Mean Trophic Rank Macrophyte Survey

An Assessment of the Trophic Status of Rivers using Macrophytes

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NERC Institute of Freshwater Ecology
with IACR Centre for Aquatic Plant Management

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R & D Interim Report 694/NW/01

ENVIRONMENT AGENCY

RESEARCH AND DEVELOPMENT
PROGRESS REPORT

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Research Contractor:
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Statement of use
This report is the first output from Project E1/i694. It summarises the work from February to July 1996, in preparation of the database, initial analysis of the data and derivation of the proposals for field work programme of surveys.

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Environment Agency Project Manager
The Environment Agency Project Manager for this project E1/i694:
Dr. K.J. Rouen (North West Region)

CONTENTS

2. EXECUTIVE SUMMARY

1. The overall objectives of this project are: to evaluate the Mean Trophic Rank system, to produce a robust transportable system for assessing the trophic status of rivers using aquatic macrophytes; to compare this and other biological methods of assessing trophic status of rivers and to evaluate them; and, to produce a Recommended Method to assist in the designation of phosphate-based Sensitive Areas (Eutrophic) under the Urban Wastewater Treatment Directive (UWWTD).

2. Issues to be addressed and proposed methods have been reviewed following a joint workshop report which is currently being circulated.

3. MTR survey and habitat data have been collected and collated together with some appropriate supplementary information.

4. A literature survey has been initiated for comparison of methods with more than 100 apparently-relevant publications. The survey is being expanded to include ecophysiology of aquatic plants in relation to nutrients and trophic status.

5. The data content, extent and organisation have been reviewed prior to the selection of an appropriate relational data base and storage media.

6. Draft proposals for a recommended Quality Assurance system await practical input and refinements to be tested during the fieldwork, although an updated MTR manual has been issued by the Agency.

7. The identification of additional data required relates to the apparent anomalies in the Agency data set, which need to be investigated, and the detailed studies of selected individual catchments to evaluate the downstream variation in MTR for other potential applications.

8. Within-budget Programme fieldwork proposals include MTR survey at 100 sites with up to :
   - 35 at anomalous and mismatched pairs of sites initially repeating upstream and downstream sites of contrasting pairs before expanding to alternative sites in the locality or finally at sites even further away;
   - 20 surveys along the major part of relatively unpolluted river systems;
   - 15 MTR and 10 Diatom surveys in the small catchments;
   - 10 sites in river catchments with changes in geology;
   - 20 for quality assurance.

9. An enhanced programme is proposed on:
   (i) phosphate analysis of water, sediment and plant;
   (ii) 20 surveys in the larger predominantly-enriched catchments contrasting enriched and less enriched tributaries; and
   (iii) low nutrient lowland river sites in West of Ireland.

3. INTRODUCTION

3.1 Background

The Mean Trophic Rank (MTR) system for the assessment of the trophic status of rivers using macrophytes is based on the principle that plant communities will respond to anthropogenic disturbances of the ecosystem. The MTR system works by allocating a Species Trophic Rank (STR) Score to 126 aquatic plant species. The scores range from 1 to 10. A high score indicates that the plant is intolerant of eutrophication. A low score indicates that the plant is either tolerant of eutrophication or is cosmopolitan in its requirements, *i.e.* has no preference.

In undisturbed ecosystems a theoretical maximum score should be achieved. In degraded ecosystems a score somewhat less than the perfect score is to be expected. The change from the perfect score can be used as a measurement of the impact or damage caused to the ecosystem by the disturbance.

Under the remit of this project, the MTR system is being assessed as a tool for designation of sites subject to eutrophication under the Urban Waste Water Treatment Directive.

The overall objectives of this project are thus :
1. to evaluate the Mean Trophic Rank system, developed by Nigel Holmes for NRA Anglian Region, in order to produce a robust transportable system for assessing the trophic status of rivers using aquatic macrophytes at the national level;
2. to compare this and other biological, primarily diatom-based, methods of assessing trophic status of rivers and to evaluate the role of each in such assessment; and,
3. to produce a Recommended Method(s) for use to present data for designation of the essentially phosphate-based Sensitive Areas (Eutrophic) under the Urban Wastewater Treatment Directive (UWWTD).

3.2 Introduction

The purpose of this report is to review progress on the project, particularly on preparation of the database and initial analysis of the data leading to proposals for fieldwork. The timing of this interim report (7/05/96) has been altered due to pressures of work arising from delays in the start date (1/01/96), the supply of data on both plant and habitat from previous NRA surveys, the supply of supplementary data on water chemistry and input sites STWs and formal access to data jointly owned by English Nature (EN), Scottish Natural Heritage (SNH) and Countryside Council for Wales(CCW). However, although we had expected to complete this report earlier, we are with this report about back in line with the schedule for the field work and other aspects through the parallel approach proposed in our original submission.

In addition, not only is every effort being made to adhere to the strict final deadline of 31 March 1997 but agreement has been reached to incorporate in the progress report for mid September, current best-available advice and guidance on the interpretation of regional MTR data. This will assist in the preparation of cases for designation by March 1997.

3.3 Context of this report within the project

This project is organised into four stages. The work items of Stage 1, to which this report refers, are to:

1. (I) compile a comprehensive list of issues to be addressed and propose methods to address them together with a timetable for the work programme; and, to
   (ii) review list of issues and timetable after initial workshop and recommend changes;

2. collate survey information from NRA surveys as available and bring into one format;

3. collate relevant literature to determine which methods (TDI) are to be compared with MTR;

4. develop a database for storage and (easy) manipulation of data;

[5. organise a discussion workshop in early 1996;]

6. draft proposals for a recommended Quality Assurance system;

7. (i) identify additional data needed to evaluate the MTR system, compare the MTR with other methods and meet project objectives;
   (ii) agree with Project Leader a programme for additional field and laboratory work required to gather this data (prior to Project Board Approval).

Stage I is considered complete upon authorisation of fieldwork proposals from the Project Board.

Subsequent stages (II-IV) of the project incorporate:

Phase II - fieldwork at 100 MTR sites, continued database development and (entry and) collation of Environment Agency regional field data for 1996.

Phase III - completion of data inputting; assessment of the MTR system for adequacy, robustness, reproducibility, amenability to QA, ease of use, national applicability, cost effectiveness and ease of understanding and interpretation by non biologists; outline and refine MTR; define limits; recommend QA protocol; compare and contrast MTR with other systems; and, outputs of work undertaken and produce a procedural manual.

Phase IV - organise and run training workshop for implementation of recommended method(s) in mid 1997.

These subsequent stages of the project interact with this initial stage and such interactions must be anticipated in the organisation of the developing field work programme and the further analyses of data.

4. PROGRESS TO DATE

4.1 Summary

1. Issues to be addressed and proposed methods have been reviewed. Additions to those listed in the contract are incorporated in the joint workshop report which is currently being circulated.

2. Collection and collation of MTR survey and habitat data, supplementary information and a uniform level of response across the regions, are now substantially complete. (See 4.2 below)

3. Collation of literature for comparison of methods (or data) has so far identified more than 100 apparently relevant papers, reports or other publications. This survey is being expanded to fully include relevant aspects of the ecophysiology of aquatic plants in relation to nutrients and trophic status. Detailed comparisons have not yet been undertaken, however, other issues have been identified which can reasonably be expected to affect the simple issue of macrophyte-phosphorus interaction. (See 4.3 below)

4. The data content, extent and organisation have been reviewed prior to the selection of a database. Progress in determining the implications of selecting a specific relational database (probably Access) for storage and the future inputting of data, together with the ease of manipulation and output of results in an appropriate range of types by area end users, is also well advanced. (See 4.4 below)

5. The discussion workshop on March 7-8, 1996 was organised by Karen Rouen. The preliminary analysis of some data were presented and extensive notes were recorded. The draft report of the meeting has been jointly produced and is being circulated to all participants for comment, to ensure an accurate and fair representation. This final 'short-term' report will be distributed to all participants, selected other internal Agency staff and some external organisations unable to attend the meeting.

6. Draft proposals for a recommended Quality Assurance system await practical input and refinements to be tested during the fieldwork. However several issues have been raised following the workshop and a new MTR methodology incorporating some improvements, has been issued by the Agency. The QA of this season's fieldwork will be carried out on a few sites in each region at an appropriate time considering the timetables received from each region. (see 6.4.6 below)

7. The identification of additional data required. Two broad categories of additional data have been identified which are required to evaluate the MTR system, to compare the MTR with other methods, and to meet the project objectives. The first category relates to the apparent anomalies in the Agency data set, which need to be investigated. The second category relates to detailed studies of selected individual catchments to evaluate the downstream variation in MTR within a catchment context, and to give some indication of whether the MTR could be used for applications other than UWWTD monitoring.

Detailed proposals are given in the proposals for fieldwork (see 6.3-6.4 below)

4.2 Collection and collation of data

Data have been collected for some 140 STW discharge points, including upstream and downstream sites for two or three years, making a total of 971 surveys which have so far been entered onto the database. Data are mainly complete (>90%) although some are still lacking or for 1994 have not been collected. The database is formally structured as a flat file in a standard package for straightforward entry of data and ease of analysis by a variety of more complex packages but from which it can be readily transferred to a relational database.

Field data have been collected using a variety of forms. However there were some inconsistencies in almost all aspects of the data, these mainly relating to the early development of the field sampling programmes of the project in some regions. Early surveys in at least one region were based on 10 m sections and these have been added up to create standard 100 m sections. After discussion at the Project Board meeting (30.6.96), the few 500 m sections which were not divisible into smaller 100 m sections have not been included in the data analysis. The various cover scales have been normalised to the standard C-scale (0-9).

Collection of supplementary information on water chemistry for plant growth nears completion. This includes data on phosphorus, alkalinity, macronutrients (nitrate, potassium & magnesium), conductivity and acidity. For meaningful analysis of the results, the distance between regular chemical sampling points and the corresponding MTR sites remains a major problem. However, whilst the analysis of samples taken at the time of survey may assist in clarifying the situation at many sites, particularly in the partitioning of phosphorus between water, sediment and plant, additional samples at the normal sampling positions may still need to be taken to give perspective to the regular standard sampling programme results.

A standard printout of input data and calculated MTRs is currently being produced for return to each region for correction of obvious errors. This is expected to be available by mid August following the completion of in-house verification.

Map-based data have been derived to allow categorisation of MTR site types in terms of the 11 River Habitat Segment (RHS) river segment types to give a broader context to the habitat of the sites sampled for MTR. [Links with the RHS data base will also be made to incorporate information on the type and extent of channel vegetation and of shade.]

Data on the location of the larger of the non-qualifying discharges has been requested to clarify the effects of nutrient loadings on MTR scores in some river systems, but is not yet complete.

