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RESEARCH REPORT

No. 17

Integrated classification and assessment of lakes in Wales: Phase II

Editor: D.T. Monteith

A Final Report to the Countryside Council for Wales under Contract No: FC 73-01-13

CCW Contract Science Report No. 128

August 1995

Environmental Change Research Centre
University College London
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Integrated Classification and Assessment of Lakes: Phase II - Final Report

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A report to the Countryside Council for Wales by ENSIS Ltd.

Contract No. FC 73-01-13

Nominated Officer DR. C. A. DUIGAN

August 1995

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Executive Summary

1 This is the final report to the Countryside Council for Wales under contract FC 73-01-13: 'Integrated Classification and Assessment of Lakes: Phase II' and follows the format adopted in Phase I (Allott *et al.* 1994).

2 Data are presented for the ten lakes surveyed in this phase of the study, all of which occur in central-west Wales. These are Bugeilyn, Llyn Eiddwen, Llyn Fanod, Llyn Glanmerin, Llyn Gynon, Llyn Hir, the most westerly of the Llynnoedd Ieuan, Maes-Llyn and the two Talley Lakes.

3 The field survey and analytical methodology adopted incorporates the characterisation of the lake-water chemistry and the following biological groups: epilithic diatoms, surface sediment diatom assemblages, aquatic macrophytes, littoral zooplankton, open water zooplankton and littoral macroinvertebrates. Previously collected data on the study lakes is referred to.

4 All data collected during this study are stored in a relational database at the Environmental Change Research Centre. The database allows flexible data retrieval, suitable for both this research programme and other potential uses and users.

5 The survey data are used to classify the lake systems, based on existing, commonly employed schemes.

6 Further development of classification techniques outlined in the Phase I report require the incorporation of data from a further fifteen lakes, six of which have already been surveyed under Phase III (in July 1995) and nine which are scheduled to be surveyed in 1996 under Phase IV.

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1 Introduction

This report presents data from the second phase of the study on integrated classification and assessment of lakes in Wales. The classification and assessment project is described in detail by Allott *et al.* (1994).

Ten lakes in central-west Wales, listed on the following page have been assessed over the period 1994-1995. The report includes data on water chemistry and physical variables, aquatic macrophyte species lists and distribution maps, epilithic diatoms, surface sediment diatoms, open water zooplankton, littoral zooplankton and littoral macroinvertebrates. Methodologies follow those described by Allott *et al.* (1994).

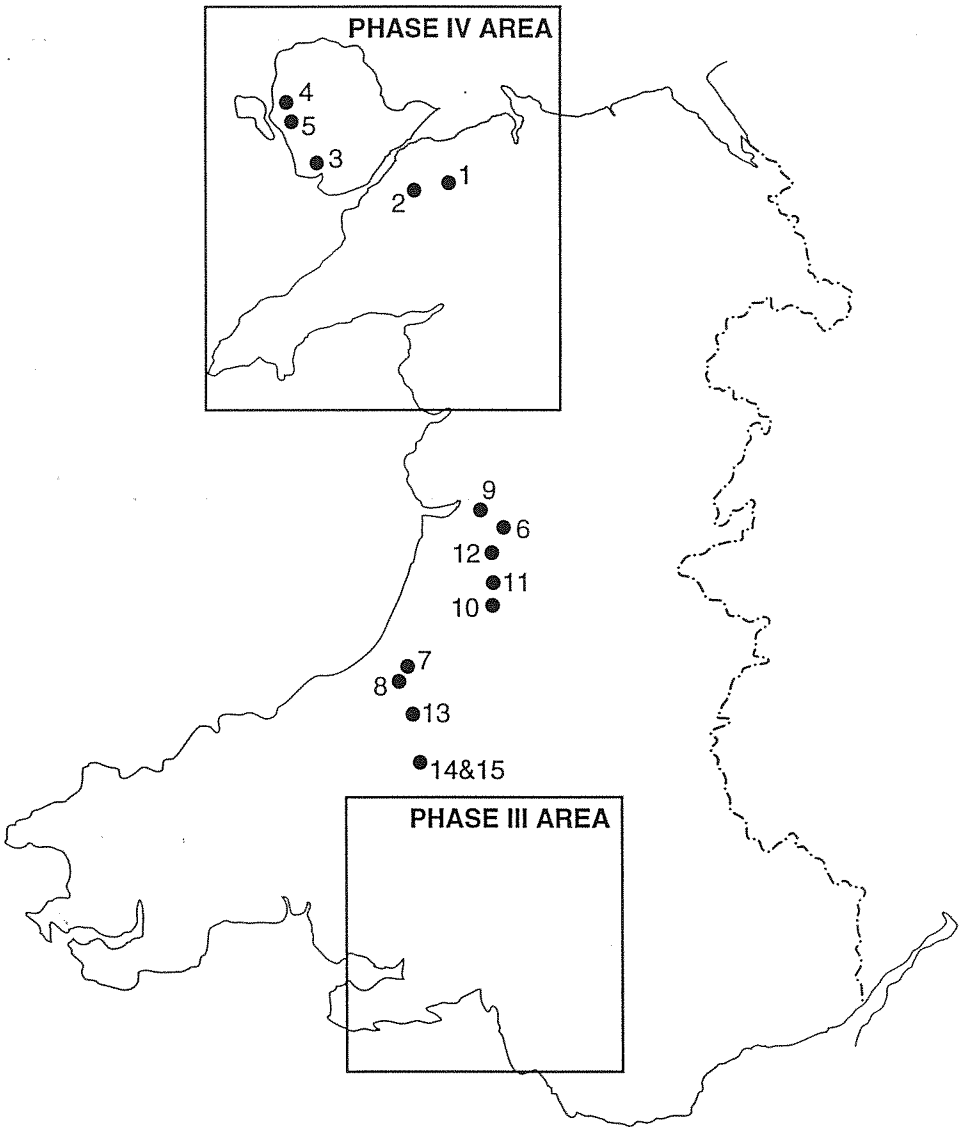
In addition the data have been used to place the lakes into existing classification schemes discussed in the first report. However, data from a further 15 lakes are required before statistical methods, also discussed in the first report, can be applied to develop a new integrated classification scheme for Welsh lakes.

Site Selection

The sites included in this survey were selected by the Countryside Council for Wales. Due to operational demands, it was necessary to include a number of specific sites throughout Wales; rather than randomly select a series of lakes. Information was urgently required on a number of sites which are the subject of active casework such as those being considered for inclusion as proposed Special Areas for Conservation under the EC Directive on the Conservation of Natural Habitats and of Wild Flora and Fauna. It was also intended that this survey would provide an opportunity to up-date the ecological descriptions of the majority of the Welsh standing waters included in Ratcliffe (1977). The sites recognised in the Nature Conservation Review (Ratcliffe 1977) are considered key conservation sites in a British context and some of the descriptions were considered "dated" even at the time of publication. Many of the sites were the subject of previous macrophyte surveys, and consequently there is scope to investigate changes in the macrophyte assemblages over time.

To ensure that a representative range of Welsh lakes are included in the final dataset, the range of the principal physico-chemical features of the selected sites are being evaluated during the development of the survey programme. Table 1.1 summarises the physical characteristics of sites included in both Phase I and II of the project, and Table 1.2 summarises the mean measured water chemistry data. In some cases it will be possible to assess the representativity of these sites by comparison with larger Welsh datasets, and datasets generated for lakes in other areas of Britain.

Figure 1.1 The location of sites in the CCW classification and assessment project



PHASE I SITES		PHASE II SITES	
1	Llyn Idwal	6	Bugeilyn
2	Llyn Cwellyn	7	Llyn Eiddwen
3	Llyn Coron	8	Llyn Fanod
4	Llyn Dinam	9	Llyn Glanmerin
5	Llyn Penrhyn	10	Llyn Gynon
		11	Llyn Hir
		12	Llynnoedd Ieuan
		13	Maes-Llyn
		14&15	The Talley Lakes

Table 1.1 Summary of physical parameters of lakes in Phase I and Phase II

Site name	Grid reference	Lake altitude (m)	Lake area (ha)	Lake catchment area (ha)	Lake maximum depth (m)	Lake mean depth (m)	Approximate lake volume (10^3 m^3)
Llyn Idwal	SH 646595	370	14	319	13.0	3.4	480
Llyn Cwellyn	SH 560550	150	85	2073	36.0	22.6	19000
Llyn Coron	SH 378380	10	26	1743	2.8	1.8	470
Llyn Dinam	SH 311775	4	9	657	1.8	1.4	130
Llyn Penrhyn	SH 315770	4	19	62	3.0	2.2	420
Bugeilyn	SN 822923	455	9	143	2.1	1.9	171
Llyn Eiddwen	SN 605670	305	10	45	7.2	2.6	260
Llyn Fanod	SN 603643	310	5	40	8.7	3.8	190
Llyn Glanmerin	SN 755991	195	3	36	3.1	2.5	48
Llyn Gynon	SN 800647	425	25	225	11.0	2.1	525
Llyn Hir	SN 789677	435	5	22	8.8	2.8	140
West Ieuan	SN 795815	525	4	12	8.7	3.9	156
Maes-Llyn	SN 693628	180	3	59	5.5	2.7	81
Upper Talley Lake	SN 632337	105	5	37	4.2	1.9	95
Lower Talley Lake	SN 633332	105	10	166	4.3	1.9	190

Table 1.2 Summary of mean water chemistry of sites in Phase I and Phase II

Determinand		mean for site														
		Idwal	Cwellyn	Coron	Dinam	Penrhyn	Bugeilyn	Eiddwen	Fanod	Glanmerin	Gynon	Hir	Ieuan	Maes-	U.Talley	L.Talley
lab pH		6.72	6.35	8.61	7.84	8.07	5.17	6.55	6.71	6.50	5.43	5.57	4.92	7.31	6.99	6.81
Alkalinity 1	µeq l^{-1}	70	37	1869	1533	2153	7	89	108	97	13	14	-9	527	448	343
Alkalinity 2	µeq l^{-1}	61	29	1878	1552	2178	2	83	103	91	4	5	-11	528	449	342
lab Conductivity	µS cm^{-1}	28	36	322	335	442	31	57	56	66	33	35	35	109	100	93
Sodium	µeq l^{-1}	109	175	1050	1341	1846	149	280	240	315	162	171	154	276	335	315
Potassium	µeq l^{-1}	4	7	70	65	134	6	16	15	7	6	6	5	24	21	27
Magnesium	µeq l^{-1}	34	46	634	567	524	58	119	123	133	70	65	50	254	177	186
Calcium	µeq l^{-1}	101	89	1988	1516	2202	58	160	187	181	63	74	45	623	495	411
Chloride	µeq l^{-1}	105	192	957	1497	1824	144	299	257	332	162	182	163	282	353	342
Aluminium total monomeric	µg l^{-1}	2	4	7	1	1	81	5	7	18	23	25	80	5	5	8
Aluminium non-labile	µg l^{-1}	2	3	3	1	1	59	5	7	18	16	18	24	3	4	6
Aluminium labile	µg l^{-1}	0	2	4	0	0	22	0	0	0	7	7.3	56	2	1	2
Absorbance	(250nm)	0.027	0.038	0.262	0.378	0.242	0.326	0.245	0.295	.128	0.187	0.099	0.070	0.170	0.118	0.157
Carbon total organic	mg l^{-1}	1.1	1.3	6.8	10.3	8.8	4.9	5.5	6.1	6.4	4.0	3.1	2.2	4.5	3.4	3.7
Phosphorus total	µgP l^{-1}	5.3	7.1	156.1	111.9	1085	18.0	20.5	18.1	14.7	7.7	6.8	5.0	52.6	51	69
Phosphorus total soluble	µgP l^{-1}	4.2	4.7	99.4	87.1	1038	11.9	10.9	11.1	7.8	5.5	4.9	2.7	18.4	27.3	26.0
Phosphorus soluble reactive	µgP l^{-1}	2.4	4.7	73.8	65.3	1016	6.8	4.2	3.1	1.8	2.4	1.3	0.7	5.9	10.4	12.2
Nitrate	µgN l^{-1}	112	170	700	68	142	61	54	151	151	65	63	77	508	256	291
Silica soluble reactive	mg l^{-1}	0.84	1.36	7.79	2.99	2.22	1.94	1.56	2.58	1.65	0.96	0.48	0.70	2.47	2.50	3.50
Chlorophyll a	µg l^{-1}	1.1	1.9	21.2	7.8	4.3	3.1	8.4	2.9	2.9	1.7	1.7	0.8	23.1	10.5	24.6
Sulphate	µeq l^{-1}	64	80	393	256	449	63	93	90	127	67	77	75	165	133	142
Copper total soluble	µg l^{-1}	<1*	<1*	<1*	<1*	<1*	39	0	0	0	10	1.8	0	5	4	0
Iron total soluble	µg l^{-1}	3*	23*	279*	237*	151*	621	91	238	315	189	66	57	277	192	183
Lead total soluble	µg l^{-1}	<1*	<1*	<1*	<1*	<1*	3	0	0	2	2	3	2	4	3	3
Manganese total soluble	µg l^{-1}	1*	12*	53*	161*	174*	39	10	82	51	28	46	91	11	102	1
Zinc total soluble	µg l^{-1}	<5*	21*	<5^{8}	<5*	<5*	10	5	4	38	3	10	8	4	4	4

* = one sample (March 1993) only

2 Site Descriptions

2.1 Llyn Bugeilyn

Llyn Bugeilyn lies at an altitude of 455 m within the Punlumon (Plynlimon) SSSI in the Montgomery district of central Wales. The catchment of approximately 140 ha consists predominantly of Ordovician mudstones. The soils are mainly ferric stagnopodzols of the Hafren Series with some thick acid raw peat soils of the Crowdy Series to the south. Peat erosion is evident on slopes at the southern and western ends of the catchment. The catchment vegetation is typical of acid moorland, dominated by *Calluna vulgaris*, *Molinia caerulea* and some *Vacinium myrtillus*.

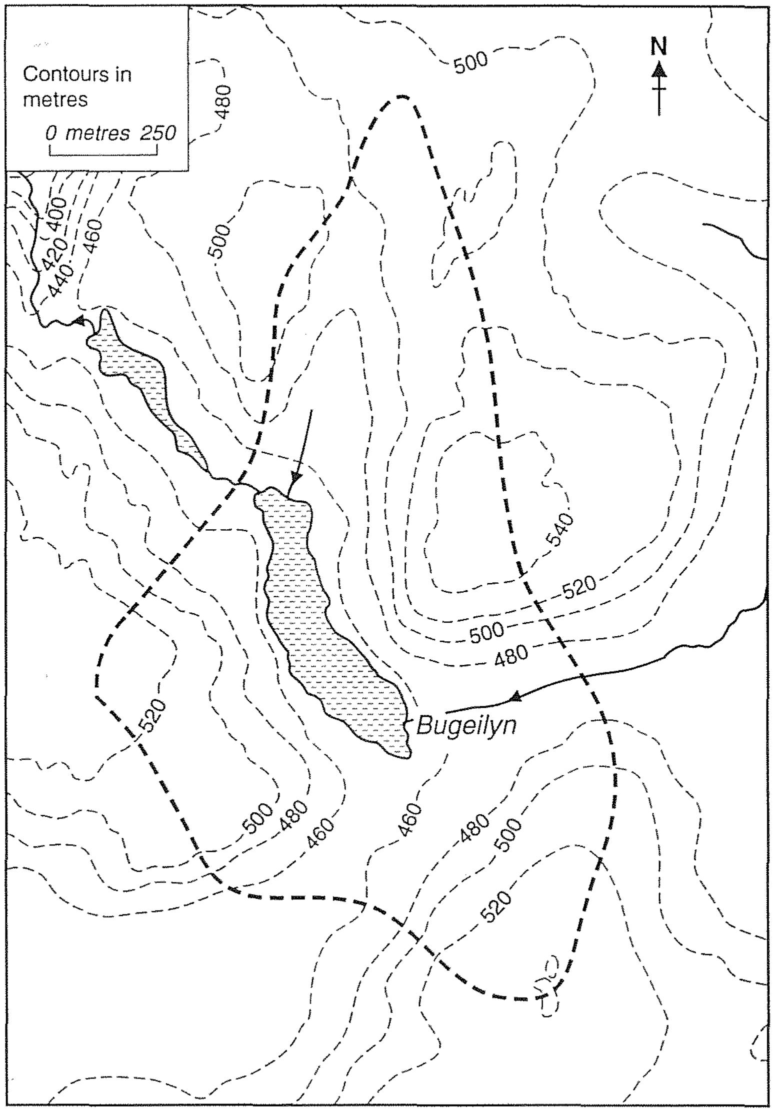
Land of low relief around much of the lake is dominated by wetland plants, particularly *Juncus* sp., *Sphagnum* sp. and *Polytrichum* sp.. Two major inflows feed the lake, one at the northern end and one at the southern end. At the south-western end of the lake a channel has been cut to supply an underground pipeline, possibly feeding the Nant-y-moch reservoir. To the north-west a channel connects with a smaller dammed lake. However the direction of flow between the two water bodies is not clear.

Llyn Bugeilyn has a surface area of approximately 9 ha and is uniformly shallow with a maximum depth of only 2.1 m. The lake is reputed to possess the most diverse lacustrine flora and fauna within the Punlumon reserve, and provides a roosting site for Greenland whitefronted geese during the latter part of the winter.

Table 2.1 Bugeilyn: site characteristics

Grid reference	SN 822923
Lake altitude	455 m
Maximum depth	2.1 m
Mean depth	1.9 m
Volume	171 x 10^3 m^3
Lake area (including lake)	9 ha
Shoreline development index	2.2
Estimated hydraulic residence time	34 days
Catchment area	143 ha
Catchment:lake ratio	15.9
Net relief	85 m
Mean annual rainfall	1705 mm
Total S deposition	1.15 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.77 keq H^+ ha^{-1} yr^{-1}

Figure 2.1 Catchment of Bugeilyn



2.2 Llyn Eiddwen

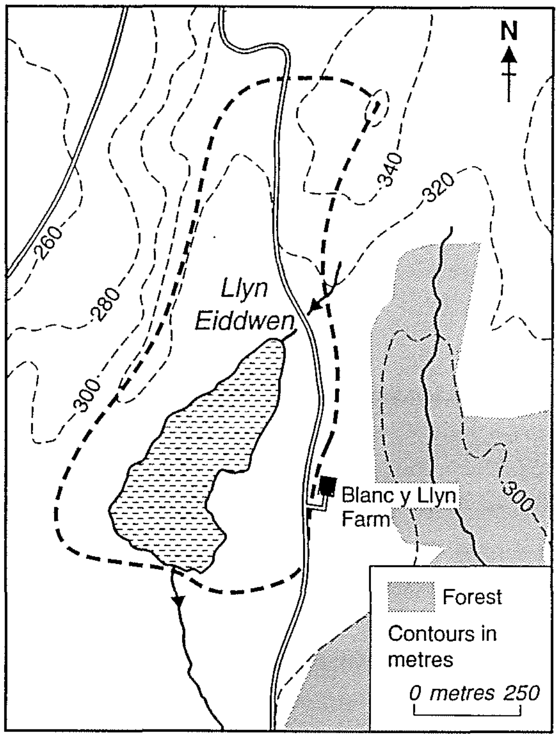
Llyn Eiddwen is situated in a small area of upland Silurian Aberystwyth grits, known as the Mynydd Bach, at an altitude of 305 m and approximately 10 km from the coast, in Ceredigion district. It occupies a hollow, probably glacially cut and morraine dammed (Moore & Thomas 1963). The lake and the surrounding area were designated as a SSSI in 1967, at least partly on the grounds of its unusual aquatic macroflora. The catchment of c. 45 ha is mainly sheep grazed pasture, improved along both eastern and western sides, and contains several small stands of deciduous trees and hawthorn scrub. Soils are largely raw amorphous peats of the Crowdy Series with some loamy permeable soils with a wet peaty surface horizon (Gelligaer Series) to the north-west. A minor road, on which is situated Banc-y-Llyn farm, runs along the eastern edge of the catchment and cuts across the northern end.

A 20 m wide swathe of wetland vegetation, dominated by *Juncus* sp. circles the lake. The southern end is dominated by *Eriophorum angustifolium* and *Sphagnum* sp.. At the north end the main inflow to the lake drains the most steeply sloping area of the catchment with a maximum altitude of 361 m. Llyn Eiddwen occupies an area of 10 ha, and a maximum depth of 7.2 m occurs off the north-east shore.

Table 2.2 Llyn Eiddwen: site characteristics

Grid reference	SN 605670
Lake altitude	305 m
Maximum depth	7.2 m
Mean depth	7.2 m
Volume	260×10^3 m^3
Lake area	10 ha
Shoreline development index	2.0
Estimated hydraulic residence time	225 days
Catchment area (including lake)	45 ha
Catchment:lake ratio	4.5
Net relief	45 m
Mean annual rainfall	1367 mm
Total S deposition	0.88 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.23 keq H^+ ha^{-1} yr^{-1}

Figure 2.2 **Catchment of Llyn Eiddwen**



2.3 Llyn Fanod

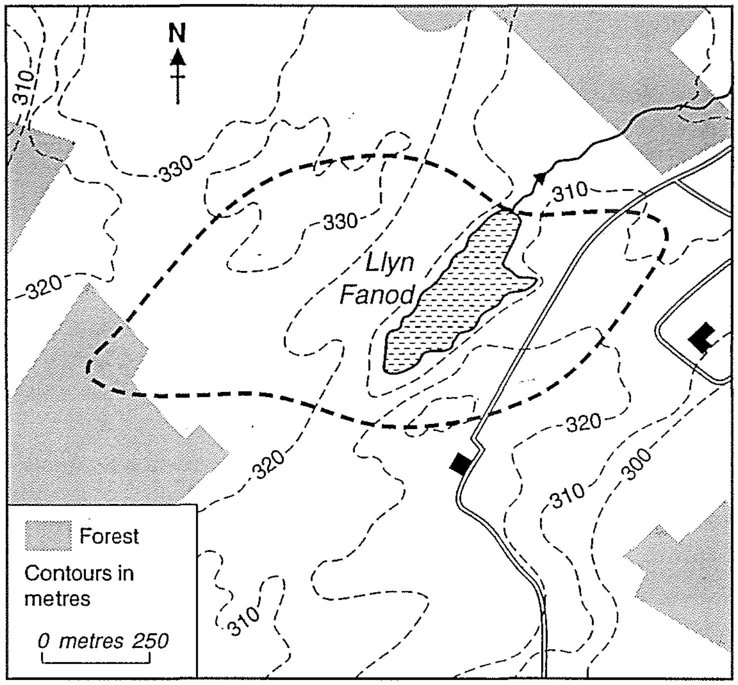
Llyn Fanod is situated 2.5 km due south of Llyn Eiddwen, it also lies on the Mynydd Bach at a similar altitude, posseses similar soils and is likely to have had the same origin. Once designated a SSSI as a seperate entity, the lake is now incorporated in the Cors Llyn Farch SSSI, a basin mire lying largely to the south of the lake. The majority of the catchment, of approximately 40 ha, is extensively grazed by cattle and sheep and to the north-west contains several stands of deciduous (mainly beech) trees. Pasture to the east of the lake appears not to have been so well developed and *Juncus effusus* tussocks are common. The shoreline to the east is flanked by a wetland association of *Juncus* sp. *Sphagnum* sp. and *Polytrichum* sp..

There are no obvious natural inflows to the lake although there are two man-made drainage channels on the north-western side. The more northerly of these channels may have been cut to drain a smaller lake which is now dry. Drainage of Llyn Fanod is to the north-east. This elongate lake of c. 5 ha surface area, consists of one main basin with a maximum depth of 8.3 m and a sizeable central area extending below a depth of 5 m.

Table 2.3 Llyn Fanod: site characteristics

Grid reference	SN 603643
Lake altitude	310 m
Maximum depth	8.7 m
Mean depth	3.8 m
Volume	190×10^3 m^3
Lake area (including lake)	5 ha
Shoreline development index	1.6
Estimated hydraulic residence time	186 days
Catchment area	40 ha
Catchment:lake ratio	8
Net relief	25 m
Mean annual rainfall	1367 mm
Total S deposition	0.88 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.23 keq H^+ ha^{-1} yr^{-1}

Figure 2.3 Catchment of Llyn Fanod



2.4 Llyn Glanmerin

Llyn Glanmerin lies at an altitude of 195 m, located 3 km to the south of Machynlleth in the Dovey valley. The lake is of artificial origin and its level is maintained by an earthwork dam at the outflow with an old weir gate providing evidence of previous level control. A boat house on the lake shore is used for recreational coarse fishing. The catchment geology consists primarily of Ordovician mudstones of the Ashgill Series and soils are dominated by those of the Manod Series, ie. well drained fine loamy brown podzols.

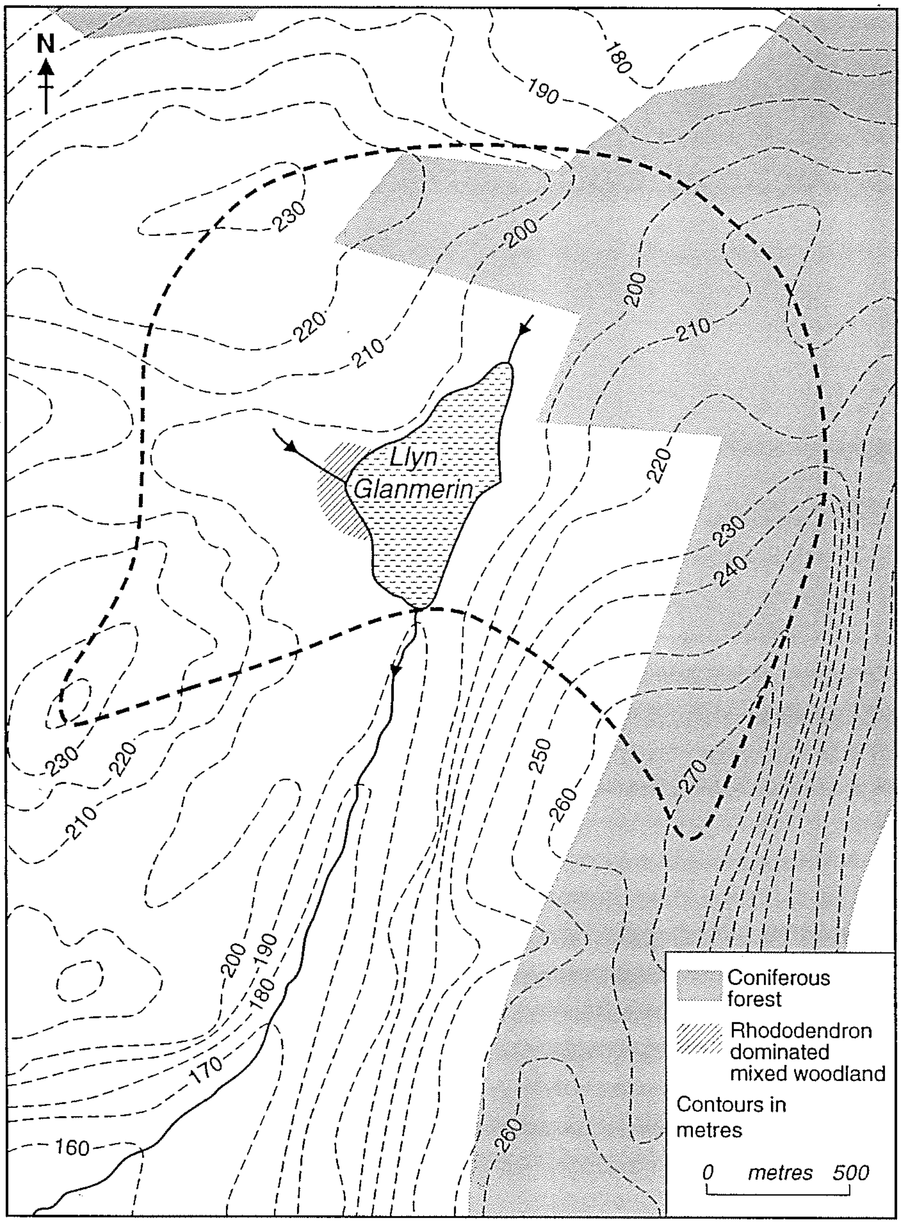
The lake catchment occupies approximately 36 ha of which the lake comprises 3 ha. Most of the catchment consists of sheep grazed rough pasture which has previously been improved but is now significantly innundated with bracken. It also includes the edge of an extensive coniferous forest plantation on the higher ground to the north and east. There is a small *Salix/Alnus* dominated wood at the north end of the lake and an enclosed area of rhododendron dominated mixed woodland surrounding the eastern bay. The remainder of the eastern shoreline is partly fringed by alder.

There are two principal inflows; one runs through the coniferous plantation to the north, the other drains rough pasture and finally passes through the woodland enclosure to the east. The outflow is via a sluice in the dam wall at the south end. The lake is a relatively shallow water body (mean depth c. 2 m) with a small 3 m deep area close to the outflow.

Table 2.4 Llyn Glanmerin: site characteristics

Grid reference	SN 755991
Lake altitude	195 m
Maximum depth	3.1 m
Mean depth	2.5 m
Volume	48×10^3 m^3
Lake area	3 ha
Shoreline development index	1.3
Estimated hydraulic residence time	46 days
Catchment area (including lake)	36 ha
Catchment:lake ratio	12
Net relief	80 m
Mean annual rainfall	1495 mm
Total S deposition	0.88 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.19 keq H^+ ha^{-1} yr^{-1}

Figure 2.4 Catchment of Llyn Glanmerin



2.5 Llyn Gynon

Llyn Gynon occupies an area of 25 ha, at an altitude of 425 m, in a shallow depression in the highland plateau east of Aberystwyth, overlooking the Claerwen Reservoir. It lies in the west of the extensive Elenydd SSSI, first notified in 1954, an area noted for its range of breeding birds of upland and woodland. The 225 ha catchment consists mainly of amorphous *Molinia/Eriophorum* blanket peats of the Crowdy Series overlying base poor, lower Palaeozoic, Silurian mudstones and shales. The better drained slopes however have allowed the development of stagnopodzols and stagnohumic gleys of the Hafren Association (Rudeforth *et al.* 1984). Typically these soils are thin (30-40 cm) with a wet peaty surface horizon and bleached subsurface horizons, often with a thin iron pan.

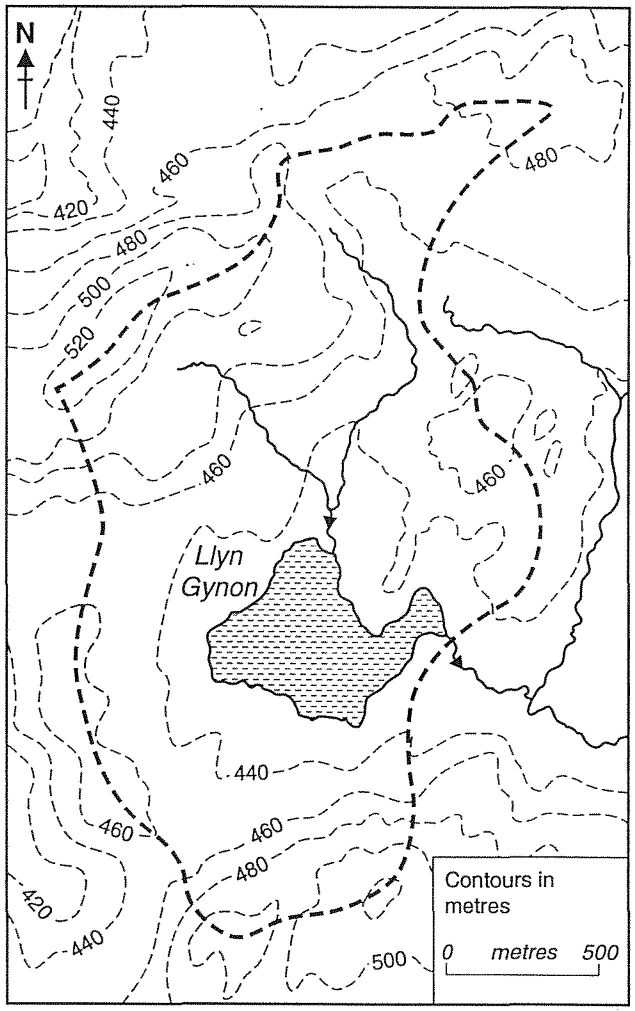
The catchment vegetation largely comprises *Molinia caerulea* in the extensive nutrient rich flushes and *Eriphorum vaginatum* and *Sphagnum* (e.g. *S. cuspidatum*, *S. papillosum* and *S. compactum*) communities in wetter areas. The better drained slopes are dominated by *Nardus stricta* and *Festuca ovina* grassland.

The lake occupies a broad, irregular basin consisting of two relatively small yet deep basins (maximum depths of 10 m and 11 m), surrounded by a shallow rim. It is fed chiefly by a stream from the north, Nant Llethr-du, and groundwater flows. The Nant Brwynog, the outflow at the east end, flows into the Claerwen Reservoir. Llyn Gynon has been the subject of a previous palaeoecological investigation (Stevenson and Patrick, 1986) which revealed that the site has acidified as a consequence of the deposition of atmospherically derived pollutants.

Table 2.5 Llyn Gynon: site characteristics

Grid reference	SN 800647
Lake altitude	425 m
Maximum depth	11 m
Mean depth	2.1 m
Volume	525 x 10^3 m^3
Lake area	25 ha
Shoreline development index	1.5
Estimated hydraulic residence time	67 days
Catchment area (including lake)	225 ha
Catchment:lake ratio	9
Net relief	100 m
Mean annual rainfall	1673 mm
Total S deposition	1.23 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.86 keq H^+ ha^{-1} yr^{-1}

Figure 2.5 Catchment of Llyn Gynon



2.6 Llyn Hir

Llyn Hir is an elongate lake lying at an altitude of 435 m within the group of Teifi pools in the Elenydd SSSI, in the Ceredigion District of Dyfed. The lake area of 5 ha comprises approximately one quarter of the total catchment area. Catchment geology consists predominantly of base poor lower Palaeozoic, Silurian mudstones and shales. The soils are chiefy stagnopodzols and stagnohumic gleys, belonging to the Hafren Association of the Hiraethog Series (Rudeforth *et al.* 1984). These soils are typically thin (30-40 cm) with a wet peaty surface horizon and bleached sub-surface horizons, often with a thin iron pan. In places amorphous acid *Sphagnum/Eriophorum* peat has accumulated and some peat erosion is apparent to the south and east of the lake.

The vegetation is dominated by sheep grazed *Nardus stricta* and *Festuca ovina* grassland, while small areas of *Eriophorum vaginatum* and *Sphagnum* bog are restricted to the wettest flushes and incipient drainage channels. *Molinia caerulea* is restricted to the nutrient rich wet flushes around the edge of the lake where *Sphagnum* and *Juncus* sp. also occur in abundance.

A detailed bathymetry of Llyn Hir (Fritz *et al.* 1986) reveals three significant depositional basins. Each basin shelves steeply to depths of over 7 m, the deepest point being slightly over 8 m in the most northerly one. The southern basin is fed directly by the outflow from Llyn-y-Gorlan. A second distinct inflow enters the northern tip of the lake and direct seepage is also evident at numerous locations around the lake shore.

Llyn Hir has a well documented fishing history which goes back at least 800 years. Until the mid-1900s the lake appears to have supported a healthy trout population although during most of this century an increased intensity of stocking makes any inference of changes in trout population over this period rather dubious. However, from the 1960's there was a marked deterioration in the fishery which has been linked to acidification and by 1984 it was virtually fishless. In 1985 the Welsh Water Authority began a programme of liming and further stocking of trout has been successful (Underwood *et al.*, 1987).

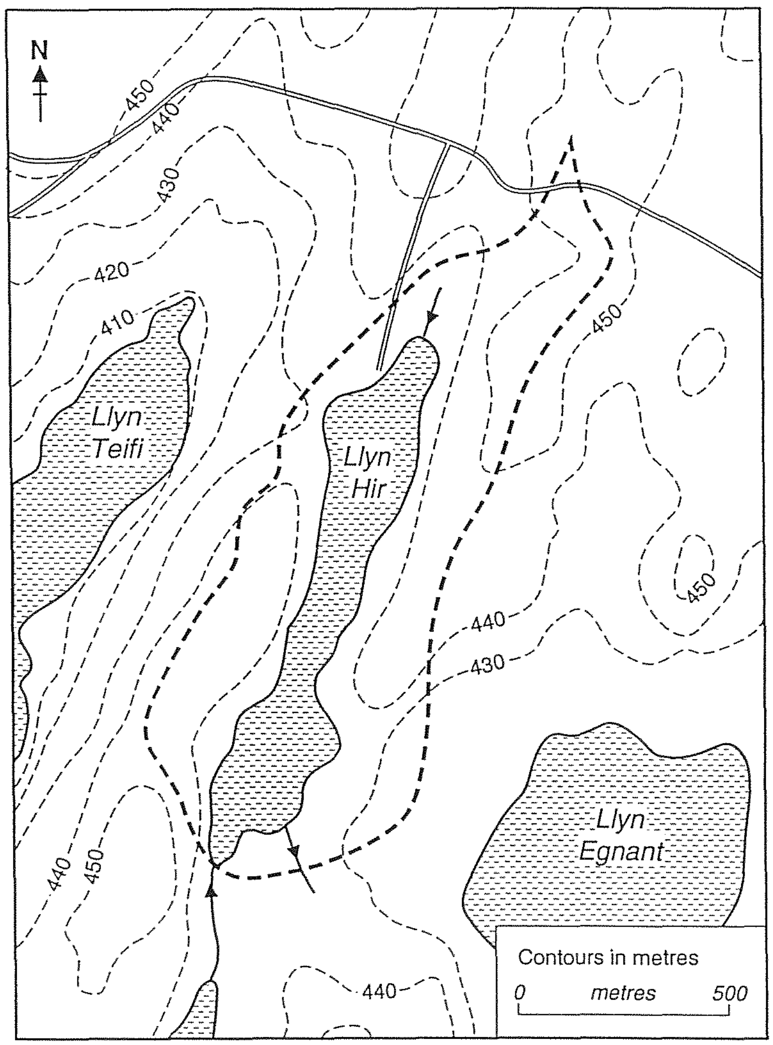
Table 2.6 Llyn Hir: site characteristics

Grid reference	SN 789677
Lake altitude	435 m
Maximum depth	8.8 m
Mean depth	2.8 m
Volume	140 x 10^3 m^3
Lake area	5 ha
Shoreline development index	3.2
Estimated hydraulic residence time	244 days
Catchment area (including lake)	22 ha
Catchment:lake ratio	4.4

Llyn Hir: site characteristics (continued)

Net relief	20m
Mean annual rainfall	1367 mm
Total S deposition	0.88 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.23 keq H^+ ha^{-1} yr^{-1}

Figure 2.6 Catchment of Llyn Hir



2.7 Llynnoedd Ieuan (West Lake)

The lake under investigation is the western-most of the three Llynnoedd Ieuan lakes, all at an altitude of approximately 550 m, which form the northern part of the Llynnoedd Ieuan SSSI in Ceredigion District. The lakes were formed as a result of past lead mining operations in the area (Rimes 1992). The underlying geology consists of Palaeozoic, Silurian slaty mudstones of the Upper Llandovery Series. The catchment soils are predominantly ferric stagnopodzols, typically loamy permeable soils with wet peaty surface horizons and some peat while *Eriophorum/Sphagnum* blanket peat is evident in lower lying wetter depressions.

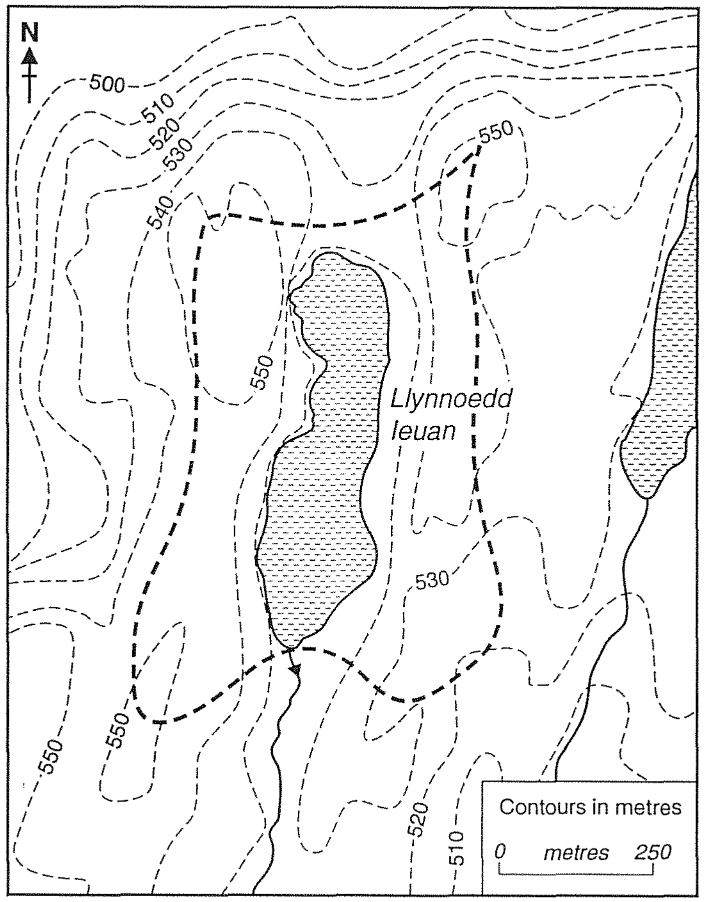
The catchment of the lake is very small; the lake occupies 4 ha out of a total catchment area of 12 ha. The vegetation is dominated by *Calluna vulgaris* and *Vaccinium myrtillus* with some *Empetrum nigrum* and *Erica cinerea*, *Molinia caerulea*, *Polytrichum* sp. and *Sphagnum* sp..

There is no obvious inflow to the lake and direct seepage through the soil is evident. An old weir gate indicates previous control of the water level when the Llynnoedd Ieuan were used as reservoirs for a nearby leadmine. The lake appears to comprise two main basins, the deepest point of 8.7 m occurring in the relatively small north basin, while the more extensive south basin includes a large area over 5 m deep.

Table 2.7 West Llynnoedd Ieuan: site characteristics

Grid reference	SN 795815
Lake altitude	525 m
Maximum depth	8.7 m
Mean depth	3.9 m
Volume	156×10^3 m^3
Lake area	4 ha
Shoreline development index	1.9
Estimated hydraulic residence time	432 days
Catchment area (including lake)	12 ha
Catchment:lake ratio	3
Net relief	30 m
Mean annual rainfall	1495 mm
Total S deposition	0.88 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.19 keq H^+ ha^{-1} yr^{-1}

Figure 2.7 Catchment of west Llynnoedd Ieuan



2.8 Maes-llyn

Maes-llyn is a glacial kettle-hole lake situated adjacent to the eastern edge of the Cors Caron SSSI, Ceredigion district, an extensive raised bog system which itself developed over a late-glacial lake. This small lake (surface area 2 ha) is at an altitude of 170 m, and much of the catchment area totalling c. 60 ha is derived from steeply sloping hillsides to the east. The underlying geology consists of Palaeozoic, Silurian mudstones which have given rise to typical brown podzols of the Manod Series, and well drained fine loamy or fine silty soils, which can be thin in places.

