Institute of Freshwater Ecology

The Cheshire Meres: an analysis of data and a prioritisation of sites

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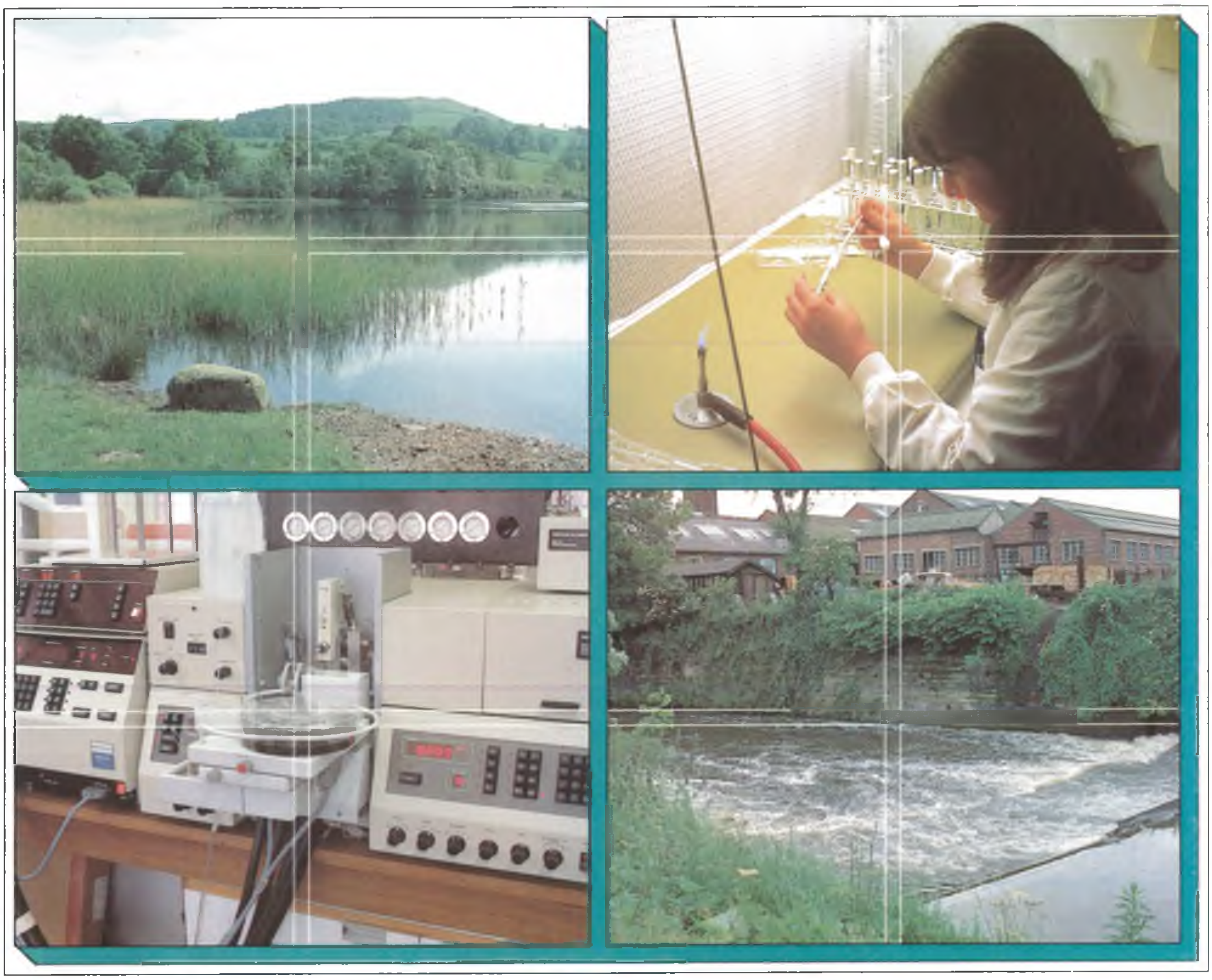

Natural Environment Research Council

Report to Environment Agency, North West Region

THE CHESHIRE MERES: AN ANALYSIS OF DATA AND A PRIORITISATION OF SITES

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EXECUTIVE SUMMARY

The report addresses data collected by the Agency for 24 basin sites in Cheshire. At least two samples were collected from each site, though not simultaneously. Sites were visited in May/June and in November. The determinands are standard and they included: water temperature, conductivity, pH, DO, fractional white-light penetration, TSS, chlorophyll, TP, ortho-phosphate P, nitrate-, nitrite- and ammonium-nitrogen and silicate. Though concentrations were often higher than for other lakes in the region, rather exceeding criteria for classification as eutrophic lakes, the results conform to previous judgements that the series of lakes is, naturally, highly eutrophic and nothing in the present data differs so far from expectation that is persuasive that the ecosystems are reacting adversely to environmental stresses.

The data set is reviewd and summarised, site-by-site, in an appendix.

The grounds for prioritisation are discussed. A scheme of monitoring at four to six sites is suggested where insidious or long-term changes in the hydrology, hydrochemistry and hydrobiology of representative sites are monitored three or four times every second or third year.

The sites nominated are: Betley Mere (for the Marginal group), Hatch Mere and Oak Mere (Delamere), Budworth and Rostherne or Tatton Mere (Knutsford) and Marbury Big Mere or, possibly, Quoisley Big Mere (Whitchurch).

Whether or not this preferred prioritised option is adopted, the Agency is recommended to review the way it carries out monitoring. The determinands and the sampling frequency need to be geared to the information that is required.