Data on location and extent of potential or actual environmentally-sensitive sites such as SSSIs & NNRs, have not yet been incorporated.

Collaboration with EN, SNH & CCW has been pursued by Karen Rouen. However, access to the data on the Rivers database has not yet been made available and as such could not be incorporated into the planning of field work. It is hoped that the data can be used to clarify

potential MTR ranges along river systems.

4.3 Literature survey

Collation of literature for comparison of methods (or data) has so far identified more than 100 apparently relevant papers(~50), reports (~20) or other general outputs (~25). Detailed comparisons have not yet been undertaken. However issues have been identified which can reasonably be expected to affect the simple issue of macrophyte-phosphorus interaction. These include the effects of non-organic pollution, other compounds including toxic metals, pesticides, etc, variation in the physical habitat between upstream and downstream of discharges, biomass effects, sediments and shade. The literature survey will consider the ecophysiology of water plants in relation to their trophic status. This study is unlikely to affect the planning of the field survey itself except for the modification to the detail required for the recording of physical parameters but may greatly assist with the interpretation of results.

4.4 Content and development of the database

4.4.1 Content of database

The data content, extent and organisation have been reviewed prior to the selection of a database. The content of the data collected was presented at the first Project Board meeting (30 June 1996) and has only been abstracted here but it will form a major section of the final project report.

The national distribution of MTR survey sites in relation to qualifying discharges (QD) shows that few data have been generated by Welsh, Southern or South Western Regions (Figure 1.) The lack of QDs in these regions may account for this but this needs to be confirmed and locations of both qualifying and non-qualifying discharges from STWs throughout the country have been requested. This may also show the accumulated effect of smaller non-qualifying discharges on the downstream changes in some rivers.

4.4.2 Database development

Progress has been made on the implications of the selection of a specific relational database for storage, future data inputting, ease of manipulation and output of results in an appropriate range of types, together with the ease of manipulation and output of results in an appropriate range of types by area end users. The immediate response in terms of general applicability, easy of handling, cost, licensing and the Agency IS recommendation or policy, suggests that MS Access is the current first choice for the final output of the project. However, this does not preclude indirect links with other more comprehensive databases during the project, such as ORACLE. This would not only allow easy transfer to any other commercial data base format but allow the data to be incorporated directly onto a GIS analysis system. This would be extremely useful in assessing the appropriateness of cover of the original sampling sites or for other applications such as assessment of, or changes to, the nutrient supply during the modification of agricultural practices or in urbanisation, river networking, or other hydrological aspects. The RIVPACS data

are already in a similar relational database following the setting-up of a new site location numbering system which is more systematic than the former NRA's system so that more focused searches can be undertaken.

Discussions have been held and an outline proposal for the database and output structure have been agreed internally. The output media also needs to be discussed; magnetic can be updated whereas optical will act as an incorruptible source. Further elicitation of user requirements is required but a proposed calculation and on-screen query structure with three alternative output formats are expected to be available by late August as fieldwork is completed.

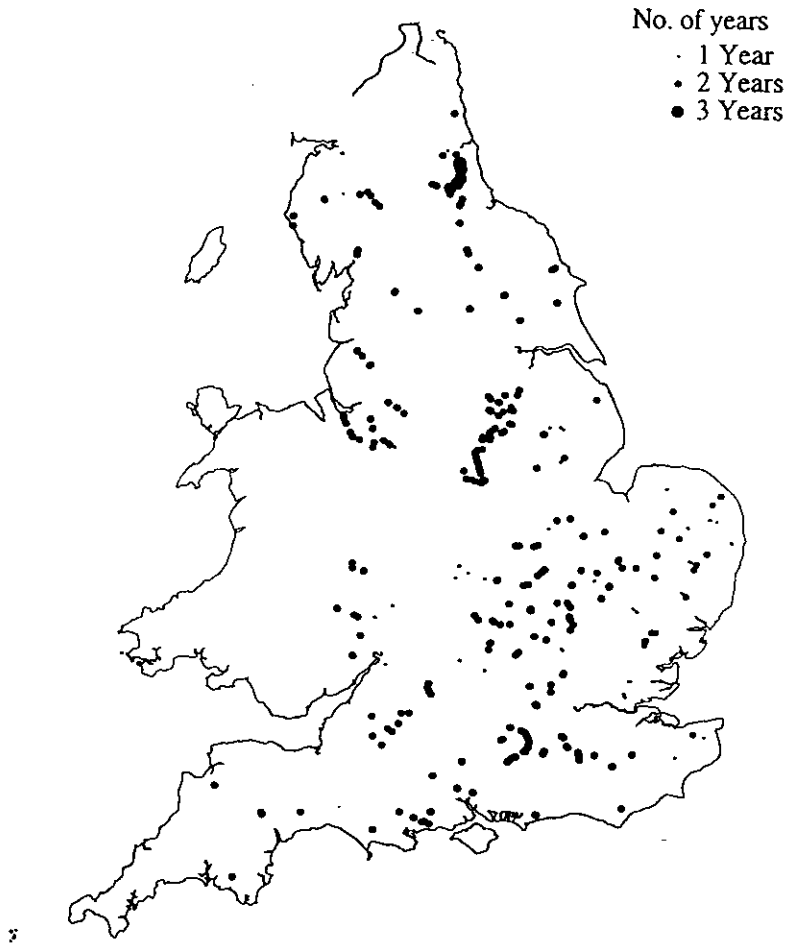


Figure 1. The location of MTR survey sites indicating the number of years of survey at each site during 1993-95.

5. PRELIMINARY ANALYSIS OF DATA

Comparative analyses have been undertaken to determine gaps or omissions in data, areas of uncertainty and identify the areas needing clarification in the field or additional data. The initial data and some analyses presented at the Project Board meeting on June 30 1996, have been abstracted here but will form a major section of the final project report.

Analysis of the surveys completed per NRA region shows that Welsh Region and Southern region have carried out the fewest surveys but this is likely to be due to lower numbers of qualifying discharges in these Regions (Figure 2). Information on the number of qualifying discharges is not currently complete.

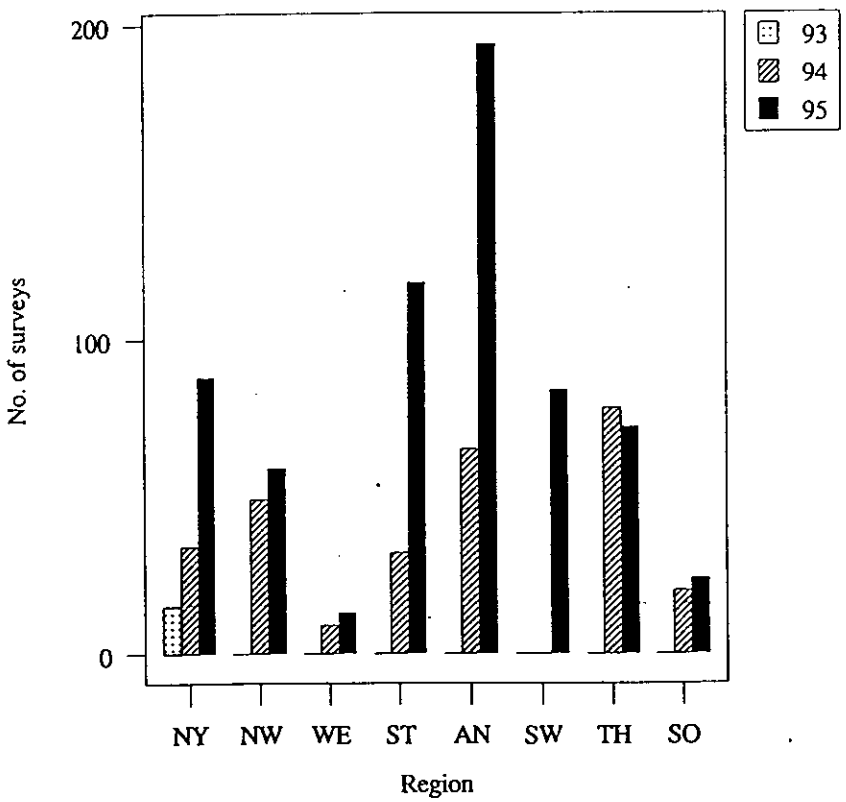


Figure 2. The number of surveys within each former NRA region by year.

The physical character of the typical site can be summarised as:
A lowland small to medium sized river rarely a small stream of category of 1 or 2, often less than 100 m in altitude with a low gradient frequently < 1:100. The river is more often greater than 3 m in width, more often 5-10 m but there are several large rivers over 20 m in width; the larger rivers are in shallow valleys nearer the coast except in East Anglia. Water depths at survey time are normally from 0.5-1 m but can be both shallower and considerably deeper. Shade varies both regionally and with size but, due to management downstream of STWs to allow water to discharge more freely, downstream sites are more often less shaded and often larger in size.

Physical similarity between the upstream and downstream sites is important for comparing the potential and actual macrophyte MTR scores resulting from the effect of the discharge; it is already apparent that more effort is needed to ensure a good match wherever possible between the upstream and downstream sites in terms of physical parameters. Most plants have a specific or preferred range of habitat requirements including light at their leaf surfaces, water flow, depth, in addition to the regular supply of suitable carbon for growth, macro- and micro-nutrients. If these balances are less than optimum, growth may be reduced, other competitors may invade and the species may be lost. Thus if there are extreme differences in the physical habitat, it may unreasonable to expect the presence of a particular plant to be present, except by chance, and the discharge may coincidentally be assessed as the cause of its loss.

The frequency and total number of scoring taxa was broad but there were a few species common to most sites (Figure. 3). The number of species per MTR survey ranged from 1 or 2 to the low twenties for a survey site (Figure 4a). A refinement to give greater confidence in the results depends upon the presence of species with 'known' levels of tolerance to pollution ie 'highlighted species' (Fig 4b). The MTR score is assigned a suffix of confidence depending upon the number of highlighted species. In the majority of surveys (41%) only the lowest level of confidence (<5 species) was achieved, with 5-8 species recorded in 38% and the highest level of confidence (>=9) only achieved in 18% of surveys; 4% of surveys had no highlighted species. The MTR scores are calculated from a ranking score given to each species for its pollution sensitivity, and its individual areal cover of the watercourse. MTR scores range from zero to ~90, whilst significance in the result increases with the number of highlighted species present (Figure 5a-d).

Preliminary data analysis shows that although there is some differentiation between upstream and downstream sample sites, the overall longitudinal trend in MTR score is not readily apparent (Figure 6a-c). Field work aims to clarify many of the anomalous results between both upstream-downstream pairs and longitudinal trends along rivers.

