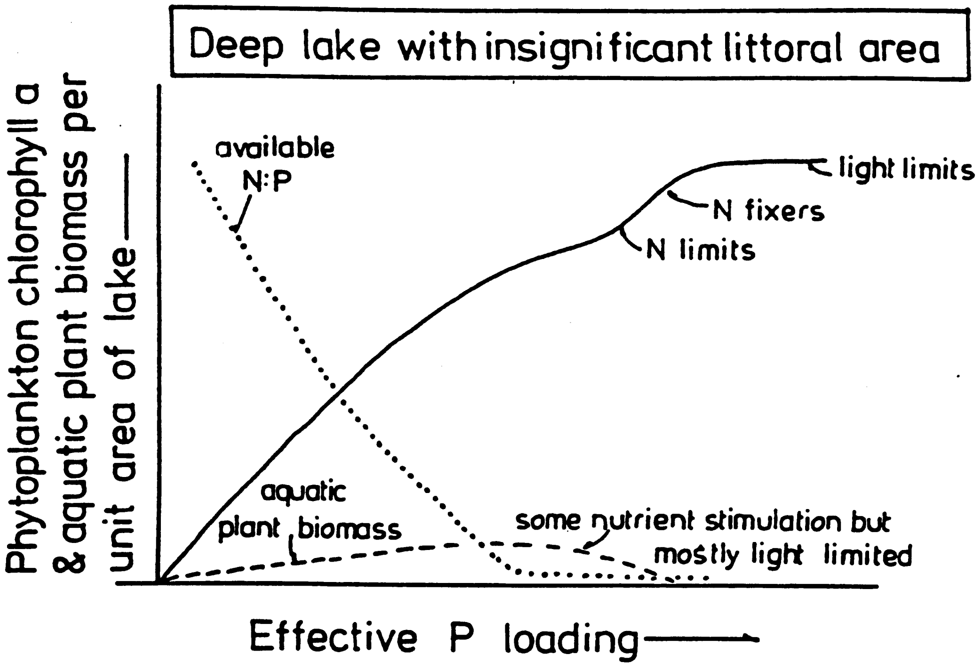

Fig. 1.
Hypothesised model for changes in the balance between submerged plant and phytoplankton communities in a lake with an insignificant proportionate area of littoral zone.

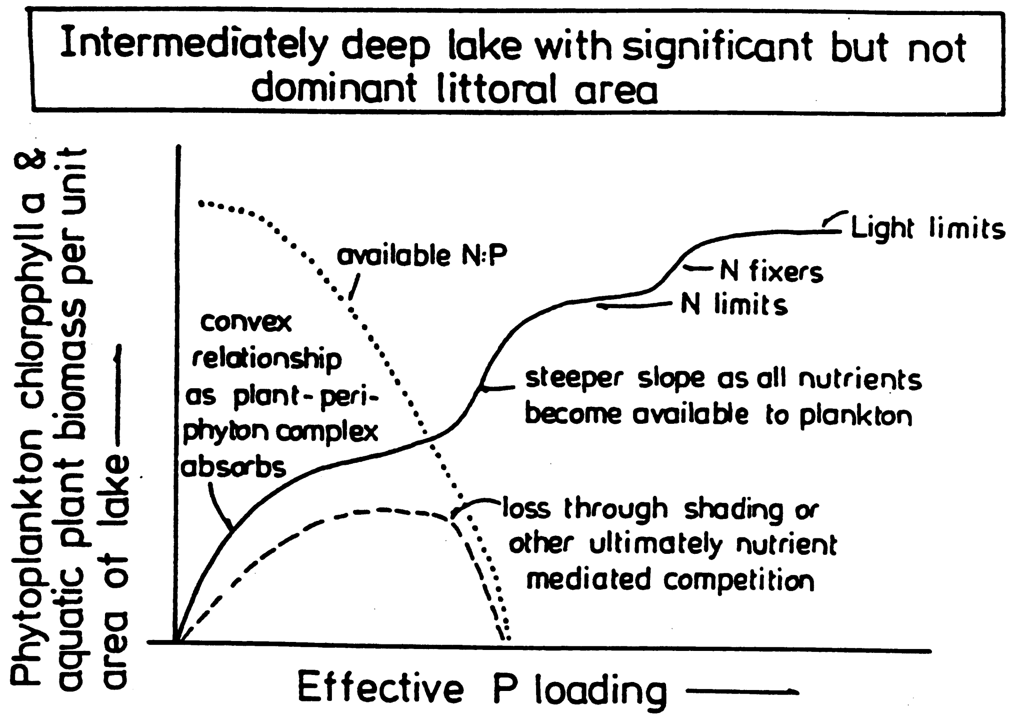

Fig. 2
Hypothesised model for changes in the balance between submerged plant and phytoplankton communities in a lake with a significant but not dominant proportionate area of littoral zone.