CONTENTS

1. INTRODUCTION

This report addresses a requirement of the North West Region of The Environment Agency for an interpretative framework for a water quality strategy for still waters in the southerrn part of the region. Judged against the lakes elsewhere in the region and, indeed, against the criteria for lake classification, most of the water bodies of Cheshire and south Lancashire appear to conform to a disturbingly low water quality. This outcome is unreasonable - it says more about the system of classification system than the quality of these water bodies. Most of the water bodies in question are natural basin sites in kataglacial drift deposits, fed in part with ground water and evaporite leachates which impart a high ionic strength and nutrient load to the waters in question (Reynolds, 1979). Most are, indeed, classically eutrophic, but it is important to recognise that this condition is not the exclusive result of some recent anthropogenic deterioration. The pristine state of many of these water bodies is to be chemically rich and biologically very productive.

There are, nevertheless, many examples of poor management and degradation of these lowland mere sites. The Agency has a statutory duty to seek the protection of these water bodies and the application of adequate standards of management and it is proper that it should do this from a careful assembly of factual information and studious interpretation.

The Agency has inherited a programme of sampling and analysis of selected Cheshire meres, initiated in 1994, together with the database of information which is the focus of this evaluation. Largely by reference to these data but supplemented by other information and historical records, where these are appropriate, the report seeks evidence of trends in the accumulated data and attempts to put these into some overall perspective. A further section proposes some basis for prioritisation of the sites according to the problems that they present; this includes suggestions for alternative schemes of monitoring the progress of future management policies.The report begins with a short overview of the origin and limnological peculiarities of the meres.

2. OVERVIEW OF THE LIMNOLOGY OF THE CHESHIRE MERES.

The meres of the north-west Midlands constitute a series of small, generally fertile basin sites in the glacial drift deposits that cover the Shropshire Cheshire Plain. Most were formed by contemporary kataglacial processes at the end of the last ice-age, though it is not ceratin that all have been continuously water-filled and it is likely that some basins have appeared subsequently as a result of subsidence over wet-head solution of the underlying saliferous strata. Most of the lakes are isolated from surface inflows and outflows. The unrefuted contention is that the lakes are fed and drained predominantly by lateral flows of ground water, although it is quite clear that land drainage work during the last two or three centuries has modified the water balance.

Many of the lakes have been recognised to be eutrophic and well-supplied with plant nutrients. They are capable of producing large populations of phytoplankton, which are often dominated by nitrogen-fixing cyanobacteria. Historical records and palaeolimnological investigations reveal that this is not a recent phenomenon, rather that the implicit supportive fertility has existed for three or more millennia. The natural fertility of particular sites is related to the large quantities of Triassic evaporite present in the drift: these were originally derived from the rocks overridden by the advancing Devensian glaciers emanating from Cumbria and Galloway and were incorporated in the till and drift mantle left in its wake. Reynolds (1979) was able to characterise the series as a whole by their distinctive origin, distribution, morphometry, hydrology and fertility.

Within this broad circumscription, there are important variations. The lakes are clustered and each group has certain distinctions. Those of the eastern Marginal group occupy basins in thick drift trapped between the residual lowland ice and the waning Pennine glaciers are especially calcareous. Those of the Knutsford Group are distinguished by a high sulphate content. The drifts of the Delamere Forest are thin and sandy and the lakes there have tended to be of rather lower ionic strength and some are quite acidic. The natural nutrient content of all the meres is probably just as widely variable though even the most dilute examples are considerably richer in phosphorus (TP, generally > 40 $\mu g\ l^{-1}$). Reynolds (1979) considered this to be typical of the series but that soluble sources of inorganic nitrogen, long ago leached from the drift, now relied more on present exchanges in precipitation. Recent agricultural practices, especially the application of nitrate fertilser to grassland, are suggested to have been responsible for increased fertility this century and some of the instances of enhanced phytoplankton production, especially of non-nitrogen-fixing species, have been identified.

Eutrophication of already eutrophic meres cannot be considered to be unimportant. Changes in groundwater flow and nutrient content of the meres does affect the biota they support but the greater sensitivity of these sites might be to other forms of pollution and to alterations in the physical habitats. Growing demand for recreational access and water-based activities may also be damaging but the enhanced risks of contact with potentially toxic organisms remains a factor in how sites are managed and protected. In the review of the present dataset, both the importance of the site and the risk to casual users has been included in the assessment.

3. REVIEW OF THE CURRENT DATABASE

The materials offered for review included:

- Listed data from analysis of field sites; 24 of these were Cheshire Meres, specified for the assessment. Each had been sampled at least twice, in May and November. Determinands included water temperature, conductivity, pH, DO, fractional white-light penetration, TSS, chlorophyll, TP, ortho-phosphate P, nitrate-, nitrite- and ammonium-nitrogen and silicate.

- Copy of internal report *MSP-CME-95-02*, "Cheshire Meres 1995 May-June Surveys"

- Copy of internal report *MSP-CME-96-01*, "South Area Still Waters 1995 November Surveys"

- Copy of internal report *MSP-CME-96-02*, "Cheshire Meres Stillwaters May-June 1996 Surveys"

- Two lists of main phytoplankton for meres sampled in May, 1995 and May, 1996

- One list of main zooplankton for meres sampled in May-June, 1996.

There is no explanation for the choice of sites or the frequency and timing of the samplings. Most sites were visited twice, in May/June and November of the same year or in November and May/June the following year; it is argued that this scheme improves the comparability. In most instances, data were collected at three stations. I am concerned that the between-station measures are sometimes larger than would be normally expected for closely adjacent sites in the same small lake and would urge the Agency to satisfy itself on the levels of analytical control that it applies. Results are presented clearly in the reports behind a narrative which compares results between stations and ranks the lakes sampled according to the lake-specific mean value of each determinand. The reason for doing this is not transparent but the results are certainly clear. The determinands are themselves fairly standard and have not been chosen for their sensitivity to any single process in any particular lake. The lists of plankton were given for "interpretation" - presumably in the knowledge that such "snapshots" are notoriously difficult to explain.