The determination of a significant difference in the MTR score upstream and downstream is the subject of further research (Figure 7). The absence of scoring species either upstream or downstream or data on the relationship to the discharge, are an examples of anomalous results and should be investigated further. It is envisaged that changes in scores should be presented as a percentage change compared to the upstream site. This eliminates any prejudice which is associated with inherently low scores, *i.e.* degraded systems u/s. A banding system is envisaged in which for example: >20% change is considered to be evidence of gross change; 10-20% change - moderate change; 5-10% - small change; and, <5% change - no significant difference. These figures may need to be adjusted after statistical analysis of error within the system but this use of relative or of absolute differences is the subject of further stages.

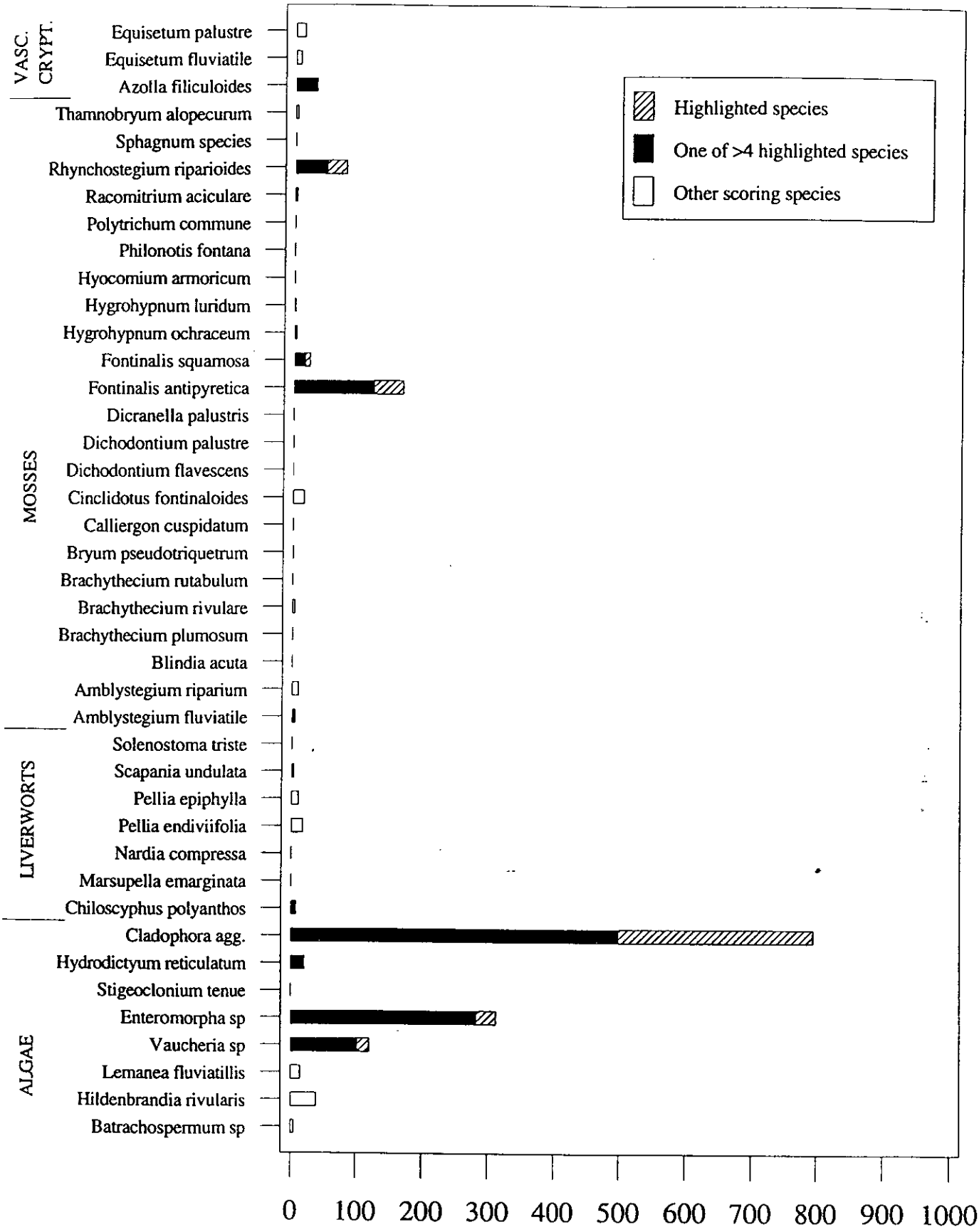


Figure 3a. A frequency histogram of the scoring species of algae, bryophytes and vascular cryptograms recorded during MTR Macrophyte surveys 1993-95.

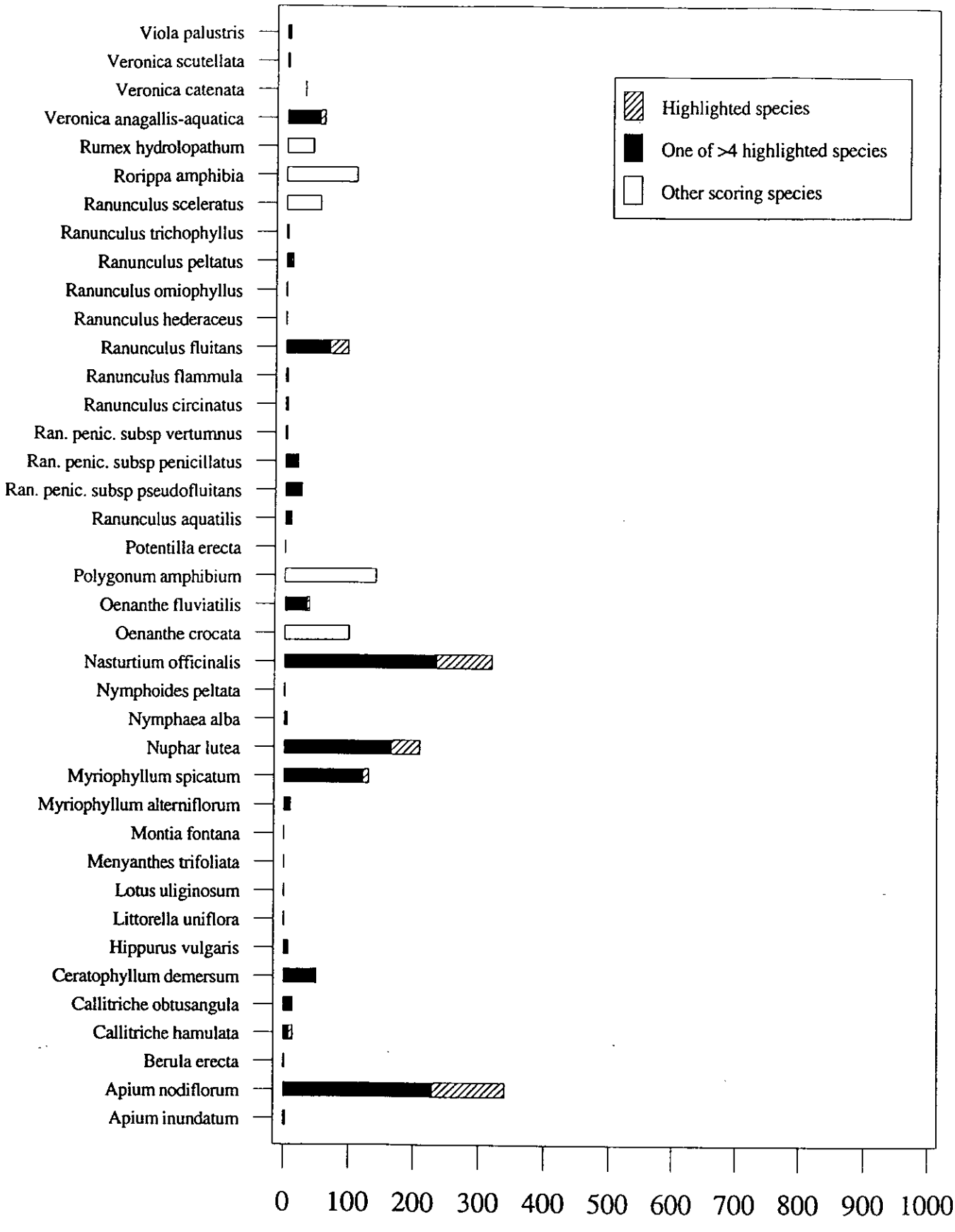


Figure 3b. A frequency histogram of the scoring species of dicotyledons recorded during MTR Macrophyte surveys 1993-95.

