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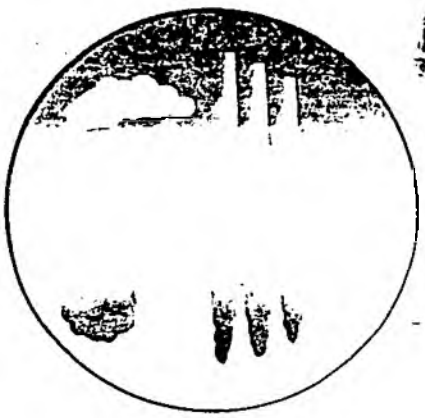

RIVER NAR EUTROPHICATION STUDIES

SUMMARY REVIEW OF 1993 TECHNICAL REPORTS

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CONTENTS

1. INTRODUCTION

1.1 This report presents a brief summary of technical reports covering studies associated with the River Nar eutrophication study commissioned by NRA Anglian Region in 1993. The reports reviewed were:-

i) Ecology Unit, University of Leicester, "Macroinvertebrates of the River Nar, Great Ouse Catchment, Anglian Region of the National Rivers Authority". Draft Report (Version 1), March 1993.

ii) University of East Anglia, "River Nar Eutrophication Studies. 2. Phosphate Budget" Final Report, March 1993.

iii) Institute of Freshwater Ecology, "River Nar eutrophication studies. 3. Diatoms" Draft Report, 1993.

iv) Ecology Unit, University of Leicester, "Mesotrophic rivers in the Anglian Region of the National Rivers Authority". Draft Report (Version 1), March 1993.

Comments received by the NRA from Mary Gibson, English Nature (letter to W T Clough, dated 22nd July 1993) were also considered.

1.2 The objectives of the Summary report are broadly as follows:-

i) Review each specific report and comment upon the appropriateness of the methods used in the reports.

ii) Highlight any areas where the conclusions drawn by any of the individual reports contradict those of the others.

iii) Recommend approaches to the River Nar Study for the years 1994 and 1995 based on the summary review and the recommendations made in each separate report.

1.3 For each report, a synopsis of the NRA's objectives (either gleaned from the original requests to tender or from the technical reports themselves) is given. This is followed by a review of whether those objectives have been met and of the recommendations made, a synopsis of the results of the work and specific recommendations for further study. The specific recommendations are made as a result of the overview of all reports.

1.4 The broad points made in each specific report are brought together in Section 7. Section 8 presents prioritised recommendations for further study.

2. FRESHWATER MACROINVERTEBRATES

2.1 NRA Objectives

The objectives of the commission can be broadly categorised as follows:-

i) Collect invertebrate samples using standardised NRA methods at 45 locations (20 main river, 25 tributary sites) preferably in early February.

ii) Identify organisms to a prescribed level, principally to species, recording abundance on a relative scale.

iii) Complete field records, to include recording of NRA Habitat Assessments, RIVPACS variables, and a sketch map of each site (with photograph).

iv) Sample water quality (for alkalinity analysis by the NRA).

v) Evaluate results to determine the degree of eutrophication in the catchment.

vi) Recommend monitoring for 1993-4 and 1994-5.

2.2 Compliance with Objectives

2.2.1 Samples were collected at the required time, using the methods specified (although the report should state the precise period of time spent "kicking" and searching). Where the taxonomic or number of sampling site objectives were not met, adequate explanation is given. Although the photographic record is provided, sketch maps of specific sampling locations are not. No use is made of the water quality data collected during the survey (alkalinity). Having recorded habitat features at each site, the report should provide a summary Table showing general characteristics to aid the readers understanding of the results presented.

2.2.2 The principal objective of this study are understood to be v) and vi) - ie evaluation of the results to determine the degree of eutrophication and to recommend further monitoring towards that evaluation for 1993 - 1995. These objectives are not satisfied directly by the report, which focuses on taxonomy, identification of possible point pollution sources, evaluation of habitat influences, discussion of feeding guilds and recommendations which relate to enhancement of invertebrate conservation value.

2.2.3 Much is made in the report of feeding guilds within the river although how this analysis is related to eutrophication or general water quality is not properly explored.

2.2.4 The recommendations made are summarised as follows:-

- Repeat the survey in the summer, with abundance estimation, more detailed feeding guild analysis and active searching for rare invertebrate species.