Nevertheless, these snapshots are adequate to give "a flavour" of the water bodies sampled, though only in the context of what is known about the lakes and the level of sensitivity with which the monitoring is designed. In this context, infrequent monitoring can reveal a great deal about the ambient condition of target waters (Kadiri & Reynolds, 1993). The possibility of breaking up lists of dominant phytoplankton into associations (as a plant sociologist classifies terrestrial vegetation) does reveal useful information, again in the context of previous knowledge and suspected susceptibilities.

The approach adopted for this review was to compile a summary table for each lake and to judge whether the information was mutually consistent; if so, to compare, where possible, against previous data; and, thus, to highlight any trend or systematic shift.

These summaries are appended to this report (Appendix 1). There is one for each lake. The grid reference is cited after the site name and a symbolis included for a known public access (☞ - to indicate public access to the waterside, ✣ - angling, ☹ - contact or immersion sport, ♥ - National Nature Reserve, access restricted). The area (A) and maximum depth (H) are noted where known, together with the conductivity noted by Reynolds (1979). Key information from dated surveys are added. The associations of phytoplankton (Reynolds 1996) represented are noted as well as the main zooplankton species.

Some remarks on a lake-by-lake basis are offered, before attempting to review and prioritise the series.

Betley Mere is a small, highly calcareous and phosphorus-rich mere of the so-called Marginal Group, which is actually quite close to a view of "the regional type". It has well-developed swamp and fen vegetation. In both samplings there was a high chlorophyll content, abundant orthophosphate (the soluble, reactive fraction now often referred to as SRP) but with depleted levels of nitrogen in the May, 1995 sample. This mere is presumably too shallow to mount the *Asterionella-Stephanodiscus* spring bloom typical of deeper meres but the *Pediastrum-Scenedesmus* plankton noted at that time (Association J) is consistent with shallow, nutrient-rich conditions. The lake is one expected to be capable of producing large crops of nitrogen-fixers of Association H but these are not registered in the May sampling. The zooplankton sample (taken on the same date this is not clear) is unhelpful in identifying only "copepods" and "*Daphnia* indet" . This much could have been predicted beforehand.

Black Lake is new to me - I assume it to be the small lake on Lindow Common. It is P-rich, N- deficient and relatively soft-watered. I guess it is also quite shallow. The May, 1996, phytoplankton sample was sample was dominated by nitrogen-fixing cyanobacteria (Association H) and by *Microcystis* (of Association L or M). I am tempted to believe that poor fluid exchange and shallow depth permits year-to-year carryover of cyanobacterial biomass. *Bosmina* dominance of the zooplankton is consistent with this view. The chlorophyll concentrations (composition unspecified) in May and the following November were quite similar.

Budworth Mere is one of the larger and deeper meres of the series, which has a high (sulphate-dominated) ionic strength, the typical high phosphorus content and what is believed to be an agriculturally-enhanced nitrogen supply (Reynolds, 1979). The 1995 samplings are consistent with the previous view. Two phytoplankton samples suggest a shift from a clear-water spring plankton of colonial chlorococcales (Association F) giving way to a summer assemblage of *Microcystis, Ceratium, Pediastrum* and *Aulacoseira* (blending elements of Associations M, L, J and P). The spring zooplankton of *Daphnia, Diaptomus* and chydorids is typical of many meres.

Chapel Mere is part of the Whitchurch Group of small, fairly rich meres, though carrying very little phytoplankton on either of the two sampling occasions. Its J-dominated phytoplankton is consistent with the pond-like properties, while the coincidence of the May, 1996, minimum with a dominant *Daphnia* population is encouragingly indicative of a well-balanced trophic cascade.

Combermere is one of the largest meres and, in many ways, one of the region's finest. Its size and depth confer upon it the functional attributes of a larger lake and these give the impression of a lesser trophic status. In fact it is calcareous and its nitrogen and phosphorus levels are adequate to support large standing crops. Its *Sphaerocystis* (F-) plankton in May, 1995, looked set to give way to a *Ceratium* (L-) dominated summer, arguably assisted by the presence of a significant population of filter-feeding Daphniids.

Deer Park Mere is another small lake of the Whitchurch group, though it is not necessarily typical: neither the phosphorus nor the nitrogen levels were found to be very high and the chlorophyll concentrations were far below even the mild supportive capacity of the nutrients. Dominance by chrysophytes (Association E) is atypical of the meres series but the filter-feeding *Daphnia* population is suggestive of high productivity. The best interpretation is that primary production at this site is dominated by the macrophytic component, though the suggestion is made without recent personal acquaintance with the site.

Doddington Pool shows the high calcium, high phosphorus, low nitrogen condition of Marginal group meres and with a May, 1996 preponderance of nitrogen fixing phytoplankton (Association H) and spring chlorophytes of the F and G Associations).

Hatch Mere is grouped with others of the Delamere Forest area, although its water has a higher ionic strength than is typical of most of its near neighbours. The occurrence of large populations of *Microcystis* (Association M) is in no way unexpected but its dominance in May, 1995, is surprising. It is suspected that substantial overwintering of biomass occurs.

Gull Pool, Lily Pool and **Round Pool** are not sites I know but they share with Oak Mere (q.v) the low ionic strength, acidic water of sites fed from sand-drained ground water. All these waters have low conductivity but are not "oligotrophic" in the sense of having low nutrient content. The phytoplankton sample from Gull Pool of May 1996, which indicates a predominance of Cryptomonads, *Uroglena* and *Dinobryon*, is consistent with the water quality.