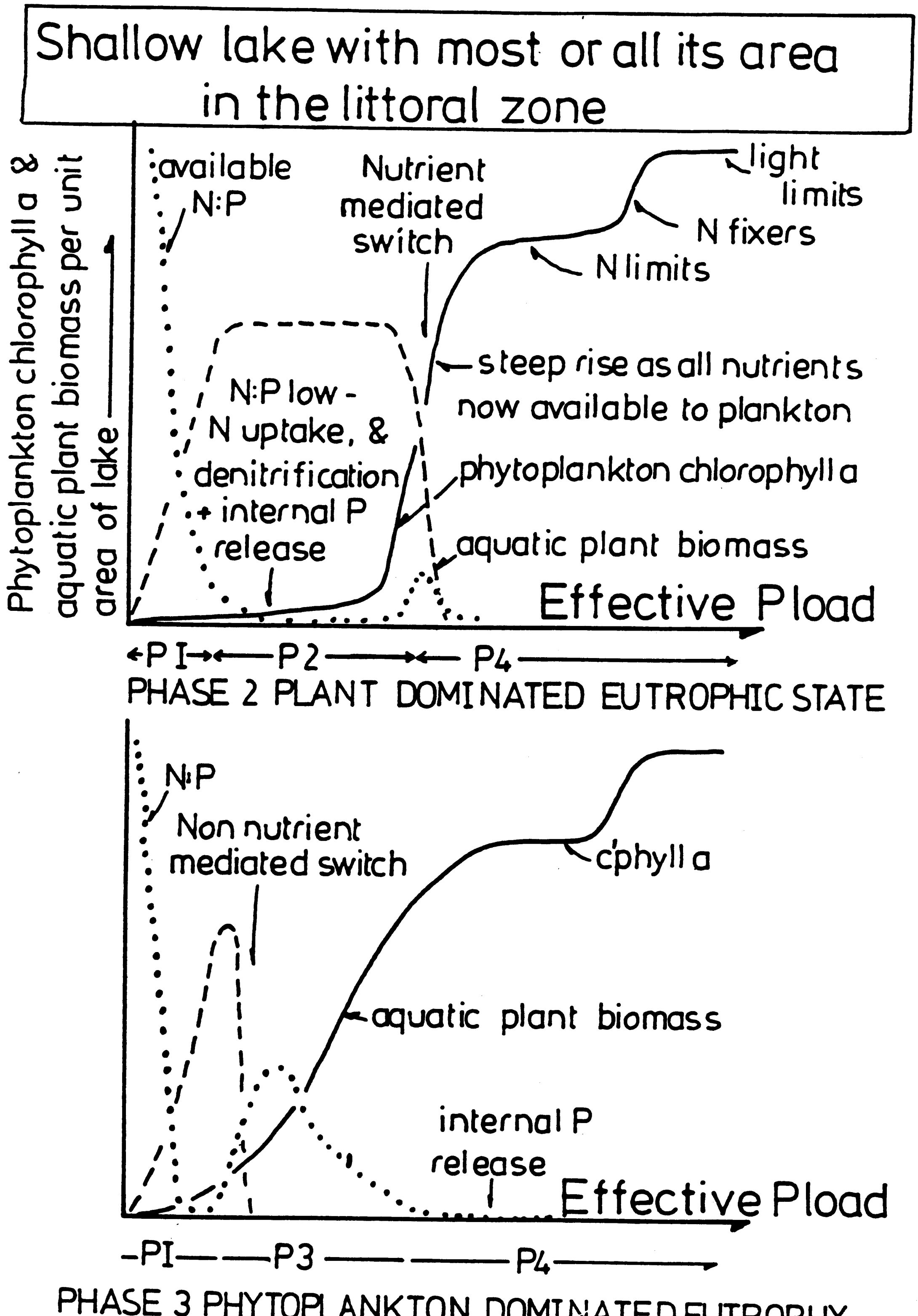

Fig. 3

Hypothetical model for changes in the balance between submerged plant and phytoplankton communities in a lake dominated by its littoral zone. The upper panel shows the situation where plants dominate over natural nutrient loadings. The lower panel shows the situation where the plants are displaced at low nutrient loads by usually human-induced and non-nutrient mediated mechanisms.

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