- Analyse the data in conjunction with water quality and river corridor data.

- No further specific recommendations for 1993 - 1995 are given, although statements of the preferred conservation objectives for the lower river are made (including the statement that the lower reaches of the river and the lower tributary contain almost all of the taxonomic richness of the river and would therefore make the ideal focus for any conservation efforts).

These are discussed at the end of this Section of the report.

2.3 Synopsis of the Results

2.3.1 The data provide a valuable record of the macroinvertebrates in a single month. In general, the upstream sites supported fewer taxa than those lower down the system, with more pollution sensitive taxa present in several of the mid - river sites. On the basis of the invertebrate communities, no site was identified as being badly polluted, with habitat limitations (stream size, silt and leaf litter domination and general lack of variation) having a presumed greater influence than water quality in the upper reaches in particular.

2.3.2 Possible depressions in water quality were highlighted downstream of villages and trout farms (Narborough, above site 19 and Castle Acre, above site 27). However, in neither case does there appear to be any "real" difference in the communities present upstream compared with downstream (although there are more Hemiptera at site 19 than at site 20, indicating a possible habitat change). The change in BMWP score is relatively small in each case and is not necessarily sufficient to warrant the definitive statement that there were "slight depressions in water quality".

2.4 Recommendations

2.4.1 Repeat the survey in the summer. The survey was repeated in autumn (October) 1993, with the October data set containing a marked increase in the number of taxa present (145 in October, 92 in February). The general pattern of lower scores and taxonomic richness in the upper reaches of the river, higher scores and more pollution sensitive taxa in the middle reaches and the highest taxonomic richness in the lower reaches, was repeated. There were several changes in the invertebrate community, but no real differences evident between upstream and downstream of Castle Acre or Narborough.

2.4.2 There was a slight reduction in BMWP and ASPT score below Litcham sewage works (between sites 41 and 42) in both surveys. This was not pronounced in either case.

2.4.3 The recommendation for repeat summer survey remains valid, as no data are yet available to cover a period of high biological activity and low sewage effluent dilution. There is also some indirect evidence that the flow at some sites may be ephemeral. *Limnephilus auricula* and *Grammotaulius nigropunctatus,* Trichopterans which are often associated with temporary water bodies, were found at the head of two of the tributaries (sites 35 and 13 respectively). However, a third Trichopteran *(Limnephilus affinis/inciscus)* which is also often associated with emphemeral water bodies was present in the pool at site 37.

2.4.4 More extensive analysis of feeding guilds may be useful, although this type of analysis can be difficult to interpret. It is clear from the data that identification to family level only is unlikely to yield information of sufficient depth to fully to understand changes in community which may, or may not, be a consequence of eutrophication - especially where such changes are only slight. On the basis of data available to date, habitat limitations appear to be the dominant influence on invertebrate populations. In that context, specific water quality influences have not yet been clearly identified and to fully understand the influence of water quality in determining the invertebrate population, greater emphasis on characterising habitat changes and their possible relationship to eutrophication (e.g in influencing macrophyte growth) would be useful.

2.4.5 In the context of the arguments explored above, repeated surveys, in conjunction with analysis of water quality data and collection of detailed river corridor survey data (extended to include more detailed in river habitat description) would be justified. To ensure that resources are effectively deployed, it would also be helpful if the February and October 1993 data are analysed to determine whether any of the 45 survey locations are redundant - i.e. whether there are any sites which do not differ sufficiently from their nearest neighbour to justify repeated survey in the future. Comments on sampling requirements to develop the P- budget are made later in this report. Those requirements should ideally form the basis of decisions over where to undertake biological surveys i.e. the P- budget sampling sites should be biologically surveyed.

3. DIATOMS

3.1 NRA Objectives

The objectives are stated in the report as:-

i) Collect diatom samples at 45 sites (20 main river, 25 tributary sites) in February according to the draft SCA method "Use of epilithic diatoms to monitor water quality in rivers".

ii) Identify organisms to a level sufficient for assessing water quality, with enumeration based on relative abundance.

iii) Complete field records, to include photographs and a sketch map of each site.

iv) Evaluate results to determine the degree of eutrophication in the catchment.

v) Recommend further monitoring for 1993 - 1995.