Little Mere is the small (2 ha) basin at the end of Mere Mere (qv),which, until recently, received the effluent from Mere STW. The biology of this lake has been studied by Professor Moss and his group at Liverpool University (see Carvalho, 1994): despite the high nutrient loading, the phytoplankton biomass was often kept low by Daphniid grazing. The nutrient content of the 1995 and 1996 water samples was quite low but the algal biomass on either occasion was substantial. The May plankton flora was of a carbon-rich pond (E,J associations well represented) with abundant *Uroglena*. **Mere Mere**, which empties to Rostherne Mere via Little Mere, is representative of the moderate- alkalinity, high- P, low-N Knutsford Group. Its plankton in Spring, 1996, was dominated Association-C diatoms and Association-L dinoflagellates and cyanobacteria. These are not inconsistent with the hydrography and hydochemistry of the site.

Marbury Big Mere is a fairly typical representative of the Whitchurch Group, in being calcareous and phosphate-rich, though with increasingly significant nitrogen penetration. The phytoplankton in 1996 was dominated by (potentially) nitrogen fixers (Association H), apparently succeeding a good spring diatom crop (Association C). The dominant zooplankter, *Daphnia*, would have been able to find its food resource made up by *Cryptomonas* (Association Y).

Oak Mere is one of the most fascinating of all the meres. It is relatively expansive but mostly very shallow. It lies in the sandy drift of the Delamere Forest. The basin may have been formed or modified by subsidence. The present basin traverses another which is peat-filled. The water is not merely acid but is noticeably humic. Its marginal flora, like its phytoplankton and zooplankton, are very distinctive. The lake has been subject to a long history of supra-annual cycles of water-level fluctuations and, at times, has been used as a holding store of pumped ground water.

The present sampling has confirmed the continuing acid state of the lake, its low nitrogen content and significant phosphorus content. The plankton in 1995 was dominated by Association-P ("eutrophic") desmids and one of its distinctive algae, *Botryococcus*. The zooplankton still has the regionally-distinctive *Bosmina corregoni* among its prominent components.

Oss Mere is a Whitchurch-group mere, part fringed with woodland, the rest abutting pasture. It has a high conductivity and phosphorus content. Although the measured levels of dissolved inorganic nitrogen are quite low, the *Pediastrum-Coelastrum* (J-) dominated phytoplankton is consistent with shallow, nutrient-rich environments. I was interested in the report of *Oscillatoria princeps* - this is a benthic/shore-line species, increasingly implicated in toxicity to dogs.

Petty Pool is one of the Delamere group of meres but it is not one of the acidic ones. Its water is chemically similar to that of Hatch Mere. In spring, 1996, its plankton also resembled that of Hatch Mere the previous year in being dominated by Cyanobacteria (H,M associations), summer diatoms (P) and large Chlorococcales (J).

Pick Mere is a site for popular recreation, despite the highly eutrophic nature of the lake. Close to Budworth Mere, it shares a similar, sulphate-dominated anionic spectrum but is yet more concentrated. The nitrogen and phosphorus figures were not especially high on either of the 1995 samplings. The dominance of green algae is also expected, even though the *Geminella-Ulothrix* association (now referred to as T) is possibly unusual for such a high-ionic strength water. Many other elements are represented, including the P-diatom group, the J-pond greens and the H-nitrogen-fixing cyanobacteria. The dominance of the zooplankton by *Daphnia curvirostris* is unusual for the meres generally but it may be a quite regular member of the Pick Mere fauna.

Quoisley Big Mere is another of the Whitchurch group of small calcareouus, phosphorus-rich meres, nitrogen-depleting meres and, in the best traditions of such waters, sports a typical summer phytoplankton dominated by nitrogen-fixing cyanobacteria (H), Volvocales (G) and eutrophic diatom species (C, P).

Redes Mere is one of the meres of the marginal belt, though it is apparently less phosphorus rich than (say) Betley Mere and, thus, not so drawn down on its content of dissolved inorganic nitrogen. The phytoplankton in May, 1995, was still in transition between vernal diatoms (association C) and early-summer *Pediastrum-Scenedesmus* populations (assemblage J). *Daphnia* dominance is in accord.

Rostherne Mere is a National Nature Reserve with limited public access; it is also the largest and most studied of the north-west Midlands meres. Its waters are of moderate ionic strength, rich in phosphorus and, hitherto, subject to nitrogen depletion by prolific phytoplankton growth after the onset of stratification (Reynolds, 1979). There is also a record of gradual nitrogen enrichment (Reynolds & Bellinger, 1992) which the present data suggest has been continuing: to have 0.6 mg N l^{-1} remaining at the end of the summer stratification is noteworthy. The species prominent in the phytoplankton in 1995 include those normally associated with the meres (eutrophic diatoms, nitrogen-fixing cyanobactera, *Microcystis* and *Ceratium*). The *Daphnia*-dominance of the zooplankton is also familiar in this lake, although *Bosmina* and chydorids are usually expected to be relatively more abundant during summer.

Tabley Mere is another Knutsford-group mere, with the typical high ionic strength, high phosphorus content and modest but accelerating concentrations of nitrogen associated with these meres. Predictably, its plankton is liable to nitrogen fixers (H) and these were already dominant in the sample of May, 1995. Winter diatoms were still dominant in May, 1996.

Tabley Moat is adjacent to the north-west corner of Tabley Mere. I have no information other than it surrounds a ruin and is possibly a site open to public access. Its waters are clearly of high ionic strength, very rich in phosphorus and modest in their content of inorganic nitrogen. The plankton was dominated by *Anabaena* (Association H) and *Dinobryon* (Association E) and an assortment of other species typical of the meres.