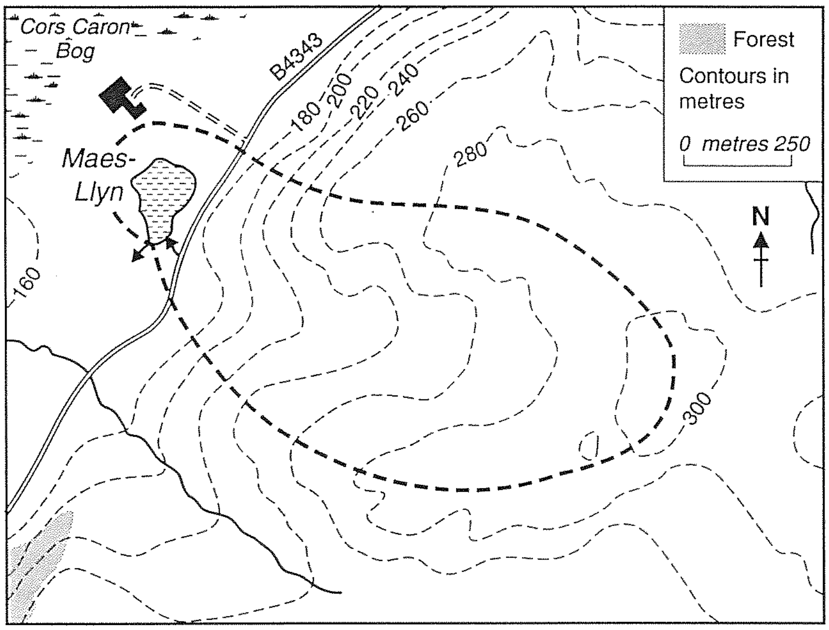
The lake is in the immediate vicinity of Maes-llyn farm, and the limited catchment area to the north, west and south consists almost entirely of enclosed, improved pasture grazed by cattle and sheep. The livestock have direct access to the lake and use it as a watering hole. On the east side of the lake a recently planted plot of deciduous trees is bordered to the east by a disused railway line and parallel to this is the B4343 road from which some run off drains into the only defined inflow. A small coniferous forest is situated on the lower slopes to the east of the road and above this is a large area of enclosed, improved pasture.

Maes-llyn consists of a single basin, with the deepest area (maximum depth 5.5 m) towards the centre of the lake, and has no distinct outflow. In the 1960's a cache of ammunition from the "Free Wales Army" was dumped in the lake. All items are believed to have been recovered by an underwater search which is likely to have caused some sediment disturbance.

Table 2.8 Maes-llyn: site characteristics

Grid reference	SN 693628
Lake altitude	180 m
Maximum depth	5.5 m
Mean depth	2.7 m
Volume	81×10^3 m^3
Lake area	1.5 ha
Shoreline development index	1.2
Estimated hydraulic residence time	55 days
Catchment area (including lake)	59 ha
Catchment:lake ratio	39
Net relief	130 m
Mean annual rainfall	1367 mm
Total S deposition	0.88 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.23 keq H^+ ha^{-1} yr^{-1}

Figure 2.8 Catchment of Maes-llyn



2.9 - 2.10 The Talley Lakes

Forming the Llynnoedd Tal-Y-Llechau SSSI in the Borough of Dinefwr, Dyfed, Lower and Upper Talley Lakes are connected, mineral-rich pools lying to the north of Talley village. The lakes, which occupy a total surface area of c. 15 ha in a total catchment area of c. 170 ha, are thought to occupy hollows in glacial drift derived from Palaezoic, Silurian slaty mudstones. The quaternary history of the Talley lakes is currently the subject of a student project at the University of Wales, Aberystwyth (H.Lamb pers. comm.). The soils in the lower lying parts of the catchment are dominated by Cambic stagnogleys of the Brickfield Association: slowly permeable, seasonally waterlogged fine loamy to fine silty soils. The upper reaches are dominated by typical brown podzols of the Manod Series which have a similar texture but are better drained. The lakes provide an important resource for breeding, feeding and roosting wildfowl.

There are no distinct permanent inflows to the Upper lake although the permanent outflow indicates that the lake receives substantial groundwater inputs. There are however a few ephemeral drainage channels entering the lake. The lake is fringed by cattle and sheep grazed improved grassland, leading down to interspersed *Alnus* and *Salix* stands and *Juncus* dominated shoreline vegetation. To the east the B4302 cuts through the catchment, behind which there is a further area of pasture with some mixed deciduous woodland. A minor road runs along the edge of the catchment to the west, bordering a mature coniferous plantation. St Michael's church, graveyard and the remains of an Abbey are situated at the southern end of the site. The southern end of Upper Talley lake consists of a basin with a maximum depth of 4.2 m, while the northern end is more uniformly shallow with an average depth of about 1 m.

The outflow from Upper lake flows for approximately 150 m through *Alnus/Salix* scrub before reaching the southern end of the Lower lake, which is also supplied by a much smaller inflow from the west. The Lower lake is entirely fringed by a 15 to 20 m wide band of a vegetational sequence of reedswamp through to alder carr and salix scrub. The wider sub-catchment (i.e. excluding the catchment of the Upper lake) consists largely of improved pasture and some coniferous forestry. The two roads mentioned above also pass through this sub-catchment. The bathymetry of the Lower lake describes a single basin, with a maximum depth of 4.3m.

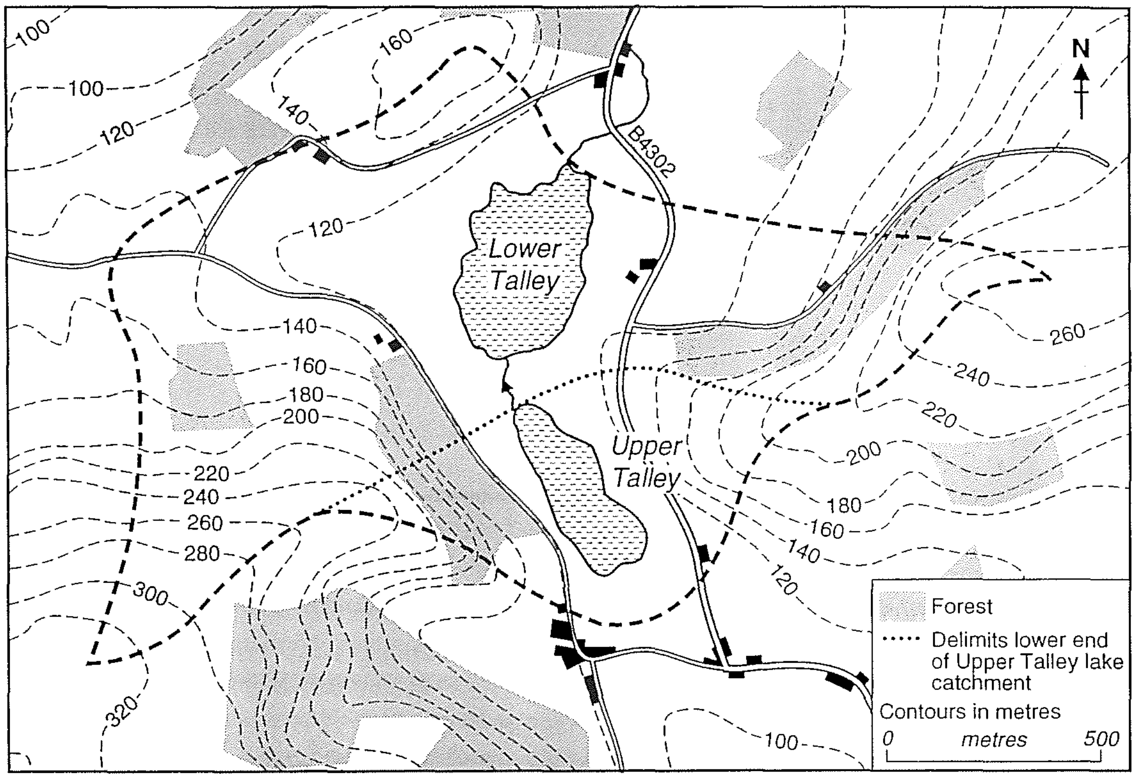
Table 2.9 Upper Talley Lake: site characteristics

Grid reference	SN 632337
Lake altitude	105 m
Maximum depth	4.2 m
Mean depth	1.9 m
Volume	95×10^3 m^3
Lake area	5 ha
Shoreline development index	1.5
Estimated hydraulic residence time	94 days
Catchment area (including lake)	37 ha
Catchment:lake ratio	7.4
Net relief	220 m
Mean annual rainfall	1460 mm
Total S deposition	0.93 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.23 keq H^+ ha^{-1} yr^{-1}

Table 2.10 Lower Talley Lake: site characteristics

Grid reference	SN 633332
Lake altitude	105 m
Maximum depth	4.3 m
Mean depth	1.9 m
Volume	190×10^3 m^3
Lake area	10 ha
Shoreline development index	1.3
Estimated hydraulic residence time	42 days
Catchment area (including lakes)	166 ha
Catchment:lake ratio	16.6
Net relief	220 m
Mean annual rainfall	1460 mm
Total S deposition	0.93 keq H^+ ha^{-1} yr^{-1}
Total N deposition	1.23 keq H^+ ha^{-1} yr^{-1}

Figure 2.9 Catchment of the Talley Lakes



3 Methods

The variables recorded and measured were determined by the Countryside Council for Wales in their tender document for this programme (Phase 2). The sampling methodologies have been adopted after consultation with relevant specialists, and where possible recognised standard field and analytical methods have been used. All methods are described in the Final Report for Phase 1 of the Integrated Classification and Assessment of Lakes in Wales (Allott *et al.* 1994). However following recommendations made in the Phase 1 report, minor modifications have been made to the sampling methodologies; samples have not been taken for open water phytoplankton, littoral macroinvertebrates were sampled in the Autumn only, and littoral zooplankton samples were taken from five sampling stations from each lake only, in order to represent the dominant vegetation and substrate types.

4 Results

Physio-chemical and biological data for individual sites are presented in a series of Appendices (A - J) and further notes on the sampling locations for littoral Cladocera and macro-invertebrates are provided in Appendices K and L respectively.

4.1 Physio-chemical data

4.1.1 Llyn Bugeilyn

Bugeilyn is characterised by low pH, conductivity, alkalinity, and transparency, and moderately low chlorophyll *a* concentrations (Table A.1). The March water chemistry sample was taken after a period of low temperatures and heavy snow and was particularly acid, with markedly negative alkalinity. Aluminium and total soluble iron levels were high throughout the year. Phosphorus levels were relatively high when compared to the other more acid sites investigated to date with the total phosphorus (TP) concentration of all samples above 10 $\mu g\ l^{-1}$. Absorbance at 250 nm, a measure of water colour, was high, and a chlorophyll *a* maximum of 6.8 $\mu g\ l^{-1}$ in late July 1994 coincided with a secchi depth measurement of only 1.3 m. The data are indicative of a trophic status strongly influenced by catchment derived peat. Concurrent physio-chemical profiling (see Figure A.2) showed this shallow lake to have been isothermic and oxygen saturated throughout.

4.1.2 Llyn Eiddwen

Llyn Eiddwen is a slightly acid lake, yet possesses significant buffering capacity with an alkalinity consistently above 60 $\mu eq\ l^{-1}$ (Table B.1). The mean chlorophyll *a* value is relatively high, the maximum of 20.2 $\mu g\ l^{-1}$ being recorded in the March sample. The summer secchi depth recorded was 3.2 m although the relatively high mean total organic carbon (TOC) and absorbance values would suggest that transparency is usually poorer than this. Physio-chemical profiling in late July 1994 revealed the existence of a thermocline at approximately 2.5 m depth and there was significant oxygen depletion in the hypolimnion, with apparent deoxygenation of the surface sediment at the lake's maximum depth of 7 m. The TP and nitrate concentrations are relatively low for a site within an agricultural catchment.

4.1.3 Llyn Fanod

The water chemistry of Llyn Fanod is indicative of a site of intermediate nutrient status (relative to the other sites in this survey), which is well buffered and close to neutral pH (Table C.1). The discrepancy between the laboratory and field recorded pH values for the December sample suggests an error in the measurement of the former which appears to be unusually high. Chlorophyll *a* concentrations are low throughout the year and as with Llyn Eiddwen the mean TP concentration (18.1 $\mu g\ l^{-1}$) appears low despite the extensively grazed catchment in the proximity of a farm. The late July secchi disc value was 3.6 m. However this coincided with the lowest recorded levels of TOC and absorbance, indicating that transparency is poorer than this for much of the year. Physio-chemical profiling carried out in late July showed the existence of a thermocline at approximately 4 m depth and hypolimnion oxygen depletion to a minimum of 0.5 $mg\ l^{-1}$ just above the sediment surface (7.5 m).

4.1.4 Llyn Glanmerin

Llyn Glanmerin appears to be slightly acid (although the field recorded pH in December was above 7) but is well buffered (Table D.1). TP and chlorophyll *a* levels over the sampling year suggest a site of an intermediate trophic status although the late July secchi depth measured only 1.8 m. The high mean TOC value was due to the particularly high December value but other samples showed concentrations similar to most other sites in this survey. The late July physio-chemical profile showed the development of a thermocline at approximately 2 m depth and significant oxygen depletion beneath this, the concentration at the sediment surface (2.5 m depth) being less than 2 $mg\ l^{-1}$.

4.1.5 Llyn Gynon

The water chemistry for Llyn Gynon is indicative of an upland, poorly buffered, acid, nutrient poor lake (Table E.1). Alkalinity was very low throughout the year, all values recorded being less than 20 $\mu eq\ l^{-1}$, and TP levels were consistently below 10 $\mu g\ l^{-1}$. The late July secchi depth was 3.3 m, and the relatively stable absorbance, TOC and chlorophyll *a* values throughout the year would suggest that this transparency is unlikely to vary substantially. The physio-chemical profiling in late July reveal the lake was almost isothermal and oxygen saturated to a depth of 10 m.

4.1.6 Llyn Hir

Like Llyn Gynon, the water chemistry for Llyn Hir is characteristic of an upland, poorly buffered, acid, nutrient poor lake (Table F.1). Indeed the values of all determinands for the two lakes are remarkably similar, with the exception of TOC and absorbance values which are generally lower than for Llyn Gynon. This is also reflected by the considerably higher summer secchi depth of 6.5 m for Llyn Hir, although the seasonal variation in TOC and absorbance suggests that transparency is lower than this for much of the year. Physio-chemical profiling carried out at the same time also shows similar characteristics to Llyn Gynon, being isothermal and oxygen saturated to the maximum depth of over 8 m.

4.2 Epilithic diatoms

4.2.1 Bugeilyn

The epilithic diatom flora of Bugeilyn (Table A.2) is dominated by *Eunotia incisa*, a species common in acid, oligotrophic waters. The species diversity is very low, with this single species accounting for a very high percentage of the total count. The other taxa present, including *Tabellaria flocculosa*, *Eunotia rhomboidea*, and *Frustulia rhomboides* var. *viridula*, are also indicative of acid waters.

4.2.2 Llyn Eiddwen

The epilithic diatom assemblages (Table B.2) are indicative of circumneutral to slightly acid waters. The dominant taxon is *Achnanthes levanderi*, a good indicator species of relatively unpolluted, circumneutral conditions because of its narrow ecological tolerance. Other common taxa are typical of circumneutral, oligotrophic to mesotrophic waters and include *Synedra acus*, *Synedra miniscula*, *Navicula pseudoscutiformis* and *Achnanthes minutissima*, a cosmopolitan species commonly found in circumneutral waters.

4.2.3 Llyn Fanod

The epilithic diatom flora of Llyn Fanod (Table C.2) is typical of relatively nutrient poor, circumneutral to slightly acid waters. The dominant taxa are *Achnanthes minutissima* and *Achnanthes levanderi* (as for Llyn Eiddwen), *Cymbella cistula*, and a short form of *Tabellaria flocculosa,* which has a wide tolerance for different types of freshwater but is generally associated with slightly acid waters. Species diversity is low with the four most common species accounting for a large percentage of the total count.

4.2.4 Llyn Glanmerin

The epilithic diatom assemblages (Table D.2) are dominated by *Achnanthes minutissima*, *Fragilaria virescens* var. *exigua*, a species common in circumneutral to slightly acid waters but rare in nutrient-rich conditions; *Navicula jaarnfeltii* and *Achnanthes detha*. Species diversity is high, with 27 taxa achieving a mean abundance greater than 1%.

4.2.5 Llyn Gynon

The epilithic diatom assemblages are indicative of slightly acid, nutrient-poor waters (Table E.2). The dominant taxa are *Tabellaria flocculosa* (as for Llyn Fanod), *Eunotia incisa*, *Fragilaria virescens* var. *exigua*, and *Eunotia rhomboidea*, which is typical of acid conditions. These species are all indicative of nutrient-poor waters.

4.2.6 Llyn Hir

The epilithic diatom flora of Llyn Hir is typical of acid, nutrient-poor waters (Table F.2). The dominant taxa are similar to those of Llyn Gynon, and include *Eunotia incisa*, *Eunotia rhomboidea*, and *Tabellaria flocculosa*. The species diversity is high, with 21 species occurring with a mean and *Tabellaria flocculosa*. The species diversity is high, with 21 species occurring with a mean abundance greater than 1%.

4.2.7 Llynnoedd Ieuan

The epilithic diatom assemblages are indicative of acid waters (Table G.2). The flora is dominated by two species, *Eunotia incisa* and *Tabellaria quadriseptata*, a species indicative of very low pH conditions (pH < 5). The species diversity is low with these two taxa accounting for a large percentage of the total count.

4.2.8 Maes-llyn

The epilithic diatom assemblages (Table H.2) are dominated by *Cymbella microcephala*, a species which prefers well-aerated habitats but which is widely distributed, *Achnanthes minutissima*, *Fragilaria construens* var. *venter*, one of the most common of all freshwater diatoms, and *Fragilaria intermedia*, which is regarded as alkaliphilous with a pH optimum of about 7-7.8. The species diversity is low with the four dominant taxa accounting for a high percentage of the total count.

4.2.9 Upper Talley Lake

The epilithic diatom assemblages of Upper Talley Lake (Table I.2) are rather more diverse than that of most lakes in this survey. The most common species are the small *Fragilaria* taxa, particularly *F. pinnata* and *F. construens* var. *venter*, chains of *Aulacoseira granulata* var. *angustissima*, a cosmopolitan, alkaliphilous species normally found in the plankton of eutrophic lakes and which has presumably bloomed in the water column at this time and has contaminated the epilithic sample, *Rhoicosphenia curvata*, a widely distributed taxon with a preference for alkaline waters, *Nitzschia inconspicua*, commonly observed in alkaline conditions, and *Navicula pseudoscutiformis*. Therefore, the flora is indicative of a shallow, nutrient-rich, alkaline lake.

4.2.10 Lower Talley Lake - (Epiphytic samples only)

Owing to the dense macrophyte community around the lake shore and the lack of stony substrates, epiphytic diatom samples rather than epilithic samples were analysed for Lower Talley Lake (Table J.2). *Achnanthes minutissima* is clearly the dominant taxon, and is commonly found attached to plants across a wide range of freshwater types. Another *Achnanthes* species, *A. linearis* is also present in high relative abundances. This is also a widely distributed taxa but prefers well-aerated conditions and a pH of less than 7. Similarly to Upper Talley, the small *Fragilaria* taxa are abundant, in this case *F. elliptica* is the dominant species. The flora is indicative of a shallow, alkaline lake.

4.3 Surface Sediment Diatoms

4.3.1 Bugeilyn

The surface sediment diatom assemblage (Table A.3) is dominated by two taxa typical of nutrient-poor, acid lakes; *Eunotia incisa* (the dominant species in the epilithic communities of the lake) and *Aulacoseira perglabra*. This latter species is indicative of coloured waters. The other common taxa include *Frustulia rhomboides* var. *viridula*, a common species in oligotrophic, low-alkalinity waters, *Navicula soehrensis*, a taxon usually associated with epipsammic (sand dwelling) communities, and *Aulacoseira distans* var. *nivalis*. The assemblage is indicative of acid waters with high levels of dissolved organic carbon.

4.3.2 Llyn Eiddwen

The surface sediment diatom assemblage is indicative of circumneutral, nutrient-poor waters and is dominated by non-planktonic taxa (Table B.3). The dominant species are *Fragilaria virescens* var. *exigua*, *Fragilaria construens* var. *venter*, *Achnanthes minutissima*, and *Eunotia incisa*.

4.3.3 Llyn Fanod

The surface sediment diatom assemblage is indicative of nutrient-poor, circumneutral, slightly alkaline waters and is dominated by non-planktonic taxa (Table C.3). The dominant species are *Achnanthes minutissima* (as found in the epilithic communities of the lake), *Fragilaria virescens* var. *exigua,* and *Fragilaria construens* var *venter*. The lake supports very little plankton, most probably due to its low trophic status.

4.3.4 Llyn Glanmerin

The surface sediment diatom assemblage is indicative of circumneutral, rather nutrient-poor waters (Table D.3). The dominant taxa are *Fragilaria virescens* var. *exigua*, *Achnanthes minutissima*, *Brachysira vitrea*, indicative of circumneutral, nutrient-poor conditions, and *Fragilaria construens* var. *venter*. The lake supports very little diatom plankton, presumably due to its low trophic status.

4.3.5 Llyn Gynon

The surface sediment diatom assemblage is dominated by *Fragilaria virescens* var. *exigua*. The other common taxa are *Eunotia incisa*, *Tabellaria flocculosa*, and *Cymbella perpusilla* (Table E.3). A notable species present in the assemblage is *Tabellaria quadriseptata*, indicative of strongly acid conditions. The assemblage is typical of an acid, nutrient-poor lake.

4.3.6 Llyn Hir

The surface sediment diatom assemblage of Llyn Hir is indicative of nutrient-poor, slightly acid waters (Table F.3). The assemblage is dominated by *Tabellaria flocculosa*, *Fragilaria virescens* var. *exigua* and *Brachysira vitrea*. Other common taxa include *Cymbella microcephela*, typically found in circumneutral waters, *Navicula leptostriata*, indicative of slightly acid waters, and *Achnanthes minutissima*. The lake supports very little diatom plankton, presumably because of its low trophic status.

4.3.7 West Llynnoedd Ieuan

The surface sediment diatom flora of Llynnoen Ieaun (Table G.3) is indicative of acid waters with pH < 5. The assemblage is dominated by *Tabellaria quadriseptata* and *Eunotia incisa*, species also dominant in the epilithic flora. Other common species include *Brachysira vitrea*, *Brachysira brebissonii*, indicative of acid waters, and *Achnanthes minutissima*.

4.3.8 Maes-llyn

The surface sediment diatom assemblage (Table H.3) is dominated by two taxa: *Asterionella formosa*, a planktonic species appearing in large blooms especially in nutrient rich lakes, and *Achnanthes minutissima*, which was one of the dominant species in the epilithic samples. *Stephanodiscus parvus*, another taxon commonly associated with nutrient-rich waters is also present. Therefore, the assemblage is indicative of eutrophic conditions.

4.3.9 Upper Talley Lake

The surface sediment diatom assemblage (Table I.3) is clearly dominated by two taxa, indicative of nutrient-rich, alkaline, shallow waters: *Aulacoseira granulata* var. *angustissima* (55%), which appears to have bloomed in the lake, and *Fragilaria construens* var. *venter* (25%). The only other species with a relatively high abundance is *Cyclotella stelligera* (3%), a taxon often found in the plankton of shallow lakes. Upper Talley Lake appears to support more planktonic diatom species than some of the other lakes in the survey, reflecting a higher trophic status. The shallow depth of the lake and the abundance of the benthic taxa in the surface sample suggest that surface sediments lie within the normal photic zone. This has been observed in other shallow waterbodies (e.g. Bennion, 1994).

4.3.10 Lower Talley Lake

The surface sediment diatom assemblage of Lower Talley Lake (Table J.3) is dominated by similar taxa to that of Upper Talley Lake, although in this case the dominant *Fragilaria* species is the more elliptical form, *F. elliptica* (38%), and *Aulacoseira granulata* var. *angustissima* has a lower relative abundance of 25%. Again, there are more planktonic taxa than in the nutrient-poor sites, for example *Cyclotella pseudostelligera*, a species often found in the plankton of shallow, eutrophic, turbid waters, and *Asterionella formosa* are present.

4.4 Aquatic macrophytes

4.4.1 Llyn Bugeilyn

Llyn Bugeilyn contains an acidophilous flora dominated by *Littorella uniflora*, *Sparganium angustifolium*, *Nuphar lutea* and the liverwort *Nardia compressa* (Table A.4). The east shoreline supports the most diverse assemblage with *Littorella uniflora* and *Juncus bulbosus* var. *fluitans* dominating coarse substrates in the shallows, occasional patches of *Equisetum fluviatile,* and the floating leaved *Sparganium angustifolium* and the submergent *Utricularia minor* growing extensively in slightly deeper water. The floating leaved form of the nationally scarce *Luronium natans* also occurs here in small patches and in addition is visible from the southern side of the bridge across the outflow. Large beds of *Nuphar lutea* are confined to the muddy substrates off the west shore, while *Nardia compressa* grows most prolifically on boulders to a depth of approximately 2 m on the east side of the lake, occasionally accompanied by *Utricularia minor.* The deep water form of *Luronium natans* was observed in places, however its abundance requires further investigation.

Aquatic macrophyte communities can be described using the National Vegetation Classification (NVC) (Rodwell 1995). Three NVC community types are apparent. The shallow water on the east side is occupied by the *Littorella uniflora* sub-community of the *Littorella uniflora - Lobelia dortmanna* community (A22). This grades into a *Juncus bulbosus* (A24) community, although *J.bulbosus* is not as abundant as its associates *Sparganium angustifolium* and *Utricularia minor*. The species-poor *Nuphar lutea* community (A8) is represented off the west shore. The site is typed 2 after Palmer (1992) and the trophic index score is 5.5.

4.4.2 Llyn Eiddwen

The macroflora of Llyn Eiddwen is characteristic of a nutrient poor but not strongly acid lake (Table B.4). Much of the shallow water is dominated by *Littorella uniflora*, *Lobelia dortmanna* and *Callitriche hamulata*, and *Subularia aquatica* is present in places. The charophyte *Nitella translucens* which is intolerant of more acid conditions is present in abundance in deeper water, as is *Isoetes lacustris* which grows to a depth of approximately 2 m. The nationally scarce *Luronium natans* is locally abundant, particularly within a stand of *Equisetum fluviatile* and *Lobelia dortmanna* at the south end of the lake. This stand is flanked on the shoreline side by *Carex rostrata* which in turn grades into a wetland zone which includes *Menyanthes trifoliata*, *Eriophorum angustifolium* and *Sphagnum* sp.. A blue-green algal bloom was observed at the north end of the lake. It is likely that *Isoetes echinospora*, a species often difficult to distinguish in the field from *I.lacustris*, was also detected during the survey but further work is required to verify this.

The *Littorella uniflora - Lobelia dortmanna* (A22) and *Isoetes lacustris* (A23) NVC communities are easily identifiable. The southern end is best described by the *Carex rostrata* sub-community of the *Equisetum fluviatile* swamp community (S10). The site is typed 2 after Palmer and has a trophic index of 5.7. The macrophyte community appears little changed since an NCC survey in 1977 apart from the observation of *Potamogeton berchtoldii* (recorded as râre) in that survey and *Sparganium minimum* (classed occasional).

4.4.3 Llyn Fanod

The macroflora of Llyn Fanod (Table C.4) bears many similarities with that of the nearby Llyn Eiddwen although it is more diverse. Shallow water is dominated by a *Littorella uniflora - Lobelia dortmanna* community (NVC community A22) which includes *Elatine hexandra* and *Subularia aquatica* and a shallow water form of *Isoetes lacustris*. This grades into an *Isoetes lacustris* community (A23) in which the charophyte *Nitella* spp. and *Callitriche hamulata* thrive. The deeper water form of the nationally scarce *Luronium natans* was found at a single point only (see site 1, Figure . *Isoetes lacustris* appears to be restricted to a water depth of less than 2 m, probably reflecting the poor transparency of the lake, although the steeply shelving nature of the shoreline beneath this depth means that lake bed stability cannot be ruled out as the limiting factor. The leaves of *Potamogeton natans* form significant floating mats off the north and west shores in a generally monospecific community (NVC class A9), while open water at the southern end is occupied by a large stand of *Nuphar lutea* (NVC community A8) which includes some *Nymphaea alba* and *Equisetum fluviatile*. *Carex rostrata* forms shallow water stands on the south shore, associated with some *Sparganium angustifolium,* and in the sheltered north-east arm with *Eleocharis palustris*. The small shoreline species *Montia fontana* and *Lythrum portula* were both recorded in the north end of the lake. It is likely that *Isoetes echinospora*, a species often difficult to distinguish in the field from *I.lacustris*, was also detected during the survey but further work is required to verify this.

The site is typed 3 after Palmer and has a trophic index score of 5.9. Palmer (1992) used species data from earlier macrophyte surveys of Llyn Fanod in 1972 and 1977 to calculate trophic ranking scores of 6.1 and 6.0 respectively. Generally there seems to be little difference in species composition between these dates and the present.

4.4.4 Llyn Glanmerin

Despite showing some similarities with other slightly acid sites in the current survey Llyn Glanmerin lacks a shallow water *Littorella uniflora - Lobelia dortmanna* community (Table D.4). Approximately 40% of the open water is covered by a *Nuphar lutea* community (NVC community A8) which includes significant cover of *Nymphaea alba* in patches. Shallow water on the east shore is dominated by a *Juncus bulbosus* community (A24) which includes *Callitriche hamulata*, *Myriophyllum alterniflorum* and in slightly deeper water *Isoetes lacustris*. *C.hamulata*, *M.alterniflorum* and *Elodea canadensis* (the latter is usually characteristic of more nutrient rich lakes) which can grow to considerable heights within the water column, occur frequently throughout this shallow lake in open water habitats. A submerged association of *E. canadensis* and *Nitella flexilis* var. *flexilis* occurs in the south east corner. A species poor *Phalaris arundinacea* swamp community (S28) occupies the west bay, possibly benefiting from the shelter provided by bordering woodland, and is flanked to the north and south by smaller stands of *Typha latifolia*. The north bay is dominated by *Equisetum fluviatile* swamp (S10) grading into an expanse of species poor *Potamogeton natans* (A9) community on the open water side. A species of *Iris* with a purple flower, noticed on an earlier reconnaissance visit to the site, is thought to have been an introduced exotic. The site is typed as 3 after Palmer and has a trophic index score of 6.3.

4.4.5 Llyn Gynon

Llyn Gynon supports a macrophyte flora typical of an acid, nutrient poor lake (Table E.4). Most of the shallows around the perimeter are dominated by a *Myriophyllum alterniflorum* sub-community of the *Littorella uniflora - Lobellia dortmanna* community (NVC class A22) and epiphytic filamentous algae are abundant here. *L.uniflora* is restricted to 1 m water depth, *Lobelia dortmanna* to approximately 1.2 m, while the zone of occurrence of *Juncus bulbosus* var. *fluitans* stretches into deeper water. The red alga *Batrachospermum* sp., which is common in nutrient poor waters, occurs in abundance, often in association with *J.bulbosus*. A few individual *Subularia aquatica* plants were found in a dessicated condition above the current water line. The shallow water community grades into a virtually monospecific stand of *Isoetes lacustris* (NVC community A23) which extends to a depth of approximately 2.5 m. This is exceeded by a few centimetres depth in places by the deep water form of the nationally scarce *Luronium natans* . A silty/peaty bay at the north of the lake contains a relatively diverse assemblage including *Callitriche hamulata*, *Glyceria fluitans* and *Luronium natans* within the normal shallow water community. *Potamogeton polygonifolius* is locally abundant mainly in the proximity of inflows, a single stand of *Sparganium angustifolium* occurs off the north-west shore, and *Nuphar lutea* is locally frequent in the outflow.

The site is typed as 3 after Palmer and has a trophic index score of 5.7. The nationally scarce *Pilularia globulifera* was found in Llyn Gynon in 1964 by Seddon, but has not been recorded at the site since.

4.4.6 Llyn Hir

The macrophyte species list for Llyn Hir (Table F.2) is very similar to that for Llyn Gynon with the exclusion of *Nuphar lutea* and *Carex rostrata* which tend to favour more silty substrates notably absent from this lake. The shallow water zone supports an abundance of epiphytic filamentous algae and is best described in NVC terms by the *Littorella uniflora - Lobelia dortmanna community* (A22) although *L. uniflora* is perhaps not as abundant as is normally the case in this classification. This could in part be due to competition in the shallow water habitat from *Juncus bulbosus* var. *fluitans*, a species which has been observed to thrive in acid lakes which have a history of liming (Roelofs *et al.* 1994). Unlike Llyn Gynon, *Subularia aquatica* grows in abundance within this community. *Isoetes lacustris* (NVC community A23) is evident in slightly deeper water although it appears to grow in association with *Lobelia dortmanna* throughout its depth range to a maximum of approximately 2.7 m. The deep water form of the nationally scarce *Luronium natans* is abundant and occupies a depth range of between 2.0 and 2.8 m. *Sparganium angustifolium* occurs occasionally, chiefly in shallow water close to the inflow.

Changes in the macrophyte flora are apparent since this lake was surveyed, albeit briefly, during a palaeoecological investigation in 1986 (Fritz *et al.* 1986) when the liverwort *Nardia compressa* was identified as being the dominant littoral macrophyte, an aquatic *Sphagnum* (probably *S. auriculatum*) was observed and *Isoetes lacustris* was estimated to grow to a depth of 4 m. All of these features are consistent with the lake having been significantly more acid, and indeed, before liming in 1985, the pH varied between 4.5 and 5.1. A comprehensive species list was not compiled at the time and so it is not possible to establish a pre-liming macrophyte typing according to Palmer (1992). However it is unlikely that this would have differed from the current typing of 3 as the presence/absence of liverworts is not included in the typing scheme and the presence of *Sphagnum* is only given weight when *L.uniflora* or *M. alterniflorum* are absent. Currently the site has a trophic index score (according to Palmer) of 5.4.

4.4.7 Llynnoedd Ieuan (west lake)

The western-most lake of the Llynnoedd Ieuan group supports a particularly impoverished aquatic macrophyte community (Table G.4), typical of acidified, nutrient poor lakes in upland areas of the UK. The liverwort *Nardia compressa* and two species of filamentous green algae were the most abundant macrophytes at the site, occurring in shallow water in association with *Juncus bulbosus* var. *fluitans* and a prostrate shallow water form of *Isoetes lacustris*. A *Littorella uniflora - Lobelia dortmanna* community, (NVC class A22) forms a band around the lake from a water depth of approximately 0.5 to 1.0 m, and possibly does not extend into shallower water because of effects of occasional winter ice scouring. This community grades into a virtually monospecific stand of *Isoetes lacustris* (A23). The site is typed as 3 after Palmer and has a trophic index score of 5.5.

4.4.8 Maes-Llyn

The relatively short aquatic macrophyte species list for Maes-Llyn (Table H.4) is probably more a reflection of its small size and lack of habitat diversity rather than its water chemistry. The south-east shore is partly fringed with *Salix* sp. with stands of *Nuphar lutea* (NVC community A8) and *Menyanthes trifoliata* extending out into open water. A larger stand of *N.lutea* rings much of the south-west shore, out from which occurs a submerged association of *Myriophyllum alterniflorum*, *Potamogeton berchtoldii* and *Ceratophyllum demersum*. *Elatine hexandra* is also present here in places. Deeper water (from c. 2 to 3 m water depth) is occupied by a virtually monospecific stand of *C.demersum* (NVC community (A5)). The south corner of the lake contains the only notable tall emergent stand of *Typha latifolia* (NVC swamp community S12) flanked by smaller stands of *Iris pseudacorus* and *Phalaris arundinacea*. The open north shore supports *Littorella uniflora* and *M.alterniflorum* in shallow water (NVC community A22 despite the absence of *Lobelia dortmanna*) and frequent occurences of *E. hexandra* and *P.berchtoldii*.

Observations of recent changes in the macrophyte flora of Maes-Llyn, eg. an increase in the abundance of *C.demersum*, and the only recently recorded occurrence of *Potamogeton obtusifolius* suggest that the site may be becoming increasingly nutrient enriched (Arthur Chater pers. comm.). The site is typed as 4 after Palmer (a category typifying oligotrophic sites with a eutrophic influence) and has a trophic index score of 6.9.

4.4.9 Upper Talley Lake

Upper Talley lake posseses a largely open littoral with small emergent stands of *Typha latifolia*, *Carex rostrata*, *Eleocharis palustris* and *Equisetum fluviatile* (NVC swamp communities S12,S9,S19,S10) in the south and significant beds of *Nymphaea alba*, (NVC community A7) with patches of *Nuphar lutea*, at the north end and east side (Table I.4). The charophyte *Chara globularis* var. *virgata* and *Potamogeton berchtoldii* both grow abundantly in open water habitats and an association of *Myriophyllum alterniflorum*, *Ceratophyllum demersum* and *Potamogeton obtusifolius* was found in open water at the north end. A mixed stand of *Potamogeton natans* and *Equisetum fluviatile* is flanked by a stand of *Carex rostrata*, through which the outflow drains, and this grades into Alder Carr which encircles the north end. At the time of the survey the lake was covered by a bloom of the blue-green alga *Gleotrichia*.

The site is typed as 9 after Palmer (mainly eutrophic with floating leaved communities) and has a trophic ranking score of 7.2.

4.4.10 Lower Talley Lake

The shoreline of Lower Talley lake is much more heavily dominated by an emergent macrophyte fringe (composed chiefly of stands of *Typha latifolia*) than its feeder lake, to an extent that access to the open water is very difficult (Table J.4). *Carex rostrata* and *Phalaris arundinacea* are also common components around the shore. The main NVC swamp communities represented are therefore S12, S9 and S28. The charophyte *Chara globularis* var. *virgata* occurs occasionally in open water habitats and two *Potamogeton* species, *P.berchtoldii* and *P.obtusifolius*, grow to a depth of approximately 2 metres. Stands of *Nymphaea alba* sometimes in association with *Nuphar lutea* (NVC community A7) are confined to the north and south end

The site is typed as 5a after Palmer (mesotrophic), differing in class from the Upper Lake due to the absence of *Polyganum amphibium*, yet possessing the identical trophic ranking score of 7.2.

4.5 Littoral Cladocera

A total of 34 Cladocera species have been recorded from the 50 samples taken from the ten study sites in 1994. Intact identifiable specimens were found in all the samples, with the exception of sample 2 from West Ieuan in which only shells of *Alonopsis elongata* were found. Results are given in Tables A5 - J5. Bugeilyn had the most diverse assemblage with 17 taxa being recorded, while West Ieuan supported only 5 taxa.

Most taxa had previously been recorded during phase I with the exceptions of *Acantholeberis curvirostris*, *Alona costata*, *Alona quadrangularis*, *Alonella nana*, *Bosmina longirostris* var. *cornuta*, *Ceriodaphnia pulchella*, *Ceriodaphnia quadrangula*, *Daphnia hyalina* var. *lacustris*, *Disparalona rostrata* and *Holopedium gibberum*.

Acantholeberis curvirostris was recorded only in West Ieuan. This species is known to occur in shallow acid waters over *Sphagnum* (Scourfield and Harding 1966; Fryer 1993). Its presence in West Ieuan agrees with its known ecology because this lake receives drainage from the surrounding blanket bog. The chydorid *Alonella nana* was also only found in West Ieuan and it is consistent with its known association with lakes surrounded by peatlands in Ireland (Duigan 1992). *Alona costata* only occurred in the Talley Lakes which is consistent with its known ecology as a frequenter of lowland, relatively alkaline sites (Fryer 1993; Duigan and Kovach 1991). *Ceriodaphnia pulchella* is also considered characteristic of lowland, alkaline conditions (Fryer 1993) and its occurrence in the Talley Lakes is the first survey record for this species. The presence of *Holopedium gibberum* in Bugeilyn is of interest because this relatively rare cladoceran is known to frequent waters with low ionic content and may be sensitive to eutrophication (Smyly 1968).

A number of species were recorded from the North Wales lakes sampled during phase I but not from the mid-Wales lakes - *Alona guttata* (Idwal), *Camptocercus rectirostris* (Cwellyn), *Leptodora kindti* (Coron), *Oxyurella tenuicaudis* (Coron), *Pseudochydorus globosus* (Coron, Dinam, Penrhyn), and *Daphnia obtusa* (Penrhyn). It is noticable that the majority of these species were found only in the Anglesey Lakes which seem to have distinctive faunal communities.

Some of the differences in taxon distribution between upland and lowland lakes noticed in Phase I of this project are also evident in this larger dataset. The most diverse assemblage occurs in Bugeilyn, one of the most acid, oligotrophic sites examined. West Ieuan appears remarkably taxon poor for an oligotrophic site, with only 5 taxa recorded, but this may be related to the lack of littoral habitat diversity. *Alonopsis elongata* does not occur in lowland sites such as Maes-llyn and the Talley Lakes. At a relatively low altitude, Upper Talley Lake is characterised by a relatively diverse *Daphnia* assemblage, not shared with its sister lake. No Cladoceran taxon occurred in every lake surveyed.

No previous records for the zooplankton of these lakes were identified, with the exception of unpublished data for Llyn Hir (Anon. 1983) and the Talley lakes (by J.Green) made available by the National Rivers Authority (see Appendix O). Further investigations are required to carry out a complete assessment of the conservation importance of the zooplankton communities reported here.

4.6 Open water zooplankton

In total 25 crustacean species, 9 species of rotifers and 1 species of insect larvae (Chaoboridae) were found in the 10 lakes investigated during the survey of open water zooplankton in summer 1994 (see Tables A-J (6-7)). Of these only 13 cladoceran and 5 rotifer species had been recorded in the five lakes in North Wales surveyed in Phase I in the previous year. The comparison is biased by the fact that only 14 of the 25 crustacean species are true open water planktonic animals. Of the true planktonic species only, 7 species from the Phase I study did not occur in the current survey.

None of the planktonic taxa recorded in the current survey were common to all ten lakes. Taking seasonal fluctuations of zooplankton populations into account, it is likely that *Diaphanosoma brachyurum* has the most common frequency of occurrence (a comment on the distribution pattern of the calanoid *Eudiaptomus gracilis* will be presented later).

Seasonality can be illustrated at the two Talley Lakes which were sampled in May 1994, i.e. two and half months earlier, by Dr. J. Green (pers. comm.). Out of 10 crustacean species listed by J. Green for May, only 7 were recorded in August. Nevertheless, the absence of 3 "spring species" was compensated by the detection of three other species, not previously recorded. Regardless of the incidence of species which are not truely planktonic, e.g. *Chydorus sphaericus* and *Paracyclops affinis*, the disappearance of *Daphnia longispina* from Lower Talley Lake and the appearance of *Daphnia pulex* in Upper Talley Lake is probably a seasonality linked phenomenon.

Upper Talley Lake was the most planktonic species-rich of all sites (15 species), while only six species were recorded in Llyn Hir. It is difficult to estimate the degree of similarity between the lakes purely on the basis of species lists provided, because of the 25 crustacean taxa, fourteen species were of incidental occurrence (i.e. rare species with relative abundance below 1%). Nevertheless, the data appear to reveal a positive relationship between species richness and trophic status, despite the fact that the gradient for the latter is relatively small compared to the set of lakes investigated in 1993.

There was no conspicuous difference in the presence of the dominant zooplankton species between samples taken at the deepest sampling station and in shallower parts of the lake. However analysis of samples taken at the shallower sites can sometimes make the list of lake species, richer by up to one third, as was the case at Llyn Gynon and Lower Talley Lake. From the point of view of determining biodiversity, the sampling of these shallower areas is clearly important, although it is unlikely to expand the list of truely planktonic species.

Ecological notes

Eudiaptomus gracilis - This calanoid is one of the dominant zooplankton species in 13 of the 15 lakes surveyed to date and is particularly useful as a bioindicator because it tends to reproduce throughout the whole year. Fryer (1993) reports it as an open-water species of wide occurrence preferring alkaline conditions. The two sites, where this species has not been recorded are: a) Llyn Idwal, where its environmental niche appears to be occupied by *Arctodiaptomus laticeps* and; b) Llyn Bugeilyn - see notes on *H. gibberum* below.

Holopedium gibberum - An open-water cladoceran which favours low calcium, dystrophic conditions. The occurrence in Llyn Bugeilyn may be its first record for Wales, although this is most likely to be due to the limited number of zooplankton surveys in the region rather than rarity (Dr. C. Duigan, pers. comm.).

Acanthocyclops robustus - A cyclopoid which is not a true open-water planktonic animal. It was found in the Lower Talley Lake. Fryer (1993) refers to it as a typical lowland species which seems to require the pH of the water to be above 6.

4.7 Littoral macroinvertebrates

Macroinvertebrates were abundant in the littoral zones of all lakes. Data is presented in Tables A - J (8). Broadly speaking, the lakes can be divided into four groups based on their macroinvertebrate fauna:

(1) upland, relatively species poor lakes (Bugeilyn, Llynnoedd Ieuan, Llyn Hir and Llyn Gynon);
(2) lakes with intermediate species richness but no Malacostraca (Llyn Eiddwen and Llyn Fanod);
(3) lakes with intermediate species richness, dominated by Malacostraca (Llyn Glanmerin and Maes-Llyn) and;
(4) lakes with very high species richness (Upper and Lower Talley Lakes).