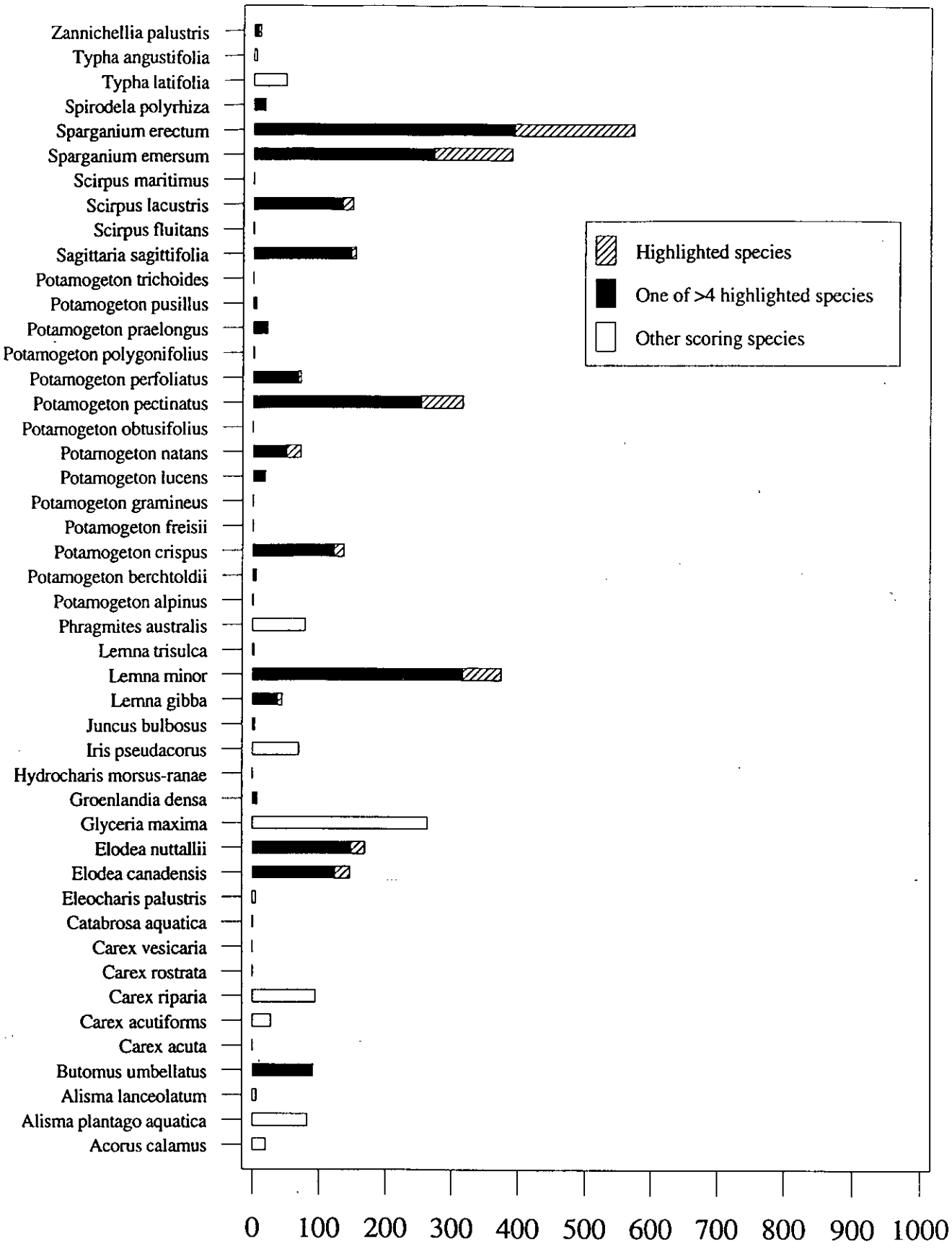
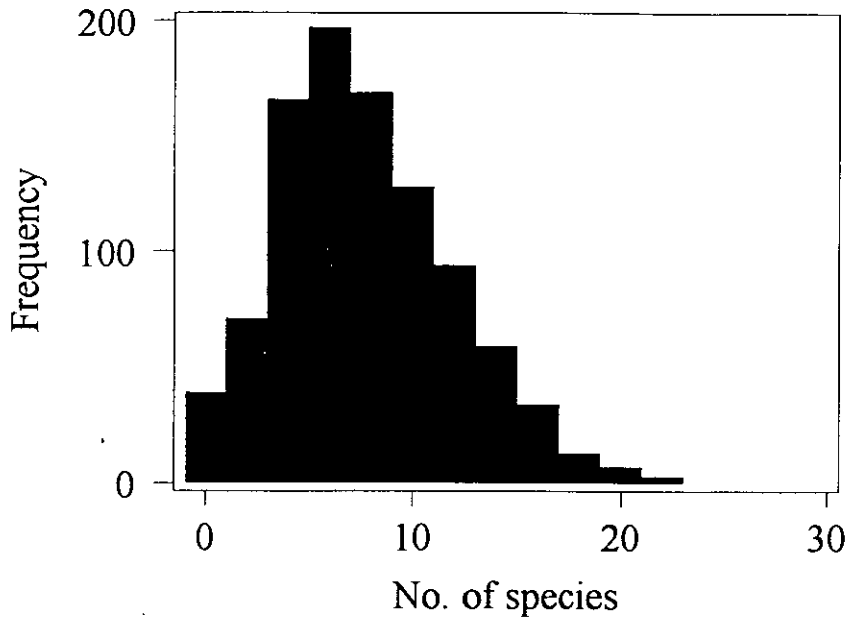


Figure 3c. A frequency histogram of the scoring species of monocotyledons recorded during MTR Macrophyte surveys 1993-95.

a)



b)

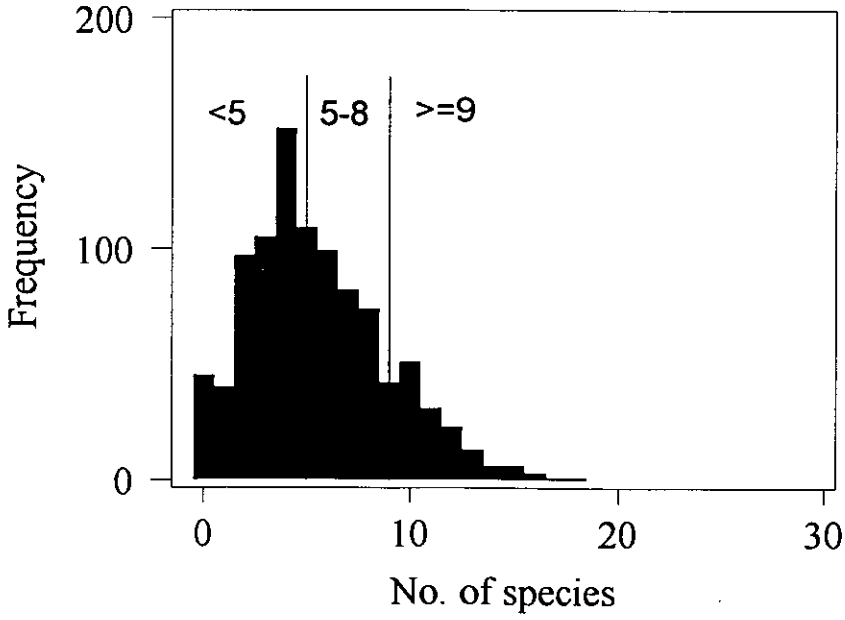


Figure 4. The frequency histogram of a) the number of scoring species and b) the number of highlighted species indicated by vertical bars dividing the data to three groups (<5, 5-8, and >8) recorded per site during MTR Macrophyte surveys 1993-95.

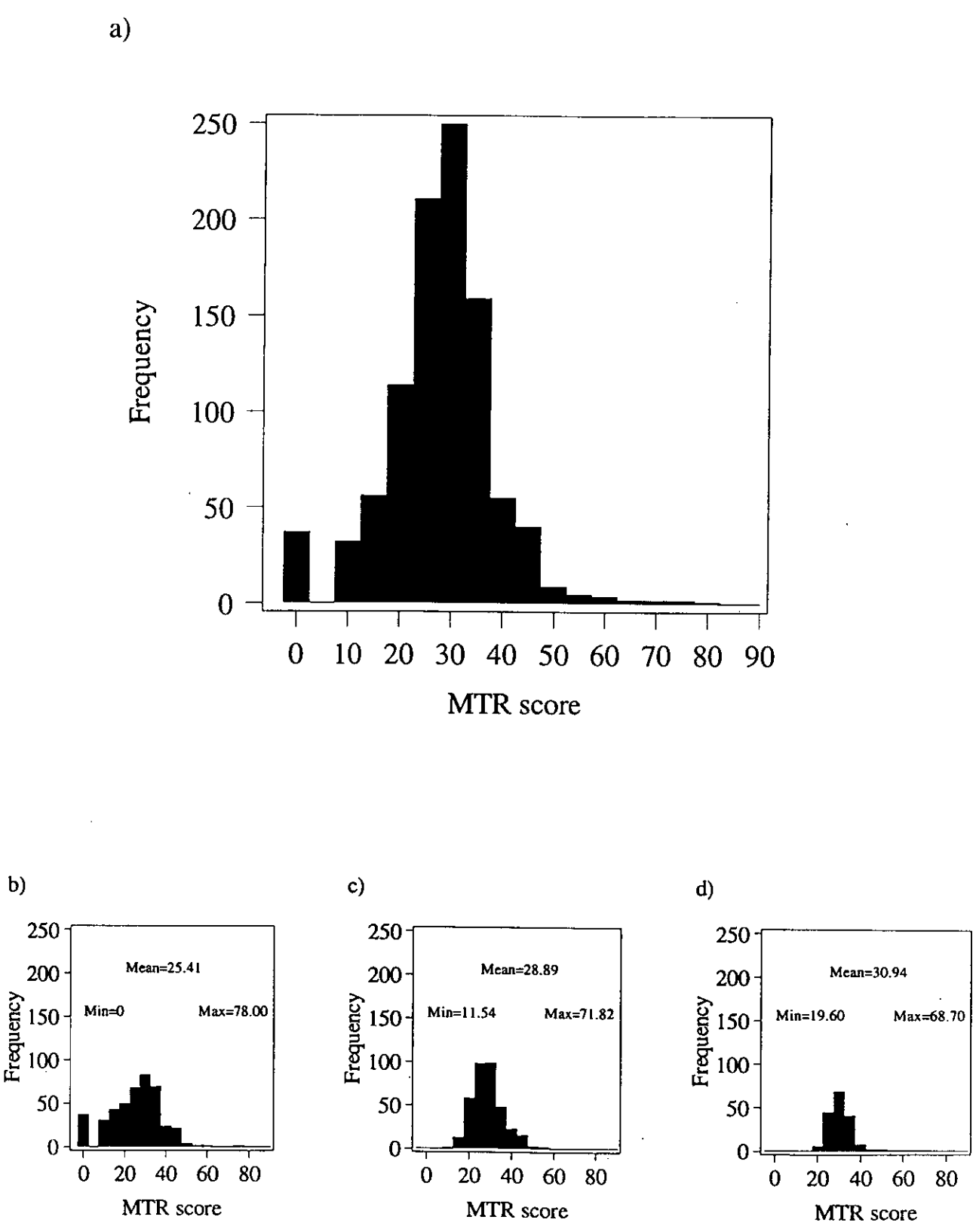


Figure 5. The frequency distribution of MTR scores at a) all MTR survey sites, b) sites with less than 5 highlighted species c) sites with 5-8 highlighted species and d) sites with 9 or more highlighted species.