3.2 Compliance with Objectives

3.2.1 Samples were collected, subject to certain exceptions where the target features (undisturbed riffle of preferably less than 0.5m depth having flat, small stones which are not covered by green algae or silt and where macrophyte cover is not extensive) could not be located.

3.2.2 The principal objective of evaluating trophic status at each site was attempted using a range of different indices. Limitations in the approach include sampling at a less than ideal time of year, sampling at 25 locations where the habitat/river characteristics were less than ideal and lack of a single widely accepted diatom index of trophic status. Despite these limitations, the authors use extensive experience of UK chalk stream diatom populations to address the issue very thoroughly.

3.2.3 Repeat surveys in the period July - September are recommended, with particular emphasis below sewage works at Litcham (sites 4-5) and West Acre (sites 22-23) and fish farms at West Acre(site 24), River Nar downstream Stanch Breck (site 25 - notated as site 21 in the invertebrates report but not sampled for invertebrates), Narborough (site 28) and Priory Farm (sites 43-44).

3.3 Synopsis of the Results

3.3.1 The report numbers the survey sites in reverse order to that adopted in the

macroinvertebrate report, making direct comparisons difficult without first transcribing the data. Also, precise survey locations differ in some cases between the reports and no map showing sites sampled is given.

3.3.2 The diatom report indicates that, using the HMSO classification recommended in the SCA method, all sites surveyed fall into pollution category 3 - indicative of alkaline, enriched but not seriously polluted water. The SCA index is not considered to be sufficiently robust to cater for all of the minor variations in quality observed in the river. Adoption of the authors preferred index (the Coste and Descy index) appears to separate out the effects of mans influence from that of basic chemistry (alkalinity) - with this index suggesting that the upper reaches of the river are more stressed than the middle and lower components.

3.3.3 The middle (and lower) reaches of the river support more classic chalk stream diatom communities, again characteristic of clean but slightly eutrophic waters. Where taxa which are indicative of degraded waters were present, they generally comprised a small proportion of the total. The author concludes that this indicates a deteriorating situation, with the area around (and upstream of) Priory Farm being selected for particular reference (together with those sewage and fish farm discharges previously mentioned in this Summary Report). At Priory Farm, (diatom survey site number 41-44, invertebrate sites 3-6) the stretch identified as having deteriorating water quality includes sites both up and downstream of the fish farm discharge, and is within the area identified in the invertebrates report as containing (along with the lower reaches of the Nar) almost all of the taxonomic richness of the river. The BMWP/ASPT scores for the equivalent invertebrates sites are not particularly unusual, although the BMWP's were slightly lower in October than locations slightly further upstream on this tributary. Clearly the two survey types have produced slightly contradictory results when considered in detail, although the overall conclusions for the river are broadly comparable.

3.4 Recommendations

3.4.1 The diatom data have not produced definitive results, although the author suggests that better data would be generated from a summer survey. Given that the February data contain several indications that water quality could be deteriorating and that deterioration could be better reflected in the summer diatom population, this recommendation appears to be soundly based. However, there is an evident need to co-ordinate the diatom and invertebrate surveys, with greater emphasis on sampling at identical sites (and adopting a common habitat description format, site mapping and site numbering systems).

3.4.2 Clearly there were many sites sampled which were not ideal. This issue should be addressed in detail before any repeat survey is mounted. It is recommended that the rationalisation of the number of future biological survey locations includes consideration

of those sites where diatom surveys are possible.

3.4.3 Where specific parts of the river are selected for reference in the text of the report, the data presented do not necessarily indicate a significant change in quality (although not all of the data are presented, and the experience of the authors is such that the professional judgements presented should be reliable). Changes are highlighted apparently on a precautionary basis - there is no real indication from the data that specific sites are badly degraded.

4. PHOSPHATE BUDGET

4.1 NRA Objectives

4.1.1 The objectives were as follows:-

i) Collate and review existing phosphate data in the catchment and identify gaps in the database.

ii) Produce a phosphate budget using available data and assess its accuracy.

iii) Recommend further monitoring for 1993 - 1995 necessary to refine the budget.