Tatton Mere is a further member of the Knutsford Group, towards its the eastern edge. It is ionically more dilute than those to the west and, indeed, it compounds the impression of a gradient of declining ionic strength and lowering sulphate content between Budworth Mere and the meres and mosses towards Wilmslow (including Black Lake, above). On the occasion of the May, 1995, sampling, it was apparent that a spring bloom of *Asterionella* and *Aulacoseira* (Association C) was waning and being replaced by a population of nanoplanktonic algae, said to be dominated by *Chlorococcum* (of Association X1), with other chlorococcales (J) and dinoflagellates (L) expected in the meres. *Daphnia lonispina* dominated the zooplankton.

OVERALL, it has to be said that there is very little to pick from this database which seems in any way unexpected or untoward. Bearing in mind the background of an extremely wet spring in 1995, followed by a hot and dry summer, a mild autumn and, then, by a cold and relatively dry winter, there is little to point to in the data which could be considered symptomatic of any real regional response. The one factor which changes consistently in all the currently listed waters with historical measurements is conductivity. It is one of the easiest determinands to investigate with one of the least sophisticated measuring instruments and conductivity does genuinely fluctuate through time. Reynolds' (1979) tabulations were normalised to 25°C: we may not be comparing like with like.

The number and the spread of samples are adequate to tell us that the condition of given water bodies are as we would expect. The series, as a whole is, naturally, highly eutrophic and, not only should we expect to find a lot of blue-green algae in them, we know that they will have been present in most of these waters for several millennia. Two samples will not detect more subtle changes but there is nothing in the present data that differs so far from expectation that is persuasive that ecosystems are reacting adversely to new sources of environmental stress.

4. PRIORITISATION

To follow a suggestion that there is insufficient evidence for any marked deterioration in the sites nominated for monitoring as part of the Agency's still waters strategy with proposals for a scheme of priortitisation based on present and future management problems is not obviously self-electing. These waters are characteristically very fertile and nutrient rich and they do have flora and fauna to match, sometimes forming habitat types that are very sensitive to public access. Many of the relevant sites in Cheshire have been identifiedas SSSIs and the responsibility for their upkeep and proper management is the primary concern of English Nature. Certain sites which are National Nature Reserves (like Rostherne Mere) or which are considered of sufficient national importance (e.g. Oak Mere) to be subject to careful monitoring will already be a priority for the statutory conservation body. Of the 24 sites included in the present study, only one other (Hatch Mere) was recommended by Reynolds (1979) for consideration as a "classic site", worthy of vigourous protection.

The Agency's work on controlled waters must also take into account the public perceptions, the fact that more people visit, or use, lakes and they have been made much more aware of the issues about water quality and the possible hazards of toxic algal growth. It is repeated that cyanobacterial blooms are perfectly natural on these lakes and palaeolimnological evidence supports the documentary record that they are no new phenomenon to the meres. No eutrophication strategy applied to these sites is about to "clear up" the problem. Nevertheless, as the knowledge and understanding of the toxicity hazard arising from cyanobacterial blooms accumulates, it becomes clearer how important it is to ensure that public contact with blooms is minimised. A basis for prioritisation could be to concentrate on sites with unrestricted public access (those in the appendix identified by ☞) in this way, the Agency would be more quickly able to anticipate bloom problems and ensure that warning notices or exclusions are posted when necessary.

I suspect that this suggestion would be considered to be a reversal of current policy guidance on "reactive monitoring". I would share the scepticism of any who doubted the ability of structured monitoring to improve on reactive sampling as a means of assuring the public. I do not feel able to recommend prioritisation on this basis.

A more strategic prioritisation might be to set up a scheme of monitoring at four to six sites deemed to detect changes in the series as a whole, especially in those attributes which appear most under threat: water-table variation, added nitrogen and floristic change. A "typical" or a "most natural" in each main agroup would be appropriate, say Betley Mere (for the Marginal group), Hatch Mere and Oak Mere (Delamere), Budworth and Rostherne or Tatton Mere (Knutsford) and Marbury Big Mere or, possibly, Quoisley Big Mere (Whitchurch). I would propose that these were sampled three or four times in a calendar year (January, April, July or August and October) though not necessarily every year, perhaps every second or third. In this way, the sampling would cover more of the relevant productive part of the year while any insidious trends in hydrology, hydrochemistry and biology can be assembled over periods of years.

5. FUTURE STRATEGIES

Whether or not this preferred option for prioritisation is adopted, the Agency should review the way it carries out its monitoring. The determinands are apparently standardised "because that is what you measure in monitoring exercises" but not all are necessarily appropriate. However, this is not a recommendation to omit any, simply that there is an adequate justification for each. Monitors should try additionally to register water levels, vegetation cover in and around the water.

Sampling in November is not very revealing - it is nearly everywhere after the overturn and it is a poor proxy of the summer vegetation. I suggest September or ealy October is as late as the last sample should be. April rather than May will tell us how the vernal crop is dominated: July is much the best time to assess the summer species composition and succession. January is optional - it is the time when the plant nutrients are the highest.

So, target lakes are sampled three or four times per year - this is a demonstrably good compromise between effort and information yielded (Kadiri & Reynolds, 1993). The year is characterised and can be compared with the output from the same lake in other years and other lakes in the same year. Future interpretation would assess whether the sites showed only stochastic year-to-year variations or whether site differences were responding to environmental change.