The species count for Lower Talley lake is conservative, owing to sampling difficulties. Virtually all species found in the Lower Lake are also present in the Upper Lake. The proximity of these two lakes suggests that the species "missing" from the lower lake would almost certainly be present if it were possible to sample effectively.

The upland, relatively species poor lakes are dominated by the insect taxa that are fairly typical of nutrient poor, stony lake shores. The littoral food webs are likely based on the attached algae and fine detritus of the lake bottom. Leptophlebid mayflies, the elmid beetles *Oulimnius* spp. and some of the cased caddisflies such as *Agrypnia* spp. that feed on the periphyton and detritus were common. Abundant taxa that are primarily predatory in their feeding habits included the net spinning caddisfly *Polycentropus flavomaculatus* that lives on the benthos, and the free swimming Corixidae and some dytiscid beetles.

The lakes with intermediate species richness were also dominated by insect taxa, but with some representatives of the Hirudinea and Mollusca, and these assemblages are characteristic of systems with moderately poor nutrient levels. Their littoral food webs are likely based on the attached algae and fine detritus of the lake bottom. The elmid beetles *Oulimnius* spp. and leptophlebiid and caenid mayflies that typically occur in the silt/mud between stones and that feed on periphyton and detritus, were common. The pea mussel *Pisidium*, which filters fine detritus from water at the substrate surface, was very abundant. The semi-sessile caddisfly *Tinodes waeneri* that grazes attached algae was also characteristic of these lakes. The predatory species included various leeches and the caddisfly *Polycentropus flavomaculatus* that live in close association with the substrate, and some free swimming Corixidae and dytiscid beetles.

Two lakes (Maes-llyn and Llyn Glanmerin) were characterised by moderately abundant and diverse assemblages of molluscs, leeches, Malacostraca and various insects, all typical of productive, nutrient rich lakes. The dominant genera, *Asellus* and/or *Gammarus*, shred decomposing plant parts and other detritus. Curiously, Maes-llyn was dominated by the common aquatic isopod *Asellus aquaticus*, whereas only the less common *Asellus meridianus* occurred in Llyn Glanmerin, but in great abundance. *Asellus aquaticus* is widely distributed throughout the British Isles; *A. meridianus* tends to be restricted to western and island areas, but the ecological differences between these two species is not clear. The predatory invertebrates were well represented by the abundant and diverse assemblages of Odonata, Corixidae, some Hirudinea and polycentropodid caddisflies.

The two Talley lakes had abundant and diverse assemblages of all the major groups of aquatic macroinvertebrates, typical of highly productive, nutrient rich systems. The littoral food web is influenced to a great extent by the well developed macrophyte beds found in these lakes. The molluscs and mayflies graze algae growing on plants and other substrates. The haliplid beetles also live in close association with aquatic macrophytes and are herbivorous. The leeches are all predatory on invertebrates, primarily those living on substrate surfaces, with the exception of *Theromyzon tessulatum* which is parasitic on water fowl. The abundant Corixidae, Odonata and Dytiscidae are free swimming predators, whereas the net-spinning polycentropodid caddisflies live in association with various substrates.

5 Summary and discussion

Inspection of the data presented in this report reveals certain similarities and differences in site attributes which allow some generalised site comparisons to be drawn.

For example Llynnau Bugeilyn, Gynon, Hir and West Llynnoedd Ieuan all exhibit acid, nutrient poor water chemistry which is clearly reflected in their biological characteristics, such as their isoetid dominated macrofloras and acidophilous diatom and invertebrate taxa. Of these sites the latter appears to be particularly acid and species poor. Bugeilyn possesses many characteristics indicative of a trophic status strongly influenced by catchment derived peat, emphasised by the occurrence of the unusual open-water cladoceran *Holopedium gibberum*. However Total Organic Carbon levels are similar to most other sites in the current study.

Llynnau Eiddwen, Fanod and Glanmerin are close to neutral pH but are also nutrient poor and show many biological features in common with the more acid sites, such as the occurrence of the macrophytes *Isoetes lacustris* and *Callitriche hamulata*. However these sites are generally more species rich and contain taxa intolerant of more acid conditions such as the charophyte *Nitella* spp..

The two Talley lakes are of approximately neutral pH but are considerably more nutrient rich than other sites in the Phase 2 study with the exception of Maes-llyn. These sites support diverse floras and faunas but only the Lower Lake is fringed by extensive reed beds.

Maes-llyn is the most strongly alkaline lake in the current study. It has a similar level of phosphorus to the Talley lakes but considerably higher winter levels of nitrate. Its overall biodiversity appears to be restricted, partly because of its relatively small size and simple shoreline and partly because of the effects of shoreline grazing which have prevented the establishment of emergent macrophyte stands.

This grouping of sites is subjective. It is likely that other classifications will result if only a sub-set of the chemical, physical and biological determinands are considered. For example, if the macroinvertebrate data is referred to in isolation, Maes-llyn appears to have most in common with Llyn Glanmerin, although chemically it has more in common with the Talley Lakes. However, pH, nutrient status and to some extent altitude are clearly major factors determining the biological characteristics of the study sites.

Existing lake classification schemes, as discussed in the Phase 1 report, have been applied to the data for the Phase 2 lakes (Table 5.1). Classification by thermal mixing (Lewis 1983) is difficult as only one temperature profile, is available for each site. However, the profiles provide evidence of summer thermal stratification at all sites other than West Llynnoedd Ieuan and Upper Talley lake. Stratification may have developed at the former site, which is situated at the highest altitude of all sites in the project to date, later in the summer. The sites which show stratification vary significantly in depth, volume, hydrological characteristics and altitude and are thus likely to have differing thermal regimes. Bugeilyn, Llyn Glanmerin and the Talley Lakes are relatively shallow water bodies and are therefore susceptible to mixing by atmospheric interaction during the summer. This tendancy is perhaps demonstrated by the differences in the profiles of the two Talley Lakes, which are similar in depth. The isothermal profile of the Upper lake was recorded following a period of heavy rain, whereas the stratified profile of the Lower Lake was recorded a day later in hot, calm conditions. Bugeilyn, West Llynnoedd Ieuan and Llynnau Gynon and Hir are all situated at relatively high altitudes (ie. > 400m) and are therefore more vulnerable to winter freezing and subsequent inverse thermal stratification. However, no site was found to be ice covered during a water sampling visit in early March 1995 following a period of low temperatures and heavy snow, and it seems likely that even West Llynnoedd Ieuan, at an altitude of 525m, will not be consistently seasonally ice covered. By discounting the likelihood of seasonal ice cover at any site the thermal mixing classification of these sites becomes dependent on lake depth. Therefore the deeper Llynnau Eiddwen, Fanod, Gynon, Hir, Maes-llyn and West Llynnoedd Ieuan have been classed as warm monomictic (ie. stably stratified for part of the year and mixed once a year) and Bugeilyn, Llyn Glanmerin and the two Talley Lakes as discontinuous warm polymictic (stratifying for days or weeks at a time, but mixing more than once a year).

The inappropriateness of the Dillon and Rigler (1975) classification, (based on summer chlorophyll *a* level), for conservation purposes was discussed in the phase 1 report. Llyn Hir and

Table 4.1 Site classifications based on existing schemes

Classification scheme	Bugeilyn	Eiddwen	Fanod	Glanmerin	Gynon	Hir	Ieuan	Maes-Llyn	U.Talley	L.Talley
Thermal mixing (Lewis 1983)	discontinuous warm polymictic	warm monomictic	warm monomictic	discontinuous warm monomictic	warm monomictic	warm monomictic	warm monomictic	warm monomictic	discontinuous warm polymictic	discontinuous warm polymictic
Dillon and Rigler (1975)	Class III	Class II	Class III	Class III	Class II	Class I	Class I	Class IV	Class III	Class IV
OECD (1982)	problematic	mesotrophic	mesotrophic	mesotrophic	oligotrophic	oligotrophic	oligo-/ultra oligotrophic	eutrophic	eutrophic	eutrophic
UKAWRG (1989)	permanently acid	never acid	never acid	never acid	permanently acid	permanently acid	permanently acid	never acid	never acid	never acid
Critical load for total acidity (Henriksen model) (keq H^+ ha^{-1} yr^{-1})	1.41	2.69	3.13	3.02	1.50	1.10	0.71	10.36	8.18	6.95
Critical load exceedance for total acidity (Henriksen model) (keq H^+ ha^{-1} yr^{-1})	not exceeded	not exceeded	not exceeded	not exceeded	not exceeded	not exceeded	0.30	not exceeded	not exceeded	not exceeded
Critical load for total acidity (diatom model) (keq H^+ ha^{-1} yr^{-1})	0.55	1.63	1.96	1.66	0.60	0.68	0.38	7.08	5.63	4.46
Critical load exceedance for total acidity (Diatom model) (keq H^+ ha^{-1} yr^{-1})	0.61	not exceeded	not exceeded	not exceeded	0.64	0.21	0.51	not exceeded	not exceeded	not exceeded
Palmer *et al.* (1992) Site type	2	2	3	3	3	3	3	4	9	5a
Category	oligotrophic	oligotrophic	oligotrophic	oligotrophic	oligotrophic	oligotrophic	oligotrophic	oligotrophic with eutrophic influence	mainly eutrophic / sometimes marl	mesotrophic
Trophic Ranking Score	5.5	5.7	5.9	6.3	5.7	5.4	5.5	6.9	7.2	7.2
National Vegetation Classification (Rodwell 1995) Community types	A22,A24, A8	A22,A23, S10	A22,A23, A8,A9	A24,A8, A9,S28,S10	A22,A23	A22,A23	A22,A23	A8,A5,A22,S12	A7,S12,S9,S19,S10	A7,S12,S9, S28

West Llynnoedd Ieuan are the only sites with Class I status (ie. lakes for recreational use maintaining a salmonid fishery) but this underlines a further weakness with the method as it fails to take into account pH or related factors such as soluble aluminium, which at the latter site are possibly too extreme to support a healthy salmonid population. Llynnau Eiddwen and Gynon are the only Class II sites (recreational use) while Bugeilyn, Llyn Fanod, Llyn Glanmerin and Upper Talley Lake have the status of Class III (little or no recreational use other than non-salmonid fishing). Lower Talley Lake and Maes-llyn rank as Class IV lakes (suitable only for Cyprinid fishing)

Classification by the OECD trophic classification scheme produces groupings similar to those outlined at the beginning of this section, when a broad qualitative evaluation of the chemical, physical and biological data was made. Bugeilyn is a problematic site and appears to show dystrophic characteristics, ie. dependence on a peat derived nutrient supply It was classified as mesotrophic on the basis of TP, oligotrophic to ultra oligotrophic according to chlorophyll *a* and hyper-eutrophic on the basis of the secchi disc depth. Otherwise most sites had compatible TP and chlorophyll *a* levels and secchi disc depths. West Llynnoedd Ieuan is classed as oligotrophic to ultra-oligotophic, Llynnau Gynon and Hir, as oligotrophic, Llynnau Eiddwen, Fanod and Glanmerin as mesotrophic and Maes-llyn and the two Talley lakes as eutrophic.

The UK Acid Waters Review Group scheme (UKAWRG 1989), designed to enable the identification of waters susceptible to acidification, groups the sites in two categories. Bugeilyn, West Llynnoedd Ieuan, Llyn Hir and Llyn Gynon are classed as permanently acid, while the remaining sites are classed as never acid. Similar groupings are evident in the determination of the Critical Loads for these sites. Maes-llyn and the Talley lakes have very high Critical Loads for total acidity (ie. for sulphur and nitrogen deposition) and are not exceeded according to either the Henriksen or Diatom models. Llynnau Fanod, Glanmerin and Eiddwen have Critical Loads greater than the estimated current acid deposition levels. Bugeilyn, Llyn Gynon, Llyn Hir and West Llynnoedd Ieuan are exceeded according to the Diatom model, but only the latter site, the most acid of all lakes analysed in the project to date, is also exceeded according to the Henriksen model.

The aquatic macrophyte classification of Palmer (1992) places all sites other than Maes-llyn and the two Talley Lakes in oligotrophic classes. A distinction is made in this classification between Type 2 (Bugeilyn and Llyn Eiddwen) and Type 3 which includes Llynnau Fanod, Glanmerin, Gynon, Hir and West Llynnoed Ieuan. It is interesting that the latter site, which supports a clearly impoverished macroflora, has the most heavily exceeded critical load and exhibits ultra-oligotrophic characteristics, is placed in the same class as Llynnau Fanod and Glanmerin. These latter sites are considerably more species rich, relatively well pH buffered and classed mesotrophic by the OECD scheme. The classification of West Llynoedd Ieuan within Type 3 results in part from the occurrence of *Littorella uniflora* and *Isoetes lacustris* and despite the fact that few other species are present. Those sites which are not placed in oligotrophic classes by the Palmer scheme fall into different groups. Maes-llyn is classed as a Type 4 lake (oligotrophic with eutrophic influence), which is interesting given the observations of recent changes in the macrophytes at this site possible indicative of nutrient enrichment (see section 4.4.8). Lower and Upper Talley Lakes are classed as Type 5a (mesotrophic) and Type 9 (mainly eutrophic) respectively despite the fact that the former receives the drainage of the latter. These sites are strikingly different in appearance, the former being entirely fringed with reed beds and the latter with a largely open littoral. Although they show very similar nutrient levels throughout the year the Lower Lake generally shows a markedly higher chlorophyll *a* concentration. Upper Talley exhibits the greatest diversity of macrophyte communities of all lakes in the Phase 2 study.

A comprehensive chemical, physical and biological data-set has now been compiled for 15 lakes in this integrated classification and assessment survey, but data for a further 15 sites are still required before analytical techniques discussed in the Phase 1 report (Allott *et.al*) can be usefully applied.

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Appendix A Data Tables and Figures: Bugeilyn

Table A.1 Bugeilyn water chemistry

Determinand		Sample				
		26-7-94	23-9-94	1-12-94	6-3-95	mean
lab pH		5.42	5.14	5.44	4.91	5.17
field pH		5.75		5.84	4.86	
Alkalinity 1	µeq l^{-1}	14	6	20	-12	7
Alkalinity 2	µeq l^{-1}	6	-2	16	-13	2
lab Conductivity	µS cm^{-1}	30	30	30	35	31
field conductivity	µS cm^{-1}	32		28	32	
Sodium	µeq l^{-1}	147	141	134	174	149
Potassium	µeq l^{-1}	7	4	5	8	6
Magnesium	µeq l^{-1}	62	56	58	56	58
Calcium	µeq l^{-1}	58	59	71	42	58
Chloride	µeq l^{-1}	136	122	113	206	144
Aluminium $_{total\ monomeric}$	µg l^{-1}	62	100	86	74	81
Aluminium $_{non\text{-}labile}$	µg l^{-1}	53	77	64	42	59
Aluminium $_{labile}$	µg l^{-1}	9	23	22	32	22
Absorbance	(250nm)	0.351	0.448	0.346	0.160	0.326
Carbon $_{total\ organic}$	mg l^{-1}	4.1	5.8	6.0	3.5	4.9
Phosphorus $_{total}$	µgP l^{-1}	26.3	13.1	19.5	13.1	18.0
Phosphorus $_{total\ soluble}$	µgP l^{-1}	16.2	7.9	14.6	8.8	11.9
Phosphorus $_{soluble\ reactive}$	µgP l^{-1}	7.9	4.0	10.8	4.3	6.8
Nitrate	µgN l^{-1}	35	77	49	84	61
Silica $_{soluble\ reactive}$	mg l^{-1}	0.23	1.77	4.29	1.48	1.94
Chlorophyll a	µg l^{-1}	6.8	3.4	1.2	0.9	3.1
Sulphate	µeq l^{-1}	71	60	62	59	63
Copper $_{total\ soluble}$	µg l^{-1}	154	0	0	0	39
Iron $_{total\ soluble}$	µg l^{-1}	1535	358	450	140	621
Lead $_{total\ soluble}$	µg l^{-1}	12	0	0	0	3
Manganese $_{total\ soluble}$	µg l^{-1}	41	42	28	22	39
Zinc $_{total\ soluble}$	µg l^{-1}	15	11	9	3	10

Table A.2 Bugeilyn epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes sp.	1.6
Aulacoseira distans var. *nivalis*	1.6
Aulacoseira perglabra	1.1
Cymbella microcephala var. *microcephala*	1.0
Cymbella perpusilla	2.8
Eunotia exigua var. *exigua*	1.4
Eunotia incisa	69.7
Eunotia naegelii	1.9
Eunotia pectinalis var. *minor*	1.2
Eunotia rhomboidea	3.2
Fragilaria pinnata var. *pinnata*	1.8
Frustulia rhomboides var. *saxonica*	1.9
Frustulia rhomboides var. *viridula*	2.7
Navicula cumbriensis var. *minor*	1.3
Navicula mediocris	1.7
Navicula ventralis	1.5
Nitzschia gracilis	1.5
Nitzschia palea var. *palea*	1.5
Tabellaria flocculosa var. *flocculosa*	2.3

Table A.3 Bugeilyn surface sediment diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes austriaca var. *helvetica*	1.2
Asterionella ralfsii	1.9
Aulacoseira distans var. *nivalis*	4.0
Aulacoseira perglabra	12.2
Aulacoseira perglabra var. *floriniae*	3.1
Aulacoseira sp.	1.2
Cymbella perpusilla	4.2
Eunotia incisa	29.1
Eunotia rhomboidea	1.6
Frustulia rhomboides var. *saxonica*	3.1
Frustulia rhomboides var. *viridula*	5.6
Navicula mediocris	1.4
Navicula soehrensis	5.6
Nitzschia palea	2.1
Pinnularia subcapitata var. *hilseana*	1.2
Surirella delicatissima	1.4
Tabellaria flocculosa	2.8

Table A.4 Bugeilyn aquatic macrophyte abundance summary: 27-7-94

Taxon	code	Abun
Emergent taxa		
Equisetum fluviatile	350202	O
Menyanthes trifoliata [1]	364701	R
Carex rostrata	381129	F
Floating taxa		
Nuphar lutea	365501	F
Luronium natans [1 2]	383401	O
Potamogeton polygonifolius [1]	384017	F
Sparganium angustifolium [1 2]	384601	A
Submergent taxa		
Filamentous green algae species 1	170000	R
Filamentous green algae species 2	170000	O
Nardia compressa	343701	A
Utricularia minor	369600	F
Callitriche hamulata [1]	361103	O
Littorella uniflora [1]	363901	A
Luronium natans [1 2]	383401	O
Juncus bulbosus var. fluitans	383006	O
Fringing taxa		
Hydrocotyle vulgaris	363401	A
Juncus effusus	383010	A
Juncus articulatus	383003	F
Sphagnum sp.	327400	F

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table A.5 Bugeilyn littoral Cladocera taxon list: 27-7-94

Taxon	Sample number				
	1	2	3	4	5
Acroperus harpae	18	68	1	165	9
Alona affinis					+
Alona quadrangularis	2				
Alona rustica	+	+			
Alonopsis elongata	60	84	17	17	117
Alonella excisa		+			
Ceriodaphnia quadrangula	13			1	
Chydorus sphaericus	1	+		1	
Diaphanosoma brachyurum		255	2	41	1
Eubosmina longispina		1	13	1	
Eurycercus lamellatus	10	2	1	19	1
Graptoleberis testudinaria	1	9	1	9	
Holopedium gibberum	+	13			1
Monospilus dispar	+				
Pleuroxus truncatus	21	2	5	9	1
Polyphemus pediculus	199	29	358	47	27
Scapholeberis mucronata	12	49	1	10	1
Sida crystallina	13	+	1	8	
Total Count	350	512	400	328	158

Table A.6 Bugeilyn zooplankton abundance summary: 27-7-94 Abundance in vertical net hauls (number of individuals 0.01 m^{-2})

TAXON	Abun
Diaphanosoma brachyurum	2100
Eubosmina longispina	570
Ceriodaphnia quadrangula	X
Eurycerus lamellatus	X
Polyphemus pediculus	X
Cyclops abyssorum	X
Holopedium gibberum	140

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table A.7 Bugeilyn zooplankton characteristics

Site depth (m)	1.8
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	1.09
Chaoborus larvae biomass (g DW m^{-2})	0
Net algal biomass (g DW m^{-2})	0
Cladoceran biomass as proportion of total zooplankton biomass (%)	96
Large cladoceran (>710µm) as proportion of total zooplankton biomass (%)	19
Large Copepoda (>420µm) as proportion of total zooplankton biomass (%)	2

Table A.8 **Bugeilyn littoral macroinvertebrate summary. Mean number of individuals per one minute kick/sweep sample.**

code	Taxon	mean count/ sample
	TURBELLARIA	
03120000	Tricladida	2.8
	HIRUDINAE	
17040102	*Erpobdella octoculata*	1.2
	EPHEMEROPTERA	
30040100	*Leptophlebia* sp.	398.4
	PLECOPTERA	
31020401	*Nemoura cinerea*	0.4
31030104	*Leuctra nigra*	0.4
	HEMIPTERA	
33110000	Corixidae sp.	6.8
33110801	*Sigara dorsalis*	0.4
33110807	*Sigara scotti*	0.8
	COLEOPTERA	
35030000	Dytiscidae undet. (larvae	1.2
35110600	*Oulimnius* sp.	3.2
	MEGALOPTERA	
36010101	*Sialis lutaria*	23.6
	TRICHOPTERA	
38030301	*Polycentropus flavomacula*	40.8
38030401	*Holocentropus dubius*	0.8
38060600	*Oxyethira* sp.	0.4
38070400	*Agrypnia* sp.	2.4
38080500	*Limnephilus* sp.	6.8
38081901	*Chaetopteryx villosa*	1.2
38120203	*Mystacides longicornis*	54.4
38130201	*Silo pallipes*	2.4
38150101	*Sericostoma personatum*	10.4
	DIPTERA	
40090000	Chironomidae	656.8

Figure A.1 Bugeilyn: sample location and substrate map

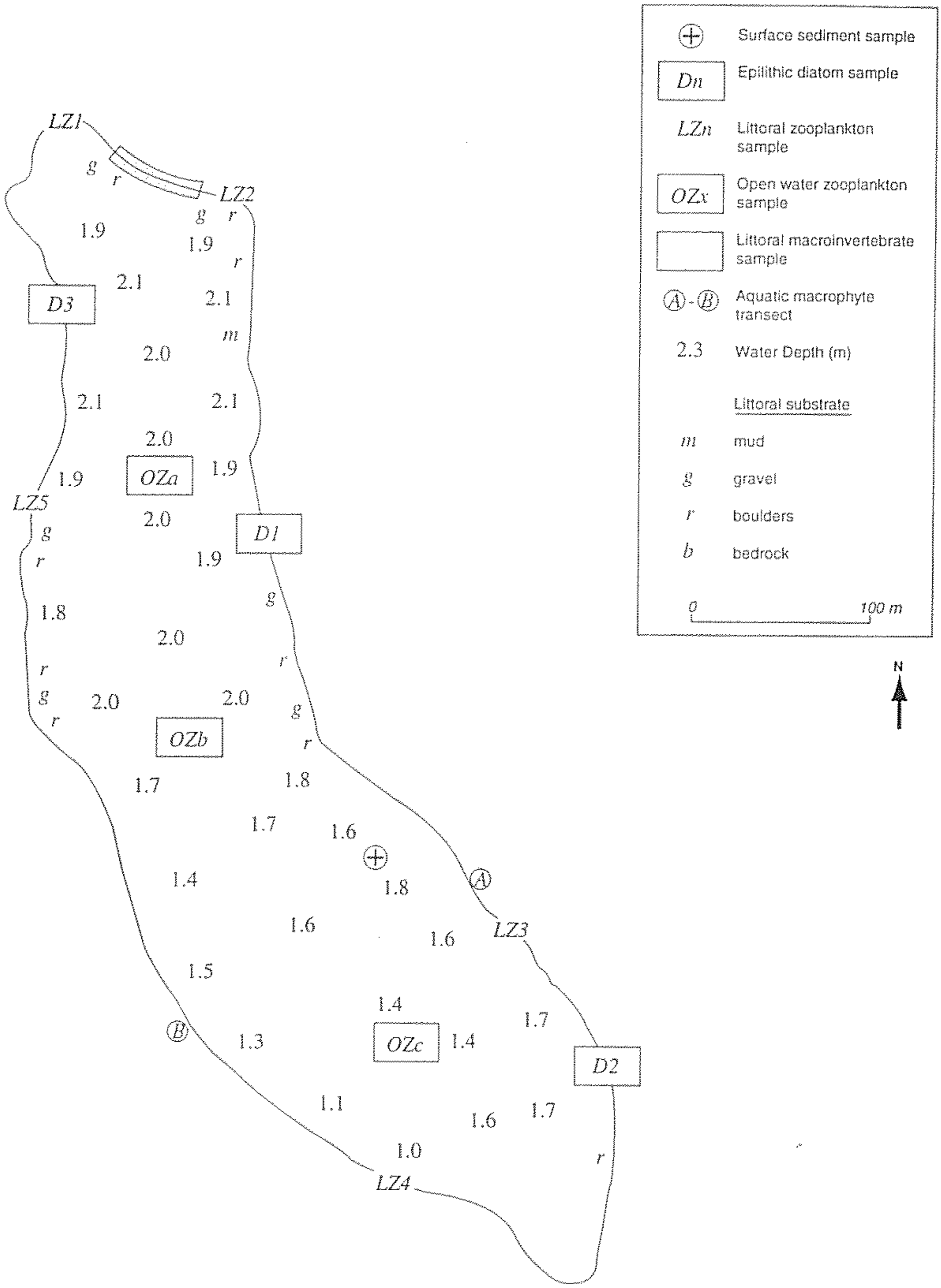


Figure A.2 Bugeilyn: aquatic macrophyte distribution map 27-7-94

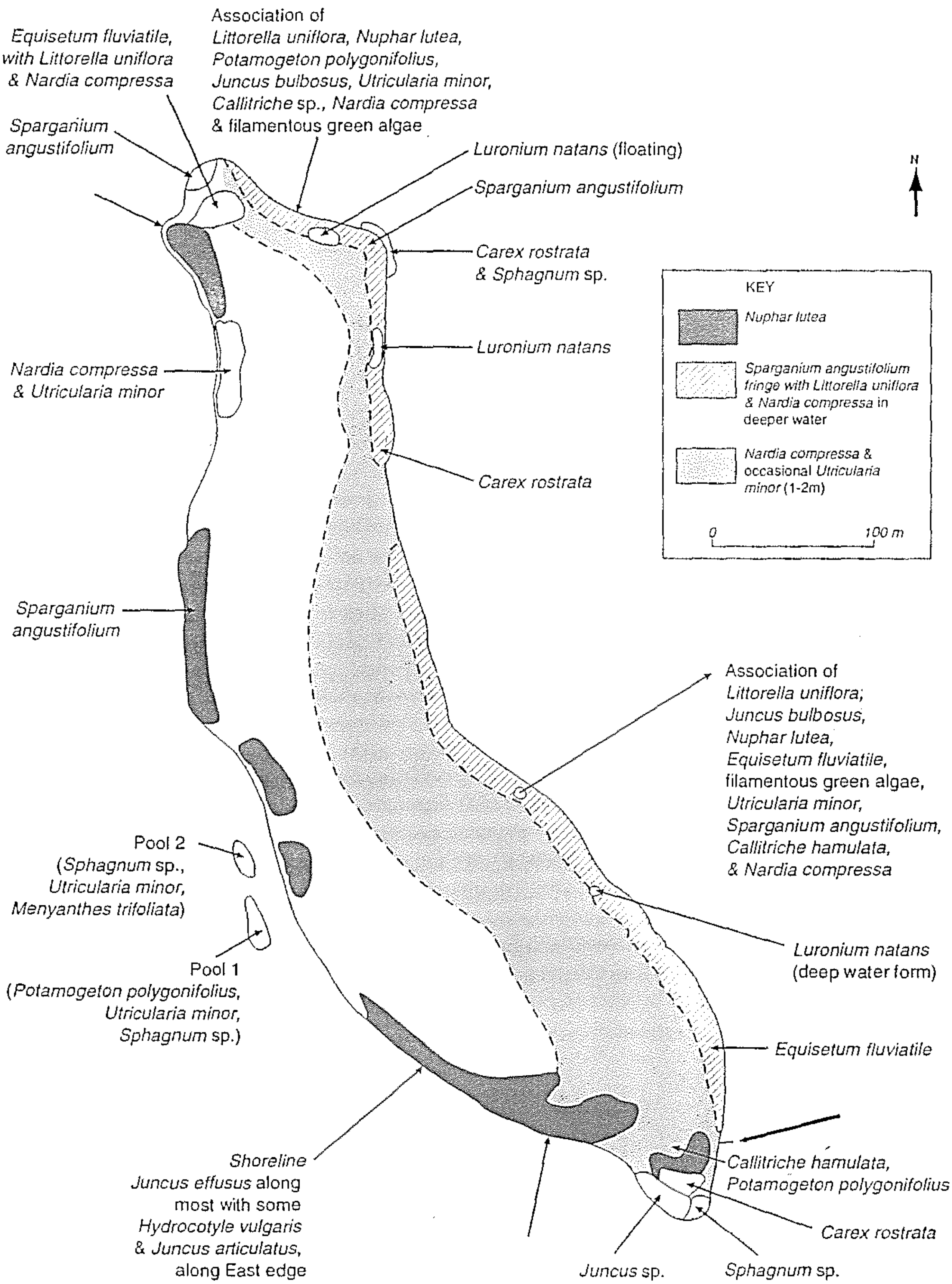


Figure A.3 Bugeilyn: aquatic macrophyte transect profile

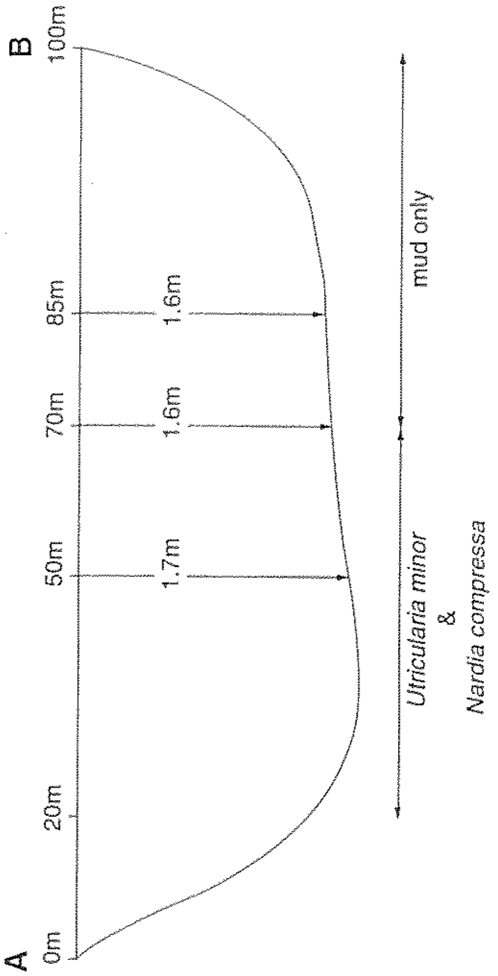
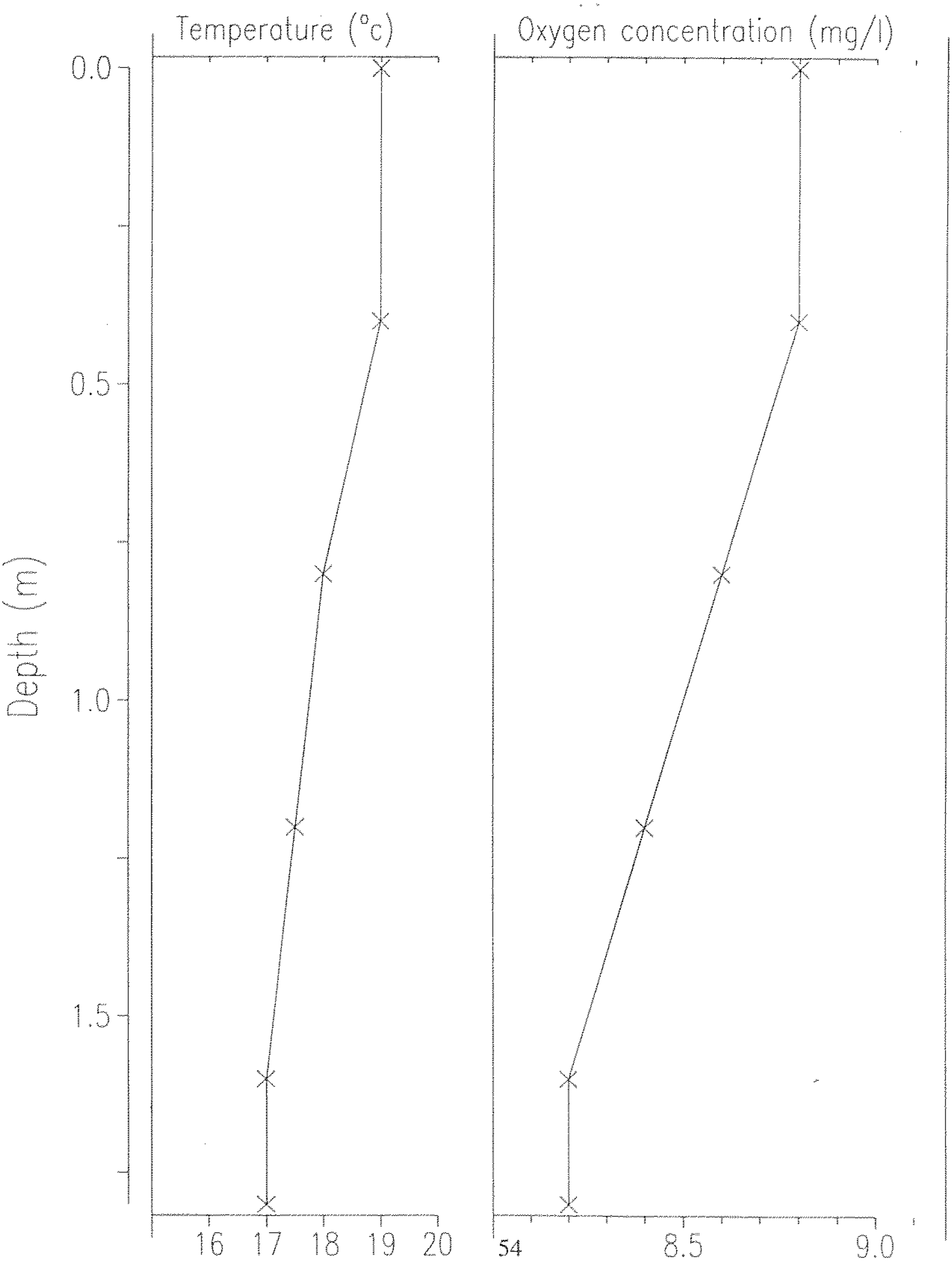


Figure A.4 Bugeilyn: Temperature and dissolved oxygen profiles 27-7-94



Appendix B Data Tables and Figures: Llyn Eiddwen

Table B.1 Llyn Eiddwen water chemistry

Determinand		Sample				
		27-7-94	**21-9-94**	**2-12-94**	**5-3-95**	**mean**
lab pH		6.41	6.73	6.76	6.41	6.55
field pH		6.72		6.85	6.70	
Alkalinity 1	μeq l^{-1}	95	100	91	69	89
Alkalinity 2	μeq l^{-1}	89	97	86	61	83
lab Conductivity	μS cm^{-1}	61	60	59	47	57
field Conductivity	μS cm^{-1}	58		60	50	
Sodium	μeq l^{-1}	297	296	273	254	280
Potassium	μeq l^{-1}	14	14	18	19	16
Magnesium	μeq l^{-1}	131	131	120	93	119
Calcium	μeq l^{-1}	173	178	168	122	160
Chloride	μeq l^{-1}	316	307	284	288	299
Aluminium $_{total\ monomeric}$	μg l^{-1}	1	2	8	8	5
Aluminium $_{non\text{-}labile}$	μg l^{-1}	0	2	8	8	5
Aluminium $_{labile}$	μg l^{-1}	1	0	0	0	0
Absorbance	(250nm)	0.189	0.250	0.305	0.235	0.245
Carbon $_{total\ organic}$	mg l^{-1}	4.3	5.5	7.0	5.0	5.5
Phosphorus $_{total}$	μgP l^{-1}	22.7	14.9	19.8	24.7	20.5
Phosphorus $_{total\ soluble}$	μgP l^{-1}	11.9	9.2	13.3	9.1	10.9
Phosphorus $_{soluble\ reactive}$	μgP l^{-1}	2.2	3.4	1.9	9.1	4.2
Nitrate	μgN l^{-1}	28	28	98	63	54
Silica $_{soluble\ reactive}$	mg l^{-1}	1.27	1.49	2.80	0.66	1.56
Chlorophyll a	μg l^{-1}	5.3	3.6	4.5	20.2	8.4
Sulphate	μeq l^{-1}	112	90	83	86	93
Copper $_{total\ soluble}$	μg l^{-1}	0	0	0	0	0
Iron $_{total\ soluble}$	μg l^{-1}	51	118	135	60	91
Lead $_{total\ soluble}$	μg l^{-1}	0	4	0	0	0
Manganese $_{total\ soluble}$	μg l^{-1}	22	19	0	0	10
Zinc $_{total\ soluble}$	μg l^{-1}	9	9	0	0	5

Table B.2 Llyn Eiddwen epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes sp.	1.6
Aulacoseira distans var. *nivalis*	1.6
Aulacoseira perglabra	1.1
Cymbella microcephala var. *microcephala*	1.0
Cymbella perpusilla	2.8
Eunotia exigua var. *exigua*	1.4
Eunotia incisa	69.7
Eunotia naegelii	1.9
Eunotia pectinalis var. *minor*	1.2
Eunotia rhomboidea	3.2
Fragilaria pinnata var. *pinnata*	1.8
Frustulia rhomboides var. *saxonica*	1.9
Frustulia rhomboides var. *viridula*	2.7
Navicula cumbriensis var. *minor*	1.3
Navicula mediocris	1.7
Navicula ventralis	1.5
Nitzschia gracilis	1.5
Nitzschia palea var. *palea*	1.5
Tabellaria flocculosa var. *flocculosa*	2.3

Table B.3 Llyn Eiddwen surface sediment diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes minutissima	9.5
Achnanthes pusilla	4.6
Asterionella formosa	2.6
Brachysira vitrea	3.7
Cymbella lunata	3.9
Cymbella microcephala	1.5
Cymbella perpusilla	1.5
Eunotia incisa	7.8
Eunotia pectinalis var. *minor*	1.1
Eunotia sudetica	1.3
Fragilaria construens var. *venter*	10.0
Fragilaria vaucheriae	2.4
Fragilaria virescens var. *exigua*	16.5
Gomphonema angustatum	2.8
Navicula radiosa var. *tenella*	3.0
Navicula seminulum	1.7
Synedra acus	4.8
Tabellaria flocculosa	5.4

Table B.4 Llyn Eiddwen aquatic macrophyte abundance summary: 27-7-94

TAXON	code	Abun
Emergent taxa		
Equisetum fluviatile	350202	F
Menyanthes trifoliata [1]	364701	F
Carex rostrata	381129	F
Equisetum palustre	350204	R
Floating taxa		
Luronium natans [1 2]	383401	O
Potamogeton natans [1]	384012	O
Potamogeton polygonifolius [1]	384017	O
Submergent taxa		
Blue green alga (sp. 1)	100000	A
Nitella sp.	220000	A
Fontinalis sp.	234010	O
Luronium natans [1 2]	383401	R
Isoetes lacustris	350302	F
Callitriche hamulata [1]	361103	A
Littorella uniflora [1]	363901	A
Lobelia dortmanna	364001	A
Subularia aquatica	368701	O
Fringing taxa		
Juncus articulatus	383003	F
Juncus effusus	383010	F
Eriophorum angustifolium	382401	F
Hydrocotyle vulgaris	363401	F
Hypericum elodes 1	363401	F
Myosotis secunda	365103	O
Potentilla palustris	366704	F
Galium palustre	362803	F
Sphagnum sp.	327400	F
Polytrichum sp.	326200	F

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table B.5 Llyn Eiddwen littoral Cladocera taxon list: 31-7-94

TAXON	Sample number				
	1	2	3	4	5
Acroperus harpae	1		1	25	
Alonopsis elongata	1	1		4	
Bosmina longirostris var. *cornuta*	2	155			
Chydorus piger		+			
Disparalona rostrata			1		
Drepanothrix dentata			3		
Eubosmina longispina					2
Eurycercus lamellatus				4	
Pleuroxus truncatus				12	1
Streblocerus serricaudatus		3			
Total Count	4	159	5	45	3

**Table B.6 Llyn Eiddwen zooplankton abundance summary: 31-7-94
Abundance in vertical net hauls (number of individuals $0.01m^{-2}$)**

TAXON	Abun
Eudiaptomus gracilis	640
Eubosmina longispina	19500
Macrocyclops albidus	x
Cyclops abyssorum	90
Other planktonic organisms (not quantitatively sampled)	
Conochilus sp.	2500
Volvox	50
Kellicottia longispina	12500
Nauplia	50

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table B.7 Llyn Eiddwen Zooplankton characteristics

Site depth (m)	6.2
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	1.62
Chaoborus larvae biomass (g DW m^{-2})	0
Net algal biomass (g DW m^{-2})	0
Cladoceran biomass as proportion of total zooplankton biomass (%)	38
Large cladoceran (>710μm) as proportion of total zooplankton biomass (%)	0
Large Copepoda (>420μm) as proportion of total zooplankton biomass (%)	4

Table B.8 Llyn Eiddwen littoral macroinvertebrate summary. Mean number of individuals per one minute kick/sweep sample.

code	TAXON	mean count/sample
	TURBELLARIA	
03120000	Tricladida	10.8
	MOLLUSCA	
13070107	*Lymnaea peregra*	4.8
13090312	*Planorbis laevis*	3.2
	BIVALVIA	
14030200	*Pisidium* sp.	356.8
	HIRUDINIA	
17020302	*Glossiphonia complanata*	0.8
17020501	*Helobdella stagnalis*	0.4
17030101	*Haemopsis sanguisuga*	0.4
17040102	*Erpobdella octoculata*	9.2
	EPHEMEROPTERA	
30020000	Baetidae	4.8
30020302	*Cloeon simile*	1.6
30040100	Leptophlebia sp.	44.4
30080204	*Caenis horaria*	130.8
30080206	*Caenis luctuosa*	121.2
	HEMIPTERA	
33110000	Corixidae sp.	6
33110801	*Sigara dorsalis*	5.2
33110807	*Sigara scotti*	19.2
	COLEOPTERA	
35030000	Dytiscidae undet. (larvae)	0.4
35030706	*Stictotarsus duodecimpustulatus*	0.4
35110600	*Oulimnius* sp.	38
	MEGALOPTERA	
36010101	*Sialis lutaria*	1.2
	TRICHOPTERA	
38030301	*Polycentropus flavomaculatus*	63.6
38040201	*Tinodes waeneri*	22.4
38060300	*Hydroptila* sp.	24
38070400	*Agrypnia* sp.	1.2
38080500	*Limnephilus* sp.	8.4
38080510	*Limnephilus lanatus*	12.4
38080523	*Limnephilus vittatus*	23.2
38120000	Leptoceridae sp.	1.6
38150101	*Sericostoma personatum*	5.6
	DIPTERA	
40010000	Tipulidae	0.8
40080000	Ceratopogonidae	0.4
40090000	Chironomidae	503.6