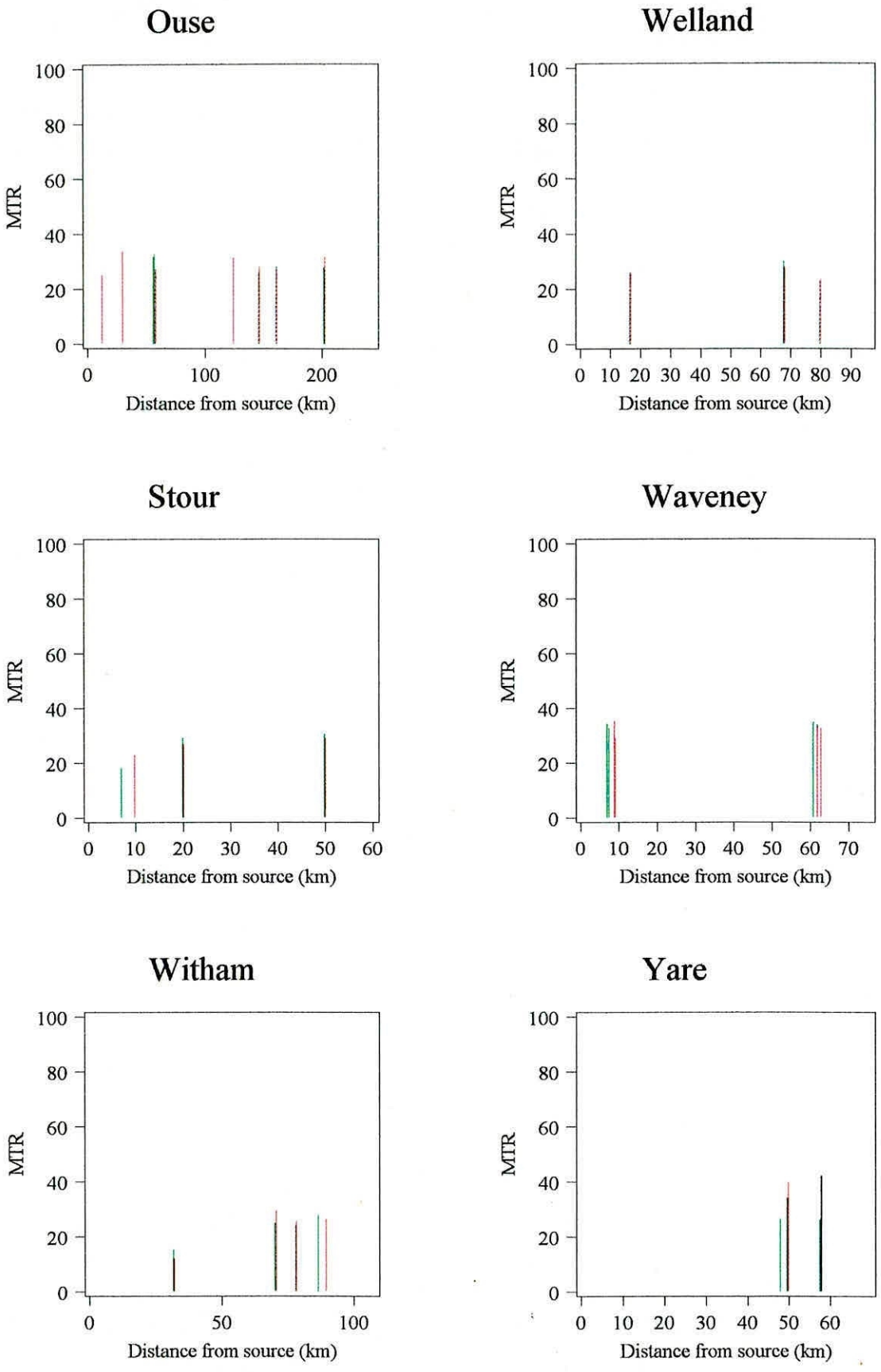


Figure 6a. The change in MTR score with distance along several rivers sampled during MTR Macrophyte surveys 1993-95. [Key to colours: upstream of STW = green; downstream = red; both ie between STWs = yellow; unknown = black]

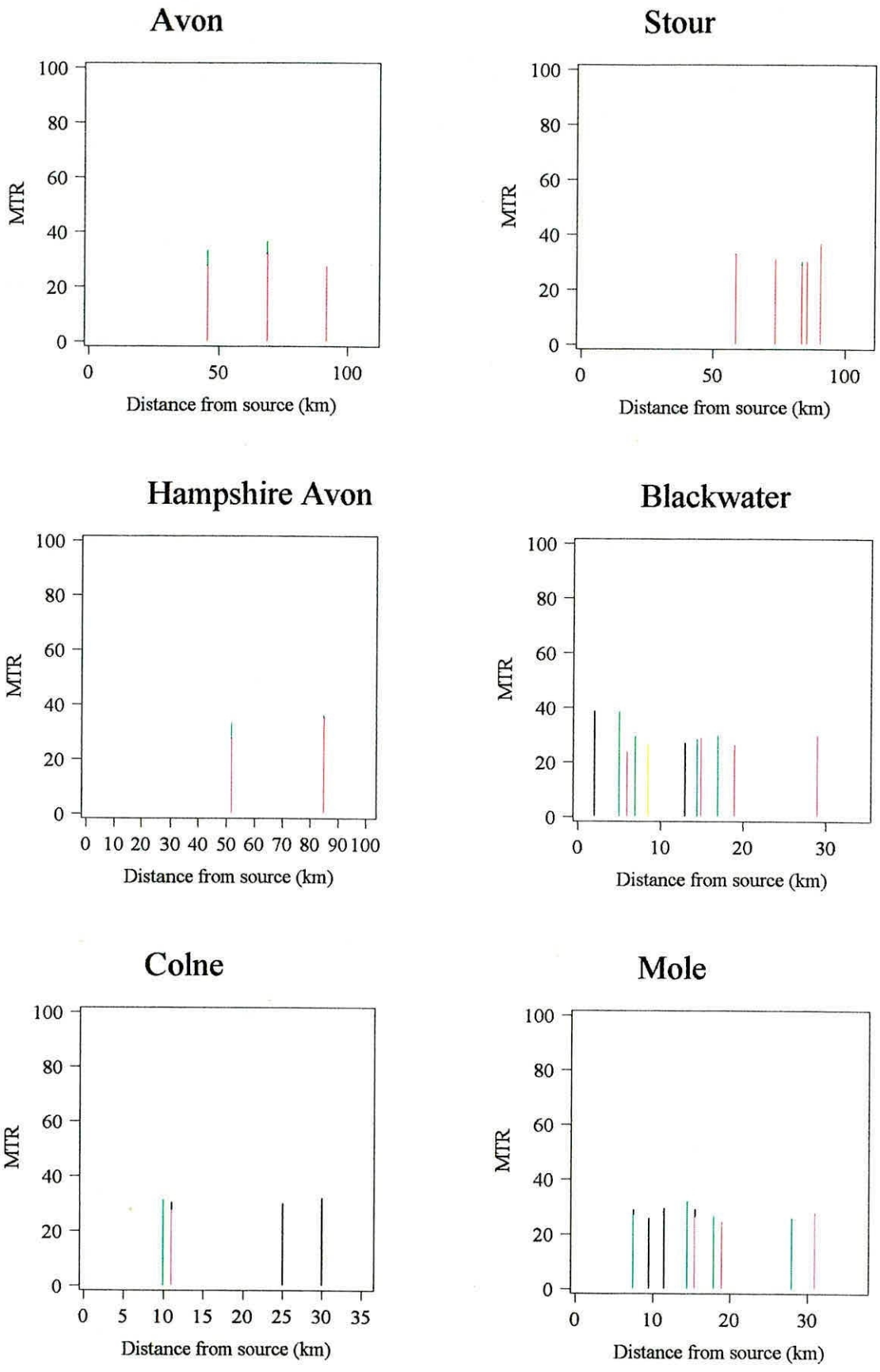


Figure 6b. The change in MTR score with distance along several rivers sampled during MTR Macrophyte surveys 1993-95. [Key to colours: upstream of STW = green; downstream = red; both ie between STWs = yellow; unknown = black]

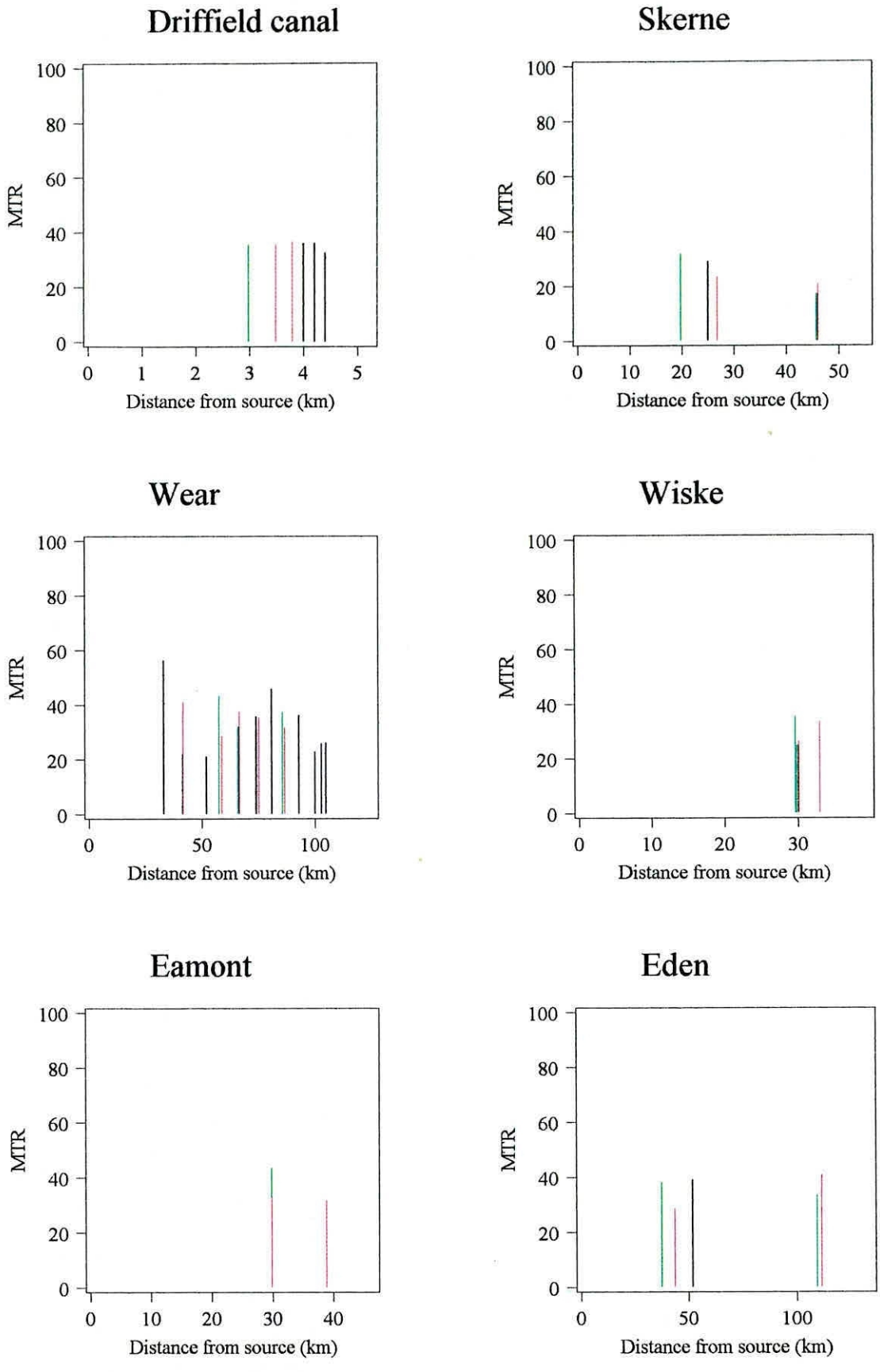


Figure 6c. The change in MTR score with distance along several rivers sampled during MTR Macrophyte surveys 1993-95. [Key to colours: upstream of STW = green; downstream = red; both ie between STWs = yellow; unknown = black]