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APPENDIX

DATA SUMMARY TABULATION

INFORMATION BY SITE

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1. Betley Mere (SJ749479) ☞✣

Reynolds (1979): 26		A: 9.3 ha	H: 1.8 m	Cond. 631
5/95:	Secchi Disk, 0.6 - 1.0 m;	Cond 642	Chl 54 - 97	
	Nitrate N: 0.03 mg/l	Ammonium N: 0.05 mg/l	TP: 0.45 mg/l	SRP: 0.38 mg/l
11/95:	Secchi Disk, 0.8 - 0.9 m	Cond:	Chl : 70	
	Nitrate N: 0.49 mg/l	Ammonium N: 0.05 mg/l	TP: 0.68 mg/l	SRP: 0.55 mg/l

Phytoplankton, May 1995: J*, + D
Zooplankton, May, 1995: Daphniid*

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2. Black Lake (SJ834810) ☞

Reynolds (1979): no information

5/96:	Secchi Disk, 0.2m	Cond: 205	Chl : 133	
	Nitrate N: trace	Ammonium N: 0.09 mg/l	TP: 0.16 mg/l	SRP: 0.078 mg/l
11/96:	Secchi Disk, m	Cond: 155, pH ~neutral	Chl : 129	

Phytoplankton, Summer,1996: M, H*, G, J, P
Zooplankton, Summer, 1996: *Bosmina**, *Cyclops*

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3. **Budworth Mere** (SJ657769) ✣

Reynolds (1979): 45		A: 39.4 ha	H: 7.2 m	Cond. 669
5/95:	Secchi Disk, 2.8 - 3.2 m;	Cond 761	Chl 2 -3	
	Nitrate N: 4.8 mg/l	Ammonium N: 0.1 mg/l	TP: 0.16 mg/l	SRP: 0.13 mg/l
11/95:	Secchi Disk, 2.6 - 3.2 m	Cond:	Chl : 5	
	Nitrate N: 1.6 mg/l	Ammonium N: 0.5 mg/l	TP: 0.68 mg/l	SRP: 0.79 mg/l

Phytoplankton, August 1995: M*, + L_M J, P
Zooplankton, May, 1995: Daphniid* + Bosminid, *Diaptomus*

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4. **Chapel Mere** (SJ541519)

Reynolds (1979): 11		A: 6.5 ha	H: 2.4 m	Cond. 559
11/95:	Secchi Disk, 1.6 - 1.8 m	Cond:	Chl : 5	
	Nitrate N: 0.07 mg/l	Ammonium N: 0.51 mg/l	TP: 1.50 mg/l	SRP: 1.66 mg/l
5/96:	Secchi Disk, 1.5 - 2.2 m	Cond: 751	Chl : 2	
	Nitrate N: 0.07 mg/l	Ammonium N: 0.17 mg/l	TP: 0.76 mg/l	SRP: 0.58 mg/l

"Phytoplankton", Summer,1996: dominated by benthic spp + J.
Zooplankton, Summer, 1996: *Daphnia**, + *Eudiaptomus*

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5. **Combermere** (SJ586445) ☞✣

Reynolds (1979): 21		A: 51.5 ha	H: 11.8 m	Cond. 400
5/95:	Secchi Disk, 1.9 - 2.7 m;	Cond 535	Chl: 6 - 22	
	Nitrate N: 1.65 mg/l	Ammonium N: 0.07 mg/l	TP: 0.14 mg/l	SRP: 0.09 mg/l
11/95:	Secchi Disk, 2.8 - 4.6 m	Cond:	Chl : 7	
	Nitrate N: 0.15 mg/l	Ammonium N: 0.88 mg/l	TP: 0.39 mg/l	SRP: 0.36 mg/l

Phytoplankton, May 1995: F* J L_M P
Zooplankton, May, 1995: Daphniid *

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6. **Deer Park Mere** (SJ542508)

Reynolds (1979): 12		A: 9.4 ha	H: 3.4 m	Cond. 347
5/96:	Secchi Disk, 2.0 - 2.6 m	Cond: 453	Chl : 4	
	Nitrate N: 0.02 mg/l	Ammonium N: 0.09 mg/l	TP: 0.031 mg/l	SRP: 0.012 mg/l
11/96	Secchi Disk, m	Cond: 423	Chl :	

Phytoplankton, Summer, 1996: E*, + F, J, P
Zooplankton, Summer, 1996: *Daphnia**, + *Eudiaptomus*

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7. **Doddington Pool** (SJ705464) ☞

Reynolds (1979): 25		A: 19.3 ha	H: 1.3 m	Cond. 490
5/96:	Secchi Disk, 0.9 - 1.2 m	Cond: 518	Chl : 17 - 24	
	Nitrate N: 0.07 mg/l	Ammonium N: 0.17 mg/l	TP: 0.69 mg/l	SRP: 0.58 mg/l
11/96	Secchi Disk, m	Cond: 575	Chl :	

Phytoplankton, Summer,1996: H*, + G, F
Zooplankton, Summer, 1996: *Daphnia**

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8. **Hatch Mere** (SJ553722) ☞

Reynolds (1979): 27		A: 4.7 ha	H: 3.8 m	Cond. 406
5/95:	Secchi Disk, 1.0 - 1.2 m;	Cond 435	Chl: 23 - 27	
	Nitrate N: 3.7 mg/l	Ammonium N: 0.05 mg/l	TP: 0.03 mg/l	SRP: 0.01 mg/l
11/95:	Secchi Disk, 0.9 - 1.0 m	Cond:	Chl : 26	
	Nitrate N: 0.06 mg/l	Ammonium N: 0.19 mg/l	TP: 0.1 mg/l	SRP: 0.02 mg/l

Phytoplankton, May 1995: M*, H, J.P
Zooplankton, May, 1995: Daphniid*, + Bosminid, *Eudiaptomus*

9. Gull Pool (SJ601688)

Reynolds (1979): no information

5/96:	Secchi Disk, 0.4 m	Cond: 66 pH 4.0	Chl : 50 - 67	
	Nitrate N: trace	Ammonium N: trace	TP: 0.09 - 0.12 mg/l	SRP: 0.012 mg/l
11/96	Secchi Disk, m	Cond: 385, pH: 4.8	Chl :	

Phytoplankton, Summer, 1996: Y, U* + E
Zooplankton, Summer, 1996: *Daphnia obtusa**