Figure B.1 Llyn Eiddwen: sample location and substrate map

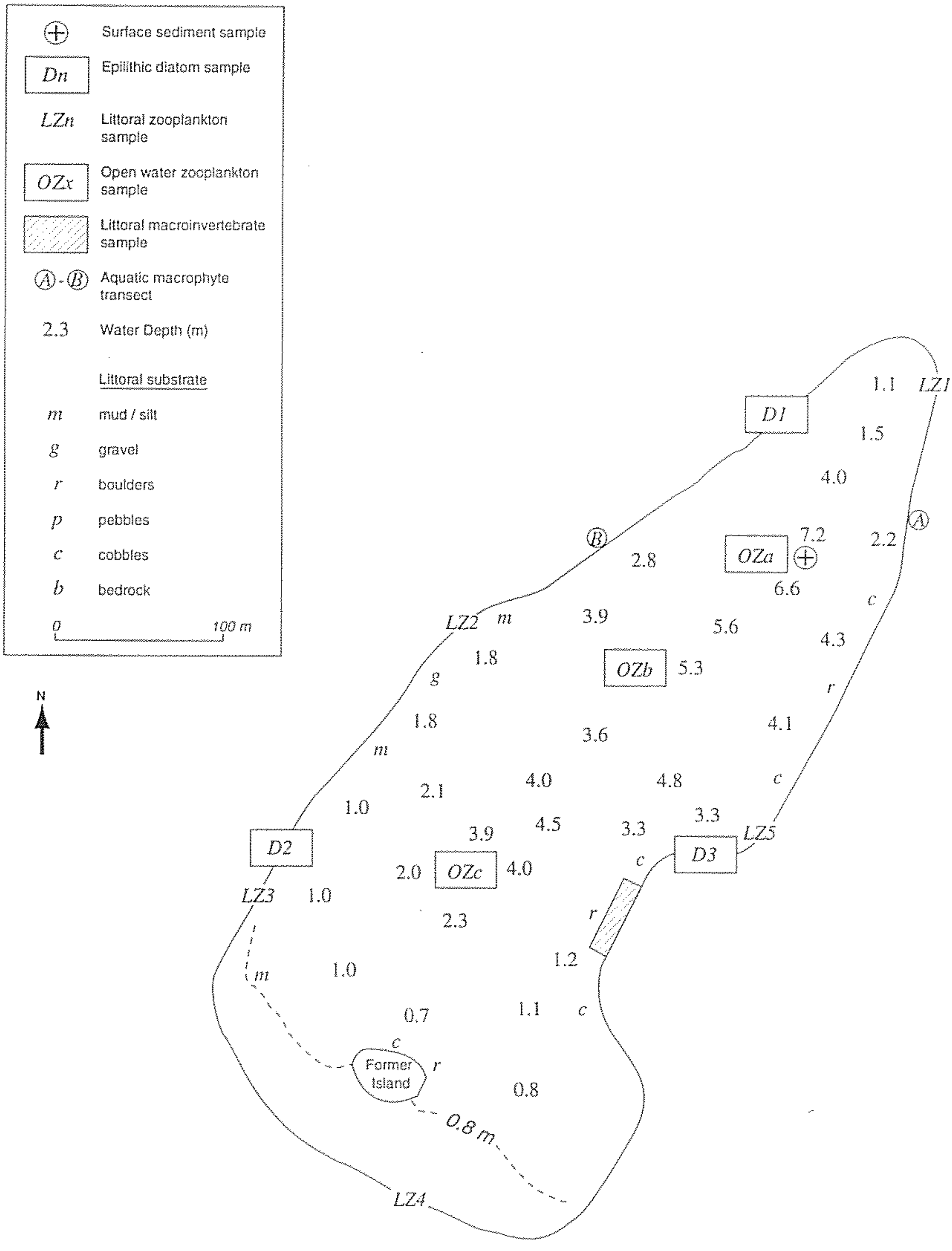


Figure B.2 Llyn Eiddwen: aquatic macrophyte distribution map 31-7-94

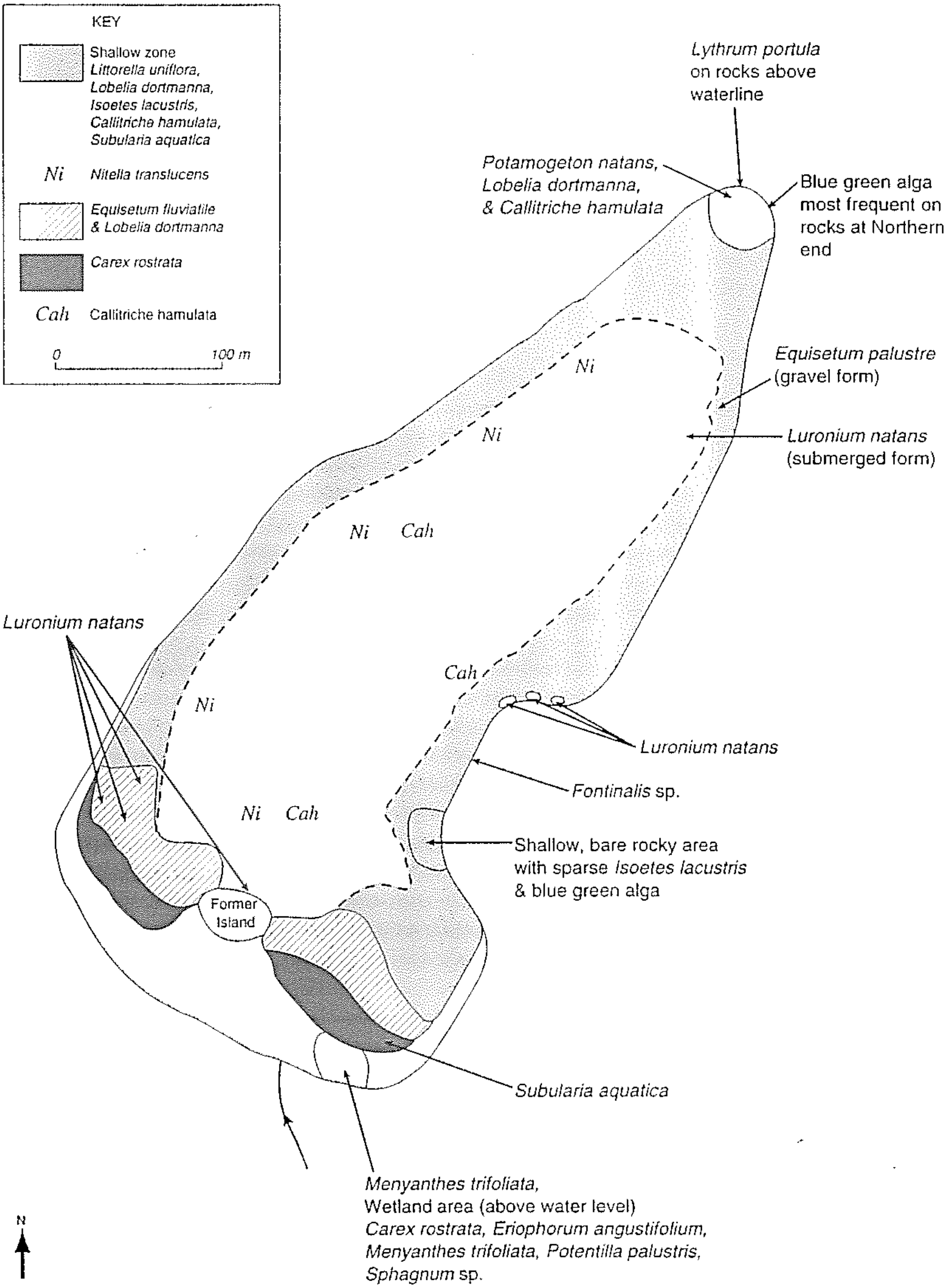
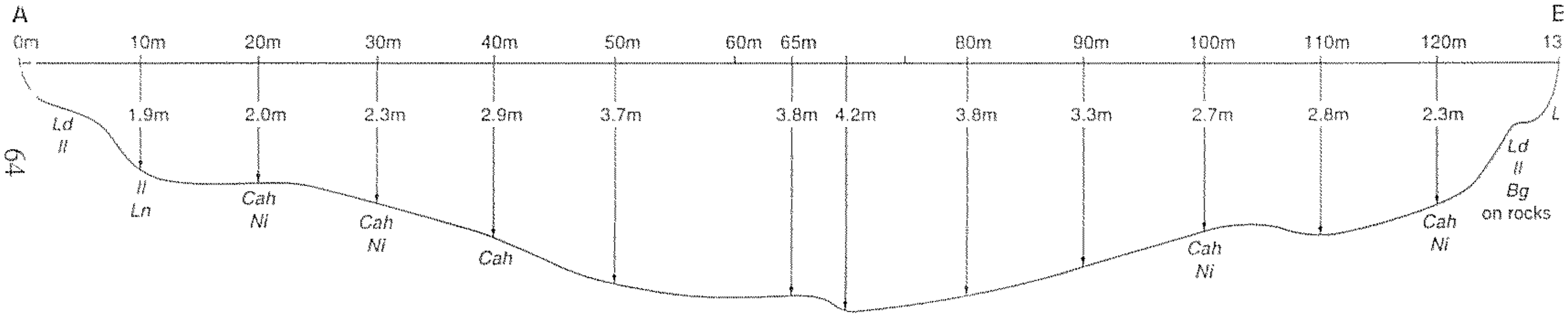
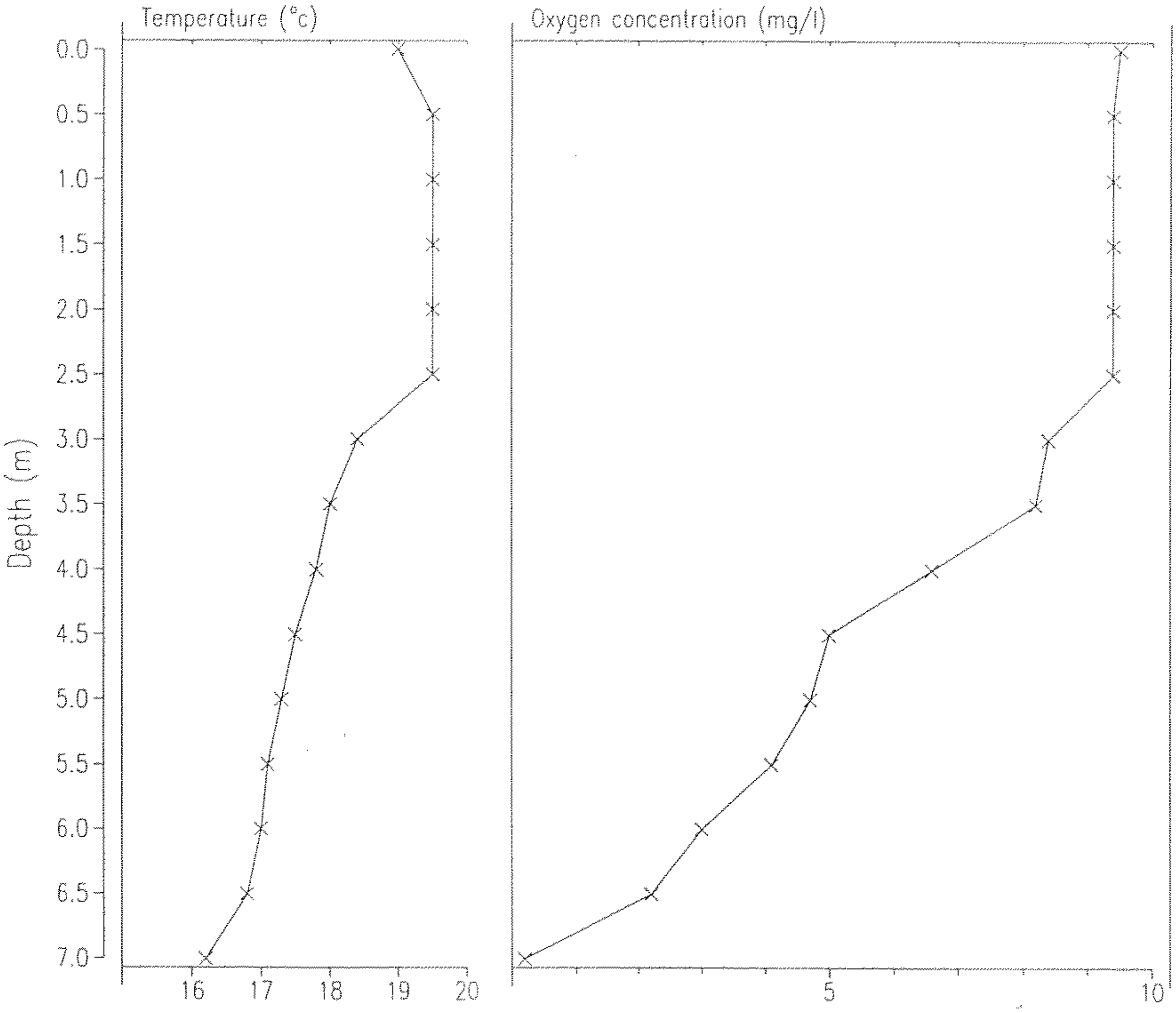


Figure B.3 Llyn Eiddwen: aquatic macrophyte transect profile



Cah	*Callitriche hamulata*
Ni	*Nitella translucens*
Il	*Isoetes lacustris*
Ld	*Lobelia dortmanna*
Lu	*Littorella uniflora*
Bg	Blue-green alga
Ln	*Luronium natans*

Figure B.4 Llyn Eiddwen: Temperature and dissolved oxygen profiles 31-7-94



Appendix C Data Tables and Figures: Llyn Fanod

Table C.1 Llyn Fanod water chemistry

Determinand		Sample				
		27-7-94	21-9-94	2-12-94	5-3-95	mean
lab pH		6.69	6.81	6.80	6.59	6.71
field pH		7.05		8.06	6.91	
Alkalinity 1	μeq l^{-1}	125	122	112	74	108
Alkalinity 2	μeq l^{-1}	119	117	108	67	103
lab Conductivity	μS cm^{-1}	58	59	57	49	56
field Conductivity	μS cm^{-1}	58		54	50	
Sodium	μeq l^{-1}	249	253	236	220	240
Potassium	μeq l^{-1}	13	12	16	18	15
Magnesium	μeq l^{-1}	129	134	126	102	123
Calcium	μeq l^{-1}	199	205	194	149	187
Chloride	μeq l^{-1}	272	262	248	247	257
Aluminium $_{total\ monomeric}$	μg l^{-1}	0	5	10	13	7
Aluminium $_{non\text{-}labile}$	μg l^{-1}	0	5	10	13	7
Aluminium $_{labile}$	μg l^{-1}	0	0	0	0	0
Absorbance	(250nm)	0.194	0.309	0.378	0.300	0.295
Carbon $_{total\ organic}$	mg l^{-1}	4.2	5.6	7.9	6.5	6.1
Phosphorus $_{total}$	μgP l^{-1}	14.5	14.7	27.8	15.4	18.1
Phosphorus $_{total\ soluble}$	μgP l^{-1}	9.8	10.1	14.8	9.8	11.1
Phosphorus $_{soluble\ reactive}$	μgP l^{-1}	1.4	3.8	4.0	3.3	3.1
Nitrate	μgN l^{-1}	21	63	105	413	151
Silica $_{soluble\ reactive}$	mg l^{-1}	0.79	2.25	3.97	3.30	2.58
Chlorophyll a	μg l^{-1}	4.2	3.1	1.8	2.4	2.9
Sulphate	μeq l^{-1}	101	95	87	78	90
Copper $_{total\ soluble}$	μg l^{-1}	0	0	0	0	0
Iron $_{total\ soluble}$	μg l^{-1}	102	500	210	140	238
Lead $_{total\ soluble}$	μg l^{-1}	0	0	0	0	0
Manganese $_{total\ soluble}$	μg l^{-1}	160	149	0	17	
Zinc $_{total\ soluble}$	μg l^{-1}	9	3	2	0	4

Table C.2 Llyn Fanod epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes didyma var. *didyma*	5.3
Achnanthes levanderi	24.0
Achnanthes minutissima var. *minutissima*	21.4
Achnanthes subatomoides	1.2
Anomoeoneis vitrea	4.4
Cyclotella stelligera	1.4
Cymbella cistula var. *cistula*	11.0
Cymbella gracilis	1.3
Cymbella microcephala var. *microcephala*	1.5
Eunotia incisa	2.5
Eunotia sp.	1.1
Fragilaria brevistriata var. *brevistriata*	1.7
Fragilaria construens var. *construens*	1.4
Fragilaria construens var. *venter*	2.9
Fragilaria intermedia	4.0
Navicula schassmannii	1.6
Nitzschia fonticola	1.2
Nitzschia frustulum	5.8
Nitzschia sp.	1.8
Synedra rumpens var. *rumpens*	3.5
Tabellaria flocculosa (short)	10.3

Table C.3 Llyn Fanod surface sediment diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes levanderi	2.1
Achnanthes linearis	2.4
Achnanthes minutissima	17.4
Anomoeoneis vitrea	1.9
Aulacoseira ambigua	1.9
Cyclotella stelligera	3.3
Cymbella gracilis	2.2
Cymbella microcephala	2.1
Cymbella silesiaca	2.4
Eunotia implicator	1.2
Eunotia incisa	3.4
Eunotia sp.	1.0
Fragilaria brevistriata	2.1
Fragilaria construens var. *venter*	10.3
Fragilaria intermedia	5.0
Fragilaria sp.	1.7
Fragilaria virescens var. *exigua*	11.9
Frustulia rhomboides	1.7
Gomphonema constrictum	1.2
Gomphonema parvulum	1.9
Navicula pseudolanceolata	1.0
Navicula schassmannii	1.4
Tabellaria flocculosa (short)	4.8

Table C.4 Llyn Fanod aquatic macrophyte abundance summary: 1-8-94

TAXON	code	Abun
Emergent taxa		
Eleocharis palustris	382004	F
Equisetum fluviatile	350202	F
Menyanthes trifoliata [1]	364701	O
Agrostis stolonifera		R
Carex rostrata	381129	F
Lythrum portula	564500	R
Montia fontana	365001	R
Potentilla palustris [1]	383801	O
Floating taxa		
Glyceria fluitans	382502	O
Potamogeton natans [1]	384012	A
Callitriche stagnalis	361108	O
Nuphar lutea	365501	F
Nymphaea alba	365601	F
Luronium natans [1 2]		R
Sparganium angustifolium [1 2]	384601	O
Submergent taxa		
Blue green alga	100000	R
Nitella (sp. 1)	220000	A
Nitella (sp. 2)	220000	A
Fontinalis antipyretica	323401	O
Isoetes lacustris	350302	A
Callitriche hamulata [1]	361103	F
Littorella uniflora [1]	363901	F
Lobelia dortmanna	364001	F
Subularia aquatica	368701	O
Utricularia minor	369600	R
Luronium natans [1 2]		R
Elatine hexandra	362401	F
Fringing taxa		
Juncus acutiflorus	383001	F
Juncus effusus	383010	F
Juncus articulatus	383003	F
Carex nigra	381119	O
Carex echinata	381110	O
Carex curta	381107	O
Hydrocotyle vulgaris	363401	O
Myosotis secunda	365103	R
Eriophorum angustifolium	382401	O
Sphagnum sp.	327400	O
Polytrichum sp.	326200	O
Veronica scutellata	369804	O
Dryopteris dilatata	------	O
Cardamine pratensis	361303	O
Drosera rotundiflora	------	O

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table C.5 Llyn Fanod littoral Cladocera taxon list: 1-8-94

Taxon	Sample number				
	1	2	3	4	5
Alonopsis elongata			1		
Daphnia longispina	4	1			10
Diaphanosoma brachyurum	6		1	2	1
Eurycercus lamellatus	1	s	1		6
Graptoleberis testudinaria				1	
Pleuroxus truncatus	2	15	4	9	1
Simocephalus vetulus		2			
Total Count	13	18	7	12	18

s = shell fragment

Table C.6 Llyn Fanod zooplankton abundance summary: 1-8-94 Abundance in vertical net hauls (number of individuals $0.01m^{-2}$)

TAXON	Abun
Eudiaptomus gracilis	1700
Diaphanosoma brachyurum	110
Chaoborus sp. larvae	20
Daphnia longispina	1300
Other planktonic organisms (not quantitatively sampled)	
Conochilus sp.	1400
Volvox sp.	300
Keratella cochlearis	20
Kellicottia longispina	360

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table C.7 Llyn Fanod zooplankton characteristics

Site depth (m)	7.5
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	1.20
Chaoborus larvae biomass (g DW $m^{-2)}$	0.28
Net algal biomass (g DW m^{-2})	0
Cladoceran biomass as proportion of total zooplankton biomass (%)	54
Large cladoceran (>710µm) as proportion of total zooplankton biomass (%)	5
Large Copepoda (>420µm) as proportion of total zooplankton biomass (%)	4

Table C.8 Llyn Fanod littoral macroinvertebrate summary. Mean number of individuals per sample.

code	Taxon	Mean count/sample
	TURBELLARIA	
03120000	Tricladida	39.2
	BIVALVIA	
14030200	*Pisidium* sp.	158
	HIRUDINIA	
17020101	*Theromyzon tessalatum*	1.2
17020302	*Glossiphonia complanata*	0.8
17040102	*Erpobdella octoculata*	9.2
	EPHEMEROPTERA	
30020302	*Cloeon simile*	21.6
30040100	Leptophlebia sp.	45.2
30080204	Caenis horaria	94
30080206	*Caenis luctuosa*	204.8
	ODONATA	
32020301	*Enallagma cyathigerum*	0.4
	HEMIPTERA	
33110000	Corixidae sp.	6.8
33110501	*Corixa dentipes*	0.8
33110803	*Sigara distincta*	6.4
33110807	*Sigara scotti*	0.8
	COLEOPTERA	
35030000	Dytiscidae undet. (larvae	0.4
35030706	*Stictotarsus duodecimpustulatus*	2.4
35030804	*Oreodytes sanmarkii*	0.4
35110600	*Oulimnius* sp.	16
	MEGALOPTERA	
36010101	*Sialis lutaria*	3.2
	TRICHOPTERA	
38030301	*Polycentropus flavomacula*	244
38030401	*Holocentropus dubius*	1.2
38040201	*Tinodes waeneri*	39.6
38070400	*Agrypnia* sp.	0.4
38080500	*Limnephilus* sp.	9.6
38120000	Leptoceridae sp.	2.8
	DIPTERA	
40010000	Tipulidae	0.4
40080000	Ceratopogonidae	1.2
40090000	Chironomidae	957.2

Figure C.1 Llyn Fanod: sample location and substrate map

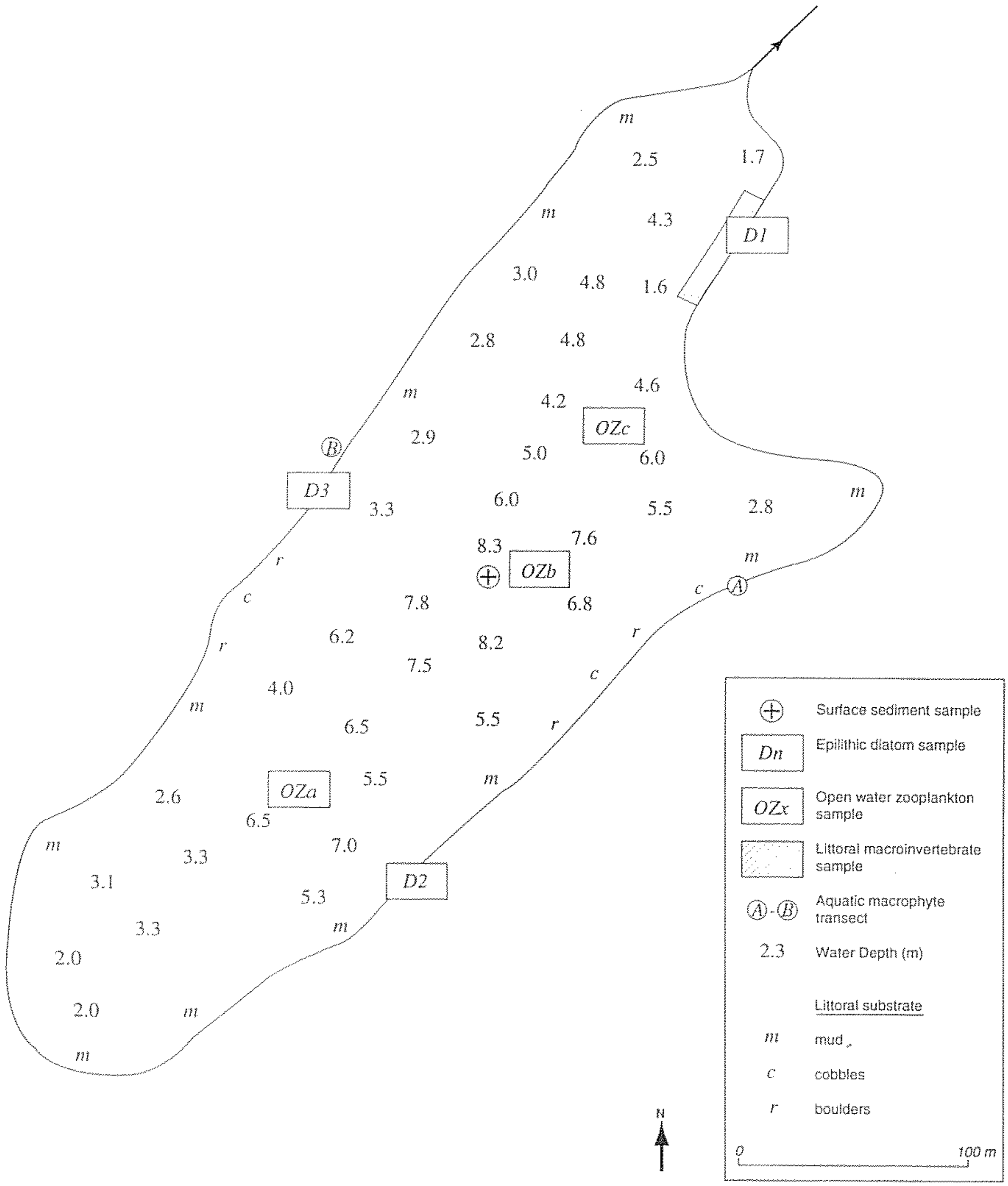
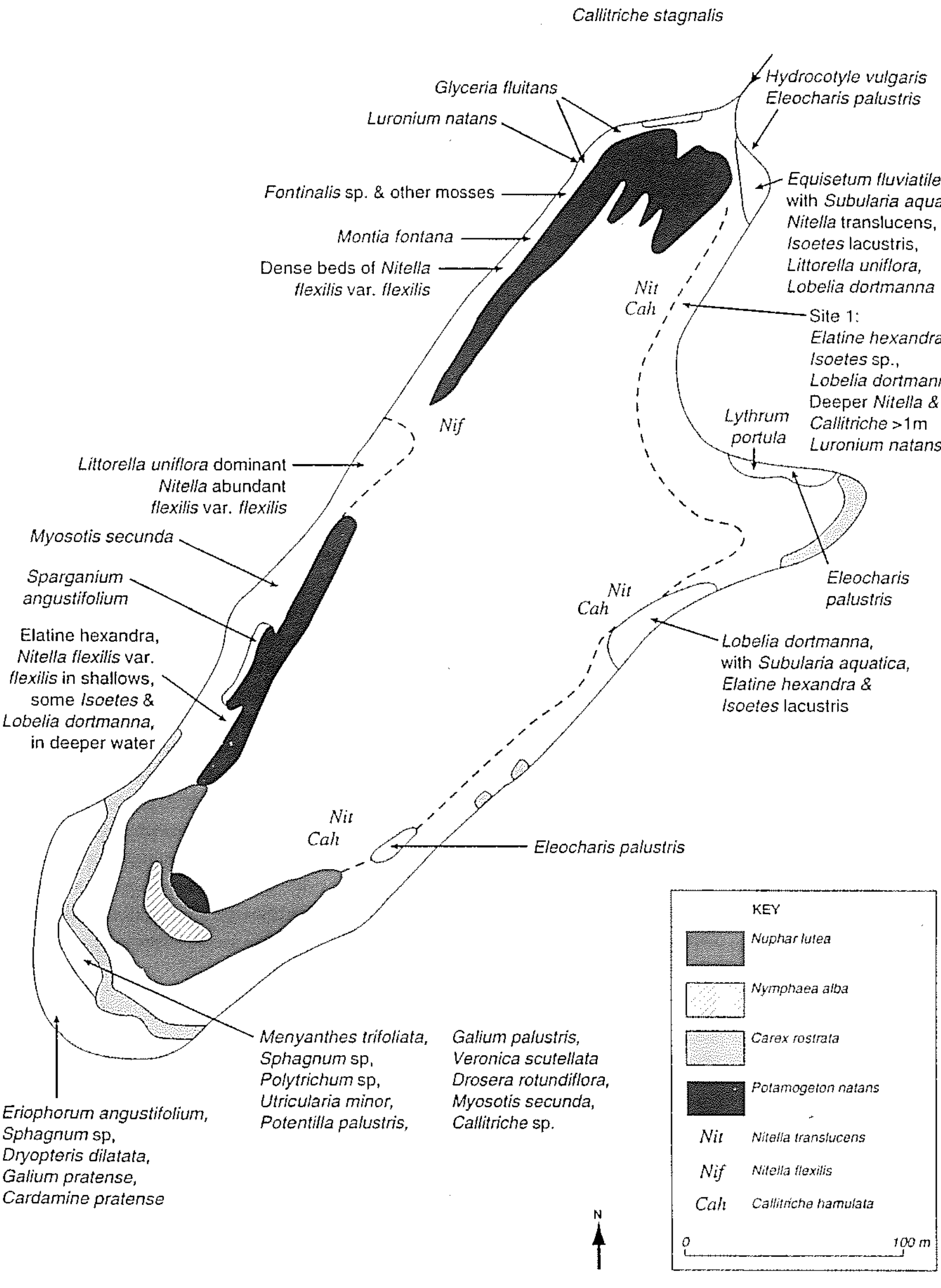


Figure C.2 Llyn Fanod: aquatic macrophyte distribution map 1-8-94



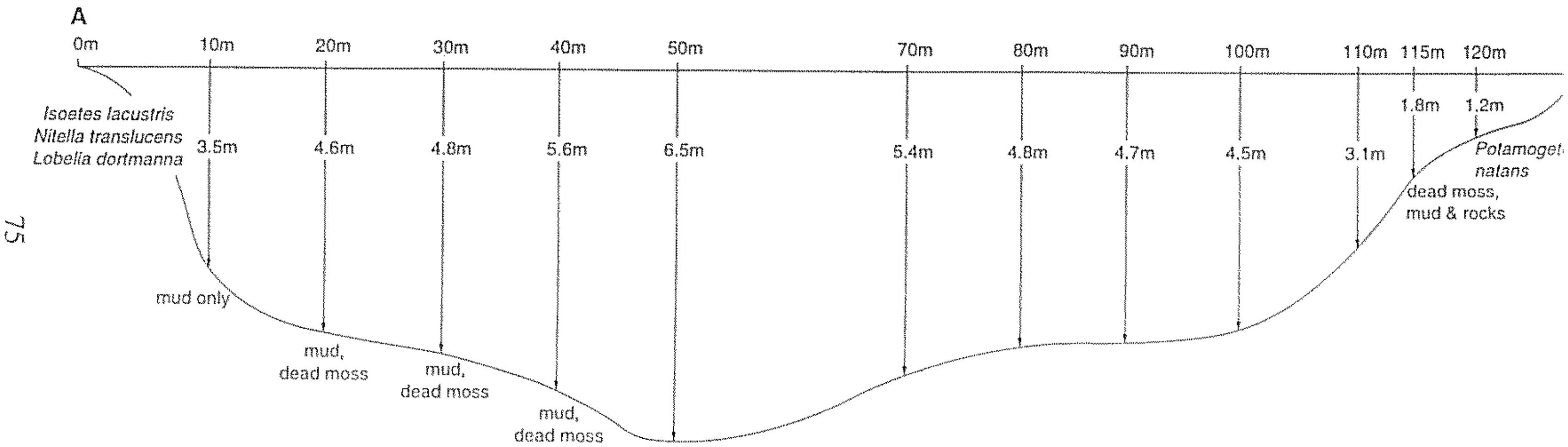
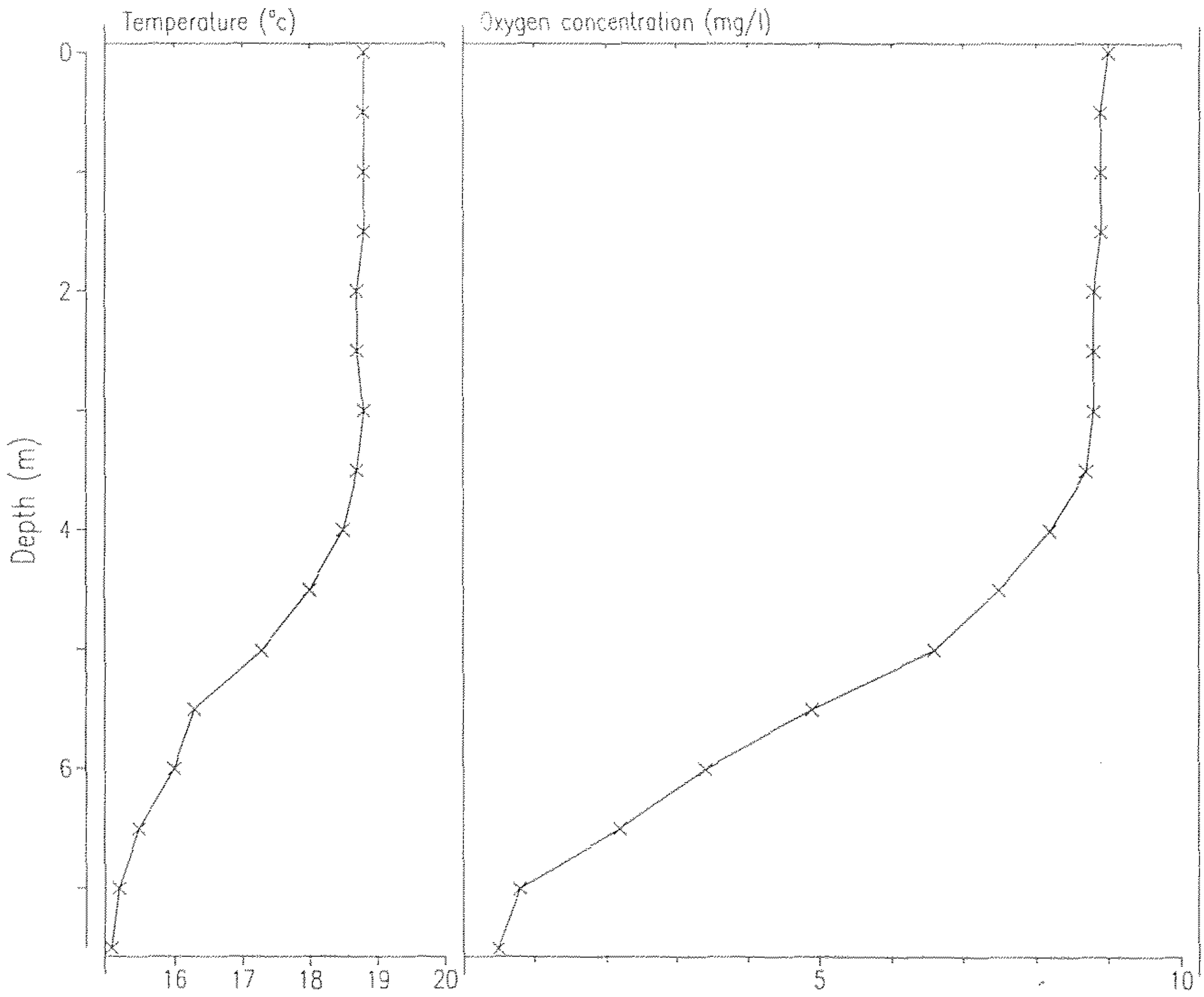


Figure C.3 Llyn Fanod: aquatic macrophyte transect profile

Figure C.4 Llyn Fanod: Temperature and dissolved oxygen profiles 1-8-94



Appendix D Data Tables and Figures: Llyn Glanmerin

Table D.1 Llyn Glanmerin water chemistry

Determinand		Sample				
		26-7-94	23-9-94	1-12-94	6-3-95	mean
lab pH		6.47	6.53	6.56	6.44	6.50
field pH		6.90		7.67	6.52	
Alkalinity 1	$\mu eq\ l^{-1}$	114	113	102	59	97
Alkalinity 2	$\mu eq\ l^{-1}$	109	107	96	50	91
lab Conductivity	$\mu S\ cm^{-1}$	63	62	67	71	66
field Conductivity	$\mu S\ cm^{-1}$	63		65	70	
Sodium	$\mu eq\ l^{-1}$	302	294	325	337	315
Potassium	$\mu eq\ l^{-1}$	5	2	10	9	7
Magnesium	$\mu eq\ l^{-1}$	142	133	124	133	133
Calcium	$\mu eq\ l^{-1}$	187	187	178	172	181
Chloride	$\mu eq\ l^{-1}$	327	280	305	416	332
Aluminium $_{total\ monomeric}$	$\mu g\ l^{-1}$	11	10	21	30	18
Aluminium $_{non\text{-}labile}$	$\mu g\ l^{-1}$	11	10	21	28	18
Aluminium $_{labile}$	$\mu g\ l^{-1}$	0	0	0	2	0
Absorbance	(250nm)	0.174	0.140	0.125	0.072	0.128
Carbon $_{total\ organic}$	$mg\ l^{-1}$	3.5	3.3	17.0	1.9	6.4
Phosphorus $_{total}$	$\mu gP\ l^{-1}$	26.2	9.2	12.7	10.7	14.7
Phosphorus $_{total\ soluble}$	$\mu gP\ l^{-1}$	11.2	6.5	6.8	6.6	7.8
Phosphorus $_{soluble\ reactive}$	$\mu gP\ l^{-1}$	1.8	1.4	1.1	2.7	1.8
Nitrate	$\mu gN\ l^{-1}$	28	28	119	427	151
Silica $_{soluble\ reactive}$	$mg\ l^{-1}$	0.35	1.49	3.18	1.59	1.65
Chlorophyll a	$\mu g\ l^{-1}$	6.0	2.4	1.8	1.5	2.9
Sulphate	$\mu eq\ l^{-1}$	105	129	144	131	127
Copper $_{total\ soluble}$	$\mu g\ l^{-1}$	0	0	0	0	0
Iron $_{total\ soluble}$	$\mu g\ l^{-1}$	690	310	180	80	315
Lead $_{total\ soluble}$	$\mu g\ l^{-1}$	7	0	0	0	2
Manganese $_{total\ soluble}$	$\mu g\ l^{-1}$	121	27	23	31	51
Zinc $_{total\ soluble}$	$\mu g\ l^{-1}$	112	6	32	3	38

Table D.2 Llyn Glanmerin epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes altaica	1.6
Achnanthes austriaca var. *helvetica*	3.3
Achnanthes detha	8.8
Achnanthes levanderi	1.0
Achnanthes marginulata	2.5
Achnanthes minutissima var. *minutissima*	30.3
Achnanthes nodosa	1.0
Achnanthes sp.	2.7
Achnanthes [*altaica* var. *minor*]	4.5
Brachysira vitrea	4.1
Cymbella lunata	1.2
Cymbella microcephala var. *microcephala*	1.7
Cymbella perpusilla	1.5
Eunotia incisa	2.8
Eunotia naegelii	1.4
Eunotia pectinalis var. *minor*	2.5
Eunotia pectinalis var *minor* fo. *impressa*	2.1
Eunotia rhomboidea	3.2
Eunotia vanheurckii var. *vanheurckii*	1.2
Fragilaria virescens var. *exigua*	6.6
Frustulia rhomboides var. *saxonica*	1.2
Navicula jaernefeltii	4.9
Navicula mediocris	1.0
Navicula radiosa var. *tenella*	1.3
Nitzschia gracilis	3.0
Peronia fibula	3.1
Tabellaria flocculosa var. *flocculosa*	4.0

Table D.3 Llyn Glanmerin surface sediment diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes altaica	2.3
Achnanthes austriaca var. *helvetica*	1.4
Achnanthes detha	2.5
Achnanthes minutissima	16.5
Brachysira vitrea	5.0
Cymbella lunata	2.5
Fragilaria construens var. *venter*	5.0
Fragilaria virescens var. *exigua*	31.9
Navicula minima	1.1
Navicula radiosa var. *tenella*	4.5
Navicula sp.	1.1
Nitzschia recta	1.8
Peronia fibula	1.8

Table D.4 Glanmerin aquatic macrophyte abundance summary: 26-7-94

TAXON	code	Abun
Emergent taxa		
Equisetum fluviatile	350202	O
Menyanthes trifoliata [1]	364701	R
Juncus effusus	383010	F
Typha latifolia	384902	O
Phalaris arundincea	383701	F
Eleocharis palustris	382004	O
Floating taxa		
Potamogeton natans [1]	384012	R
Nuphar lutea	365501	A
Nymphaea alba	365601	O
Sparganium angustifolium [1 2]	384601	O
Submergent taxa		
Nitella spp.	220000	O
Sphagnum auriculatum	327401	O
Isoetes lacustris	350302	A
Callitriche hamulata	361103	F
Myriophyllum alterniflorum [1]	365401	F
Juncus bulbosus var. fluitans	383006	F
Elodea canadensis	382101	F
Fringing taxa		
Hydrocotyle vulgaris	363401	F
Iris sp.	382900	O
Salix sp.	367500	F
Alnus glutinosa	360201	F
Ranunculus flammula	366904	O
Viola palustris	369901	R
Juncus effusus	383010	F
Juncus articulatus	383003	A
Hypericum elodes [1]	363401	F

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table D.5   Llyn Glanmerin littoral Cladocera taxon list: 26-7-94

TAXON	Sample number				
	1	2	3	4	5
Acroperus harpae	12	7			4
Alona affinis	9	2		2	
Alonopsis elongata	+	+	9	1	
Ceriodaphnia quadrangula	21	411			7
Chydorus piger			1		
Chydorus sphaericus	3	1			
Daphnia longispina	+				
Diaphanosoma brachyurum	30				
Drepanothrix dentata	3			3	
Eurycercus lamellatus	3	2		3	2
Graptoleberis testudinaria				1	
Pleuroxus truncatus	3	8	3	2	
Simocephalus vetulus			35	18	
Total Count	84	431	48	30	13

Table D.6 **Llyn Glanmerin zooplankton abundance summary: 26-7-94**
Abundance in vertical net hauls (number of individuals $0.01m^{-2}$)

TAXON	Abun
Eudiaptomus gracilis	1100
Diaphanosoma brachyurum	460
Chaoborus sp. larvae	
Ceriodaphnia quadrangula	1300
Daphnia longispina	X
Macrocyclops albidus	30
Bosmina longirostris	60
Simocephalus vetulus	X
Alona affinis	X
Other planktonic organisms (not quantitatively sampled)	
Conochilus sp.	2300
Volvox sp.	60
Keratella cochlearis	30
Nauplia	30

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table D.7 **Llyn Glanmerin zooplankton characteristics**

Site depth (m)	2.4
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	1.52
Chaoborus larvae biomass (g DW m^{-2})	0.01
Net algal biomass (g DW m^{-2})	0
Cladoceran biomass as proportion of total zooplankton biomass (%)	28
Large cladoceran (>710μm) as proportion of total zooplankton biomass (%)	0
Large Copepoda (>420μm) as proportion of total zooplankton biomass (%)	7

Table D.8 Llyn Glanmerin littoral macroinvertebrate summary. Mean number of individuals per one minute kick/sweep sample.

code	TAXON	Mean count/sample
	TURBELLARIA	
03120000	Tricladida	6.4
	BIVALVIA	
14030200	*Pisidium* sp.	38
	HIRUDINIA	
17020501	*Helobdella stagnalis*	8
17040102	*Erpobdella octoculata*	13.6
	MALACOSTRACA	
28030101	*Asellus aquaticus*	704.8
	EPHEMEROPTERA	
30020000	Baetidae	12
30020302	*Cloeon simile*	10.8
30040100	*Leptophlebia* sp.	5.2
	ODONATA	
32020000	*Zygoptera* sp.	10
32020301	*Enallagma cyathigerum*	15.2
32070205	*Aeshna juncea*	1.6
	HEMIPTERA	
33110000	Corixidae sp.	20.8
33110201	*Cymatia bonsdorffi*	19.2
33110601	*Hesperocorixa linnaei*	5.2
33110803	*Sigara distincta*	39.6
33110806	*Sigara fossarum*	3.6
33110807	*Sigara scotti*	167.2
	COLEOPTERA	
35010311	*Haliplus fluvus*	2.8
35030000	Dytiscidae undet. (larvae	2
35030702	*Potamonectes assimilis*	0.4
35031101	*Agabus guttatus*	1.6
35110600	*Oulimnius* sp.	2
	MEGALOPTERA	
36010101	*Sialis lutaria*	2.4
37000000	LEPIDOPTERA	0.4
38030301	*Polycentropus flavomacula*	0.8
38030401	*Holocentropus dubius*	42.4
38030402	*Holocentropus picicornis*	22.8
38070201	*Phryganea grandis*	1.6
38070400	*Agrypnia* sp.	17.6
38080501	*Limnephilus rhombicus*	20.4
38081901	*Chaetopteryx villosa*	0.4
38120106	*Athripsodes aterrimus*	3.2
38120701	*Triaenodes bicolor*	3.2
	DIPTERA	
40010000	Tipulidae	0.4
40090000	Chironomidae	232.4