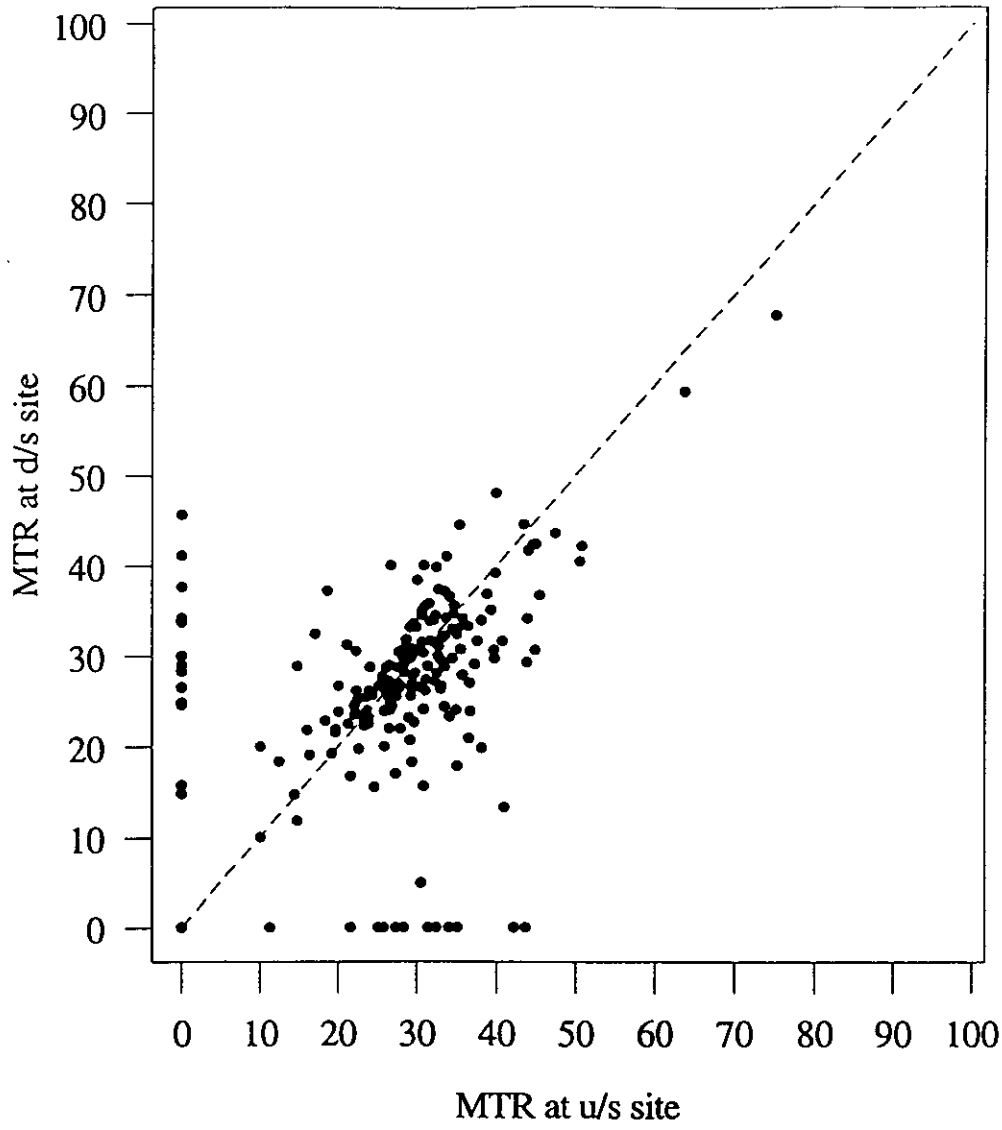


Figure 7. The relationship of MTR at sites below an discharge with the corresponding upstream site for 1993-95 (zeros on either axis indicate either anomalous results or no apparent pair-match).

Water chemistry. The basic concept upon which the MTR is based is the relationship from high MTR score with low phosphate to low MTR score with high phosphate. The results of chemical analysis for phosphate show clear divergences from the 'model' condition for which there is no immediate explanation either in terms of the recording frequency of macrophytes or in terms of macrophyte distribution within England and Wales (Figures 8-10). When considering other factors such as the potential high biomass production which is linked with higher alkalinity, there are some clear coincidences expressed in the data for very high MTR scores and low alkalinity but no clear trend in high alkalinity systems (Figure 11). The separation of alkalinity into two or more divisions will be considered although a combination of acidity, alkalinity and ionic strength may be more appropriate. The values assigned to various plant species may also need to be reexamined to remove coincidental from causal relationships. However, as almost all higher alkalinity streams and rivers are in nutrient-enriched areas, the absence of a clear pattern is not unexpected. Indeed early project planning suggested that it would be necessary to travel to Western Ireland to survey sites low phosphate, moderate-alkalinity lowland rivers to separate the effects of alkalinity and nutrient enrichment on MTR scores.

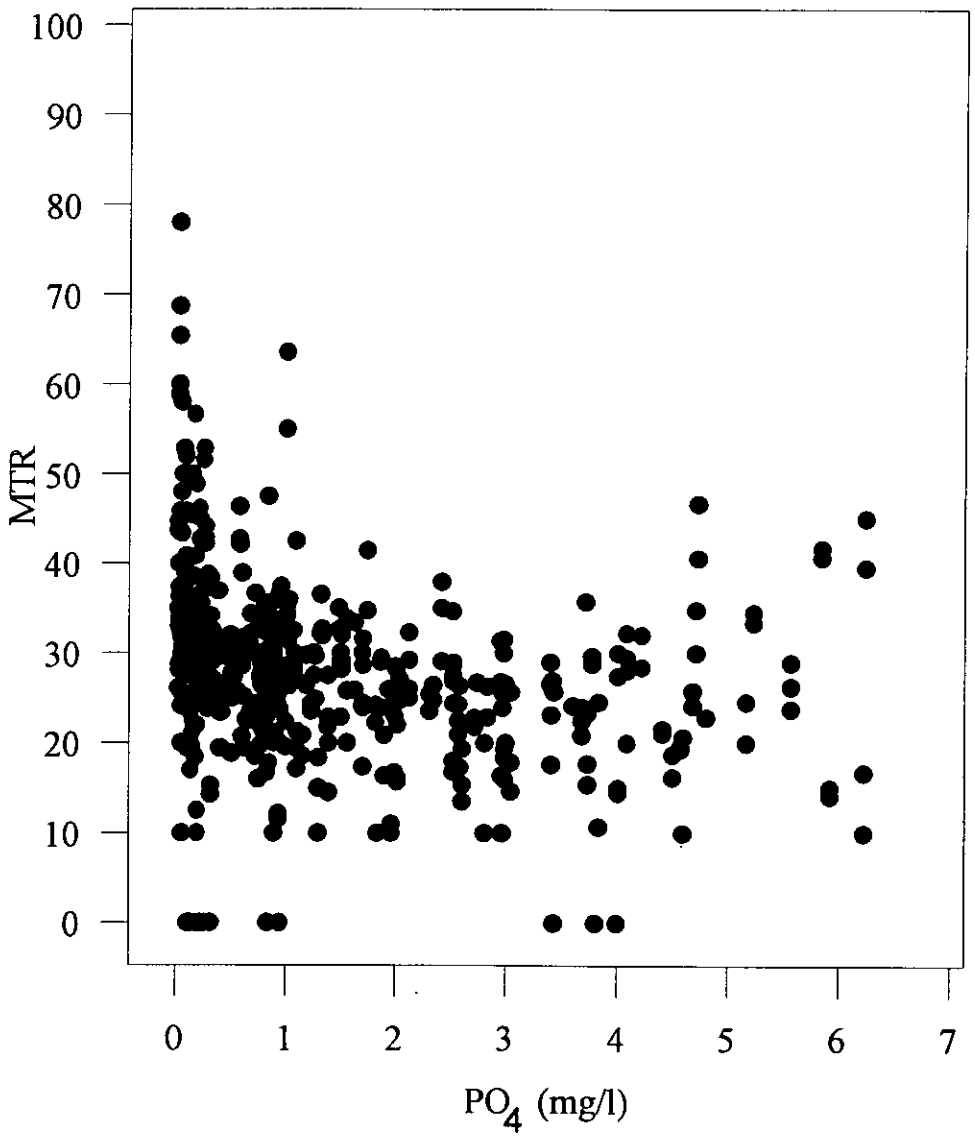


Figure 8. The relationship of MTR recorded at individual survey sites against phosphate concentration for 1993-95.