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10. Lily Pool (SJ595692)

Reynolds (1979): no information

5/96:	Secchi Disk, 0.1 m	Cond: 68 pH: 5	Chl : 48	
	Nitrate N: trace	Ammonium N: 0.07 mg/l	TP: 0.03 mg/l	SRP: 0.002 mg/l

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11. Little Mere (SJ734824)

Reynolds (1979): no information

11/95:	Secchi Disk, 0.4 - 0.6 m	Cond:	Chl : 37	
	Nitrate N: 0.25 mg/l	Ammonium N: 0.10 mg/l	TP: 0.08 mg/l	SRP: 0.05 mg/l
5/96:	Secchi Disk, 1.7 - 2.4 m	Cond: 455	Chl : 5 - 46	
	Nitrate N: trace	Ammonium N: 0.07 mg/l	TP: 0.05 mg/l	SRP: 0.02 mg/l

Phytoplankton, Summer, 1996: E, U* + J, H, P
Zooplankton, Summer, 1996: *Daphnia galeata**

12. Marbury Big Mere (SJ559454)

Reynolds (1979): 18		A: 10.5 ha	H: 8.0 m	Cond. 442
11/95:	Secchi Disk, 1.4 - 1.6 m	Cond:	Chl : 9	
	Nitrate N: 0.7 mg/l	Ammonium N: 1.5 mg/l	TP: 0.45 mg/l	SRP: 0.43 mg/l
5/96:	Secchi Disk, 2.8 - 4.6 m	Cond: 585	Chl :	
	Nitrate N: 2.26 mg/l	Ammonium N: 0.8 mg/l	TP: 0.37mg/l	SRP: 0.25 mg/l

Phytoplankton, Summer,1996: H*, + S, P, H, T
Zooplankton, Summer, 1996: *Daphnia galeata** + *Eudiaptomus*

13. Mere Mere (SJ733817) ☞

Reynolds (1979): 48		A: 15.8 ha	H: 8.1 m	Cond. 339
11/95:	Secchi Disk, 1.5 - 1.7 m	Cond: 420	Chl : 213	
	Nitrate N: <0.01 mg/l	Ammonium N: 0.09 mg/l	TP: 0.28 mg/l	SRP: 0.07 mg/l
5/96:	Secchi Disk, 0.6 - 1.4 m	Cond: 464	Chl : 7 - 10	
	Nitrate N: 0.14 mg/l	Ammonium N: 0.11 mg/l	TP: 0.013 mg/l	SRP: 0.004 mg/l

Phytoplankton, Summer, 1996: P, L_M*, +F, J, Y
Zooplankton, Summer, 1996: *Daphnia**

14. Oak Mere (SJ575677)

Reynolds (1979): 28		A: 18.3 ha	H: 5.6 m	Cond. 132
5/95:	Secchi Disk, 0.8 - 0.9 m;	Cond. 113 ; pH: 4.6	Chl: 20	
	Nitrate N: < 0.01 mg/l	Ammonium N: 0.02 mg/l	TP: 0.10 mg/l	SRP: 0.05 mg/l
11/95:	Secchi Disk, 1.0 - 1.4 m	Cond:	Chl : 28	
	Nitrate N: 0.002 mg/l	Ammonium N: 0.01mg/l	TP: 0.11mg/l	SRP: 0.07mg/l

Phytoplankton, May 1995: P*, F
Zooplankton, May, 1995: *Bosmina corregoni** + Daphniid, *Eudiaptomus*

15. Oss Mere (SJ566438)

Reynolds (1979): 20		A: 9.5 ha	H: not cited	Cond. not cited
11/95:	Secchi Disk, 0.7 - 0.9 m	Cond:	Chl : 17	
	Nitrate N: 0.04 mg/l	Ammonium N: 0.34 mg/l	TP: 0.31 mg/l	SRP: 0.24 mg/l
5/96:	Secchi Disk, 1.2 - 1.3 m	Cond: 506	Chl : 27	
	Nitrate N: 0.15 mg/l	Ammonium N: 0.07mg/l	TP: 0.15 mg/l	SRP: 0.06 mg/l

Phytoplankton, Summer, 1996: J*, + H, P, benthos
Zooplankton, Summer, 1996: *Daphnia galeata*, + *Daphnia magna*

16. Petty Pool (SJ619701)

Reynolds (1979): 29		A: 11.7 ha	H: 3.1 m	Cond. 337
11/95:	Secchi Disk, 1.5 - 1.7 m	Cond:	Chl : 15	
	Nitrate N: 1.08 mg/l	Ammonium N: 0.15 mg/l	TP: 0.12 mg/l	SRP: 0.08 mg/l
5/96:	Secchi Disk, 1.1 - 1.2 m	Cond: 486	Chl : 33 - 43	
	Nitrate N: 1.3 mg/l	Ammonium N: 0.02 mg/l	TP: 0.04 mg/l	SRP: 0.015 mg/l

Phytoplankton, Summer, 1996: M,H* + J, P, Y
Zooplankton, Summer, 1996: *Daphnia galeata**, + *Eudiaptomus*, Cyclopoids

17. Pick Mere (SJ684771) ☞ ✤ ☹

Reynolds (1979): 46		A: 17.5 ha	H: not cited	Cond. 870
5/95:	Secchi Disk, 1.2 - 1.4 m;	Cond. 979	Chl: 8 - 12	
	Nitrate N: 0.80 mg/l	Ammonium N: 0.11 mg/l	TP: 0.03 mg/l	SRP: <0.01 mg/l
11/95:	Secchi Disk, 1.2 - 1.4 m	Cond:	Chl : 34	
	Nitrate N: 0.12 mg/l	Ammonium N: 0.03 mg/l	TP: 0.12 mg/l	SRP: 0.05 mg/l