Figure D.1 Llyn Glanmerin: sample location and substrate map

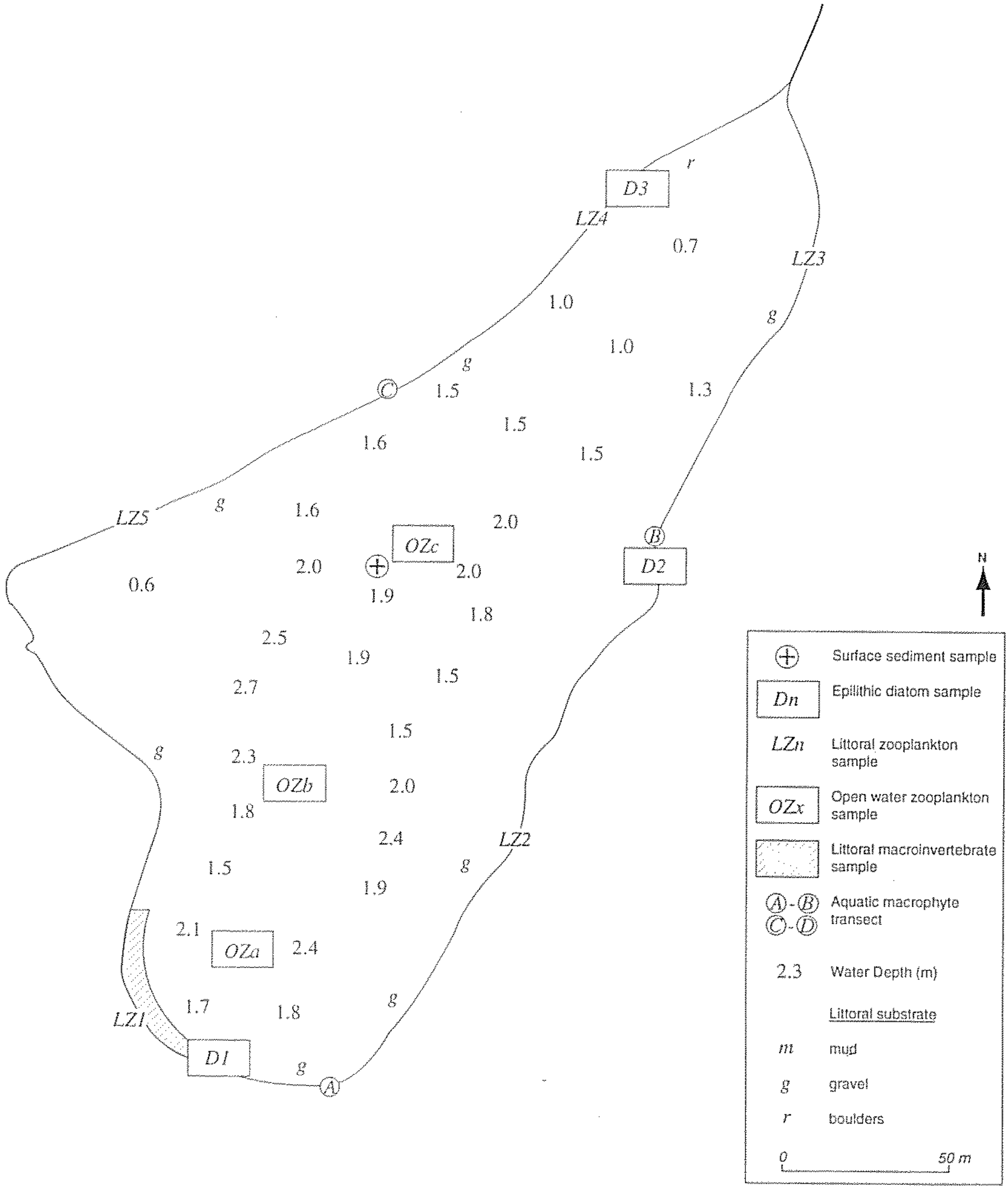
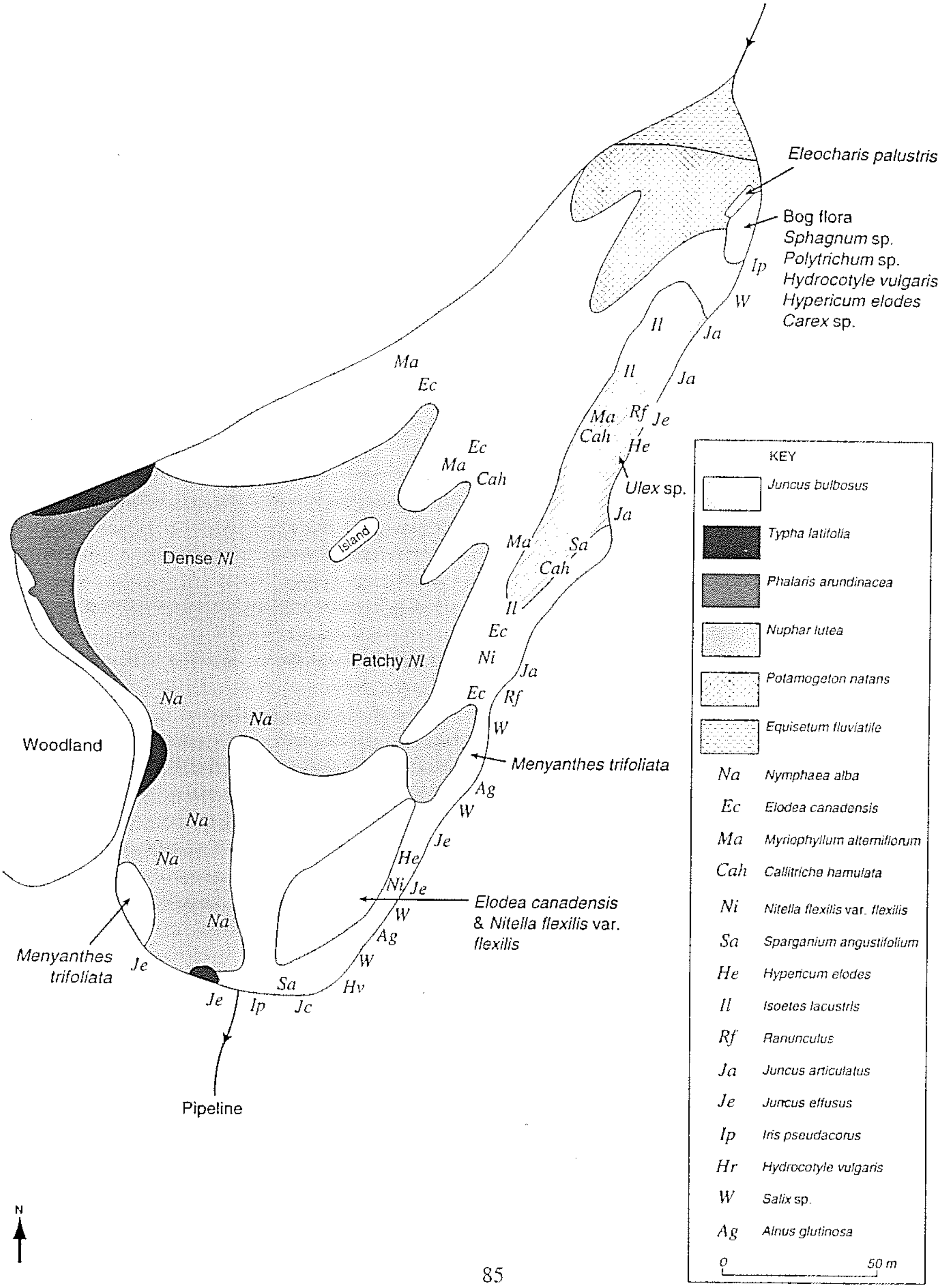


Figure D.2 Llyn Glanmerin: aquatic macrophyte distribution map 26-7-94



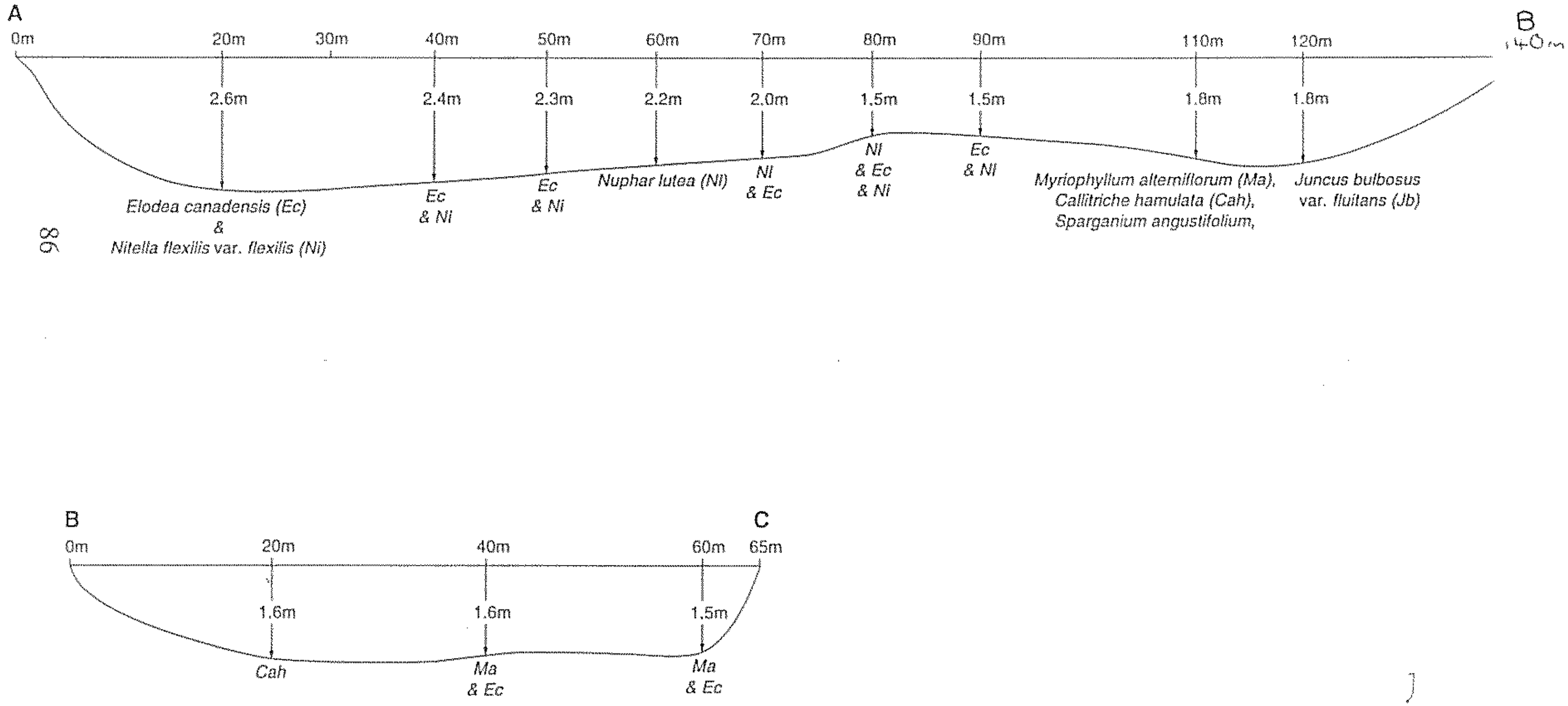
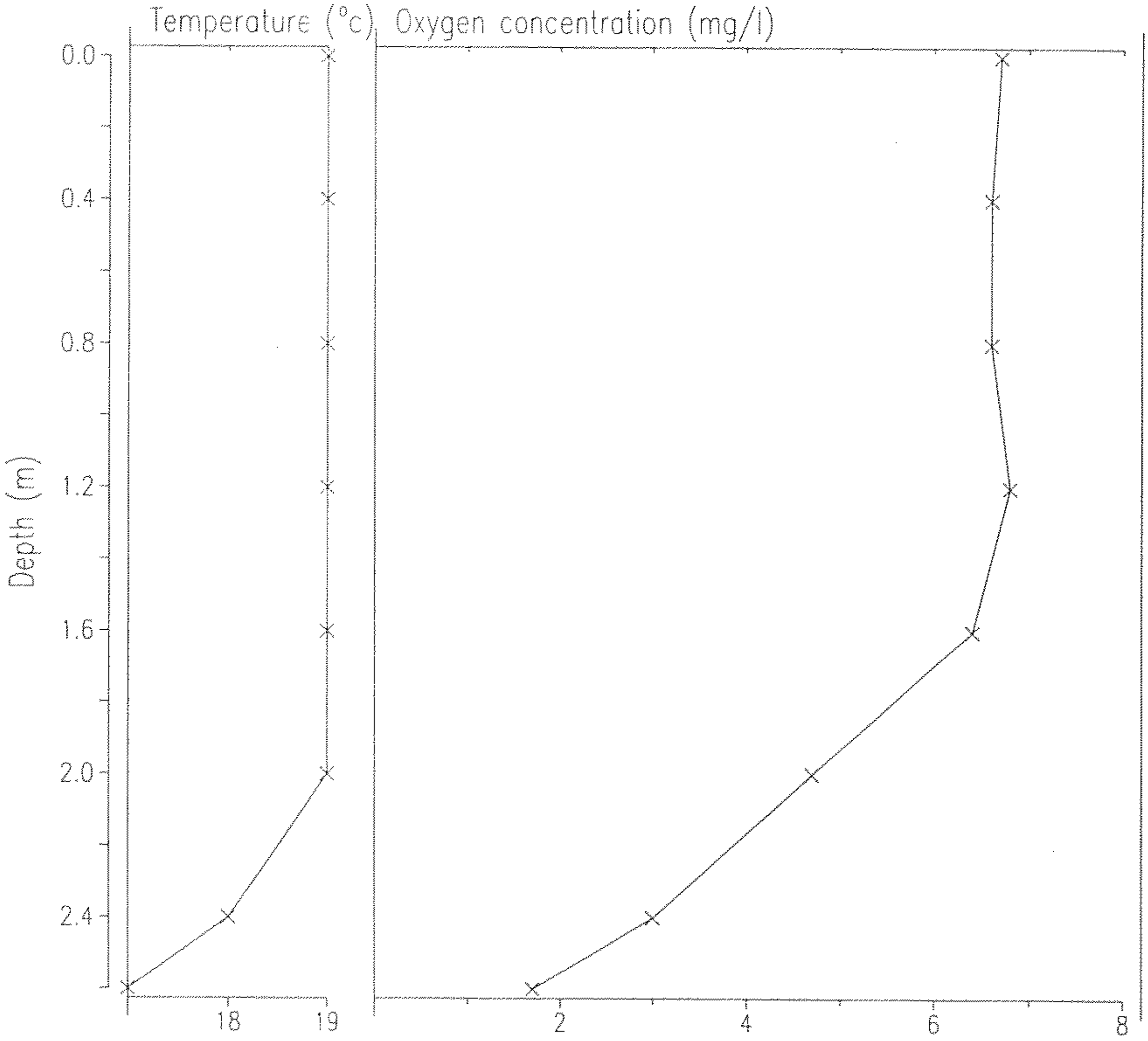


Figure D.3 Llyn Glanmerin: aquatic macrophyte transect profile

Figure D.4 Llyn Glanmerin: Temperature and dissolved oxygen profiles 26-7-94



Appendix E Data Tables and Figures: Llyn Gynon

Table E.1 Llyn Gynon water chemistry

Determinand		Sample				
		27-7-94	22-9-94	2-12-94	5-3-95	mean
lab pH		5.80	5.41	5.53	5.20	5.43
field pH		5.75		5.67	5.59	
Alkalinity 1	$\mu eq\ l^{-1}$	19	11	14	7	13
Alkalinity 2	$\mu eq\ l^{-1}$	10	3	7	-4	4
lab Conductivity	$\mu S\ cm^{-1}$	32	34	31	34	33
field Conductivity	$\mu S\ cm^{-1}$	30		29	35	
Sodium	$\mu eq\ l^{-1}$	168	165	139	174	162
Potassium	$\mu eq\ l^{-1}$	4	5	5	9	6
Magnesium	$\mu eq\ l^{-1}$	75	77	67	62	70
Calcium	$\mu eq\ l^{-1}$	66	72	67	46	63
Chloride	$\mu eq\ l^{-1}$	166	159	128	194	162
Aluminium $_{total\ monomeric}$	$\mu g\ l^{-1}$	8	25	30	27	23
Aluminium $_{non\text{-}labile}$	$\mu g\ l^{-1}$	8	11	21	22	16
Aluminium $_{labile}$	$\mu g\ l^{-1}$	0	14	9	5	7
Absorbance	(250nm)	0.130	0.184	0.279	0.155	0.187
Carbon $_{total\ organic}$	$mg\ l^{-1}$	2.8	3.7	5.6	3.8	4.0
Phosphorus $_{total}$	$\mu gP\ l^{-1}$	6.2	7.0	9.1	8.4	7.7
Phosphorus $_{total\ soluble}$	$\mu gP\ l^{-1}$	5.5	4.4	6.9	5.0	5.5
Phosphorus $_{soluble\ reactive}$	$\mu gP\ l^{-1}$	2.1	3.6	1.8	2.1	2.4
Nitrate	$\mu gN\ l^{-1}$	14	35	105	105	65
Silica $_{soluble\ reactive}$	$mg\ l^{-1}$	0.13	0.73	1.89	1.07	0.96
Chlorophyll a	$\mu g\ l^{-1}$	2.6	1.4	0.8	1.9	1.7
Sulphate	$\mu eq\ l^{-1}$	70	75	63	59	67
Copper $_{total\ soluble}$	$\mu g\ l^{-1}$	39	0	0	0	10
Iron $_{total\ soluble}$	$\mu g\ l^{-1}$	211	148	285	110	189
Lead $_{total\ soluble}$	$\mu g\ l^{-1}$	9	0	0	0	2
Manganese $_{total\ soluble}$	$\mu g\ l^{-1}$	14	19	23	56	28
Zinc $_{total\ soluble}$	$\mu g\ l^{-1}$	5	0	3	4	3

Table E.2 Llyn Gynon epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Brachysira vitrea	2.6
Cymbella perpusilla	1.9
Eunotia incisa	23.1
Eunotia rhomboidea	4.8
Fragilaria virescens var. *exigua*	6.5
Frustulia rhomboides var. *saxonica*	3.7
Navicula leptostriata	2.4
Nitzschia perminuta	4.4
Nitzschia sp.	1.0
Pinnularia viridis	1.1
Tabellaria flocculosa	37.0

Table E.3 Llyn Gynon surface sediment diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes minutissima	2.3
Cymbella lunata	1.2
Cymbella microcephala	1.4
Cymbella perpusilla	8.9
Eunotia incisa	12.1
Eunotia naegelii	1.4
Eunotia rhomboidea	1.4
Eunotia vanheurckii	1.9
Fragilaria virescens var. *exigua*	29.7
Frustulia rhomboides var. *saxonica*	3.7
Frustulia rhomboides var. *viridula*	2.6
Navicula leptostriata	1.9
Nitzschia perminuta	1.6
Peronia fibula	1.9
Tabellaria flocculosa	10.3
Tabellaria quadriseptata	3.7

Table E.4 Llyn Gynon aquatic macrophyte abundance summary: 30-7-94

TAXON	code	Abun
Emergent taxa		
Carex rostrata	381129	R
(Equisetum palustre)	350200	O
Floating taxa		
Glyceria fluitans	382502	R
Potamogeton polygonifolius [1]	384017	O
Sparganium angustifolium [1]	384601	O
Luronium natans [1 2]	383401	O
Nuphar lutea	365501	R
Submergent taxa		
Filamentous green alga	170000	F
Batrachospermum sp.	020000	A
Fontinalis antipyretica	323401	O
Isoetes lacustris	350302	F
Callitriche hamulata [1]	361103	O
Littorella uniflora [1]	363901	A
Lobelia dortmanna	364001	A
Myriophyllum alterniflorum [1]	365401	F
Subularia aquatica	368701	R
Juncus bulbosus var. fluitans	383006	A
Luronium natans [1 2]	383401	A

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table E.5 Llyn Gynon littoral Cladocera taxon list: 30-7-94

TAXON	Sample number				
	1	2	3	4	5
Acroperus harpae	1		2	26	
Alona rustica				1	
Alonopsis elongata	57	60	87	258	325
Alonella excisa					1
Ceriodaphnia quadrangula	2	1			
Chydorus piger	1	2		7	1
Chydorus sphaericus					1
Drepanothrix dentata		1	1	42	
Eubosmina longispina					+
Eurycercus lamellatus	18	5	24	11	20
Graptoleberis testudinaria				1	+
Monospilus dispar					s
Polyphemus pediculus			1		
Total Count	79	69	115	346	348

Table E.6 Llyn Gynon zooplankton abundance summary: 30-7-94 Abundance in vertical net hauls (number of individuals $0.01m^{-2}$)

TAXON	Abun
Eudiaptomus gracilis	2500
Diaphanosoma brachyurum	1400
Eubosmina longispina	40
Ceriodaphnia quadrangula	910
Macrocyclops albidus	X
Eurycerus lamellatus	x
Drepanothrix dentata	X
Acroperus elongatus	x
Acroperus harpae	x
Megacyclops viridis	X
Other planktonic organisms (not quantitatively sampled)	
Conochilus sp.	

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table E.7 Bugeilyn zooplankton characteristics

Site depth (m)	10.0
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	1.58
Chaoborus larvae biomass (g DW m^{-2})	0
Net algal biomass (g DW m^{-2})	0
Cladoceran biomass as proportion of total zooplankton biomass (%)	24
Large cladoceran (>710μm) as proportion of total zooplankton biomass (%)	0
Large Copepoda (>420μm) as proportion of total zooplankton biomass (%)	1

Table E.8 Llyn Gynon littoral macroinvertebrate summary. Mean number of individuals per one minute kick/sweep sample.

code	TAXON	Mean count/sample
	BIVALVIA	
14030200	*Pisidium* sp.	0.8
	HIRUDINIA	
17040102	*Erpobdella octoculata*	8
	EPHEMEROPTERA	
30040100	*Leptophlebia* sp.	1.6
	HEMIPTERA	
33110000	Corixidae sp.	0.8
35030000	Dytiscidae undet. (larvae	0.4
35030703	*Potamonectes depressus*	2
35110600	*Oulimnius* sp.	86.4
36010101	*Sialis lutaria*	0.8
38030301	*Polycentropus flavomacula*	13.6
38060600	*Oxyethira* sp.	2
38070400	*Agrypnia* sp.	1.2
38080500	*Limnephilus* sp.	1.2
38081901	*Chaetopteryx villosa*	0.4
38150101	*Sericostoma personatum*	4.8
40010000	Tipulidae	14.4
40090000	Chironomidae	137.6

Figure E.1 Llyn Gynon: sample location and substrate map

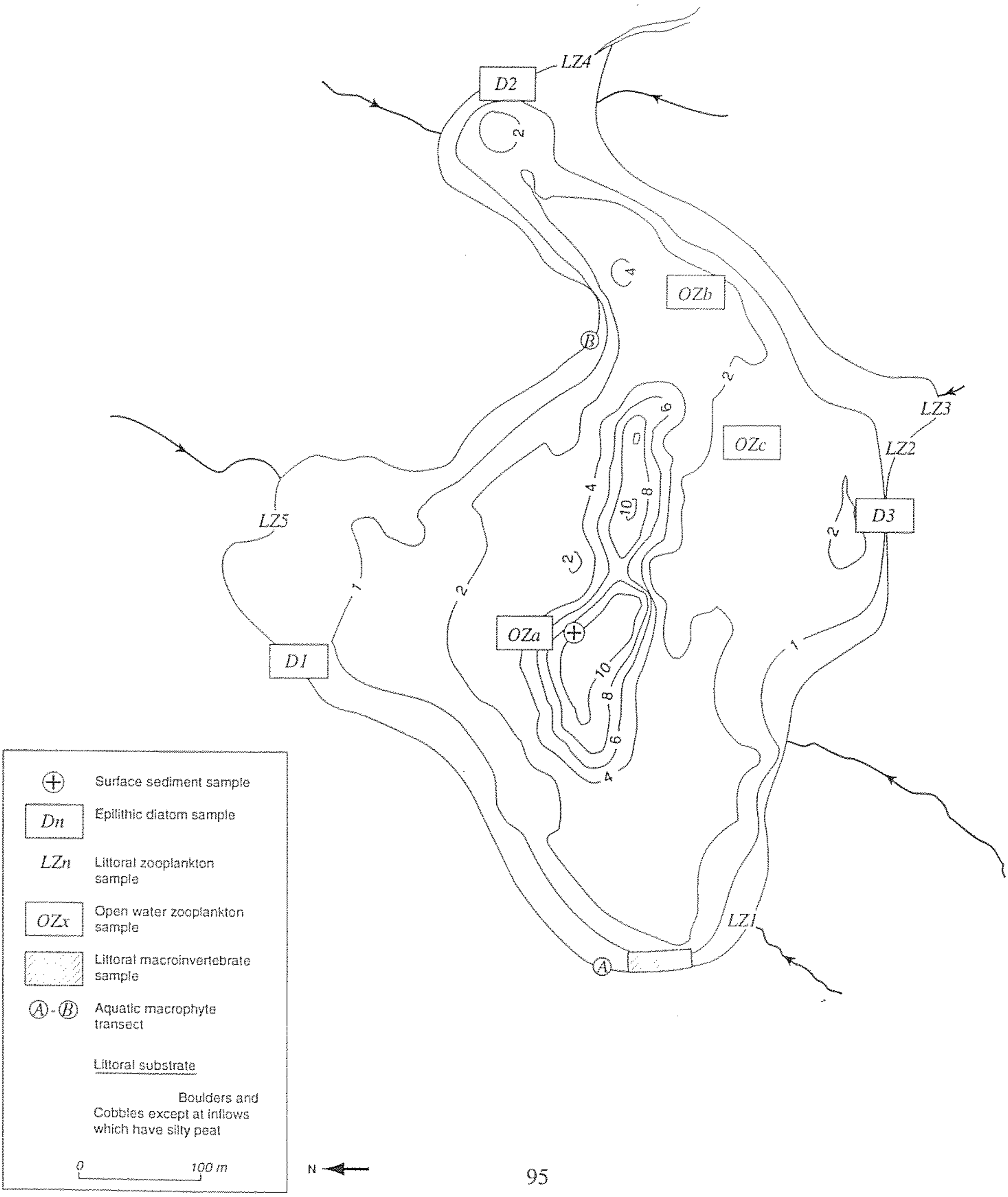
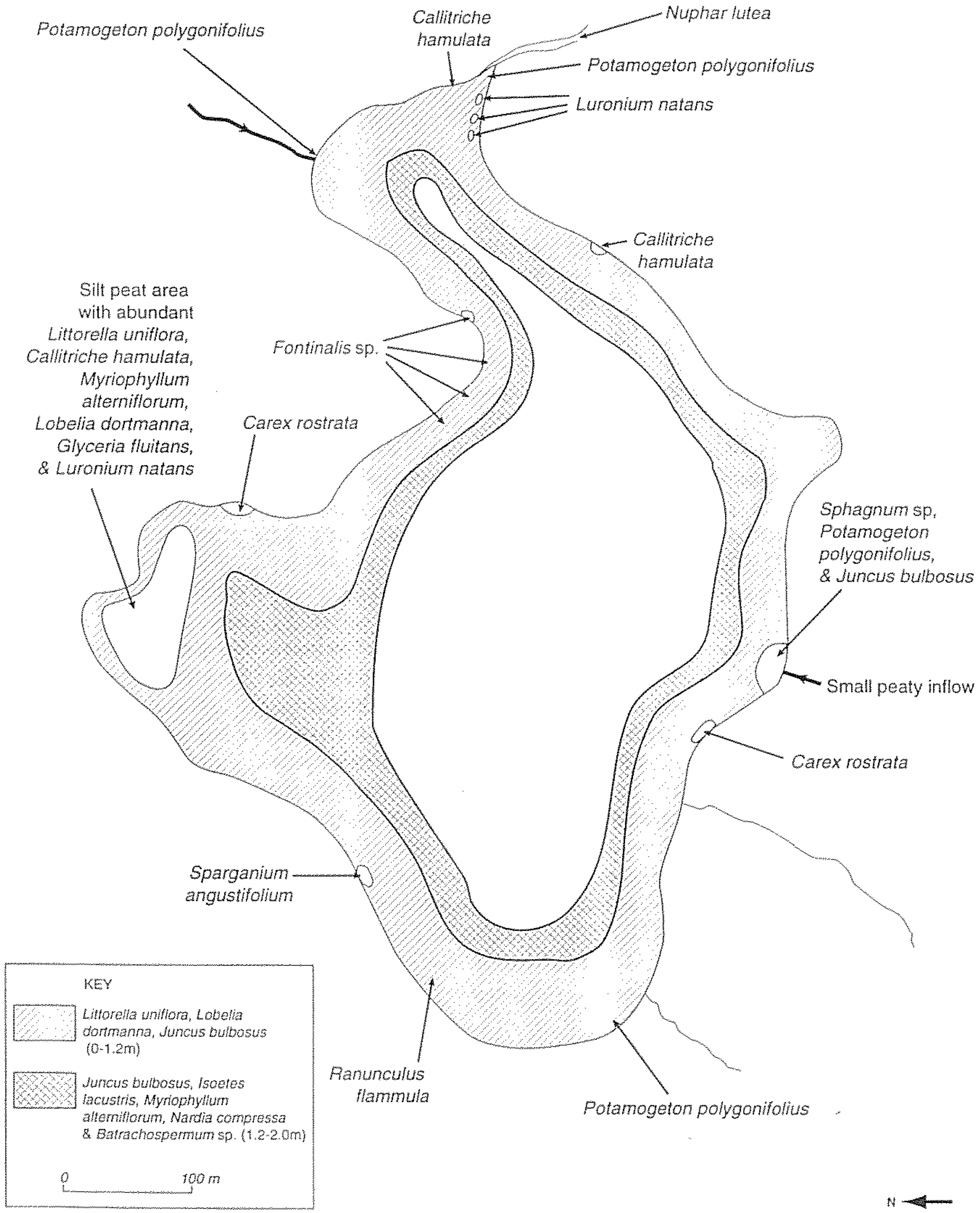


Figure E.2 Llyn Gynon: aquatic macrophyte distribution map 30-7-94



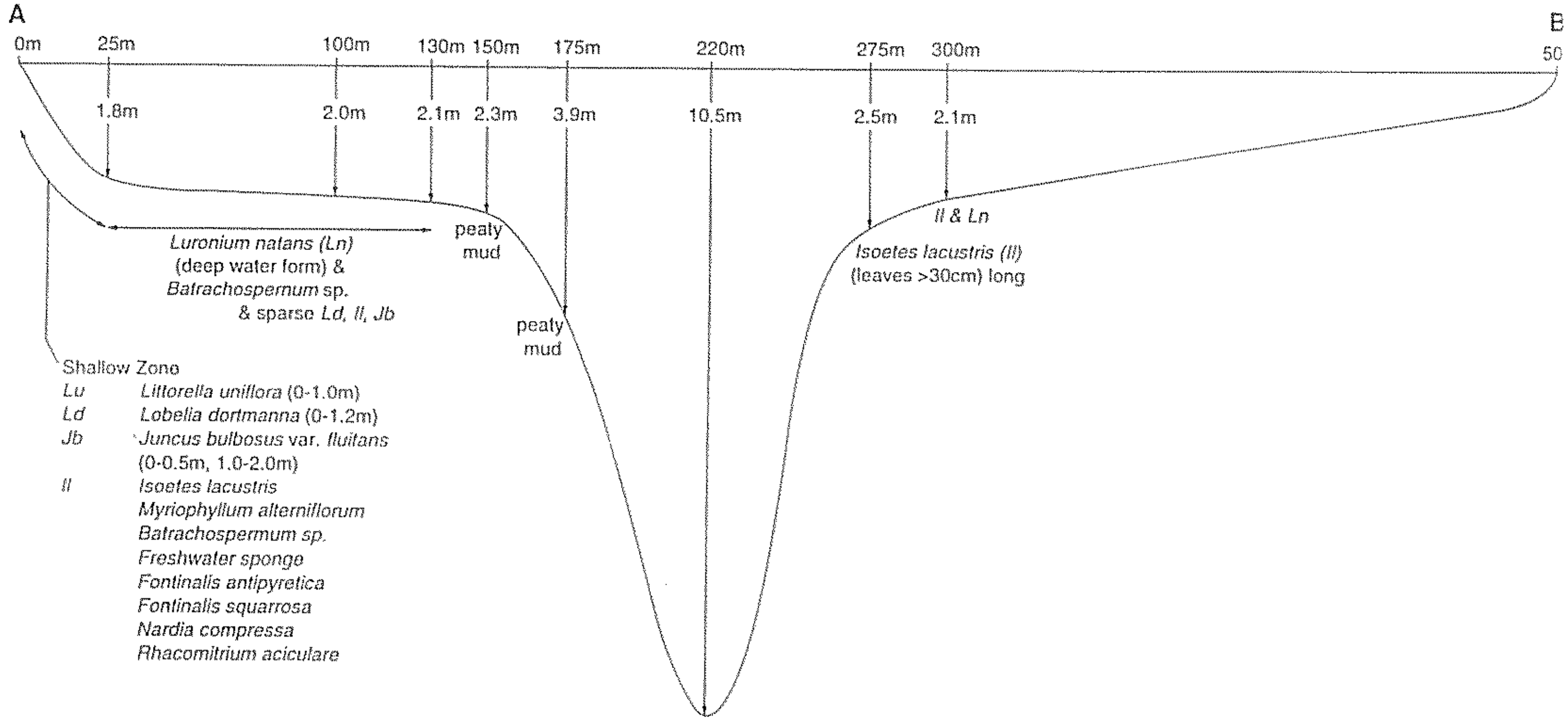
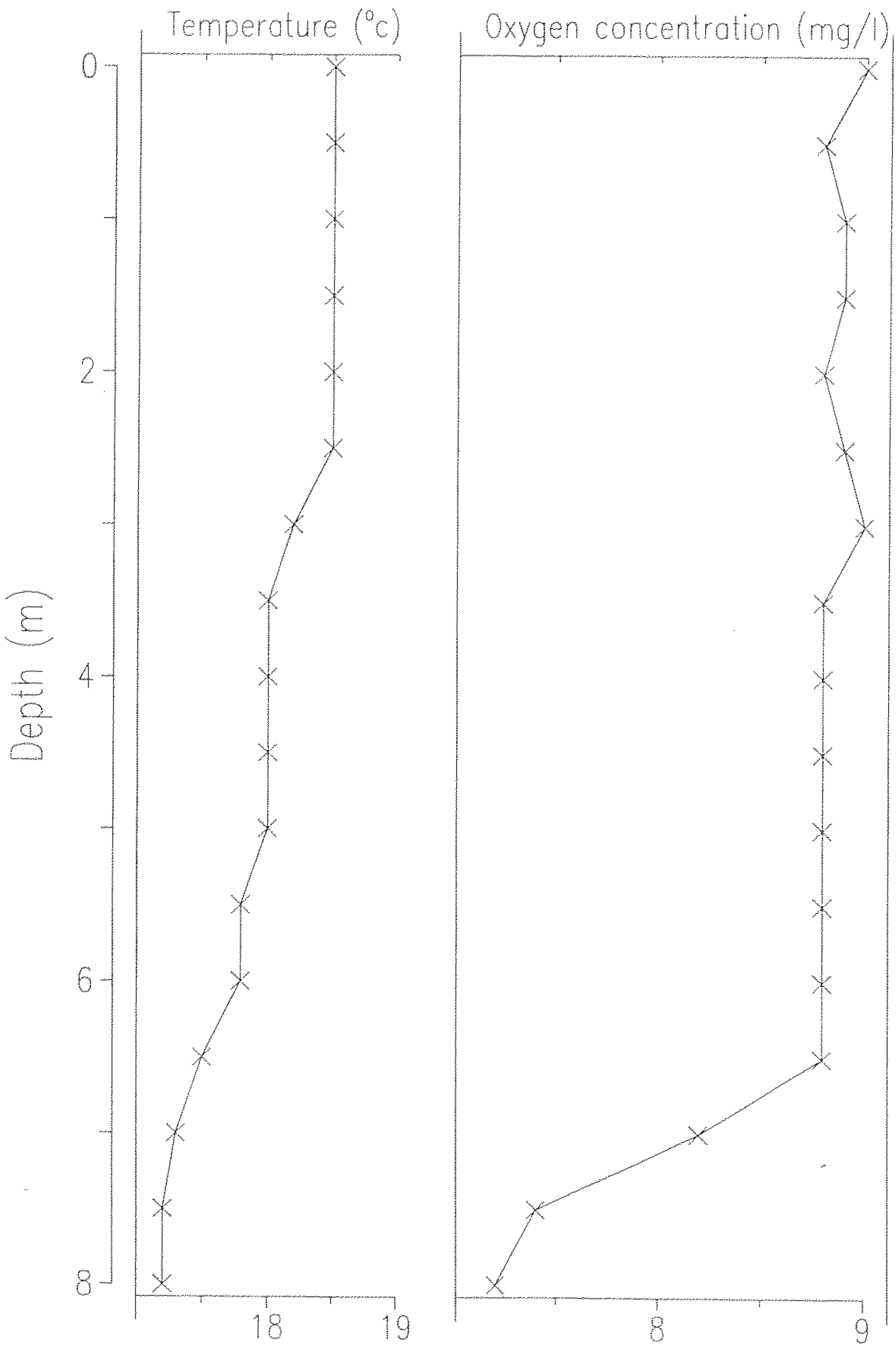


Figure E.3 Llyn Gynon: aquatic macrophyte transect profile

Figure E.4 Llyn Gynon: Temperature and dissolved oxygen profiles 30-7-94



Appendix F Data Tables and Figures: Llyn Hir

Table F.1 Llyn Hir water chemistry

Determinand		Sample				
		27-7-94	22-9-94	1-12-94	5-3-95	mean
lab pH		5.60	5.60	5.47	5.61	5.57
field pH		5.68		5.59	5.64	
Alkalinity 1	$\mu eq\ l^{-1}$	13	15	12	15	14
Alkalinity 2	$\mu eq\ l^{-1}$	4	8	4	5	5
lab Conductivity	$\mu S\ cm^{-1}$	35	38	36	31	35
field Conductivity	$\mu S\ cm^{-1}$	35		34	30	
Sodium	$\mu eq\ l^{-1}$	175	184	163	163	171
Potassium	$\mu eq\ l^{-1}$	6	6	5	7	6
Magnesium	$\mu eq\ l^{-1}$	77	55	61	56	65
Calcium	$\mu eq\ l^{-1}$	69	91	75	61	74
Chloride	$\mu eq\ l^{-1}$	193	189	166	180	182
Aluminium $_{total\ monomeric}$	$\mu g\ l^{-1}$	7	15	42	37	25
Aluminium $_{non\text{-}labile}$	$\mu g\ l^{-1}$	3	8	27	34	18
Aluminium $_{labile}$	$\mu g\ l^{-1}$	4	7	15	3	7.3
Absorbance	(250nm)	0.040	0.094	0.137	0.125	0.099
Carbon $_{total\ organic}$	$mg\ l^{-1}$	1.4	2.6	5.6	2.8	3.1
Phosphorus $_{total}$	$\mu gP\ l^{-1}$	4.5	5.9	10.1	6.6	6.8
Phosphorus $_{total\ soluble}$	$\mu gP\ l^{-1}$	3.5	4.1	7.3	4.6	4.9
Phosphorus $_{soluble\ reactive}$	$\mu gP\ l^{-1}$	0.8	1.0	1.6	1.9	1.3
Nitrate	$\mu gN\ l^{-1}$	28	63	56	105	63
Silica $_{soluble\ reactive}$	$mg\ l^{-1}$	0.06	0.34	0.83	0.67	0.48
Chlorophyll a	$\mu g\ l^{-1}$	1.9	2.1	1.5	1.4	1.7
Sulphate	$\mu eq\ l^{-1}$	82	80	78	67	77
Copper $_{total\ soluble}$	$\mu g\ l^{-1}$	7	0	0	0	1.8
Iron $_{total\ soluble}$	$\mu g\ l^{-1}$	41	98	90	35	66
Lead $_{total\ soluble}$	$\mu g\ l^{-1}$	10	0	0	0	3
Manganese $_{total\ soluble}$	$\mu g\ l^{-1}$	77	55	29	24	46
Zinc $_{total\ soluble}$	$\mu g\ l^{-1}$	14	13	9	2	10

Table F.2 Llyn Hir epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes altaica	1.0
Achnanthes levanderi	1.8
Brachysira brebissonii	1.1
Brachysira vitrea	2.1
Cymbella microcephala	2.7
Cymbella minuta	1.1
Cymbella perpusilla	4.7
Cymbella sp.	1.4
Eunotia exigua	1.2
Eunotia incisa	33.5
Eunotia naegelii	1.1
Eunotia pectinalis var. *minor*	1.4
Eunotia rhomboidea	22.1
Eunotia sp.	1.6
Eunotia vanheurckii intermedia	2.0
Eunotia vanheurckii	2.9
Navicula jaernefeltii	1.4
Navicula leptostriata	3.3
Pinnularia irrorata	2.1
Surirella delicatissima	1.5
Tabellaria flocculosa	10.3

Table F.3 Llyn Hir surface sediment diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes marginulata	1.5
Achnanthes minutissima	5.3
Aulacoseira perglabra	2.0
Aulacoseira perglabra var. *floriniae*	2.2
Brachysira vitrea	8.1
Cymbella lunata	1.8
Cymbella microcephala	6.4
Cymbella perpusilla	3.3
Eunotia exigua	2.2
Eunotia incisa	3.3
Eunotia pectinalis var. *minor*	1.1
Eunotia rhomboidea	2.2
Fragilaria virescens var. *exigua*	9.3
Frustulia rhomboides var. *saxonica*	2.2
Frustulia rhomboides var. *viridula*	3.3
Navicula cumbriensis var. *minor*	1.8
Navicula leptostriata	6.2
Navicula radiosa var. *tenella*	1.3
Pinnularia irrorata	1.1
Surirella delicatissima	2.0
Tabellaria flocculosa	10.4

Table F.4 Llyn Hir aquatic macrophyte abundance summary: 29-7-94

TAXON	code	Abun
Emergent taxa		
Agrostis stolonifera	380203	R
Menyanthes trifoliata	364701	R
Floating taxa		
Glyceria fluitans	382502	R
Luronium natans [1 2]	383401	R
Potamogeton polygonifolius [1]	384017	O
Sparganium angustifolium [1 2]	384601	O
Submergent taxa		
Filamentous green alga	170000	A
Isoetes sp.	350300	F
Callitriche hamulata [1]	361103	R
Littorella uniflora [1]	363901	O
Lobelia dortmanna	364001	A
Myriophyllum alterniflorum [1]	365401	O
Subularia aquatica	368701	F
Juncus bulbosus var. fluitans	383006	A
Luronium natans [1 2]	383401	A
Fringing taxa		
Molinia caerulea	383501	A
Eriophorum angustifolium	382401	F
Sphagnum sp.	327400	F
Polytrichum sp.	326200	F
Vaccinium sp.	------	F
Carex echinata	381110	O
Juncus effusus	383010	F
Drosera rotundifolia	------	O
Potentilla sp.	366700	O
Narthecium ossifragum	------	O

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table F.5 Llyn Hir littoral Cladocera taxon list: 29-7-94

TAXON	Sample number				
	1	2	3	4	5
Acantholeberis curvirostris			+	2	
Acroperus harpae			1		+
Alonopsis elongata	691	290	88	61	448
Chydorus piger	2		5	+	
Chydorus sphaericus		1			+
Drepanothrix dentata				1	
Eubosmina longispina	+			1	
Eurycercus lamellatus	1	2	3	1	11
Pleuroxus truncatus				+	
Polyphemus pediculus	100	141	24	6	+
Total Count	794	434	121	72	459

Table F.6 Llyn Hir zooplankton abundance summary: 29-7-94
Abundance in vertical net hauls (number of individuals $0.01m^{-2}$)

TAXON	Abun
Eudiaptomus gracilis	980
Diaphanosoma brachyurum	180
Ceriodaphnia quadrangula	30
Daphnia longispina	X
Polyphemus pediculus	X
Other planktonic organisms (not quantitatively sampled)	
Conochilus sp.	