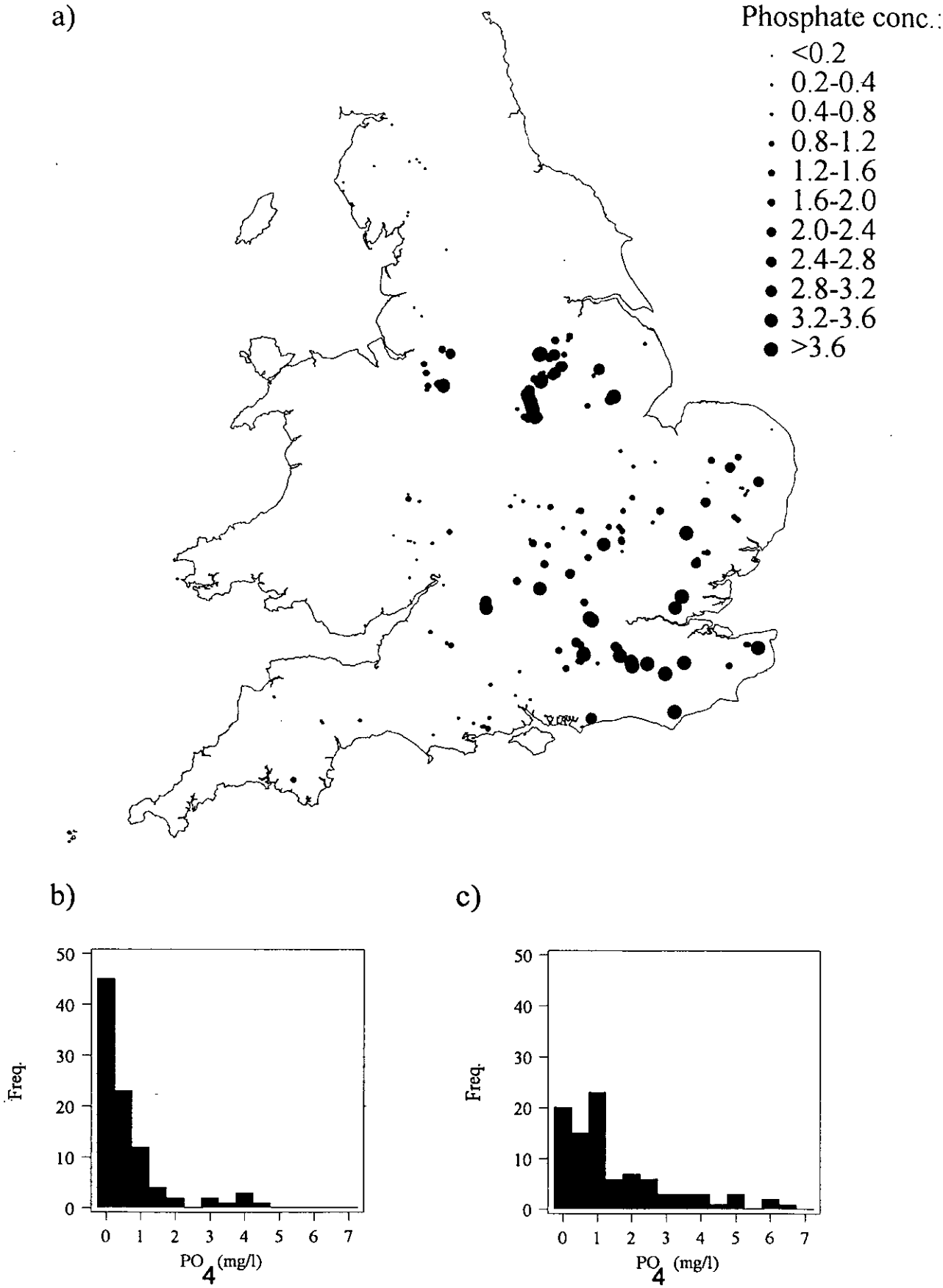


Figure 9. The Phosphate concentrations: a) national distribution, b) the frequency distribution at sites upstream and c) downstream of discharges at MTR Macrophyte survey sites.

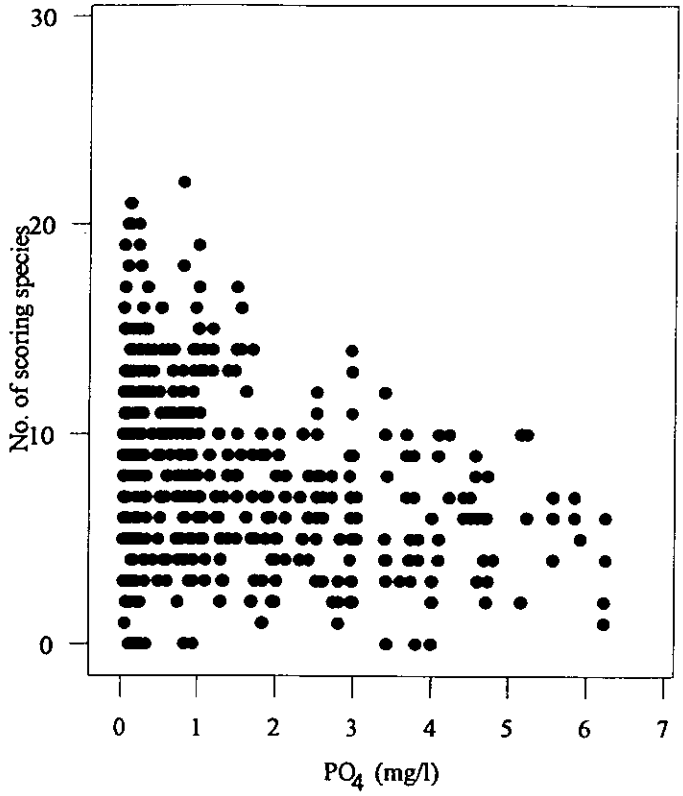


Figure 10. The number of scoring plant species recorded at each MTR Macrophyte survey site against phosphate concentration during 1993-95.

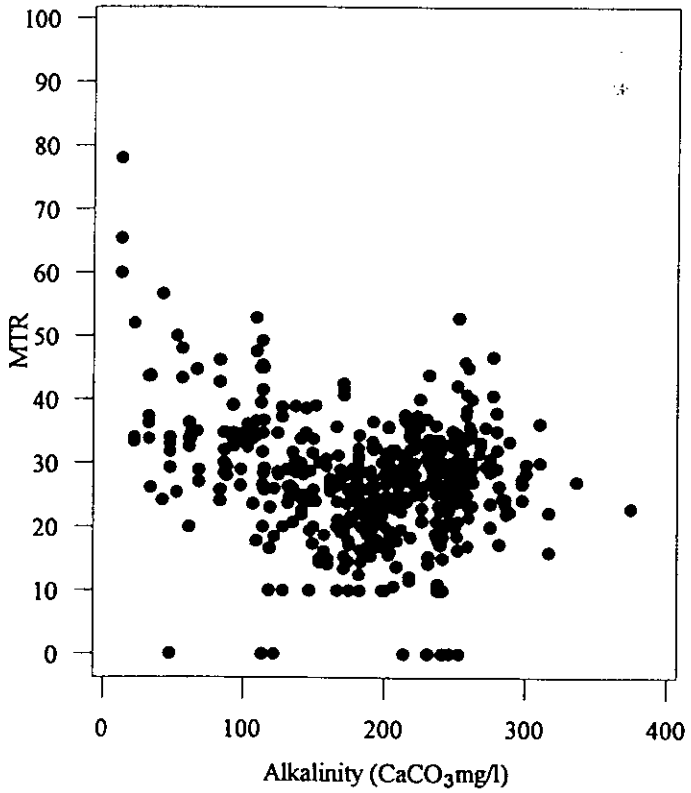


Figure 11. The MTR score against alkalinity at each site of the Macrophyte survey sites for 1993-95.

6. FIELDWORK PROPOSALS

6.1 Introduction

Additional data are required to meet the specific objectives of the project. Two categories of such data have been identified from the preliminary analysis of data. These are:

1. Investigation or confirmation of the apparently anomalous results in the Agency data set.

Preliminary analysis of the data has revealed several apparent anomalies in the Agency data set which do not conform to the hypothesis underlying the methodology. The categories where MTR scores gives inconsistent or anomalous results are:

1. high MTR score with high phosphate ie anomalous;
2. low MTR score with low phosphate ie anomalous;
3. higher MTR score downstream than upstream ie pair mismatch;
4. near constant (high, medium or low) MTR score along majority of river despite discharges;
5. change in MTR score in rivers with one major and several suspected minor non-designated discharges;
6. suspect non-organic pollution effects;
7. other effects of change in geology on water quality, substrate or flow regime along river.

These may relate to difficulties in the choice of site, effects of non-compatible upstream-downstream habitats, the completeness of plant identification, and the need to confirm phosphate concentrations. Further fieldwork is required to confirm, or understand the reasons for, these discrepancies.

2. Detailed studies on individual catchments to evaluate downstream variation in MTR within a catchment context.

The adequacy of current data was discussed at the Project Board meeting (30.6.96), with the aid of graphical representations of the data so far collected. It was decided that survey effort would best be directed at undertaking a small number of intensive catchment surveys. The rationale for this decision is as follows.

As data are collected for UWWTD monitoring purposes, most data are in the form of paired sites upstream and downstream of a qualifying discharge (QD), with very few data giving a more detailed picture of the variation in MTR score down a catchment. Preliminary analysis of the data suggests that there is not much downstream variation in MTR in an individual river, for the reaches surveyed. This requires investigation by a more detailed, catchment-based approach. This would serve to: evaluate the site selection element of the methodology as applied to the UWWTD monitoring (ie whether one set of paired sites is sufficient); put the MTR data into a catchment context; and, give some indication as to whether the MTR could be used for applications other that UWWTD monitoring (eg. for catchment studies or for assessing impacts of non-UWWTD-qualifying nutrient inputs).

The programme of additional fieldwork will also allow tests of the repeatability and reproducibility of the methodology to be made, and by incorporating diatom sampling, allow further direct comparison with the performance of TDI (DQI). Details of the proposed fieldwork programme are given below in 6.3.

6.2 Preparation for field survey

The only suitable training courses are conducted by Dr N.T.H Holmes. The Natural History Museum holds an IdQ examination for which preparation could be undertaken. The latter is more general than required and aimed at the freshwater botanist. An undue emphasis seemed to be given towards grasses which are not generally included in the MTR assessment. If IdQ were undertaken an ancillary MTR training course would also be needed.

IFE negotiated with Dr Holmes for a course which was attended by 6 surveyors, three of whom were young graduate biologists with less than 3 years experience in freshwater ecology. The others were a very experienced botanical 'technician' and an experienced doctoral zoologist both familiar with a range of freshwater survey work and as an assessor, an experienced doctoral agricultural botanist.

Field equipment will be prepared as advised in the manual and at the course eg transparent-bottomed observation buckets, grapnel, etc. An inflatable boat with safety equipment will also be available. The current forms issued in July will be used with additional features allowing better discrimination, particularly of individual physical parameters introduced following initial analysis of data for site matching.

Plant material of the species which are more difficult to identify or which require 'confirmation' (genera of *Ranunculus*, *Callitriche* and *Potamogeton*) will be collected, prepared in a plant press and kept in a herbarium. Larger or filamentous algae will be identified in the field and fresh material of each type will be returned for confirmation to the laboratory.

For the improved interpretation of the anomalous phosphate results it is proposed that the collection and analysis of water, plant and sediment samples upstream and downstream of discharges sites should be undertaken (see 6.3.2). Samples of unfiltered water will be collected for analysis of total phosphate, and also filtered water for soluble reactive phosphate analysis. Water samples will be kept cool and analysed as soon as possible on return to the laboratory. Samples of the major plant and algal species will also be collected and returned to the laboratory, for washing and removal of adhering materials, before drying at 60°C for 8 hours and stored dry for later analysis including total phosphate. Surface or ephemeral sediment samples will be collected in stainless steel implements and sieved to 2 mm before storing cool and sub-sampling fresh for Biologically available phosphate (BAP) and drying for storage and later analysis for total phosphorus. Sample containers will be prepared in a manner appropriate to the subsequent analysis eg Decon and acid washed for soluble phosphate.

Interpretation of the 100 m MTR survey in the context of the general continuity of stream habitat will be aided by undertaking standard 500 m RHS samples under IFE funding. RHS surveys will be centred on the MTR survey site where possible but not to either overlap or approach within

30 m of the discharge point. As is normal for IFE RHS surveys, additional water samples will be collected for analysis for physical, major anions and cations and for a scan of ~25 trace metals.

6.3 Proposed field work

The categories of data to be collected have been identified (see 6.1 above). Although it is difficult to establish priorities for the order of this survey work, it is clear that explanations must be found for the apparently anomalous results (category 1 above). This is so particularly for cases where high MTRs are recorded at high phosphorus concentrations, or low MTR at low phosphorus concentrations. It is proposed, therefore, that first priority will be given to the investigation of anomalous results, with individual catchment studies then prioritised as below.