4.2 Compliance with the Objectives

4.2.1 The report produces the preliminary budget and discusses its inaccuracies as required. However, use is only made of readily available data on river flow and water quality. No data are included on the size of discharges to the river or on their quality (e.g. sewage and fish farm effluents), nor has any attempt been made to estimate groundwater contributions to base flow at different sections of the river. No direct information on soil type or specific geology is provided. These omissions (particularly some indication of sewage works size) are such that the potential error in the budget produced cannot be readily understood.

4.2.2 Extensive recommendations are made, summarised as follows:-

i) Gauge flows at additional points in the catchment upstream of Marham, ideally below each point source phosphate input and at every point where chemical samples are taken.

ii) Produce a parallel nitrogen budget.

iii) Measure background land run-off P - content and assess the extent to which this is particulate.

iv) Analyse both total and soluble P.

v) Increase the number of sampling points and the sampling frequency.

vi) Increase analytical accuracy.

vii) Mount special short term surveys of water quality at selected points at times when flow is expected to change.

viii) Estimate production, biomass and P - content of higher plants in the river, together with analysis of those plants removed during maintenance.

ix) Experimentally divert flow of sewage effluents prior to their discharge to the river.

4.3 Synopsis of Results

4.3.1 Overall, the report concentrates on using flow and water quality data for the river only. These data were not collected specifically for the purposes of generating a P- budget, and as a consequence the accuracy of the budget which can be produced is questioned. This is particularly the case at all points upstream of Marham.

4.3.2 The major area of inaccuracy identified in the report relates to the use of aerial apportionment of river flow (i.e calculation of flow dependent on upstream catchment area) at points upstream of the Marham gauging station in a catchment where it is believed that groundwater flow can have a greater influence in some sub-catchments than surface run-off. That inaccuracy, together with probable problems with the representativeness of the available water quality data leads to potentially seriously flawed assumptions of P- load carried by the river at different locations. The main example of this occurs at Litcham, below the STW discharge. Data used to calculate the P load in the river at this point are as follows:-

i) Assumed fraction of Marham river flow at Litcham - 0.279

ii) Median SRP concentration at Litcham, 1991 and 1992 - 3mgl^{-1}. Range, 1991, 2.8 - 10.1mgl^{-1}, mean 1991, 4.06mgl^{-1}.

iii) 'Typical' sewage effluent contains 10-20mgl^{-1}.

4.3.3 Using these data, the P- load above Litcham is calculated in the report as 298 kg yr^{-1}. Below Litcham it is 15358 kg yr^{-1}. If the crude assumption is made that almost all of this change in riverine P- load is derived from the STW, it could be calculated that the population served by this works is:-

* Assuming effluent at 10mgl^{-1} and domestic sewage at 120 l per person per day - STW p.e. 35064.

* Assuming effluent at 20mgl^{-1} and per capita flow of 180 l per day - STW p.e.11688.

4.3.4 It is understood that Litcham has a p.e. of 829. Clearly there is a source of error in the calculations. This source could be inaccuracy in any or all of the assumptions made (i.e. the river flow assumption; the river quality data (possible mis-recording on the CDPS?), the SRP content of the effluent or the per capita contribution to Litcham STW).

4.3.5 The report should perhaps have explored this mechanism to validate, or otherwise, the calculations presented. However, the above calculations simply serve to strengthen the recommendations that better flow and quality data for the river are required to generate a reasonable budget. Also, detailed analysis of the P- load to the river from the various point sources is essential. In addition to the above, neither the invertebrates nor the diatom reports identified biotic changes below Litcham which would be expected given the assumed P input.

4.3.6 Water quality data presented for Marham suggest that there is almost always available SRP in the water. This itself indicates that nutrient supply is not normally limiting at that part of the river, and that there is potentially scope for changes in the stream biota as a consequence of the additional nutrients. However, other factors may play a more important role - for instance the invertebrates report ascribes most variation in the fauna to habitat limitations.

4.3.7 The influence of changing flows on river SRP is explored in the report, with analysis which appears to illustrate a correlation at the lower end of the flow spectrum in 1992 but not when historically higher flows are added to the analysis. In 1992, the significance of the correlation depends heavily on just two pairs of data (at the higher flows). Without them there is no real relationship, and the relationship is also weak when a wider range of flows is included. This suggests that in general flow and P concentrations are not related.