Phytoplankton, May 1995: T*, + P, J, K, (R, H, M)
Zooplankton, May, 1995: Daphniid* + Calanoid

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18. Quoisley Big Mere (SJ546456)

Reynolds (1979): 16		A: 4.0 ha	H: 2.4 m	Cond. 522
11/95:	Secchi Disk, 1.2 - 1.6 m	Cond:	Chl : 33	
	Nitrate N: 0.05 mg/l	Ammonium N: 0.03 mg/l	TP: 0.08 mg/l	SRP: 0.03 mg/l
5/96:	Secchi Disk, 1.4 - 1.6 m	Cond: 642	Chl : 31 - 39	
	Nitrate N: 0.03 mg/l	Ammonium N: 0.025 mg/l	TP: 0.04mg/l	SRP: 0.01 mg/l

Phytoplankton, Summer,1996: G, H* + J, P
Zooplankton, Summer, 1996: *Daphnia galeata**, + *Eudiaptomus*, Cyclopoids

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19. Redes Mere (SJ849717) ☞ ✣

Reynolds (1979): 53		A: 17.0 ha	H: 4.5 m	Cond. 475
5/95	Secchi Disk, 2.0 - 2.2 m	Cond: 602	Chl: 4 - 12	
	Nitrate N: 3.0 mg/l	Ammonium N: 0.07 mg/l	TP: 0.03 mg/l	SRP: <0.01mg/l
11/95:	Secchi Disk, 0.9 - 1.0 m	Cond:	Chl : 78	
	Nitrate N: 0.79 mg/l	Ammonium N: 0.07 mg/l	TP: 0.11mg/l	SRP: 0.015 mg/l

Phytoplankton, May 1995: C*, J, E/F
Zooplankton, May, 1995: Daphniid* + Bosminid, *Eudiaptomus, Mesocyclops*

20. Rostherne Mere (SJ742842)♥

Reynolds (1979): 49		A: 48.7 ha	H: 30.0 m	Cond. 382
5/95:	Secchi Disk, 1.2 - 2.2 m;	Cond 473	Chl: 22 - 47	
	Nitrate N: 1.70 mg/l	Ammonium N: 0.02 mg/l	TP: 0.22 mg/l	SRP: 0.14 mg/l
11/95	Secchi Disk, 4.5 - 5.4 m	Cond:	Chl : 7	
	Nitrate N: 0.59 mg/l	Ammonium N: 0.09 mg/l	TP: 0.22 mg/l	SRP: 0.20 mg/l

Phytoplankton, May 1995: H* + C, Y, L_M
Zooplankton, May, 1995: Daphniid*, +*Diaptomus, Eucyclops*

21. Round Pool (SJ599692)

Reynolds (1979): no information

5/96:	Secchi Disk, 0.1 m Nitrate N: trace	Cond: 75 pH: 4.1 Ammonium N: 0.04 mg/l	Chl : 222 TP: 0.14 mg/l	 SRP: 0.016 mg/l
11/96	Secchi Disk, m Nitrate N: mg/l	Cond: 212 , pH 4.6 Ammonium N: mg/l	Chl : TP: mg/l	 SRP: mg/l

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22. Tabley Mere (SJ723767)☞

Reynolds (1979): 47		A: 19.4 ha	H: 4.4 m	Cond. 769
5/95:	Secchi Disk, 1.5 - 2.5 m; Nitrate N: 0.40 mg/l	Cond 684 Ammonium N: 0.18 mg/l	Chl: 4 - 9 TP: 0.18 mg/l	 SRP: 0.11 mg/l
11/95:	Secchi Disk, 2.2 - 4.0 m Nitrate N: 1.6 mg/l	Cond: Ammonium N: 0.42 mg/l	Chl : 6 TP: 0.39 mg/l	 SRP: 0.32 mg/l
5/96:	Secchi Disk, 1.4 - 1.8 m Nitrate N: 0.23 mg/l	Cond: 880 Ammonium N: 0.22 mg/l	Chl : 2 - 6 TP: 0.30 mg/l	 SRP: 0.06 mg/l

Phytoplankton, May 1995: H*, R, L_M
Zooplankton, May, 1995: Daphniid* + *Eudiaptomus*

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23. **Tabley Moat** (SJ719773) ☞

Reynolds (1979): no information

11/95:	Secchi Disk, 0.9 - 1.2 m	Cond:	Chl : 79	
	Nitrate N: 0.115 mg/l	Ammonium N: 0.27 mg/l	TP: 0.71 mg/l	SRP: 0.62 mg/l
5/96:	Secchi Disk, 0.6 - 0.7 m	Cond: 710	Chl : 66	
	Nitrate N: trace	Ammonium N: 0.03 mg/l	TP: 0.44 mg/l	SRP: 0.36 mg/l

Phytoplankton, Summer,1996: E, H* + J, F
Zooplankton, Summer, 1996: *Acanthocyclops** + *Daphnia galeata*

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24. **Tatton Mere** (SJ755802) ☞

Reynolds (1979): 50		A: 31.7 ha	H: not cited	Cond. 469
5/95:	Secchi Disk, 1.6 - 2.0 m;	Cond 510	Chl: 11 - 38	
	Nitrate N: 0.09 mg/l	Ammonium N: 0.04 mg/l	TP: 0.05 mg/l	SRP: <0.01 mg/l
11/95:	Secchi Disk, 2.8 m	Cond:	Chl : 5	
	Nitrate N: 0.29 mg/l	Ammonium N: 0.23 mg/l	TP: 0.24 mg/l	SRP: 0.22 mg/l

Phytoplankton, May 1995: X1*, C, F, J, L_M
Zooplankton, May, 1995: Daphniid* +Chydorid, *Diaptomus*