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table F.7 Llyn Hir zooplankton characteristics

Site depth (m)	6.8
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	0.85
Chaoborus larvae biomass (g DW m^{-2})	0
Net algal biomass (g DW m^{-2})	0
Cladoceran biomass as proportion of total zooplankton biomass (%)	14
Large cladoceran (>710μm) as proportion of total zooplankton biomass (%)	0
Large Copepoda (>420μm) as proportion of total zooplankton biomass (%)	1

**Table F.8 Llyn Hir littoral macroinvertebrate summary.
Mean number of individuals per one minute kick/sweep sample.**

code	TAXON	Mean count/sample
	TURBELLARIA	
03120000	Tricladida	17.2
	BIVALVIA	
14030200	*Pisidium* sp.	14.8
	EPHEMEROPTERA	
30040100	*Leptophlebia* sp.	3.2
	ODONATA	
32020301	*Enallagma cyathigerum*	0.4
	HEMIPTERA	
33110000	Corixidae sp.	0.8
33110807	*Sigara scotti*	6.0
	COLEOPTERA	
35030703	*Potamonectes depressus*	3.2
35110600	*Oulimnius* sp.	1.6
	TRICHOPTERA	
38030301	*Polycentropus flavomaculatus*	88.8
38030401	*Holocentropus dubius*	1.2
38070400	*Agrypnia* sp.	5.2
38080500	*Limnephilus* sp.	1.6
	DIPTERA	
40090000	Chironomidae	278.4

Figure F.1 Llyn Hir: sample location and substrate map

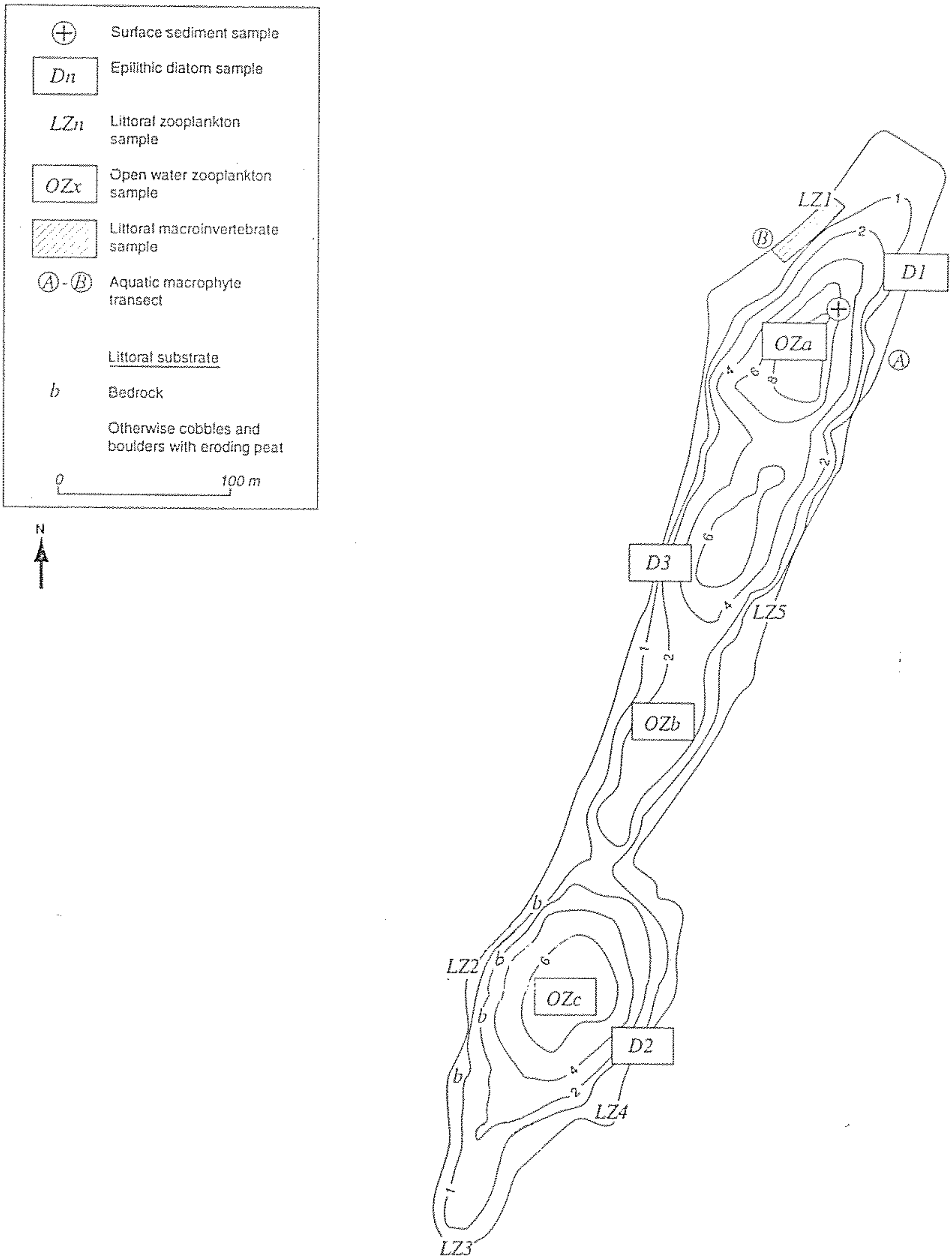


Figure F.2 Llyn Hir: aquatic macrophyte distribution map 29-7-94

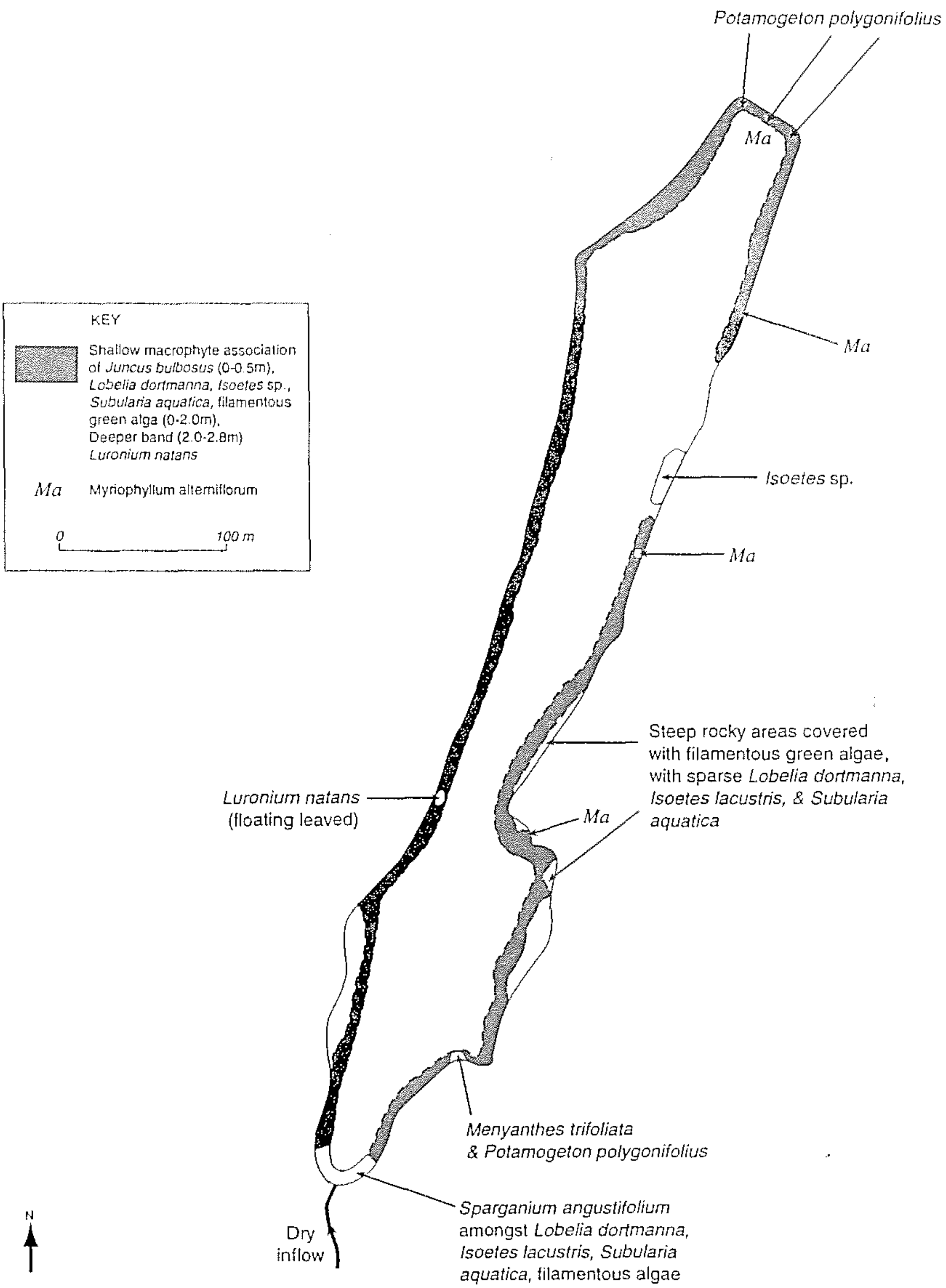


Figure F.3 Llyn Hir: aquatic macrophyte transect profile

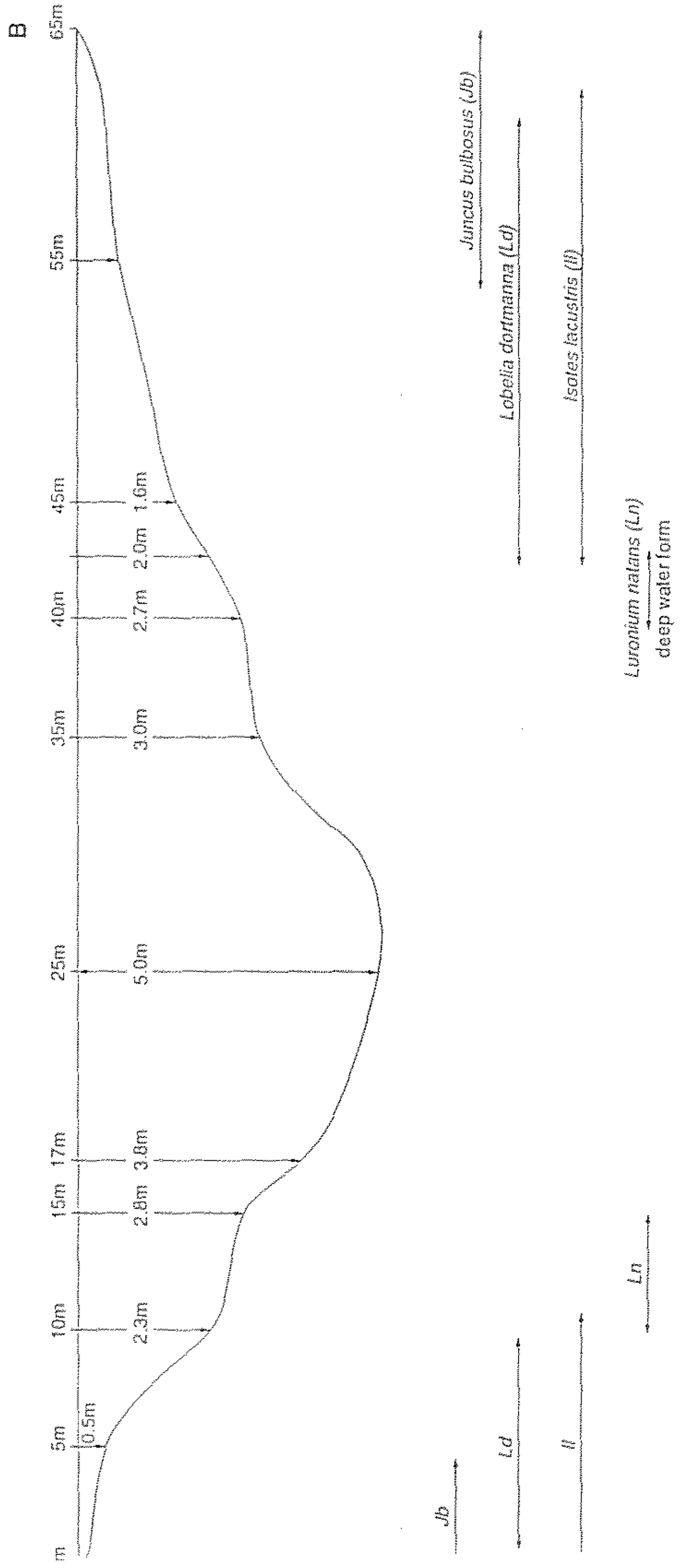
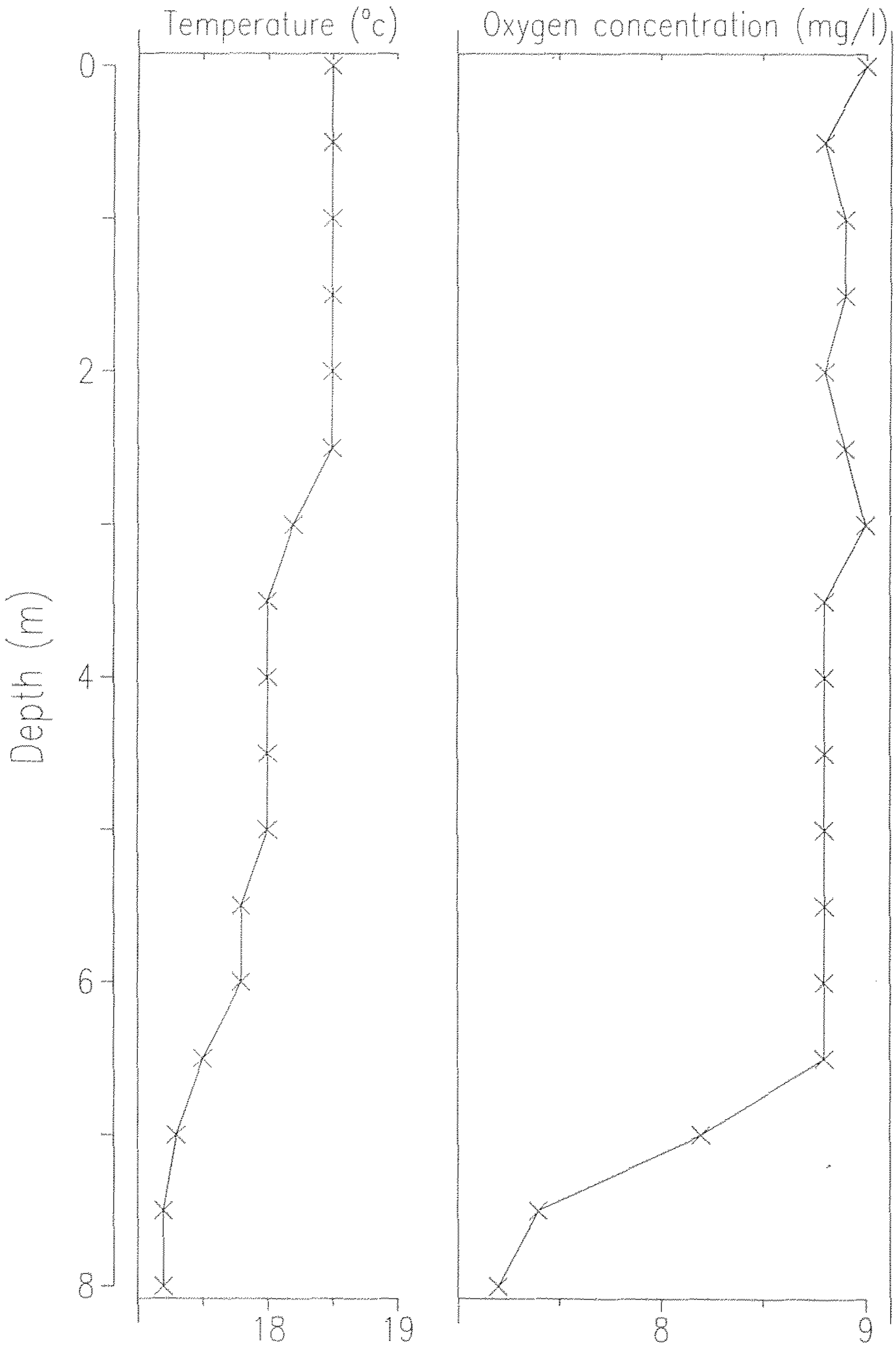


Figure F.4 Llyn Hir: temperature and dissolved oxygen profiles 29-7-94



Appendix G Data Tables and Figures: West Llynnoedd Ieuan

Table G.1 West Llynnoedd Ieuan water chemistry

Determinand		Sample				
		28-7-94	22-9-94	1-12-94	8-3-95	mean
lab pH		4.87	4.86	5.04	4.95	4.92
field pH		4.92		5.04	5.10	
Alkalinity 1	μeq l^{-1}	-13	-14	3	-11	-9
Alkalinity 2	μeq l^{-1}	-13	-12	-7	-11	-11
lab Conductivity	μS cm^{-1}	34	34	33	38	35
field Conductivity	μS cm^{-1}	30		29	37	
Sodium	μeq l^{-1}	156	151	134	175	154
Potassium	μeq l^{-1}	4	3	5	7	5
Magnesium	μeq l^{-1}	50	51	43	55	50
Calcium	μeq l^{-1}	35	36	58	49	45
Chloride	μeq l^{-1}	174	153	117	206	163
Aluminium $_{total\ monomeric}$	μg l^{-1}	65	71	95	88	80
Aluminium $_{non\text{-}labile}$	μg l^{-1}	0	8	48	39	24
Aluminium $_{labile}$	μg l^{-1}	65	63	47	49	56
Absorbance	(250nm)	0.003	0.015	0.173	0.090	0.070
Carbon $_{total\ organic}$	mg l^{-1}	0.3	0.8	6.0	2.2	2.2
Phosphorus $_{total}$	μgP l^{-1}	2.4	2.5	9.2	5.9	5.0
Phosphorus $_{total\ soluble}$	μgP l^{-1}	1.3	1.2	5.5	2.8	2.7
Phosphorus $_{soluble\ reactive}$	μgP l^{-1}	0.4	1.1	0.4	0.9	0.7
Nitrate	μgN l^{-1}	56	77	91	84	77
Silica $_{soluble\ reactive}$	mg l^{-1}	0.06	0.21	1.25	0.35	0.7
Chlorophyll a	μg l^{-1}	0.5	1.1	1.0	0.6	0.8
Sulphate	μeq l^{-1}	83	74	75	67	75
Copper $_{total\ soluble}$	μg l^{-1}	0	0	0	0	0
Iron $_{total\ soluble}$	μg l^{-1}	49	24	120	35	57
Lead $_{total\ soluble}$	μg l^{-1}	6	0	0	0	2
Manganese $_{total\ soluble}$	μg l^{-1}	159	140	41	36	91
Zinc $_{total\ soluble}$	μg l^{-1}	12	8	13	1	8

Table G.2 West Llynnoedd Ieuan epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes marginulata	1.1
Achnanthes minutissima	2.2
Brachysira brebissonii	7.1
Brachysira vitrea	2.1
Cymbella microcephala	7.0
Eunotia denticulata	2.0
Eunotia exigua	2.7
Eunotia incisa	23.8
Eunotia rhomboidea	5.6
Frustulia rhomboides var. *saxonica*	1.5
Navicula hoefleri	3.3
Navicula leptostriata	1.2
Navicula radiosa var. *tenella*	1.5
Tabellaria flocculosa	2.3
Tabellaria quadriseptata	34.8

Table G.3 West Llynnoedd Ieuan surface sediment diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes marginulata	1.6
Achnanthes minutissima	5.6
Achnanthes sp.	1.3
Brachysira brebissonii	5.2
Brachysira vitrea	5.4
Cymbella microcephala	3.1
Eunotia exigua	3.1
Eunotia incisa	8.7
Eunotia naegelii	1.1
Fragilaria virescens var. *exigua*	3.1
Frustulia rhomboides	1.1
Frustulia rhomboides var. *saxonica*	4.7
Navicula angusta	1.1
Navicula leptostriata	2.0
Navicula radiosa var. *tenella*	1.6
Nitzschia perminuta	1.1
Pinnularia biceps	2.5
Stauroneis anceps	2.0
Tabellaria flocculosa	3.1
Tabellaria quadriseptata	27.1

Table G.4 **West Llynnoedd Ieuan aquatic macrophyte abundance summary: 28-7-94**

TAXON	code	Abun
Submergent taxa		
Cladophora sp.	170000	R
Filamentous green alga species 1	170000	A
Filamentous green alga species 2	170000	A
Nardia compressa	343701	A
Isoetes lacustris	350302	F
Littorella uniflora [1]	363901	F
Lobelia dortmanna	364001	A
Juncus bulbosus var. fluitans	383006	F
Fringing taxa		
Juncus effusus	383010	A
Juncus articulatus	383003	A
Polytrichum sp.	326200	F
Sphagnum sp.	327400	F
Carex echinata	381110	O
Molinia caerulea	383501	A
Vaccinium myrtilus	------	F
Eriophorum angustifolium	382401	O

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table G.5 West Llynnoedd Ieuan littoral Cladocera taxon list: 28-7-94

Taxon	Sample number				
	1	2	3	4	5
Acantholeberis curvirostris	+		4	3	4
Alonopsis elongata	78	s	304	276	92
Alonella excisa			+		1
Alonella nana			+		
Chydorus sphaericus	10		16	15	18
Total Count	88	0	324	294	115

s = shell fragment

Table G.6 West Llynnoedd Ieuan zooplankton abundance summary: 28-7-94 Abundance in vertical net hauls (number of individuals $0.01m^{-2}$)

TAXON	Abun
Eudiaptomus gracilis	640
Diaphanosoma brachyurum	50
Eubosmina longispina	210
Drepanothrix dentata	X
Acroperus elongatus	X
Chydorus sphaericus	X

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table G.7 West Llynnoedd Ieuan zooplankton characteristics

Site depth (m)	8.2
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	0.52
Chaoborus larvae biomass (g DW m^{-2})	0
Net algal biomass (g DW m^{-2})	0
Cladoceran biomass as proportion of total zooplankton biomass (%)	17
Large cladoceran (>710μm) as proportion of total zooplankton biomass (%)	0
Large Copepoda (>420μm) as proportion of total zooplankton biomass (%)	11

Table G.8 **West Llynnoedd Ieuan littoral macroinvertebrate summary. Mean number of individuals per one minute kick/sweep sample.**

code	TAXON	Mean count/sample
	TURBELLARIA	
03120000	Tricladida	33.6
	PLECOPTERA	
31080101	*Siphonoperla torrentium*	1.2
	ODONATA	
32020301	*Enallagma cyathigerum*	0.4
	HEMIPTERA	
33110000	Corixidae sp.	24.0
33110301	*Glaenocorisa propinqua*	4.8
33110401	*Callicorixa praeusta*	0.4
33110702	*Arctocorisa germari*	1.2
	COLEOPTERA	
35030000	Dytiscidae undet. (larvae	10.4
35030702	*Potamonectes assimilis*	5.6
35030900	*Hydroporus* sp.	0.4
	TRICHOPTERA	
38030301	*Polycentropus flavomaculatus*	37.6
38060600	*Oxyethira* sp.	10.0
38070400	*Agrypnia* sp.	3.6
	DIPTERA	
40090000	Chironomidae	653.2

Figure G.1 West Llynnoedd Ieuan: sample location and substrate map

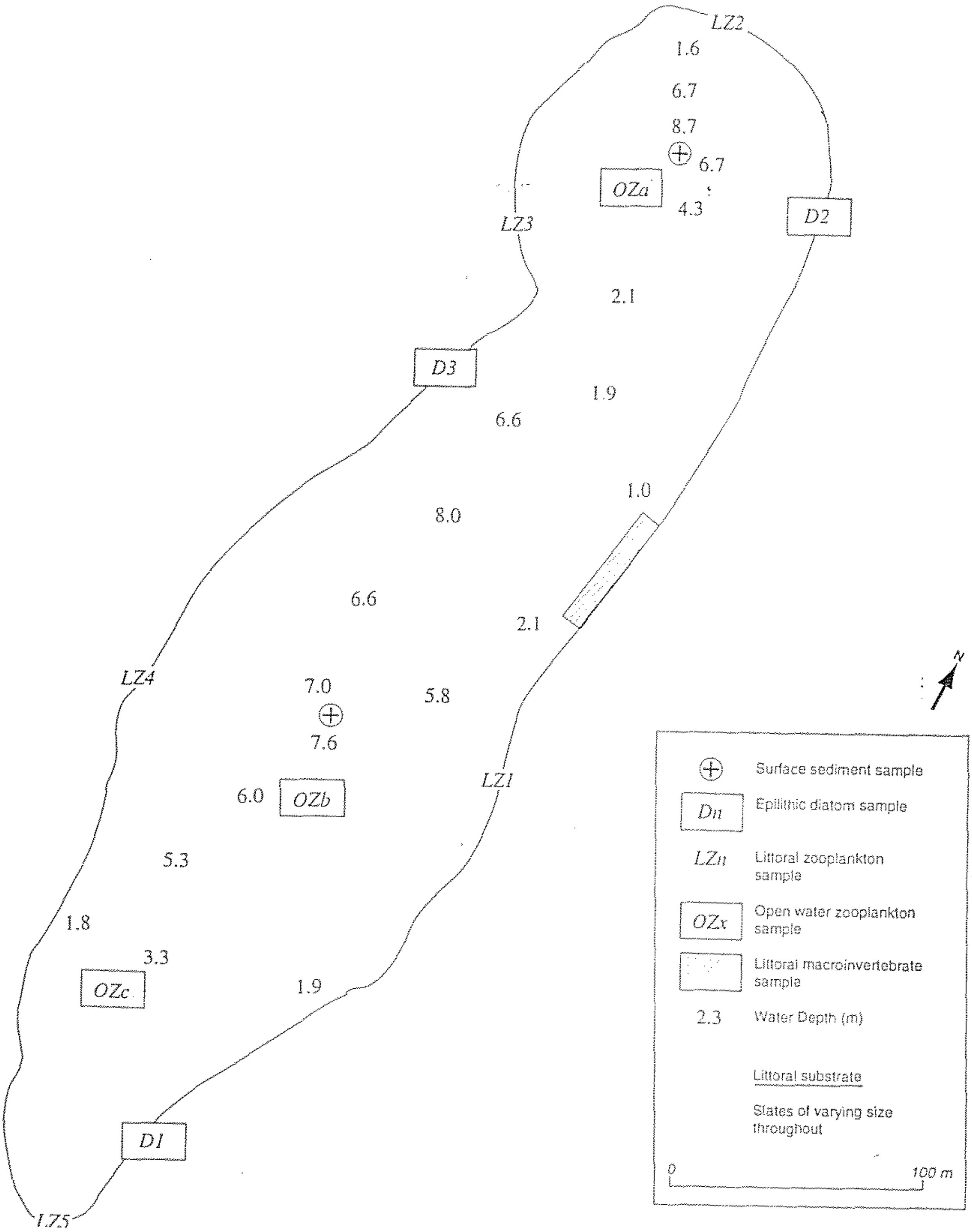


Figure G.2 West Llynnoedd Ieuan: aquatic macrophyte distribution map 28-7-94

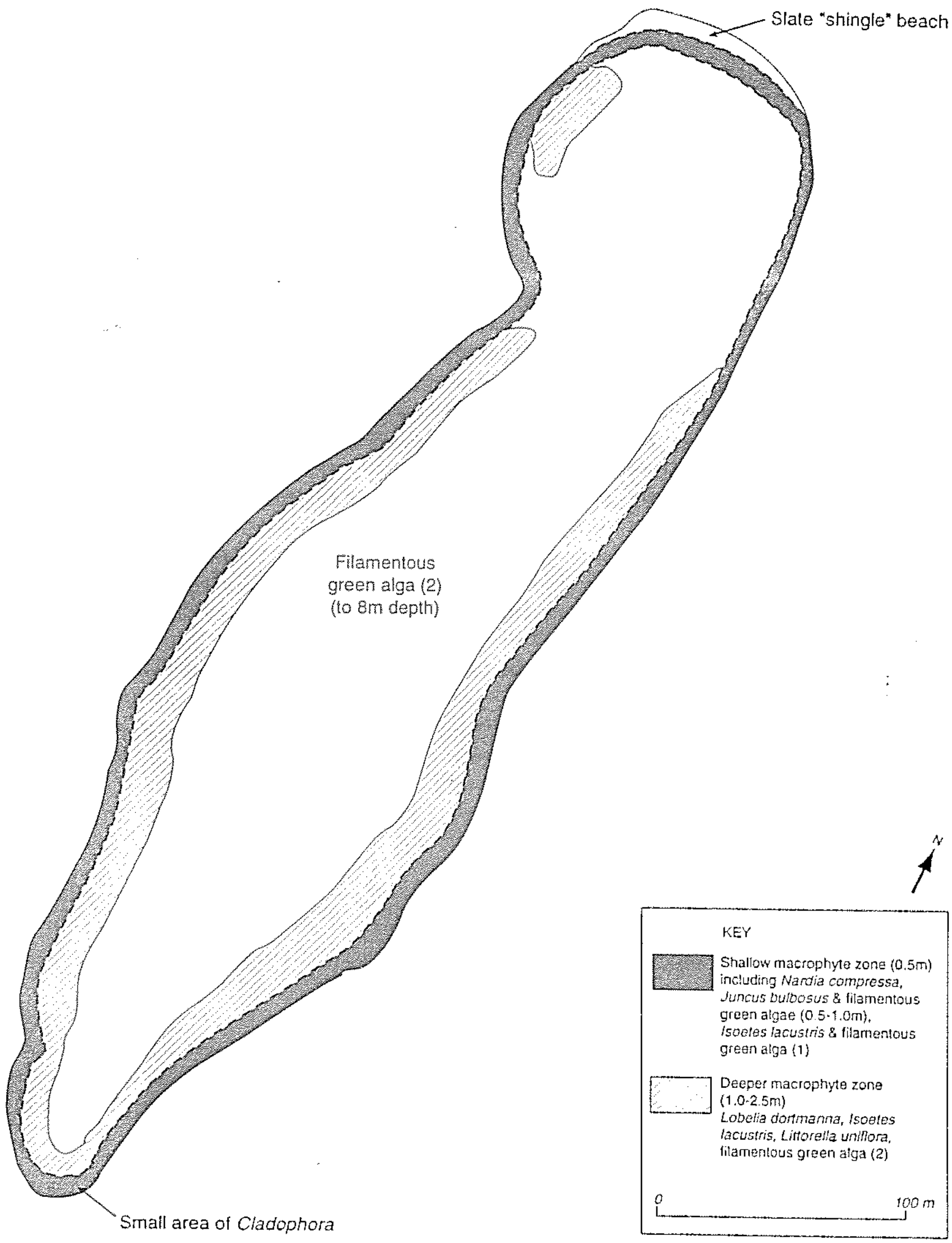
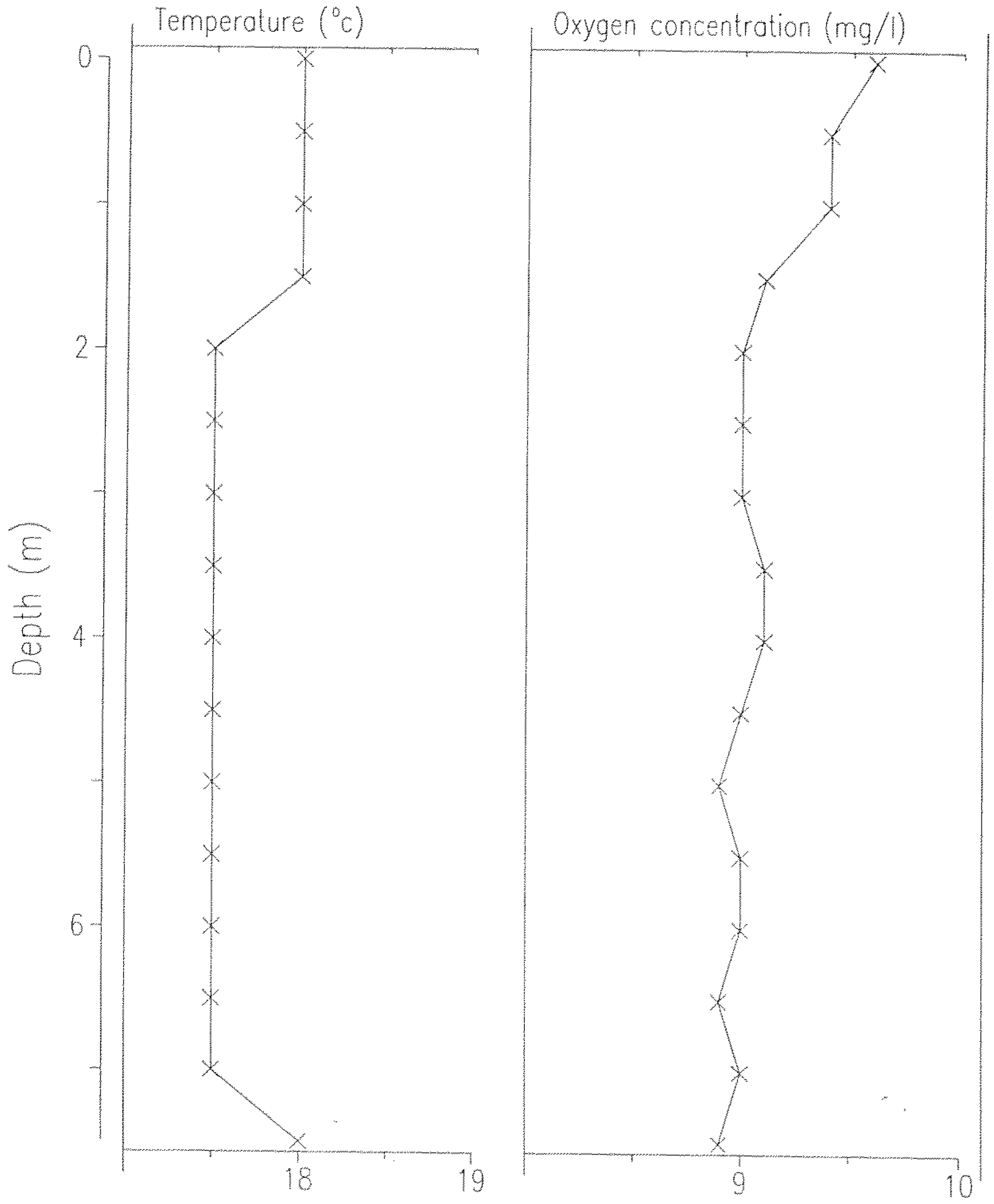


Figure G.4 West Llynnoedd Ieuan: temperature and dissolved oxygen profiles 28-7-94



Appendix H Data Tables and Figures: Maes-llyn

Table H.1 Maes-llyn water chemistry

Determinand		Sample				
		27-7-94	21-9-94	2-12-94	5-3-95	mean
lab pH		7.53	7.20	7.28	7.30	7.31
field pH		7.76		7.65	7.92	
Alkalinity 1	μeq l^{-1}	581	616	523	389	527
Alkalinity 2	μeq l^{-1}	582	621	524	385	528
lab Conductivity	μS cm^{-1}	106	115	115	98	109
field Conductivity	μS cm^{-1}	104		110	100	
Sodium	μeq l^{-1}	275	284	277	266	276
Potassium	μeq l^{-1}	20	15	39	23	24
Magnesium	μeq l^{-1}	261	274	258	223	254
Calcium	μeq l^{-1}	579	820	598	498	623
Chloride	μeq l^{-1}	293	269	269	295	282
Aluminium $_{total\ monomeric}$	μg l^{-1}	0	3	5	10	5
Aluminium $_{non-labile}$	μg l^{-1}	0	1	5	6	3
Aluminium $_{labile}$	μg l^{-1}	1	2	0	4	2
Absorbtance	(250nm)	0.166	0.188	0.205	0.122	0.170
Carbon $_{total\ organic}$	mg l^{-1}	4.4	5.8	5.4	2.4	4.5
Phosphorus $_{total}$	μgP l^{-1}	38.4	93.6	31.1	47.1	52.6
Phosphorus $_{total\ soluble}$	μgP l^{-1}	22.3	18.2	23.0	10.1	18.4
Phosphorus $_{soluble\ reactive}$	μgP l^{-1}	2.5	5.0	9.0	6.9	5.9
Nitrate	μgN l^{-1}	28	161	966	875	508
Silica $_{soluble\ reactive}$	mg l^{-1}	1.17	2.52	4.64	1.55	2.47
Chlorophyll a	μg l^{-1}	13.1	66.6	1.8	10.7	23.1
Sulphate	μeq l^{-1}	137	165	196	162	165
Copper $_{total\ soluble}$	μg l^{-1}	0	18	0	0	5
Iron $_{total\ soluble}$	μg l^{-1}	33	900	145	30	277
Lead $_{total\ soluble}$	μg l^{-1}	8	6	0	0	4
Manganese $_{total\ soluble}$	μg l^{-1}	3	40	0	0	11
Zinc $_{total\ soluble}$	μg l^{-1}	6	8	0	0	4

Table H.2 Maes-llyn epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes minutissima	21.9
Cymbella microcephala	38.0
Cymbella minuta	1.4
Epithemia adnata	1.2
Fragilaria construens var. *venter*	17.6
Fragilaria elliptica	2.0
Fragilaria intermedia	17.5
Navicula seminulum	1.8
Nitzschia frustulum	1.8
Nitzschia lacuum	4.3
Nitzschia perminuta	1.1
Rhoicosphenia curvata	2.0
Synedra delicatissima	4.9
Synedra tenera	2.1

Table H.3 Maes-llyn surface sediment diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes minutissima	27.4
Asterionella formosa	34.3
Cocconeis placentula	1.3
Cyclotella pseudostelligera	1.5
Cymbella minuta	4.7
Fragilaria construens var. *venter*	4.0
Fragilaria intermedia	3.8
Gomphonema intricatum var. *pumilum*	1.3
Gomphonema sp.	1.1
Stephanodiscus parvus	2.4
Synedra delicatissima	2.9

Table H.4 Maes-llyn aquatic macrophyte abundance summary: 2-8-94

TAXON	code	Abun
Emergent taxa		
Equisetum fluviatile	350202	O
Menyanthes trifoliata [1]	364701	F
Carex rostrata	381129	F
Typha latifolia	384902	O
Eleocharis palustris	382004	O
Floating taxa		
Nuphar lutea	365501	A
Submergent taxa		
Ceratophyllum demersum [2]	361401	A
Littorella uniflora [1]	363901	A
Myriophyllum alterniflorum [1]	365401	A
Potamogeton berchtoldii	384003	A
Potamogeton obtusifolius [1 2]	384000	R
Elatine hexandra	3612401	A
Fringing taxa		
Salix sp.	367500	F
Iris pseudacorus	382901	O
Lythrum salicaria	364502	O
Lythrum portula	3645--	R
Ranunculus omiophyllus	366909	R
Callitriche stagnalis	361108	R
Phalaris arundinacea	383701	O
Rorippa nasturtium-aquaticum	367105	R
Potentilla palustris [1]	366704	O
Carex sp.	381100	R

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table H.5 Maes-llyn littoral Cladocera taxon list: 2-8-94

TAXON	Sample number				
	1	2	3	4	5
Acroperus harpae	9	4	1		
Alona affinis				+	
Chydorus sphaericus		1			
Daphnia longispina	2	2	24	2	22
Diaphanosoma brachyurum	33	17	13	66	3
Eurycercus lamellatus	13	13	1	1	1
Pleuroxus truncatus	11	4	32	1	+
Total Count	68	41	71	70	26

Table H.6 Maes-llyn zooplankton abundance summary: 2-8-94
Abundance in vertical net hauls (number of individuals $0.01m^{-2}$)

TAXON	Abun
Eudiaptomus gracilis	1100
Diaphanosoma brachyurum	540
Daphnia longispina	370
Ceriodaphnia pulchella	x
Eucyclops serrulatus	X
Other planktonic organisms (not quantitatively sampled)	
Volvox sp.	2300
Keratella cochlearis	110
Keratella quadrata	60
Kellicottia longispina	60
Nauplia	230
Asplanchna sp.	110
Rotifera sp.	20000
Trichocerca	510

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table H.7 Maes-llyn zooplankton characteristics

Site depth (m)	5.0
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	0.90
Chaoborus larvae biomass (g DW m^{-2})	0.05
Net algal biomass (g DW m^{-2})	0
Cladoceran biomass as proportion of total zooplankton biomass (%)	48
Large cladoceran (>710μm) as proportion of total zooplankton biomass (%)	3
Large Copepoda (>420μm) as proportion of total zooplankton biomass (%)	1

Table H.8 Maes-llyn littoral macroinvertebrate summary. Mean number of individuals per one minute kick/sweep sample.

code	TAXON	Mean count/sample
	TURBELLARIA	
03120000	Tricladida	316.0
	MOLLUSCA	
13070107	*Lymnaea peregra*	1.2
13090307	*Planorbis albus*	109.6
13090310	*Planorbis contortus*	23.6
	BIVALVIA	
14030200	*Pisidium* sp.	30.4
	HIRUDINIA	
17020101	*Theromyzon tessalatum*	2.4
17020302	*Glossiphonia complanata*	1.6
17020501	*Helobdella stagnalis*	2.0
17040102	*Erpobdella octoculata*	62.4
	MALACOSTRACA	
28030104	*Asellus meridianus*	1250.8
28070305	*Gammarus pulex*	510.0
30020302	*Cloeon simile*	218.0
30080204	*Caenis horaria*	632.0
30080206	*Caenis luctuosa*	14.0
	ODONATA	
32020000	*Zygoptera* sp.	28.0
	HEMIPTERA	
33110000	Corixidae sp.	12.4
33110401	*Callicorixa praeusta*	0.4
33110801	*Sigara dorsalis*	17.2
33110803	*Sigara distincta*	1.2
33110804	*Sigara falleni*	3.6
33110807	*Sigara scotti*	0.8
	COLEOPTERA	
35010301	*Haliplus confinis*	0.4
35010304	*Haliplus ruficollis* group	0.4
35010312	*Haliplus flavicollis*	0.4
35030000	Dytiscidae undet. (larvae	1.6
35030703	*Potamonectes depressus*	32.4
35030706	*Stictotarsus duodecimpustulatus*	0.4
35110600	*Oulimnius* sp.	19.0
	MEGALOPTERA	
36010101	*Sialis lutaria*	0.8
	TRICHOPTERA	
38040201	*Tinodes waeneri*	11.6
38080500	*Limnephilus* sp.	95.6
38120203	*Mystacides longicornis*	53.6
38150101	*Sericostoma personatum*	2.4
	DIPTERA	
40090000	Chironomidae	35.2