4.3.8 The influence of P data recorded as less than the Limit of Detection (LOD) is discussed in the report, with a recommendation that this LOD is lowered in future. It is unlikely that the LOD has affected the calculated loads at Litcham, and it is not clear from the report how many instances of less than LOD data exist. Given the potential magnitude of errors introduced through poor flow and possibly poor sampling frequency, the LOD may be of secondary importance.

4.4 Recommendations

4.4.1 The budget presented has clear flaws, these are discussed at length by the authors. In the context of the NRA's objectives in studying the River Nar as a whole, these flaws are significant. It is difficult to see how the assessment of eutrophication in the river can properly proceed without overcoming the majority of these flaws, and hence the recommendations made in the P- budget should be given high priority.

4.4.2 Before establishing more detailed surveys it is recommended that the budget is refined/extended to include estimation of the P- loads entering from the known point sources. This should help focus attention on particular parts of the river where the available data are weak. In addition, further analysis of the potential contribution of groundwater to river flow in each of the sub-catchments would be of value in identifying where the aerial flow proportioning exercise is particularly vulnerable and hence where flow recording effort is best expended.

4.4.3 It is considered important that the major sources of error are considered first, with areas of refinement of the budget approached once there is confidence that the fabric is sound. Hence the following issues should be addressed in priority order:-

i) Incorporate point source loadings.
ii) Estimate groundwater flow contributions in sub-catchments.
iii) Improve and extend accuracy of flow monitoring at pre-selected points.
iv) At flow monitoring points, improve chemical sampling frequency, consider ease with which lower LOD can be achieved, add Total P to analytical suite.
v) Mount short-term automatic sampling surveys during periods of variable flow.
vi) Refine budget produced by adding consideration of land run-off quality, plant biomass and production.

5. MESOTROPHIC RIVERS

5.1 NRA Objectives

i) Identify the extent and location of mesotrophic rivers and streams (and stretches thereof) in the Anglian NRA region.

ii) Employ the Trophic Ranking System of Newbold and Palmer (1979) and Holmes and Newbold (1984) in association with the River Environmental Database, English Nature's aquatic macrophyte database, River Nar SSSI evaluation data and Haslams 1970's river surveys.

iii) Search for other relevant data sources.

iv) Use NRA river chemistry data and geological information.

v) Present classification of rivers and streams according to Trophic type, using tables and maps, with separate presentations for plants, geology and water chemistry.

vi) Make recommendations for the improvement of the trophic ranking system or an alternative and for future work.

5.2 Compliance with the Objective

5.2.1 It can be argued, that the report fails in the basic objective of identifying mesotrophic rivers in Anglian Region. Although the report states that there is insufficient information available on river trophic state, as illustrated by P concentration, to define cut-off points the statement that any river or stretch having P levels in 1992 of 0.5 mgl^{-1} or less "could be considered mesotrophic" clearly indicates that this level is considered to be a reasonable first estimate of such a cut-off. This concentration appears to be high (English Nature found levels of above 0.2 mgl^{-1} to be associated with enrichment).

5.2.2 Without presentation of a literature review, the assertion that there is insufficient published material to begin to define possible cut-off points cannot be sustained. English Nature have some data. These were not used in the report. Nor was any apparent attempt made to assimilate or review the data on which the DoE based the Urban Wastewater Directive sensitive area identification criterion of 0.1 mgl^{-1} in running waters.

5.2.3 The classification according to plants and geology is poor in the report, with only 6 rivers selected for botanical consideration. No apparent use was made of English Nature's macrophyte database or of Haslam's specific data as required in the brief.

5.2.4 Recommendations made can be summarised as follows:-

i) All Anglian rivers with mean P concentration of < 0.5 mgl^{-1} should be classed as "mesotrophic".

ii) Unsampled tributaries of rivers classed as "mesotrophic" should all be sampled quarterly for at least a year.

iii) More detailed analysis of REDS macrophyte data should be undertaken to refine the role of macrophytes in classification.

iv) Survey macro-algae in a target group of rivers of varying P- concentration to assess any correlation between macro-algae and P.

v) Study a Target group of low P rivers, using River Corridor Survey sheets, to quantify any link between habitat and water quality for plants.

vi) Analyse invertebrate functional feeding groups at low P rivers to determine whether they could act as a surrogate measure of trophic status.

5.3 Synopsis of the Results

5.3.1 The report tabulates, in rank order, all rivers (and major stretches) according to P concentration. This identifies parts of the Ancholme, Witham, Nene, Great Ouse, Waveney, Stour/Colne, Blackwater and Chelmer as having the highest P - concentrations.

5.3.2 According to the definition of mesotrophy adopted, 53.8% of all river stretches considered would be considered "mesotrophic". This is unrealistic, although the report also lists those in the highest rank (ie with the lowest P) as parts of the Ancholme, the Lud, Great Eau, Witham, Nene, Great Ouse, Bure, Yar, Deban/Gripping, Stone/Colne, Blackwater and Chelmer. As expected, these are generally the most upstream parts of the rivers.

5.3.3 The report identifies 16 stretches out of 89 which receive low volumes of sewage effluent as being phosphorus rich, whilst the remainder in this category were "mesotrophic". This shows that factors other than sewage effluent can cause increases in P levels (although it is not clear whether consideration was given to sewage loads to adjacent, upstream, sections). As a consequence of this analysis it is suggested that an additional definition of "mesotrophy" might be any stretch receiving effluent discharge of less than 500 m^3 d^{-1} (Dry Weather Flow).

5.3.4 Attempts to use the Trophic Ranking System were thwarted, largely by the presumed over-

riding influence of habitat features in determining the distribution of macrophytes. However, the authors cite lack of time available to fully evaluate the limitations of the REDS database (this is difficult to accept, given that the brief gives specific requirements which presumably the authors accepted in submitting the competitive tender).

5.3.5 Data limitations for trophic status assessment include the general absence of data on filamentous algae.

5.4 Recommendations

5.4.1 That 53% of Anglian NRA's rivers could be classed as mesotrophic is unrealistic. Clearly there are some rivers which have low P - concentrations. Those ranked as having the lowest may justify further evaluation, but to obtain a better definition this Summary Report recommends that the simple P - ranking approach should be adopted on a national scale. This exercise should be accompanied by analysis of the biotic characteristics of the least nutrient rich and a wider literature review in order to derive a more acceptable definition of mesotrophy. Only then would it be useful to begin to examine ways of protecting mesotrophic streams.

5.4.2 Meanwhile, the report identifies those stretches which could usefully be protected under the heading of "lowest nutrient content waters in East Anglia", and those which clearly carry an excessive P - load. This could provide the focus of attempts to reduce those loads.

6. OVERVIEW

6.1 Only those parts of the reports relating specifically to the River Nar are reviewed here. These reports give occasionally conflicting opinions on the trophic status of the Nar. To an extent this might relate to the adequacy of the approach adopted (e.g. can invertebrates analysis be used to describe trophic status?), or alternatively to the quality of the available data.

6.2 In overall terms, the mesotrophic rivers report categorisers the River Nar as P- rank 4 - the second lowest P- concentration category and well within the "mesotrophic" definition proposed. The phosphate budget indicates that there is a possible major input of P at Litcham (although the 15000 kg yr^{-1} quoted does not appear to stand up to closer scrutiny and may simply reflect budget inaccuracy), while further downstream there are no major inputs which result in a marked increase in P- load carried by the river. At almost all times there is available SRP in the water at Marham, suggesting that P- is not limiting. The invertebrates report highlights the rich and productive nature of the river. Potential reductions in biological quality are identified below Castle Acre and above Narborough. Biologically high quality areas are identified in the middle and lower reaches, whilst habitat limitations are considered to be the major factor controlling the invertebrates of the upper reaches. The diatoms report identifies possible "stress" conditions in the upper reaches of the river, although most of the data presented indicate a similar trophic status (alkaline, enriched but not seriously polluted). Signs of potential degradation are identified around Priory Farm and below sewage works and fish farms, although none of these signs are pronounced and professional judgement was used to augment the findings of the diatom/water quality indices used.

6.3 Of the methods used in each of the reports, the mesotrophic assessment adopts a simplistic approach which ranks the median P- concentration of Anglian NRA's rivers and suggests that those below the mid-point could be considered mesotrophic. This assessment would need to be based on a national scale and be supported by literature review before confidence could be placed in the definition of the River Nar as mesotrophic. Also, this extended review would be necessary to produce defensible water quality targets and objectives for the river (should the management approach be based on the mesotrophic issue specifically, as opposed to broader protection based on SSSI status).