Figure H.1 Maes-llyn: sample location and substrate map

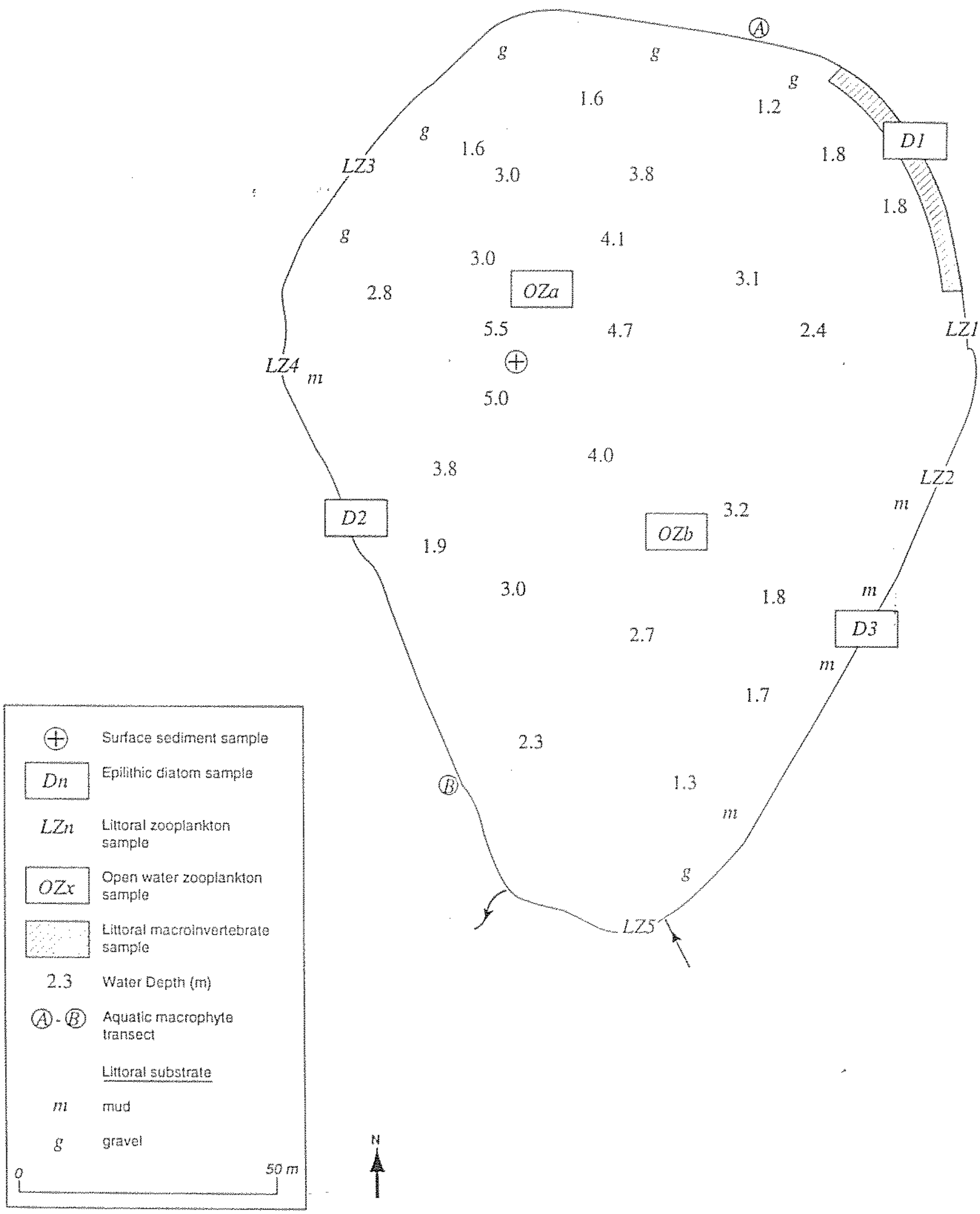


Figure H.2 Maes-llyn: aquatic macrophyte distribution map 27-7-94

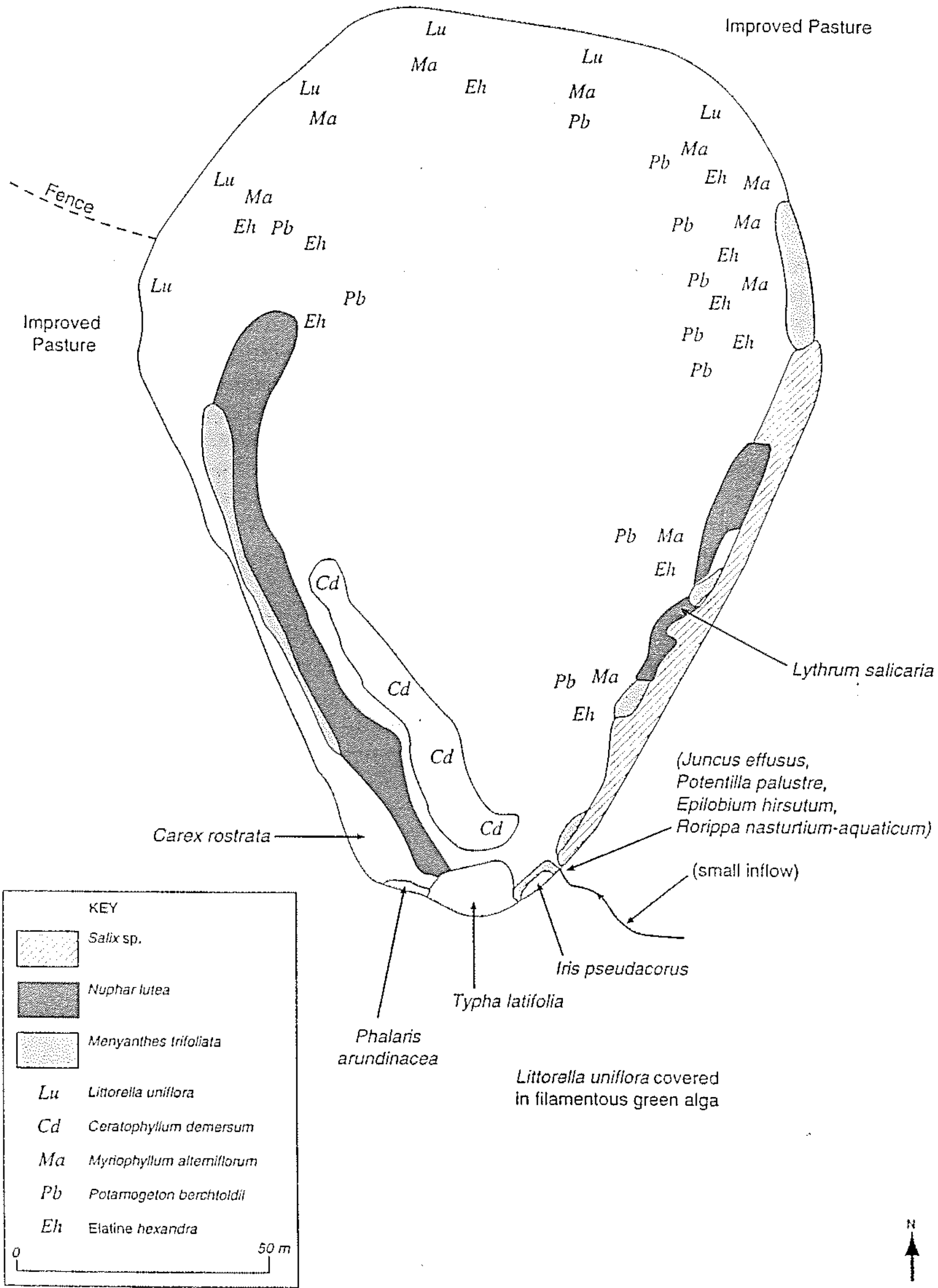
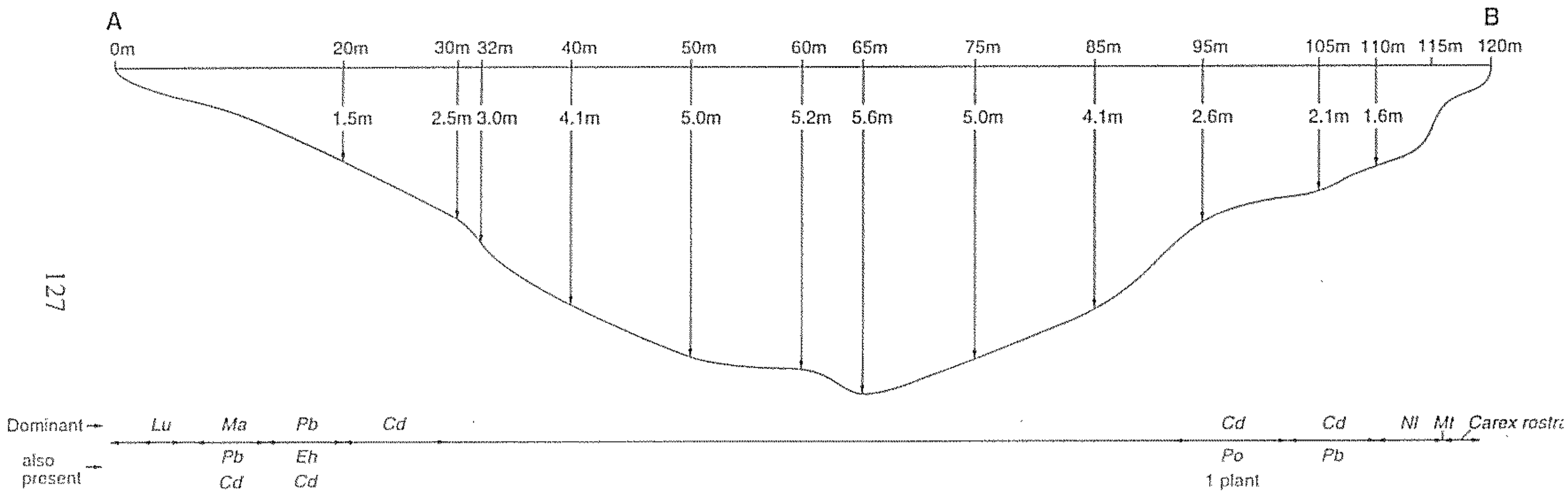


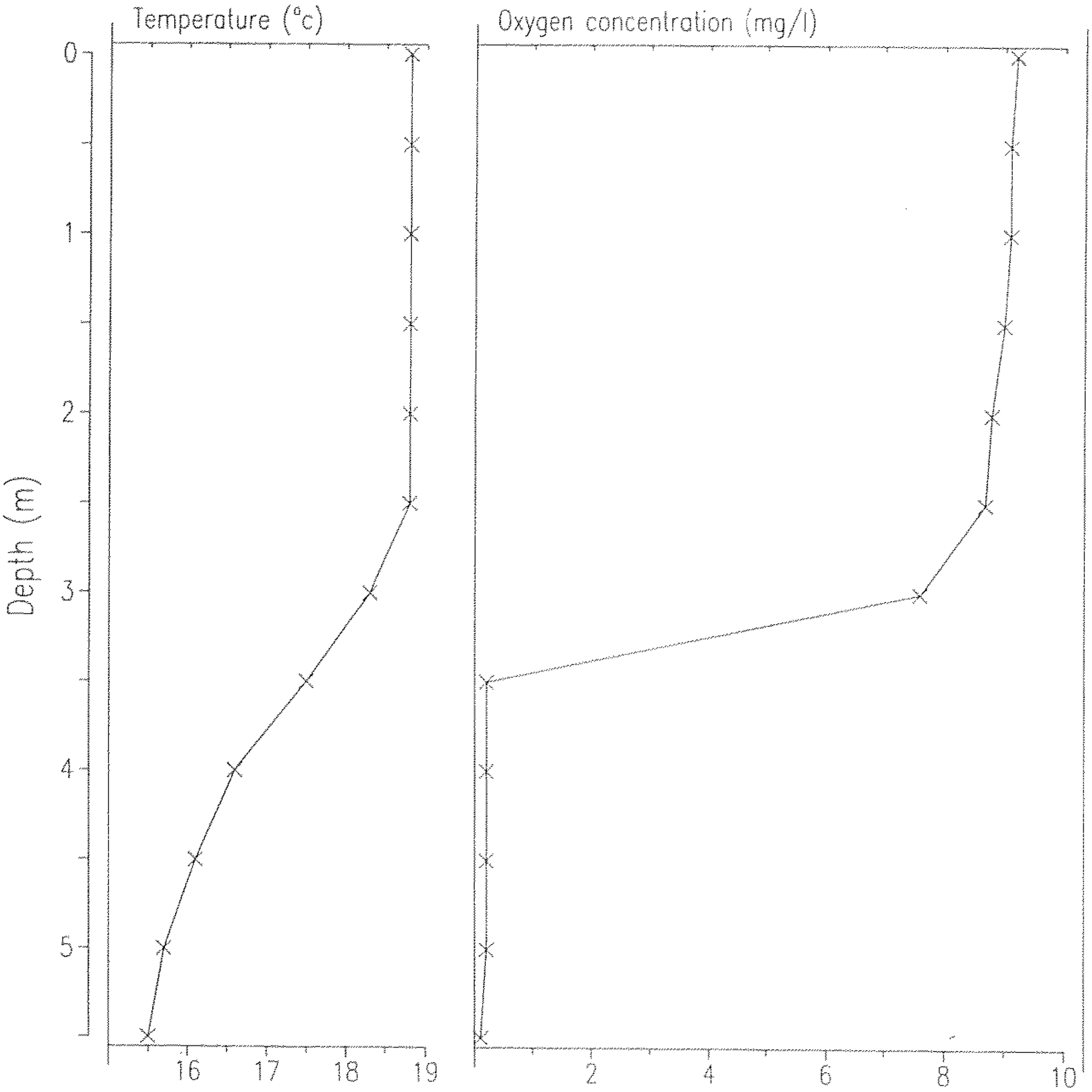
Figure II.3 Maes-llyn: aquatic macrophyte transect profile

Maes-Llyn



Lu	*Littorella uniflora*
Ma	*Myriophyllum alterniflorum*
Pb	*Potamogeton berchtoldii*
Po	*Potamogeton obtusifolius*
Cd	*Ceratophyllum demersum*
Eh	*Elatine hexandra*
Nl	*Nuphar lutea*
Mt	*Menyanthes trifoliata*

Figure H.4 Maes-llyn: temperature and dissolved oxygen profiles 27-7-94



Appendix I Data Tables and Figures: Upper Talley Lake

Table I.1 Upper Talley Lake water chemistry

Determinand		Sample				
		27-7-94	21-9-94	2-12-94	4-3-95	mean
lab pH		7.19	7.12	7.06	6.75	6.99
field pH		7.3		7.40	6.97	
Alkalinity 1	$\mu eq\ l^{-1}$	532	533	459	269	448
Alkalinity 2	$\mu eq\ l^{-1}$	532	536	462	265	449
lab Conductivity	$\mu S\ cm^{-1}$	109	109	107	75	100
field Conductivity	$\mu S\ cm^{-1}$			105	75	
Sodium	$\mu eq\ l^{-1}$	347	354	327	310	335
Potassium	$\mu eq\ l^{-1}$	15	18	30	22	21
Magnesium	$\mu eq\ l^{-1}$	198	194	170	146	177
Calcium	$\mu eq\ l^{-1}$	555	544	507	372	495
Chloride	$\mu eq\ l^{-1}$	376	351	331	353	353
Aluminium $_{total\ monomeric}$	$\mu g\ l^{-1}$	0	1	10	8	5
Aluminium $_{non\text{-}labile}$	$\mu g\ l^{-1}$	0	1	7	7	4
Aluminium $_{labile}$	$\mu g\ l^{-1}$	0	0	3	1	1
Absorbance	(250nm)	0.117	0.122	0.116	0.115	.118
Carbon $_{total\ organic}$	$mg\ l^{-1}$	3.2	3.9	3.6	2.8	3.4
Phosphorus $_{total}$	$\mu gP\ l^{-1}$	63.2	33.0	46.4	60.7	51
Phosphorus $_{total\ soluble}$	$\mu gP\ l^{-1}$	38.9	18.7	32.6	19.2	27.3
Phosphorus $_{soluble\ reactive}$	$\mu gP\ l^{-1}$	12.1	5.9	16.0	7.5	10.4
Nitrate	$\mu gN\ l^{-1}$	42	28	420	532	256
Silica $_{soluble\ reactive}$	$mg\ l^{-1}$	0.85	1.79	5.58	1.78	2.50
Chlorophyll a	$\mu g\ l^{-1}$	7.9	10.2	9.9	14.1	10.5
Sulphate	$\mu eq\ l^{-1}$	119	114	149	150	133
Copper $_{total\ soluble}$	$\mu g\ l^{-1}$	0	15	0	0	4
Iron $_{total\ soluble}$	$\mu g\ l^{-1}$	196	320	190	60	192
Lead $_{total\ soluble}$	$\mu g\ l^{-1}$	8	5	0	0	3
Manganese $_{total\ soluble}$	$\mu g\ l^{-1}$	213	61	134	0	102
Zinc $_{total\ soluble}$	$\mu g\ l^{-1}$	0	13	2	2	4.3

Table I.2 Upper Talley Lake epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes sp.	1.6
Aulacoseira distans var. *nivalis*	1.6
Aulacoseira perglabra	1.1
Cymbella microcephala	1.0
Cymbella perpusilla	2.8
Eunotia exigua var. *exigua*	1.4
Eunotia incisa	69.7
Eunotia naegelii	1.9
Eunotia pectinalis var. *minor*	1.2
Eunotia rhomboidea	3.2
Fragilaria pinnata	1.8
Frustulia rhomboides var. *saxonica*	1.9
Frustulia rhomboides var. *viridula*	2.7
Navicula cumbriensis var. *minor*	1.3
Navicula mediocris	1.7
Navicula ventralis	1.5
Nitzschia gracilis	1.5
Nitzschia palea	1.5
Tabellaria flocculosa	2.3

Table I.3 **Upper Talley Lake surface sediment diatom taxon list (including taxa >1.0%)**

TAXON	Relative frequency (%)
Achnanthes minutissima	2.4
Aulacoseira ambigua	1.2
Aulacoseira granulata var. *angustissima*	55.2
Cocconeis placentula var. *lineata*	1.0
Cocconeis placentula	1.0
Cyclotella stelligera	3.4
Fragilaria elliptica	25.1
Fragilaria pinnata	1.7
Fragilaria sp.	1.4

Table I.4 **Upper Talley Lake aquatic macrophyte abundance summary: 2-8-95**

TAXON	code	Abun
Emergent taxa		
Equisetum fluviatile	350202	O
Menyanthes trifoliata [1]	364701	O
Carex rostrata	381129	F
Typha latifolia	384902	F
Eleocharis palustris	382004	F
Polygonum amphibium	366501	O
Alisma plantago-aquatica	380303	R
Montia fontana	365001	R
Iris pseudacorus	382901	O
Floating taxa		
Potamogeton natans [1]	384012	F
Sparganium angustifolium [1 2]	384601	R
Nymphaea alba	365601	A
Nuphar lutea	365501	F
Lemna minor	383302	R
Submergent taxa		
Nitella spp.	220000	A
Myriophyllum alterniflorum [1]	365401	O
Potamogeton berchtoldii	384003	A
Potamogeton obtusifolius [1 2]	384000	O
Ceratophyllum demersum	361401	O
Fringing taxa		
Oenanthe crocata [1]	365802	F
Lysimachia vulgaris	364502	F
Hydrocotyle vulgaris	363401	O
Mentha aquatica	364601	O
Potentilla palustris	366704	O
Rorippa nasturtium	367105	O
Phalaris arundinacea	383701	F
Lotus corniculatus	------	O
Carex sp.	381000	O
Myosotis secunda	365103	O
Juncus articulatus	383003	O
Juncus effusus	383010	O
Callitriche stagnalis	361108	O
Ranunculus omiophyllus	366909	O

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table I.5 Upper Talley Lake littoral Cladocera taxon list: 2-8-94

TAXON	Sample number				
	1	2	3	4	5
Alona costata		44			3
Ceriodaphnia pulchella		1			
Chydorus sphaericus					1
Daphnia hyalina			13		3
Daphnia hyalina var. *galeata*			1		
Daphnia hyalina var. *lacustris*		3	2		
Daphnia longispina	1				
Daphnia pulex		1			1
Diaphanosoma brachyurum	1	3	4	3	4
Eurycercus lamellatus		3	9		1
Pleuroxus trigonellus		1	1		3
Pleuroxus truncatus	2				
Simocephalus vetulus		3			
Total Count	4	59	30	3	16

Table I.6 Upper Talley Lake zooplankton abundance summary: 2-8-94
Abundance in vertical net hauls (number of individuals 0.01m^{-2})

TAXON	Abun
Eudiaptomus gracilis	300
Diaphanosoma brachyurum	X
Chaoborus sp. larvae	20
Daphnia galeata	210
Macrocyclops albidus	x
Eurycerus lamellatus	X
Daphnia pulex	X
Paracyclops affinis	x
Other planktonic organisms (not quantitatively sampled)	
Conochilus sp.	
Volvox sp.	
Keratella cochlearis	
Nauplia	
Asplanchna sp.	
Trichocerca sp.	
Brachyonus sp.	
Polyarthra sp.	

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table I.7 Upper Talley Lake zooplankton characteristics

Site depth (m)	3.0
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	0.73
Chaoborus larvae biomass (g DW m^{-2})	0.23
Net algal biomass (g DW m^{-2})	3.31
Cladoceran biomass as proportion of total zooplankton biomass (%)	37
Large cladoceran (>710μm) as proportion of total zooplankton biomass (%)	9
Large Copepoda (>420μm) as proportion of total zooplankton biomass (%)	5

Table I.8 **Upper Talley Lake littoral macroinvertebrate summary. Mean number of individuals per one minute kick/sweep sample.**

code	TAXON	Mean count/sample
	TURBELLARIA	
03120000	Tricladida	70.4
	MOLLUSCA	
13070101	*Lymnaea truncatula*	4.8
13070107	*Lymnaea peregra*	1.2
13080201	*Physa fontinalis*	13.6
13090307	*Planorbis albus*	8.4
13090401	*Segmentina complanata*	0.4
	BIVALVIA	
14030200	*Pisidium* sp.	183.2
	HIRUDINIA	
17020101	*Theromyzon tessalatum*	4.8
17020301	*Glossiphonia heteroclita*	2.4
17020302	*Glossiphonia complanata*	2.0
17020401	*Bratrachobdella paludosa*	0.4
17020501	*Helobdella stagnalis*	10.0
17040102	*Erpobdella octoculata*	64.4
	MALACOSTRACA	
28070305	*Gammarus pulex*	12.8
	EPHEMEROPTERA	
30020301	*Cloeon dipterum*	123.2
30020302	*Cloeon simile*	14.0
30040100	*Leptophlebia* sp.	8.0
30080204	*Caenis horaria*	66.8
30080206	*Caenis luctuosa*	3.6
	ODONATA	
32020000	*Zygoptera* sp.	7.6
32020101	*Pyrrhosoma nymphula*	2.0
32020301	*Enallagma cyathigerum*	6.4
32020400	*Coenagrion* sp.	8.4
	HEMIPTERA	

33110000	Corixidae sp.	2.8
33110201	*Cymatia bonsdorffi*	3.6
33110401	*Callicorixa praeusta*	1.2
33110501	*Corixa dentipes*	2.0
33110803	*Sigara distincta*	115.2
33110806	*Sigara fossarum*	0.8
	COLEOPTERA	
35010304	*Haliplus ruficollis* group	2.0
35010311	*Haliplus fluvus*	0.4
35010312	*Haliplus flavicollis*	18.8
35030000	Dytiscidae undet. (larvae	0.8
35030101	*Noterus clavicornis*	6.4
35030102	*Noterus crassicornis*	7.2
35030401	*Hyphydrus ovatus*	30.8
35031101	*Agabus guttatus*	1.6
35110600	*Oulimnius* sp.	3.2
	MEGALOPTERA	
36010101	*Sialis lutaria*	3.2
37000000	LEPIDOPTERA	0.8
	TRICHOPTERA	
38030401	*Holocentropus dubius*	0.8
38030402	*Holocentropus picicornis*	0.8
38040301	*Lype phaeopa*	1.2
38070200	*Phryganea* sp.	7.2
38070201	*Phryganea grandis*	0.8
38080500	*Limnephilus* sp.	2.4
38100301	*Beraeodes minutus*	6.0
38120203	*Mystacides longicornis*	76.0
38120701	*Triaenodes bicolor*	8.4
38150101	*Sericostoma personatum*	3.2
	DIPTERA	
40010000	Tipulidae	1.6
40080000	Ceratopogonidae	2.8
40090000	Chironomidae	648.4

Figure I.1 Upper Talley Lake: sample location and substrate map

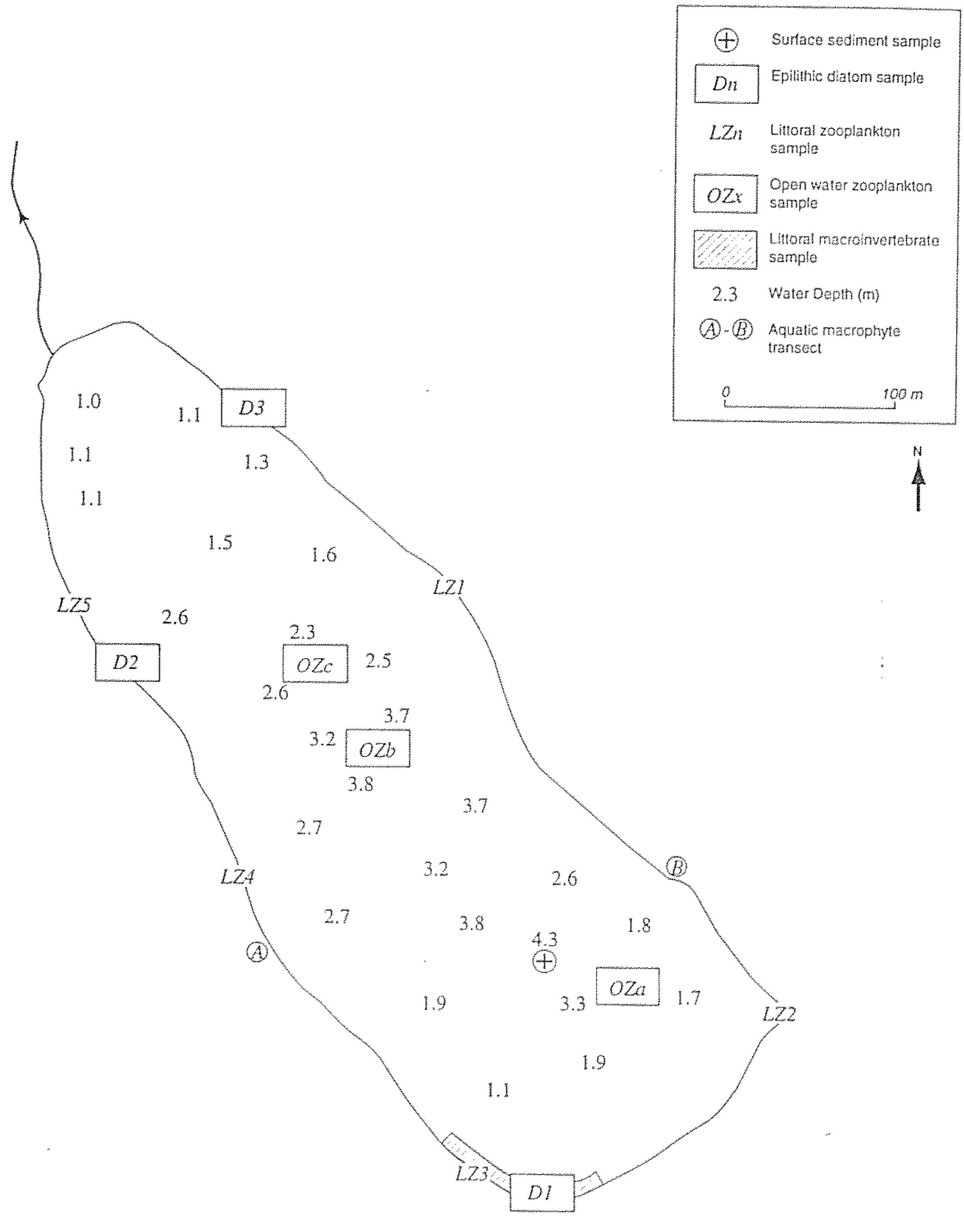
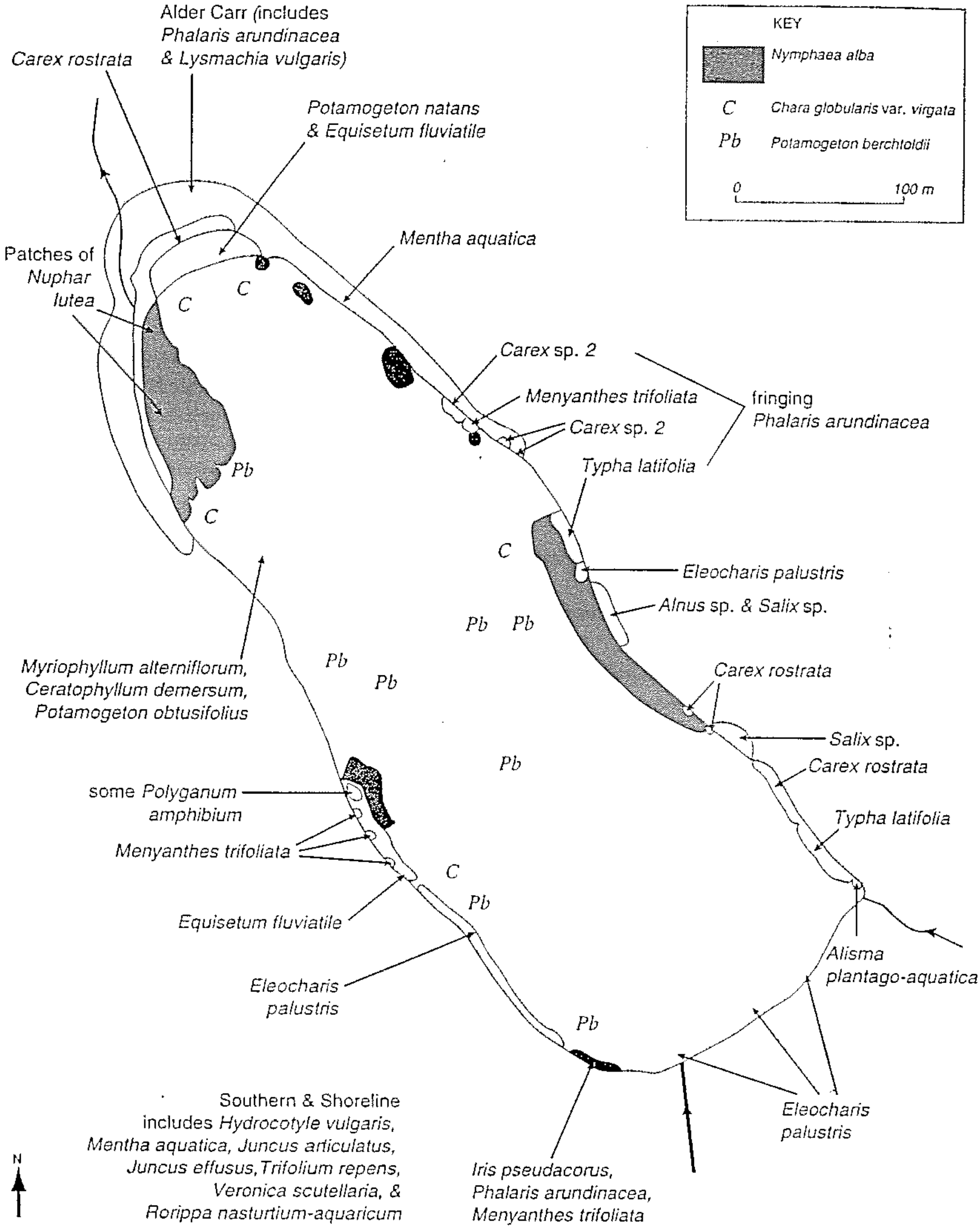


Figure I.2 Upper Talley Lake: aquatic macrophyte distribution map 2-8-94



Upper Talley

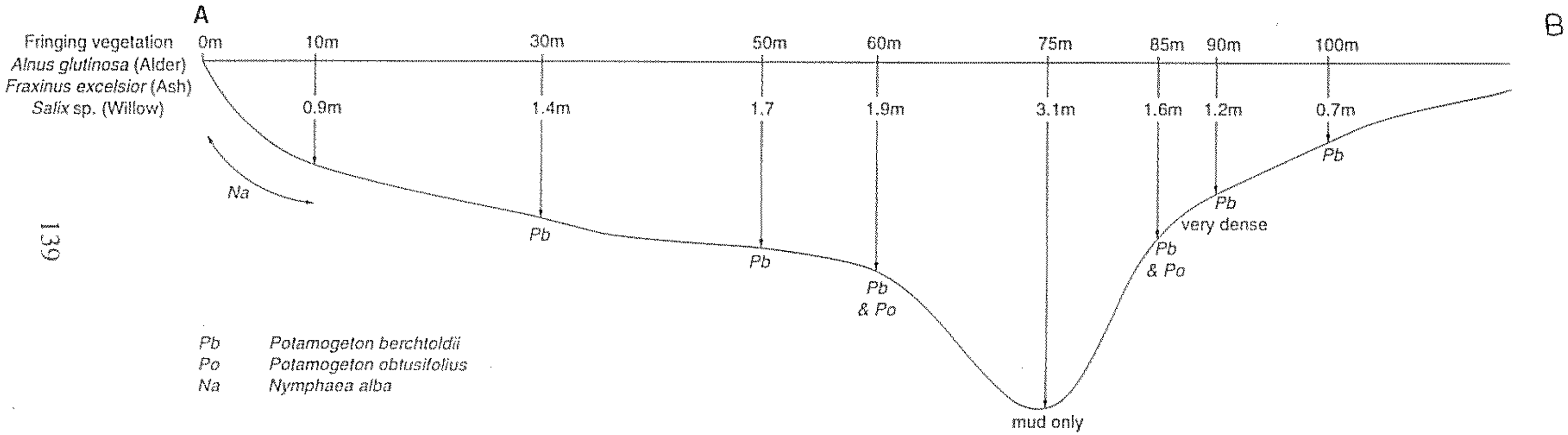
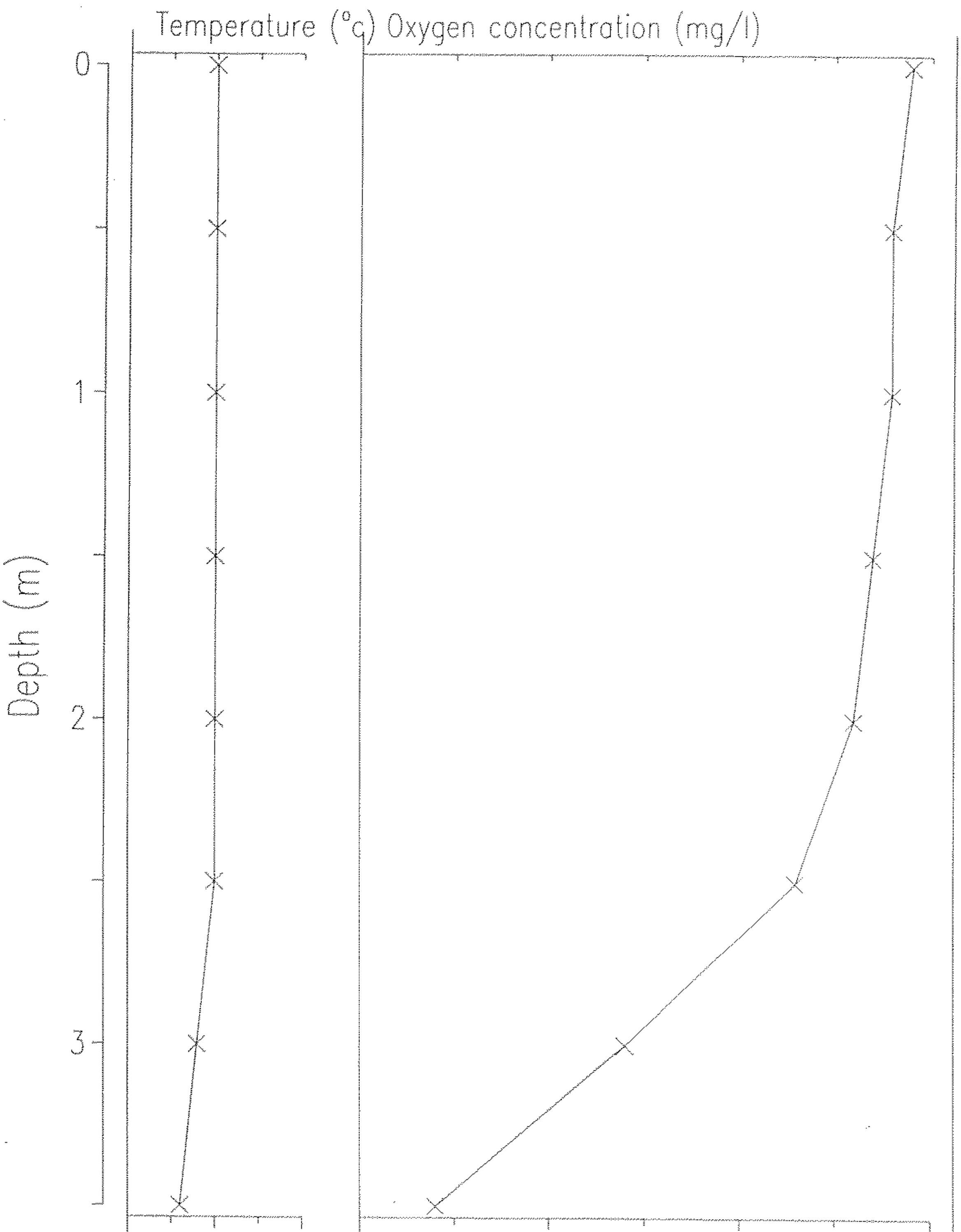


Figure I.3 Upper Talley Lake: aquatic macrophyte transect profile

Figure I.4 Upper Talley Lake: temperature and dissolved oxygen profiles 2-8-94



Appendix J Data Tables and Figures: Lower Talley Lake

Table J.1 Lower Talley lake water chemistry

Determinand		Sample				
		27-7-94	21-9-94	2-12-94	3-95	mean
lab pH		6.98	6.83	6.76	6.72	6.81
field pH		7.20		7.32	6.89	
Alkalinity 1	$\mu eq\ l^{-1}$	479	436	196	261	343
Alkalinity 2	$\mu eq\ l^{-1}$	479	438	192	257	342
lab Conductivity	$\mu S\ cm^{-1}$	102	102	89	76	93
field Conductivity	$\mu S\ cm^{-1}$	100		90	75	
Sodium	$\mu eq\ l^{-1}$	316	306	330	309	315
Potassium	$\mu eq\ l^{-1}$	29	35	23	22	27
Magnesium	$\mu eq\ l^{-1}$	200	193	185	165	186
Calcium	$\mu eq\ l^{-1}$	509	483	314	339	411
Chloride	$\mu eq\ l^{-1}$	338	326	360	342	342
Aluminium $_{total\ monomeric}$	$\mu g\ l^{-1}$	4	8	13	5	8
Aluminium $_{non\text{-}labile}$	$\mu g\ l^{-1}$	0	7	12	4	6
Aluminium $_{labile}$	$\mu g\ l^{-1}$	4	1	1	1	2
Absorbance	(250nm)	0.185	0.244	0.108	0.092	0.157
Carbon $_{total\ organic}$	$mg\ l^{-1}$	4.4	5.6	2.8	2.0	3.7
Phosphorus $_{total}$	$\mu gP\ l^{-1}$	54.5	85.4	81.1	53.2	69
Phosphorus $_{total\ soluble}$	$\mu gP\ l^{-1}$	22.8	20.2	41.0	20.1	26.0
Phosphorus $_{soluble\ reactive}$	$\mu gP\ l^{-1}$	5.3	5.9	26.2	11.5	12.2
Nitrate	$\mu gN\ l^{-1}$	42	56	539	525	291
Silica $_{soluble\ reactive}$	$mg\ l^{-1}$	2.46	2.76	5.90	2.88	3.50
Chlorophyll a	$\mu g\ l^{-1}$	38.7	37.2	8.7	13.6	24.6
Sulphate	$\mu eq\ l^{-1}$	125	139	146	156	142
Copper $_{total\ soluble}$	$\mu g\ l^{-1}$	0	0	0	0	0
Iron $_{total\ soluble}$	$\mu g\ l^{-1}$	223	360	75	75	183
Lead $_{total\ soluble}$	$\mu g\ l^{-1}$	5	5	0	0	3
Manganese $_{total\ soluble}$	$\mu g\ l^{-1}$	120	60	0	60	60
Zinc $_{total\ soluble}$	$\mu g\ l^{-1}$	5	7	3	0	4

Table J.2 Lower Talley Lake epilithic diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes levanderi	4.3
Achnanthes linearis	8.6
Achnanthes minutissima	40.2
Aulacoseira granulata var. *angustissima*	3.1
Cocconeis placentula var. *euglypta*	1.8
Cocconeis placentula	3.1
Cymbella microcephala	1.8
Eunotia implicata	3.3
Eunotia sp.	2.4
Fragilaria elliptica	15.4
Gomphonema angustatum	2.1
Gomphonema parvulum	1.8
Navicula cryptocephala	1.6
Navicula lanceolata	1.3
Navicula minima	3.0
Navicula sp.	1.3
Nitzschia frustulum	3.4
Nitzschia gracilis	1.1

Table J.3 Lower Talley Lake surface sediment diatom taxon list (including taxa >1.0%)

TAXON	Relative frequency (%)
Achnanthes minutissima	5.0
Asterionella formosa	3.4
Aulacoseira ambigua	1.4
Aulacoseira granulata var. *angustissima*	25.1
Cocconeis placentula var. *euglypta*	1.2
Cocconeis placentula var. *lineata*	1.0
Cyclotella pseudostelligera	2.1
Fragilaria construens var. *venter*	1.4
Fragilaria elliptica	38.4
Fragilaria intermedia	2.1
Fragilaria pinnata	1.7
Navicula cryptocephala	1.0
Navicula seminulum	2.1
Synedra acus	1.5

Table J.4 Lower Talley Lake aquatic macrophyte abundance summary: 3-8-94

TAXON	code	Abun
Emergent taxa		
Equisetum fluviatile	350202	O
Menyanthes trifoliata [1]	364701	R
Carex rostrata	381129	A
Typha latifolia	384902	A
Alisma plantago-aquatica	380303	R
Floating taxa		
Nymphaea alba	365601	F
Nuphar lutea	365501	O
Lemna minor	383302	O
Submergent taxa		
Nitella spp.	220000	O
Myriophyllum alterniflorum [1]	365401	R
Elatine hexandra	362401	O
Potamogeton obtusifolius [1 2]	384000	F
Potamogeton berchtoldii	384003	A
Fringing taxa		
Phalaris arundinacea	383701	F
Oenanthe crocata [1]	365802	A
Lysmachia vulgaris	364502	A
Epilobium hirsutum	------	A
Lycopus europaeus	------	F
Stachys palustris	368501	F
Scutellaria galericulata	367901	F
Mentha aquatica	364601	F
Potentilla palustris [1]	366704	O
Myosotis sp.	365100	F
Salix sp.	367500	F
Alnus glutinosa	360201	F
Hydrocotyle vulgaris	363401	F
Sphagnum sp.	327400	O

[1] = taxon regionally rare for NRA Welsh Region [2] = taxon regionally rare for NRA Severn Trent Region (after Palmer and Newbold, 1983)

Table J.5 Lower Talley Lake littoral Cladocera taxon list: 3-8-94

TAXON	Sample number				
	1	2	3	4	5
Acroperus harpae	2	1		+	
Alona affinis	6			2	1
Alona costata	6	1	1		4
Ceriodaphnia pulchella	92	145	90	74	20
Chydorus sphaericus	1				
Diaphanosoma brachyurum	178	92	192	148	5
Eurycercus lamellatus	1				
Pleuroxus trigonellus	10				
Pleuroxus truncatus	2				
Sida crystallina			7	1	1
Simocephalus vetulus	10	+			1
Total Count	308	239	290	225	32

Table J.6 **Lower Talley Lake zooplankton abundance summary: 3-8-94 Abundance in vertical net hauls (number of individuals $0.01m^{-2}$)**

TAXON	Abun
Eudiaptomus gracilis	1300
Diaphanosoma brachyurum	X
Chaoborus sp. larvae	30
Daphnia galeata	x
Macrocyclops albidus	x
Ceriodaphnia pulchella	140
Acanthocyclops robustus	x
Thermocyclops dybowskii	X
Other planktonic organisms (not quantitatively sampled)	
Volvox sp.	70
Keratella cochlearis	20
Nauplia	20
Asplanchna sp.	20

X = rare species with relative abundance below 1%
x = very rare species found at one site only

Table J.7 **Lower Talley Lake zooplankton characteristics**

Site depth (m)	3.7
Total zooplankton biomass excluding Chaoborus larvae (g DW m^{-2})	0.83
Chaoborus larvae biomass (g DW m^{-2})	0.11
Net algal biomass (g DW m^{-2})	0
Cladoceran biomass as proportion of total zooplankton biomass (%)	7
Large cladoceran (>710μm) as proportion of total zooplankton biomass (%)	0
Large Copepoda (>420μm) as proportion of total zooplankton biomass (%)	6