6.4 The data available for the P- budget were not collected for this specific purpose, and until those data can be augmented the current budget is unlikely to be fully representative of the true position. Therefore, apart from its use in highlighting areas where resources should be allocated in order to produce a more realistic assessment, the current budget does not provide much opportunity for development of management options for the river. Nonetheless, it is essential and central to the River Nar studies that priority be given to the

necessary refinements to this budget.

6.5 Macroinvertebrate surveys, and the biotic indices derived from such surveys, have principal value in assessing water quality changes over time at a single site. The currently used survey and data analysis techniques were developed mainly to detect the influence of organic pollution. Invertebrate groups vary in their response to differing levels of nutrient enrichment, and changes to the macroinvertebrate fauna of a stream following moderate nutrient enrichment might reasonably be expected therefore to reflect changes in habitat structure rather than water quality. Hence the invertebrates would act as an indirect monitor of change as a result of eutrophication if that change involved the habitat structure.

6.6 Aside from organic pollution, habitat structure is one of the principal limiting factors in determining the invertebrate community structure. This is borne out by the River Nar survey results - the upstream impoverished habitat areas have lower taxonomic diversity than the middle and lower reaches. The middle and lower reaches benefit, in invertebrate terms, from the higher plant (and thus habitat) diversity. Where there are slight perturbations in invertebrate fauna in the River Nar which are not caused by habitat limitations these may reflect organic pollution. Whether the habitat limitations of the upper Nar occur as a result of eutrophication should be considered - although all the indications are that they relate principally to stream size, silt etc.

6.7 In summary, the macroinvertebrate data mainly indicate that water quality is good (calcareous and productive) and that in places the habitat is diverse. The techniques used have not directly identified trophic status but have shown that there are no serious organic pollution problems. The use of invertebrates data and current survey/analysis techniques is therefore not considered to be directly appropriate as a stand-alone approach for assessing current trophic (nutrient enrichment) status of the river.

6.8 The diatom survey method used is directly applicable to assessment of trophic status. It suffers from lack of precision and variation between the different indices which can be calculated. Also the usefulness of the data collected was limited by time of year and attempts to sample at less than ideal locations. Repeated surveys in the summer may provide data of greater value and better definition.

7. RECOMMENDATIONS

7.1 It is apparent that the separate commissioning of individual specialist reports has led to several unnecessary conflicts between the data. The value of future work would be greater if given to a single person or organisation to complete or to actively manage and write the overall report. Areas for consideration here include ensuring that survey locations, dates and approach are the same in each case and that there is active discussion between different experts during data analysis and report preparation.

7.2 There is also a need to thoroughly review the data collected to date with the objective of rationalising the number and location of future survey sites before more surveys are instigated. This will ensure that the data generated carry maximum value and that resources will be objectively focused.

7.3 Specific overall recommendations are as follows (in priority order):-

i) Allocate resources to increase routine sampling frequency and intensity, together with increased flow measurement, at both riverine and effluent discharge locations to improve the P budget.

ii) Select representative sites for the above which should become the major reference sites for the study at which all chemical, biological and flow surveys will be focused.

iii) Monitor invertebrates, diatoms, possibly macrophytes (including filamentous algae), habitat structure/substrate type and adjacent land use during a single, intensive survey period each in mid-summer. This work should ensure that all survey types can be completed within each single site and that the effort is closely co-ordinated. The objective of such intensive surveys would be to track biotic changes through time while maximising the value of each specific survey type by direct reference to the others.

iv) Undertake a national review of average river P- concentrations, together with collation of data on biological quality of the cleanest rivers and a literature review. The purpose should be to derive, if possible, objective P and biological/habitat diversity targets for mesotrophic rivers. Consideration could then be given to adoption of these objectives as the overall guide to the required management regime for the River Nar.

v) Once initial data become available from recommendation i) above, implement more detailed studies to refine the P budget.

MANAGEMENT AND CONTACTS:

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Cardiff CF3 0LT
Tel: 01222 770 088
Fax: 01222 798 555

The 24-hour emergency hotline number for reporting all environmental incidents relating to air, land and water

ENVIRONMENT AGENCY EMERGENCY HOTLINE
0800 80 70 60

ENVIRONMENT AGENCY

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