Table J.8 Lower Talley Lake littoral macroinvertebrate summary. Mean number of individuals per one minute kick/sweep sample.

code	TAXON	Mean count/sample
	TURBELLARIA	
03120000	Tricladida	23.4
	MOLLUSCA	
13070107	*Lymnaea peregra*	3.4
13080201	*Physa fontinalis*	16.0
13090307	*Planorbis albus*	23.4
13090401	*Segmentina complanata*	10.0
	BIVALVIA	
14030200	*Pisidium* sp.	45.4
	HIRUDINIA	
17020101	*Theromyzon tessalatum*	0.6
17020301	*Glossiphonia heteroclita*	2.0
17020302	*Glossiphonia complanata*	1.4
17020501	*Helobdella stagnalis*	12.0
17040102	*Erpobdella octoculata*	16.0
	EPHEMEROPTERA	
30020301	*Cloeon dipterum*	23.4
30080204	*Caenis horaria*	8.0
	ODONATA	
32020000	*Zygoptera* sp.	5.4
32020400	*Coenagrion* sp.	3.4
	HEMIPTERA	
33090101	*Notonecta glauca*	0.6
33110803	*Sigara distincta*	0.6
	COLEOPTERA	
35010000	*Haliplidae* sp.	2.0
35010304	*Haliplus ruficollis* group	0.6
35010312	*Haliplus flavicollis*	2.6
35030000	Dytiscidae undet. (larvae	0.6
35030101	*Noterus clavicornis*	0.6
35030102	*Noterus crassicornis*	0.6
35030401	*Hyphydrus ovatus*	2.6
37000000	LEPIDOPTERA	0.6
	TRICHOPTERA	
38030401	*Holocentropus dubius*	2.0
38030402	*Holocentropus picicornis*	178.0
38070200	*Phryganea* sp.	3.4
38080500	*Limnephilus* sp.	4.0
38120701	*Triaenodes bicolor*	2.0
	DIPTERA	
40010000	Tipulidae	1.4
40080000	Ceratopogonidae	9.4
40090000	Chironomidae	567.4

Figure J.1 Lower Talley Lake: sample location and substrate map

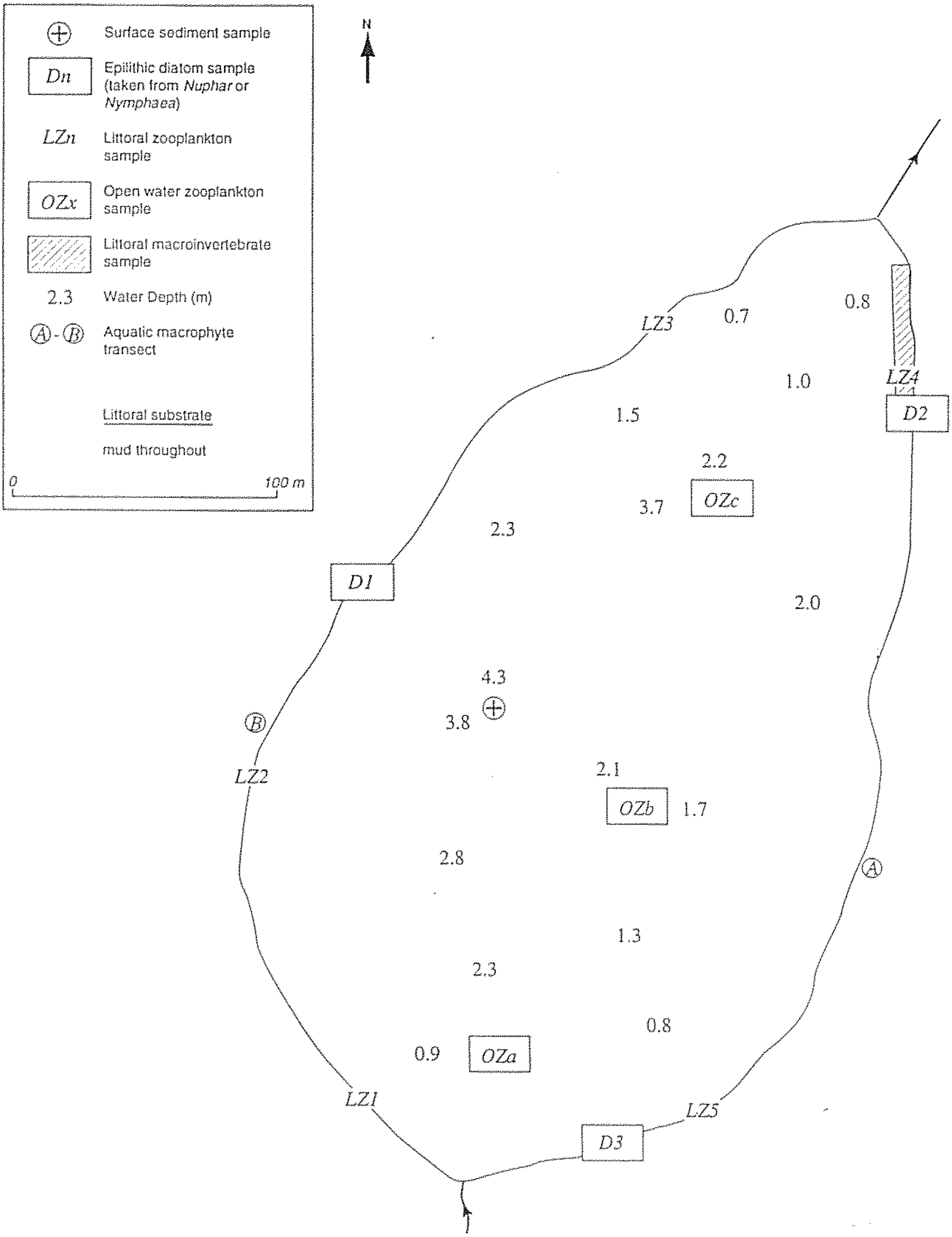
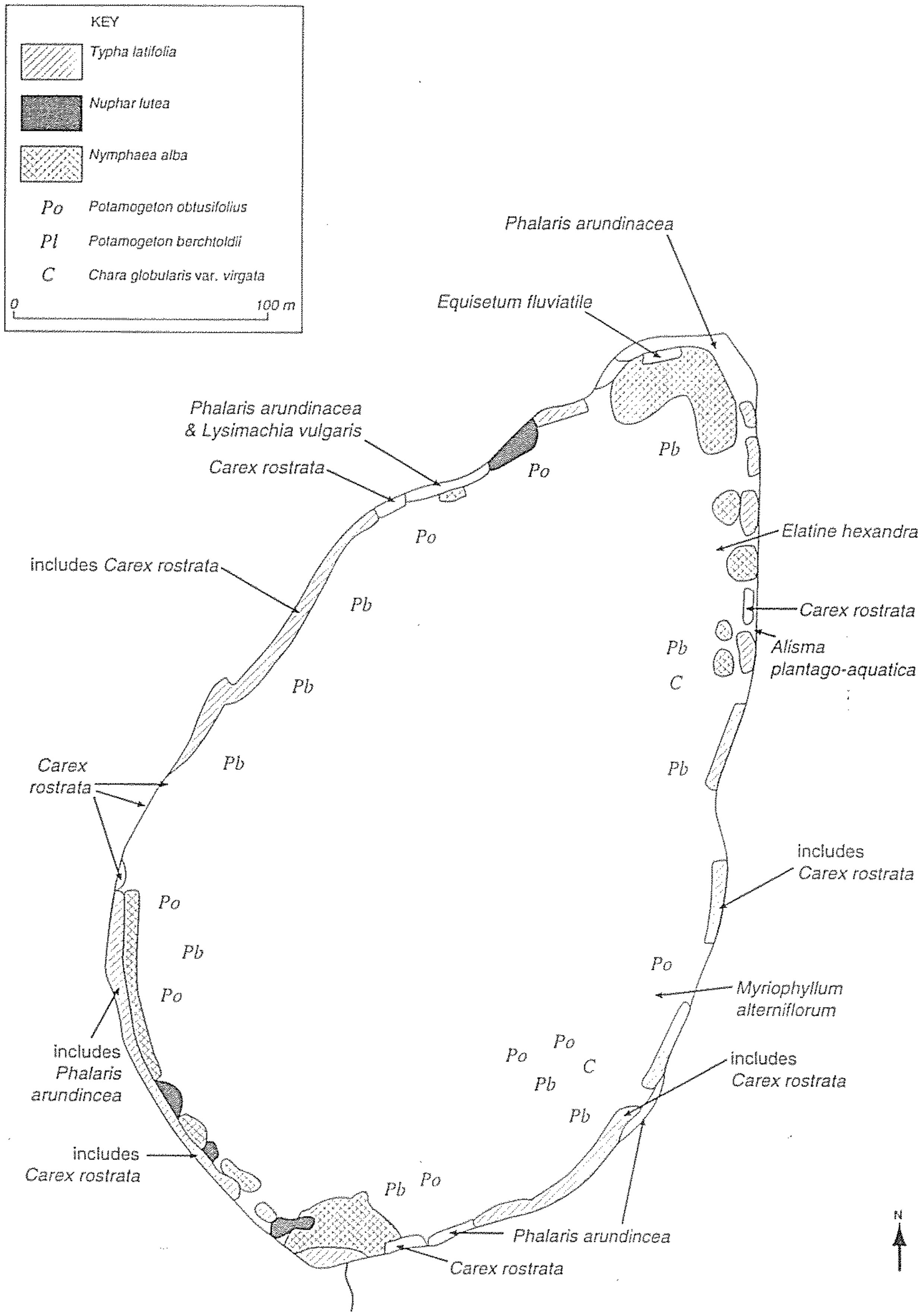


Figure J.2 Lower Talley Lake: aquatic macrophyte distribution map 27-7-94



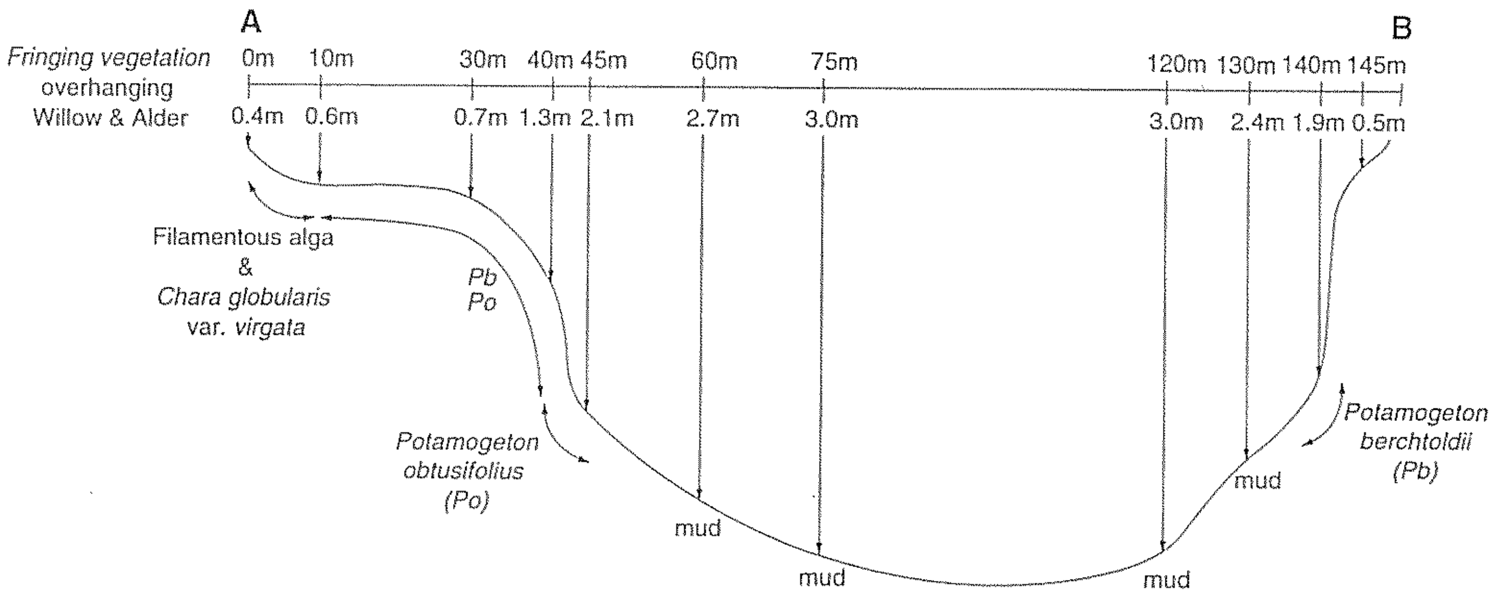
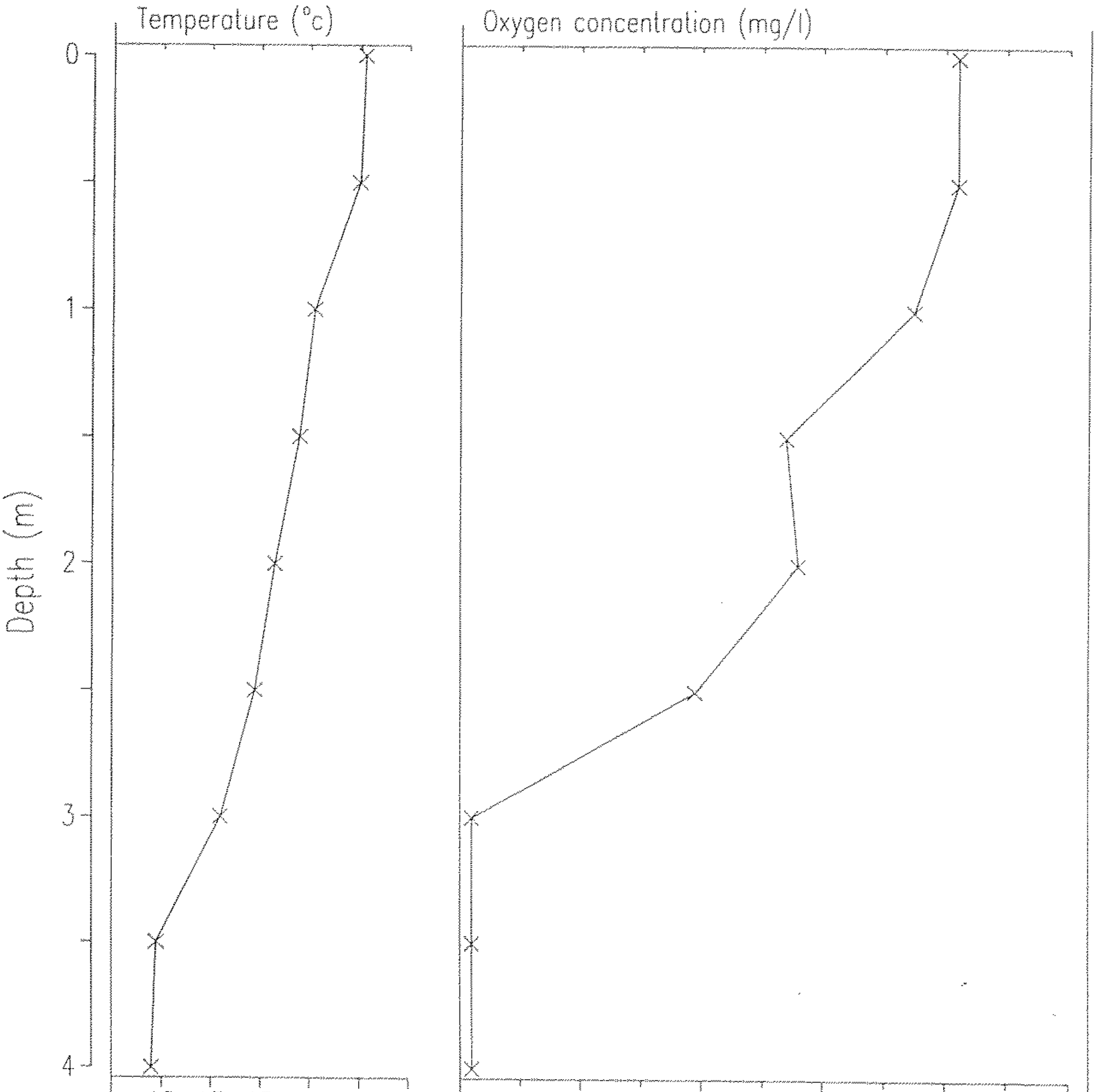


Figure J.3 Lower Talley Lake: aquatic macrophyte transect profile

Figure J.4 Lower Talley Lake: temperature and dissolved oxygen profiles 27-7-94



Appendix K Notes on Cladocera sampling sites

K.1 Bugeilyn, 27-7-94

Samples taken while walking along shoreline.

SITE 1: Beside boat house; *Sparganium angustifolium* dominant; some *Nuphar*; gravel substrate; water brown in colour.

SITE 2: Dominant vegetation is *Sphagnum*; some *Nuphar* and *Carex rostrata*; water brown in colour.

SITE 3: *Sparganium angustifolium* dominant; some *Utricularia*; stone-rock substrate; water brown.

SITE 4: Large *Nuphar lutea* bed over *Sphagnum*.

SITE 5: Dominant vegetation *Nardia compressa* on rock surface; sample taken over boulders and bedrock; some *Utricularia*.

K.2 Llyn Eiddwen, 31-07-94

Samples taken while walking along shoreline.

SITE 1: Lake inflow; *Lobelia dortmanna* and *Potamogeton natans* dominant; silt covering stoney substrate; water clear.

SITE 2: *Littorella/Lobelia* dominant; sand-rock substrate; some *Callitriche hamulata*.

SITE 3: Silt-sand substrate; some *Equisetum fluviatile*, *Littorella uniflora* and *Luronium natans*; abundant *Lobelia*; *Carex rostrata* and *Menyanthes trifoliata* also present.

SITE 4: Peaty substrate; *Carex rostrata* only.

SITE 5: Stony substrate; *Lobelia dortmanna* only.

K.3 Llyn Fanod, 1-08-94

Samples taken while walking along shoreline.

SITE 1: Sand-rock substrate; *Equisetum fluviatile* dominant; *Potamogeton natans* and *Isoetes* sp. present.

SITE 2: *Eleocharis* sp. and *Carex* sp. dominant; some *Potamogeton natans*; stone substrate.

SITE 3: Peaty substrate; *Nuphar lutea* and *Nymphaea alba* bed.

SITE 4: Sand-rock substrate; *Equisetum fluviatile* and *Juncus* sp. present along shoreline; some *Littorella uniflora* present.

SITE 5: *Equisetum fluviatile* and *Lobelia dortmanna* dominant; *Littorella uniflora* and *Isoetes* sp. present; sand-silt substrate.

K.4 Glanmerin, 26-07-94

Samples taken while walking along shoreline

SITE 1: Near outflow; mud-vegetation substrate; *Menyanthes trifoliata*, *Juncus* sp., *Nymphaea alba* dominant; large boulders covered with organic silt.

SITE 2: Sand-rock substrate; *Juncus bulbosus* only

SITE 3: *Sphagnum* mat extending into lake; some *Menyanthes trifoliata* and *Hypericum elodes*

SITE 4: Rock substrate; *Equisetum fluviatile* dominant; some *Potamogeton natans* and *Ranunculus flammula*

SITE 5: Eroded shore; silt substrate; sample taken through base of *Typha latifolia*

K.5 Llyn Gynon, 30-07-94

Samples taken while walking along shoreline.

SITE 1: Stone-rock-sand-gravel beach with *Lobelia dortmanna*, *Littorella uniflora*, *Juncus bulbosus*; algal covering on substrate.

SITE 2: Stone-rock-gravel shore; *Littorella uniflora* and *Lobelia dortmanna* mat with *Juncus bulbosus* and *Callitriche hamulata*; water clear.

SITE 3: Bed of *Carex rostrata* with water logged bird's nest; mud-vegetation substrate; some *Lobelia dortmanna*; peat silt present.

SITE 4: Near outflow; *Carex rostrata* bed with some *Lobelia dortmanna* and *Juncus bulbosus*; mud-vegetation substrate.

SITE 5: Peaty substrate; *Littorella uniflora*, *Lobelia dortmanna*, *Juncus bulbosus*, *Luronium natans* and filamentous algae.

K.6 Llyn Hir, 29-7-94

Samples taken while walking along shoreline. There was no noticable draw down at this site unlike some of the other Teifi Pools.

SITE 1: Stone substrate with algal covering; *Juncus bulbosus*, *Lobelia dortmanna* and *Subularia aquatica* present.

SITE 2: Some *Sparganium angustifolium* and *Juncus bulbosus*; *Lobelia dortmanna* dominant; rock substrate covered with algae.

SITE 3: *Sparganium angustifolium* dominant; *Lobelia dortmanna* abundant; some *Isoetes*; *Subularia aquatica* present; water very clear.

SITE 4: Peat substrate; *Lobelia dortmanna*, *Menyanthes trifoliata* and *Potamogeton polygonifolius* present.

SITE 5: Mud-vegetation substrate; peaty bank; masses of *Juncus bulbosus*; *Lobelia dortmanna* common; abundant filamentous algae.

K.7 West Ieuan, 28-07-94

Samples taken while walking along shoreline.

SITE 1: Algae and bryophytes dominant; some *Juncus bulbosus*; gravel-stone substrate; water very clear.

SITE 2: Shingle beach; some algae/bryophyte.

SITE 3: *Juncus bulbosus* covered with algae dominant.

SITE 4: Similar to site 1; algae and moss dominant; some *Juncus bulbosus*.
Small pool to west (marked on map) completely dry; bare black peat substrate; no aquatic plants.

Site 5: Bryophyte/filamentous algae dominant; small gravel beach; water very clear.

K.8 Maes-llyn, 2-08-94

Samples taken while walking along shoreline, with the exception of site 5 which was taken from boat.

SITE 1: *Littorella uniflora* present but mainly *Ceratophyllum demersum* and fine leaved *Potamogeton* sp.; silt covered stones.

SITE 2: *Menyanthes trifoliata* mat with *Ceratophyllum demersum* below and on margins.

SITE 3: *Nuphar lutea* bed with *Ceratophyllum* below; stoney substrate.

SITE 4: *Carex rostrata* bed with *Ceratophyllum* on margins; very fine silt substrate.

SITE 5: *Typha latifolia* bed.

K.9 Upper Talley Lake, 3-08-94

Samples taken while walking along shoreline.

SITE 1: *Nymphaea alba* under *Alnus* and *Fraxinus* trees; mud-vegetation substrate.

SITE 2: Base of *Typha latifolia* stand; mud-vegetation substrate.

SITE 3: Mixed *Equisetum fluviatile* and *Eleocharis palustris* stand; mud-vegetation substrate.

SITE 4: *Menyanthes trifoliata* dominant.

SITE 5: *Carex rostrata* and *Nymphaea alba* stand; fine-leaved Potamogeton present; mud-vegetation substrate.

K.10 Lower Talley Lakes, 3-08-94

All samples taken from boat, with the exception of site 1.

SITE 1: Access point for boats; sample taken at base of *Typha latifolia* bed; mud-vegetation substrate.

SITE 2: *Carex rostrata* bed near old fishing platform; some *Nitella* sp. and *Equisetum fluviatile* present; mud-vegetaion substrate.

SITE 3: Mixed *Carex rostrata* and *Typha latifolia* bed; mud-vegetation substrate.

SITE 4: *Nymphaea alba* outside *Typha latifolia* bed; mud-vegetation substrate.

SITE 5: *Typha latifolia* stand; mud-vegetation substrate.

Appendix L Notes on littoral macroinvertebrate sampling sites

L.1 Bugeilyn

-"brown water", shingle and some bare peat, some emergent and floating macrophytes

L.2 Llyn Eiddwen

-clear water, cobbles and some sand, *Juncus* at the margin, some *Lobelia*

L.3 Llyn Fanod

-clear water, gravel and cobbles under organic mud/silt, Juncus at the margin, some *Lobelia* and *Potamogeton natans*

L.4 Llyn Glanmerin

-turbid water, large flat stones with organic mud/silt inbetween, extensive stands of emergent and submerged macrophytes

L.5 Llyn Gynon

-clear water, sand,shingle, *Lobelia* and other submerged macrophytes

L.6 Llyn Hir

-clear water, cobbles and some organic mud/silt, abundant *Lobelia* and other submerged macrophytes

L.7 West Ieuan

-clear water, shingle beach and some cobbles, extensive mat of submerged darkly pigmented filamentous algae.

L.8 Maes-llyn

-clear water, cobbles, many submerged macrophytes

L.9 Upper Talley Lake

-turbid water, organic mud/silt, extensive emergent macrophytes

L.10 Lower Talley Lake

-"brown" water, organic mud/silt, extensive emergent and submergent macrophytes

Appendix M: A bibliography for the Study Sites

A bibliography for Bugeilyn

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Appendix N Previous macrophyte records for Phase II sites

Table N.1 Bugeilyn

Agrostis stolonifera Lowther (1986)
Callitriche hamulata Seddon (1964), Lowther (1986)
Carex nigra Seddon (1964), Lowther (1986)
Carex rostrata Seddon (1964)
Eleocharis palustris Lowther (1986)
Equisetum fluviatile Seddon (1964), Lowther (1986)
Eriophorum angustifolium Seddon (1964), Lowther (1986)
Glyceria fluitans Seddon (1964), Lowther (1986)
Juncus bulbosus var. *fluitans* Seddon (1964), Lowther (1986)
Juncus effusus Seddon (1964), Lowther (1986)
Littorella uniflora Seddon (1964)
Luronium natans Seddon (1964)(1972)
Nuphar lutea Seddon (1964)(1972), Lowther (1986)
Potamogeton polygonifolius Seddon (1964)(1972), Lowther (1986)
Sparganium angustifolium Seddon (1964)(1972)

Table N.2 Llyn Eiddwen

Agrostis stolonifera Lowther (1986)
Alisma plantago-aquatica Morgan (1849), Salter (1935), Seddon (1972)
Baldellia ranunculoides Moore & Thomas 1963, Seddon (1964), Newbold (1977)
Callitriche hamulata Seddon (1972), Chater 1959,1989,1990, Lowther (1986)
Caltha palustris Seddon (1964), Lowther (1986)
Carex aquatilis Lowther (1986)
Carex curta Salter (1935), Seddon (1972)
Carex nigra Seddon (1964), Lowther (1986)
Carex rostrata Salter (1952), Seddon (1972), Lowther (1986), Chater 1989
Elatine hexandra Chambers 1990
Eleocharis palustris Seddon (1972), Lowther (1986), Chater 1989
Equisetum fluviatile Salter (1935), Seddon (1972), Lowther (1986), Chater 1989
Glyceria fluitans Seddon (1972), Lowther (1986)
Hydrocotlye vulgaris Seddon (1964), Lowther (1986)
Hypericum elodes Salter 1903 (1935), Moore & Thomas 1963, Seddon (1972)
Isoetes echinospora Chater 1959,1989
Isoetes lacustris Salter (1935), Seddon 1964(1972), Newbold (1977), Chater 1989
Juncus bulbosus var. *fluitans* Seddon (1972), Lowther (1986)
Juncus effusus Seddon (1964), Lowther (1986)
Littorella uniflora Burkill & Willis (1894), Salter (1935), Seddon (1972), Chater 1959,1975,1989,1990
Lobelia dortmanna Salter (1935), WNT Bull (1977),Seddon (1972), Chater 1959-75, Newbold (1977), Chater 1989,1990
Luronium natans Salter (1905,1924,1935,1936), Chater 1959,1975,1989, Seddon (1972),Newbold (1977)
Lythrum portula Chater 1959, Seddon (1964), Lowther (1986), Chambers 1990
Menyanthes trifoliata Salter (1935), Seddon (1972), Lowther (1986), Chater (1989)
Nitella spp.
Potamogeton berchtoldii Chater 1959, Newbold (1977), Chater 1989
Potamogeton natans Seddon (1972), Newbold (1977), Lowther (1986), Chater 1989,1990
Potamogeton polygonifolius Seddon (1964)
Ranunculus flammula Seddon (1972), Lowther (1986), Chater 1989
Ranunculus omiophyllus Lowther (1986)
Sparganium angustifolium Seddon (1972)
Sparganium emersum Seddon (1964)
Sparganium minimum Newbold & Jones (1977)
Subularia aquatica Seddon (1972), Newbold (1977), Chater 1959,1975,1989,1990, Lowther (1986)
Utricularia minor Seddon (1964)

Table N.3 Llyn Fanod

Agrostis stolonifera Seddon (1964), Lowther (1986)
Baldellia ranunculoides Seddon (1964)
Callitriche hamulata Chater (1984,1989), Lowther 1986
Callitriche stagnalis Lowther (1986)
Caltha palustris Seddon (1964), Lowther (1986)
Carex aquatilis Lowther (1986)
Carex curta Salter 1935, Seddon (1972)
Carex nigra Seddon (1964), Lowther (1986)
Carex rostrata Seddon (1972), Lowther (1986), Chater 1989
Elatine hexandra Seddon (1972), Chater 1984
Eleocharis palustris Seddon (1972), Lowther (1986)
Equisetum fluviatile Seddon (1972), Lowther (1986), Chater 1989, Francis (1990)
Equisetum palustre Seddon (1964), Lowther (1986)
Glyceria fluitans Seddon (1972), Lowther (1986), Chater 1989
Hydrocotyle vulgaris Seddon (1964), Lowther (1986)
Isoetes echinospora Seddon (1972), Chater 1984,1989, Lowther (1986)
Isoetes lacustris Newbold (1977), Lowther (1986), Chater 1989, Francis (1990)
Juncus bulbosus Lowther (1986)
Juncus effusus Seddon (1964), Lowther (1986)
Littorella uniflora Burkill & Willis (1894), Marshall (1899), Salter (1935), Seddon (1972), Chater (1984), Francis (1990)
Lobelia dortmanna Seddon (1972), Newbold (1977), Chater (1989), Francis (1990)
Luronium natans Burkill & Willis (1894), Salter (1924,1935), Seddon (1972), Chater (1984,1989)
Menyanthes trifoliata Seddon (1972)
Nitella translucens Chater (1984)
Nuphar lutea Marshall (1899), Salter (1935), Moore & Thomas (1963), Seddon (1972), Newbold (1977), Lowther (1986)
Nymphaea alba Marshall (1899) Salter (1935), Seddon (1972), Newbold (1977), Lowther (1986), Chater (1989)
Potamogeton natans Seddon (1972), Chater (1984), Newbold (1977), Chater (1989)
Potamogeton polygonifolius Seddon (1972)
Ranunculus flammula Seddon (1972), Lowther (1986)
Ranunculus omiophyllus Chater 1989
Scirpus fluitans Salter (1935), Seddon (1972), Lowther (1986)
Sparganium erectum Seddon (1964), Lowther (1986)
Subularia aquatica Newbold & Jones (1977), Francis (1990)

Table N.4 Llyn Glanmerin

Callitriche hamulata Seddon (1964), Lowther (1986)
Carex nigra Seddon (1964), Lowther (1986)
Eleocharis palustris Seddon (1964)
Elodea canadensis Seddon (1964)
Equisetum fluviatile Seddon (1964)
Glyceria fluitans Seddon (1964), Lowther (1986)
Hydrocotyle vulgaris Seddon (1964), Lowther (1986)
Iris pseudacorus Seddon (1964), Lowther (1986)
Isoetes lacustris Seddon (1964), Lowther (1986)
Juncus bulbosus Seddon (1964), Lowther (1986)
Juncus effusus Seddon (1964), Lowther (1986)
Menyanthes trifoliata Seddon (1964), Lowther (1986)
Myriophyllum alterniflorum Seddon (1964)
Nuphar lutea Seddon (1964), Lowther (1986)
Nymphaea alba Seddon (1964), Lowther (1986)
Phalaris arundinacea Lowther (1986)
Potamogeton natans Seddon (1964), Lowther (1986)
Ranunculus flammula Seddon (1964), Lowther (1986)
Ranunculus omiophyllus Lowther (1986)
Sparganium angustifolium Seddon (1964)
Typha latifolia Seddon (1964), Lowther (1986)

Table N.5 Llyn Gynon

Callitriche hamulata Seddon (1972), Chater 1989
Callitriche platycarpa Chater 1984
Carex curta Chater 1989
Carex rostrata Chater 1978,1984,1989
Elatine hexandra Chater 1989
Equisetum fluviatile Chater 1978,1984,1989
Glyceria fluitans Salter (1935), Seddon (1972), Chater 1978,1984
Glyceria x *pedicellata* Chater 1989
Isoetes echinospora Seddon (1972), Chater 1984,1989
Isoetes lacustris Salter (1935)
Juncus bulbosus var. *fluitans* Chater 1984, Seddon (1972), Chater 1989
Littorella uniflora Salter (1935), Seddon (1972), Chater 1978,1984,1989
Lobelia dortmanna Salter (1935), Burkhill & Willis (1894)
Luronium natans Salter (1935), Burkhill & Willis (1894), Chater 1984, Seddon (1972), Chater 1989
Menyanthes trifoliata Salter (1935), Seddon (1972), Chater 1989
Myriophyllum alterniflorum Seddon (1972), Chater 1984,1989
Myriophyllum sp. Salter (1935)
Nuphar lutea Salter (1935), Chater 1978,1984, Seddon (1972)
Pilularia globulifera Seddon 1964
Potamogeton polygonifolius Salter (1935), Seddon (1972), Chater 1984,1989
Ranunculus flammula Chater 1978,1984,1989
Scirpus fluitans Chater 1978,1989
Sparganium angustifolium Salter (1935), Seddon (1972)
Subularia aquatica Burkhill & Willis (1894)1893, Salter (1935), Seddon (1972), Chater 1989

Table N.6 Llyn Hir

Agrostis stolonifera Lowther (1986)
Carex nigra Lowther (1986)
Carex rostrata Seddon (1964), Chater 1989, Chater & Preston 1993
Isoetes lacustris Conolly (1965), Underwwod *et al.* (1987),1985, Chater 1989
Glyceria fluitans Lowther (1986), Chater 1989, Chater & Preston 1993
Isoetes echinospora Chater 1989, Chater & Preston 1993
Isoetes lacustris Conolly (1965), Seddon (1964), Lowther (1986), Underwood *et al.* (1987)1985, Chater 1989
Juncus bulbosus Seddon (1964), Lowther (1986), Chater 1989
Juncus effusus Lowther (1986), Chater 1989, Chater & Preston 1993
Littorella uniflora Salter (1935), Burkhill & Willis (1894), Seddon (1964), Chater 1989, Chater & Preston 1993
Lobelia dortmanna Burkhill & Willis (1894), Salter (1935), Seddon (1964), Lowther (1986), Chater 1989, Chater & Preston 1993
Luronium natans Chater 1989, Chater & Preston 1993
Menyanthes trifoliata Chater 1989, Chater & Preston 1993
Myriophyllum alterniflorum Seddon (1964), Conolly (1965), Chater 1989, Chater & Preston 1993
Myriophyllum sp. Salter (1935)
Potamogeton polygonifolius Chater 1989, Chater & Preston 1993
Ranunculus omiophyllus Chater & Preston 1993
Sparganium angustifolium Seddon (1964), Lowther (1986), Underwood *et al.* (1987), Chater 1989, Chater & Preston 1993
Subularia aquatica Burkhill & Willis (1894)1893, Salter (1935), Seddon (1964), Lowther (1986), Chater 1989, Chater & Preston 1993
Utricularia minor Chater 1989, Chater & Preston 1993

Table N.7 Llynnoedd Ieuan (records for all 3 lakes undifferentiated)

Callitriche hamulata Chater 1988
Callitriche platycarpa Salter n.d.
Carex rostrata Lowther (1986)
Equisetum fluviatile Chater & Fowler 1988
Glyceria fluitans Salter (1935), Seddon (1972), Chater 1988
*Isoetes echinospora**
*Isoetes lacustris** Chater 1988
*Juncus bulbosus** Lowther (1986)
Juncus effusus Lowther (1986)
*Littorella uniflora** Burkhill & Willis (1894), Salter (1935), Seddon (1964)
*Lobelia dortmanna** Salter (1935), Seddon (1972), Chater 1988
Myriophyllum alterniflorum Seddon (1972)
Myriophyllum sp. Salter (1935)
Potamogeton polygonifolius Salter (1935), Seddon (1972)
Ranunculus omiophyllus Salter (1935)
Sparganium angustifolium Salter (1935), Chater 1988, Seddon (1972)

* indicates those plants recorded at the West lake by A.Chater in 1993

Table N.8 Maes-Llyn

Agrostis stolonifera Seddon (1964), Lowther (1986)
Carex acuta Chater 1956
Carex aquatilis Ley (1887), Salter (1935), Seddon (1972), Chater 1983
Carex curta Seddon (1972)
Carex nigra Seddon (1964), Lowther (1986)
Carex rostrata Seddon (1972), Lowther (1986)
Carex vesicaria Chater 1956, Seddon (1972), Lowther (1986)
Callitriche stagnalis Lowther (1986)
Caltha palustris Seddon (1964), Lowther (1986)
Ceratophyllum demersum Chater 1956, 1983, Seddon (1972), Chater 1991
Elatine hexandra Chater & Moscrop 1993
Eleocharis palustris Ley (1887) 1886-7, Salter (1935), Seddon (1972)
Equisetum fluviatile Seddon (1972), Lowther (1986)
Glyceria fluitans Seddon (1972), Lowther (1986)
Hydrocotyle vulgaris Seddon (1964), Lowther (1986)
Iris pseudacorus Seddon (1964), Lowther (1986)
Juncus effusus Seddon (1964), Lowther (1986)
Littorella uniflora Ley (1887), Salter (1935), Seddon (1972), Chater 1983, Lowther (1986)
Lythrum portula Conolly 1965, Lowther (1986)
Lythrum salicaria Ley (1887) 1886-7, Salter (1935), Seddon (1972), Chater 1983
Mentha aquatica Lowther (1986)
Menyanthes trifoliata Seddon (1972), Chater 1983, Lowther (1986)
Myriophyllum alterniflorum Ley (1887), Chater 1956, 1983, Seddon (1972)
Myriophyllum spicatum Salter (1952)
Nuphar lutea Seddon (1972), Chater 1976, 1983, Lowther (1986)
Phalaris arundinacea Seddon (1972), Lowther (1986)
Potamogeton berchtoldii Seddon (1972), Chater 1983
Potamogeton obtusifolius Chater & Moscrop 1993
Ranunculus flammula Ley (1887) 1886-7, Seddon (1972), Lowther (1986), Chater 1991
Typha latifolia Seddon (1964), Chater 1983, Lowther (1986)

Table N.9 The Talley Lakes

Agrostis stolonifera Seddon (1964), Lowther (1986)
Alisma plantago-aquatica Evans & Howell 1962, Seddon (1964), Lowther (1986)
Apium inundatum Seddon (1964)
Apium nodiflorum Seddon (1964)
Callitriche hamulata Lowther (1986)
Caltha palustris Seddon (1964), Lowther (1986)
Carex acutiformis Seddon (1964)
Carex nigra Seddon (1964)
Carex riparia Evans & Howell 1962
Carex rostrata Evans & Howell 1962, Seddon (1964), Lowther (1986)
Carex vesicaria Seddon (1964), Lowther (1986)
Elatine hexandra Seddon (1964)
Eleocharis palustris Seddon (1964), Lowther (1986)
Equisetum fluviatile Seddon (1964), Lowther (1986)
Glyceria declinata Seddon (1964), Lowther (1986)
Glyceria fluitans Seddon (1964), Lowther (1986)
Hydrocotyle vulgaris Seddon (1964), Lowther (1986)
Iris pseudacorus Seddon (1964), Lowther (1986)
Juncus bulbosus Lowther (1986)
Juncus effusus Seddon (1964), Lowther (1986)
Lemna minor Lowther (1986)
Littorella uniflora Seddon (1964)
Lythrum portula Seddon (1964), Lowther (1986)
Mentha aquatica Seddon (1964), Lowther (1986)
Menyanthes trifoliata Seddon (1964), Lowther (1986)
Myriophyllum alterniflorum Seddon (1964), Lowther (1986)
Nuphar lutea Evans & Howell 1962, Seddon (1964), Lowther (1986)
Nymphaea alba Evans & Howell 1962, Seddon (1964), Lowther (1986)
Phalaris arundinacea Evans & Howell 1962, Seddon (1964), Lowther (1986)
Polygonum amphibium Evans & Howell 1962, Seddon (1964), Lowther (1986)
Polygonum hydropiper Evans & Howell 1962, Seddon (1964), Lowther (1986)
Potamogeton berchtoldii Lowther (1986)
Potamogeton natans Evans & Howell 1962, Seddon (1964), Lowther (1986)
Ranunculus aquatilus Evans & Howell 1962, Seddon (1964), Lowther (1986)
Ranunculus circinatus Lowther (1986)
Ranunculus flammula Evans & Howell 1962, Seddon (1964), Lowther (1986)
Ranunculus lingua Evans & Howell 1962
Ranunculus omiophyllus Seddon (1964)
Scirpus lacustris Evans & Howell 1962
Sparganium emersum Seddon (1964)
Sparganium erectum Seddon (1964)
Typha latifolia Seddon (1964), Lowther (1986)
Veronica beccabunga Seddon (1964), Lowther (1986)
Veronica scutellata Seddon (1964)

Appendix O: Zooplankton of the Talley Lakes recorded in a survey by J.Green 12-5-94

TAXON	Upper Talley Lake	Lower Talley Lake
ROTIFERA		
Ascomorpha sp.	-	+
Asplancha priodonta	+	+
Brachionus angularis	+	+
Conochilus sp.	-	+
Filinia terminalis	+	+
Keratella cochlearis	+	+
Keratella quadrata	+	+
Polyartha dolichoptera	+	+
Synchaeta sp.	-	+
CRUSTACEA		
COPEPODA		
Eudiaptomus gracilis	+	+
Macrocyclops albidus	+	+
Eucyclops serrulatus	+	+
Thermocyclops dybowskii	-	+
CLADOCERA		
Diaphanosoma brachyurum	+	-
Daphnia galeata	+	-
Daphnia longispina	-	+
Ceriodaphnia pulchella	-	+
Eurycerus lamellatus	+	+
Chydorus sphaericus	-	+
INSECTA		
Chaoborus crystalinus	+	-

Appendix P: Project Output to Date

Research Reports -

Environmental Change Research Centre (1994). Integrated Classification and Assessment of Lakes in Wales: Phase I. A preliminary data report to the Countryside Council for Wales under Contract No. FC 7301-71.

Environmental Change Research Centre (1994). Integrated Classification and Assesssment of Lakes in Wales: Phase I. A final report to the Countryside Council for Wales under Contract No. FC 73-01-71. CCW Contract science Report No. 85.

Environmental Change Research Centre (1995). Integrated Classification and Assessmnet of Lakes in Wales: Phase II. A preliminary data report to the Countryside Council for Wales under Contract No. FC 73-01-13. CCW Contract Science report No. 89.

Publications -

Allott, T. (1995). Recent Limnological Surveys of Llyn Coron, Llyn Dinam and Llyn Penrhyn. Freshwater News - Special Issue, 8(1): 10-13.

Duigan, C.A. (1995). Anglesey Lakes Symposium. Freshwater News -Special Issue, 8(1): 1-22.

Duigan, C.A. (1994). Llyn Cwellyn - recent survey work commissioned by the Countryside Council for Wales. Freshwater News 7(3): 10-14, Appendix I: 1-4.

Duigan, C.A., T.E.H. Allott, H. Bennion, J. Lancaster, D.T. Monteith, S.T. Patrick, J. Ratcliffe and J.M. Seda (submitted May 1995). The Anglesey Lakes, Wales, UK - A Conservation Resource. Aquatic Conservation: Marine and Freshwater Ecosystems.

Other applications of information -

The results of the limnological surveys of the three Phase I Anglesey sites formed a contribution to the Anglesey Lakes Symposium, Beaumaris, Anglesey, November 1994, which was hosted by the Countryside Council for Wales.

The limnological survey data collected has been used by the Anglesey Wetland Strategy Group in its discussions on standing water management.

The data collected was used in the assessment of sites for inclusion as proposed SACs under the EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora

It is expected that the data collected will contribute to the development of management plans for the sites surveyed.

Media coverage related to the Anglesey Lakes Symposium included a series of radio and TV interviews by BBC Wales and press coverage.