Two programmes are given below, the first which could be undertaken within the contracted budget allocated for fieldwork, and the second incorporating further useful elements but which would require additional funding to that agreed in the contract.

6.3.1 Within-budget Programme

It is proposed to survey approximately 100 sites for MTR. Of these, approximately 80 sites will be prioritised and grouped to include:

1. Investigation of ~ 35 anomalous and mismatched pairs sites.
There are disparities in data from all but SW and NE regions (Figure 12). Surveys must be repeated in the first case at both upstream and downstream sites of contrasting pairs to determine which, if either, of the pair is in error, or in the second case, at alternative sites in the locality or finally at sites even further away to determine which is the true trend for the river. Where no substantial difference is found between the previous and the proposed current survey it becomes a confirmation and lesser degrees of conformity can be investigated.

2. ~20 surveys along the major part of relatively unpolluted (low phosphate) river systems to establish the natural range of MTR in an investigation of the reasonable or natural expectation of downstream trends in the context of many rivers where such changes were not found; the rivers proposed for survey are the Eden (10) and Wye with Lugg(10) and/or Coquet. It is expected that this study will be supported by analysis of data from the EN-SNH-CCW Rivers database.

3. ~15 MTR and 10 Diatom surveys in the small catchments as case studies on a manageable scale, including catchments with substantial but non-qualifying discharges; suggested catchments include the Rivers Lodden/Blackwater (or River Kennet, AMcQ), Warwickshire Avon (Blythe) or the Coquet in NE.

5. ~10 sites in river catchments with changes in geology downstream along the main course of the river, to determine the effects of 'traditional' substrate-driven plant occurrence under similar water chemistry eg Hampshire Avon, Dorset Stour;

Due to the delay in the production of this report, and the need to commence the fieldwork as soon as possible, outline agreement, at IFE risk, has been made with the Project Leader for exploratory

fieldwork at sites with anomalous results (item 1 above), prior to Board approval.

The remaining 20 of the 100 sites will involve quality assurance:

6. ~20 sites for QA of Agency data set, to gain a broad overview of the 1996 data. 2 or 3 per region of 1996 surveys will be resurveyed, unless otherwise sampled in the course of 1-5 above. The overall intention is to select sites at random, to confirm that surveys have been undertaken with Regional Contacts (RCs), to obtain a sketch map of location and to survey these within a two week period of that survey. [Agency RCs have supplied data to assist this]

6.3.2. Enhanced programme

Prioritised as follows:

7. Phosphate analysis of water, sediment and plant is proposed to allow its partitioning in order to explain some of the anomalous chemical data from non-contemporaneous water sampling and the influence of sediments. Some insight may also be obtained into the probable discontinued operation of P-removal on a site in the Ouse system.

8. ~20 surveys in the larger predominantly-enriched catchments contrasting enriched and much less enriched tributaries of similar-sized (cp upstream - downstream sampling) to determine the effect of water quality in similar habitats eg major tributaries of River Trent (although the Severn or Great Ouse are possibilities).

9. Low nutrient lowland river sites; these are very difficult to find in Britain and it is proposed that the River Unshin in West Ireland which is a high-quality moderately sized mainly undredged river with a strategically placed STW, is surveyed along its length. The alternative would seem to be an exploration of the Rivers data base to determine if a river in Scotland would be alternative eg Earn, a tributary of the Tay.

6.3.3 Quality Assurance

Fieldwork will be undertaken by two teams. QA will be involve the cross revisiting of surveys by the other team for a random sample 10% of the sites.

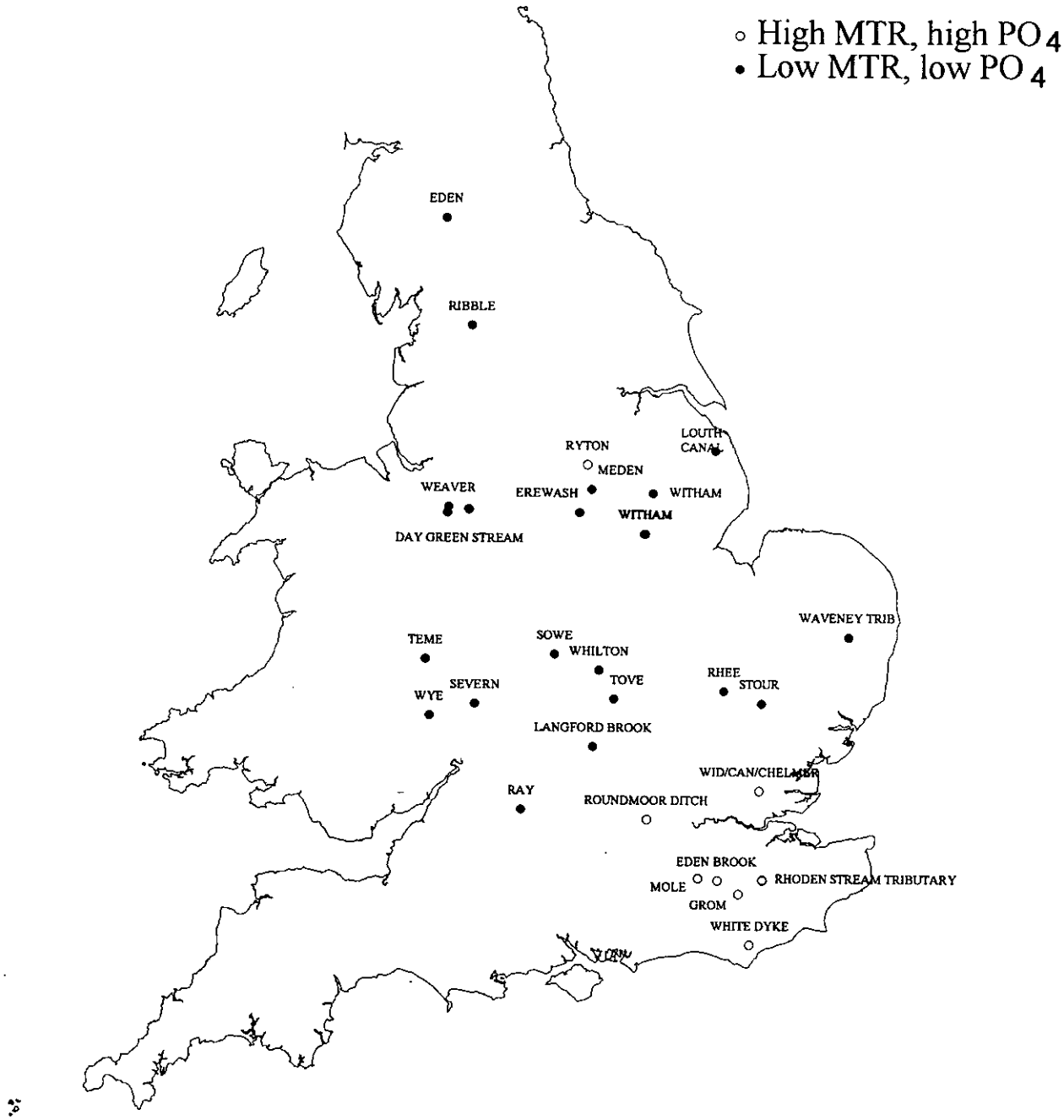


Figure 12. The distribution of sites with anomalous MTR scores proposed for initial field survey for 1996.

7. FINANCIAL SUMMARY

The financial summary is based upon the original proposal and contract. In the proposal, abstracted here, calculations were based on the assumption of a two-man field team visiting 100 survey sites (or 20% of the reported number of sites). The sites would be identified following an initial analysis of the data and in coordination with the project leader. ...assuming that some savings due to conjunctive use of site visits.... The savings obtained by this have been incorporated into our costings. We assume that the majority of the 100 sites will have macrophytes sampled. Up to 20 of these will also be sampled for diatoms. Our knowledge of sampling locations in mainland Britain ...should preclude the requirement to travel to Ireland, which would significantly increase costs due to the ferry crossings etc. It is assumed that permissions to access field sites will not be required as we will be contracted by the NRA and, as such, will be covered by legislation giving NRA staff site access without written permissions... Field work QA would involve a second team revisiting of a random sample 10% of the sites and collecting samples. These will be prepared as a herbarium collection for examination by an independent botanist. Diatom samples will be identified and counted under the supervision of Dr. E.Y. Haworth.

Stage I for 1995/96 - delayed start with some work still in progress

Stage I staff Item	fhd + jh	rtc/ wah/ eyh	jn	alib	so	aso	£
manage project							
progress reports	6		15			9	
attend 3 meetings	3		3				
Issues	1		4				
organise workshop*	5		5				
Collate literature/ comparisons			7	3			
collate 93/95 data	1		1		1	37	
develop database					5		
draft QA							
additional data proposals	2+1	2	5			12	
other - management, etc	10						
total	28+1	2	40	3	6	58	
Day rate 1995/6	391+ 519	391	370	178	197	156	37813
T&S							900
consumables							500
Total 1995/96 originally projected for completion by April 96							39213
Total - personnel 96/97 re draft QA proposals							1871
Grand Total Phase 1							41084

Note: * The organisation of the workshop by the Project Manager (excluding attendance and presentation) is seen to balance the preparation of the EN-SNH-CCW River database for use by this project or the early preparation of draft guidance notes.

Stage II for 1996/97 extracted, with additions, from proposal:

Stage II staff Item	fhd	rtc/ wah/ eyh	jn	hso	so	asos	£
manage project							
progress reports	2		5			3	
collect additional field data MTR + diatoms	3	1	3	4		59	
develop database					10		
collate 1996 data			1			9	
total	5	1	9	4	10	71	
Day rate 1995/6	391	391	370	282	197	156	19850
t&s							2000
consumables							1000
Within-budget programme Total							**22850**
enhanced programme							
Phosphate analysis							**4150**
20 additional surveys - t & s - consumables total							2600 400 200 **3200**
fieldwork Ireland - staff - t & s* total					5	5	1765 750 **2515**
enhanced programme total							**9865**
Combined total							**32715**

Note: * As an alternative, to a full field visit, a reduced amount data on the River Unshin in Ireland which may be sufficient could be available form another Agency project - RHS through Dr N.T.H. Holmes.

8. ABBREVIATIONS

CVS	Cover Value Score
DQI	Diatom Quality Index (100 - TDI)
d/s	downstream
MTR	Mean Trophic Rank system
pe	population equivalent
QD	Qualifying discharge (UWWTD >10 k pe)
STR	Species Trophic Rank
STW	Sewage Treatment Works
TDI	Trophic Diatom Index
u/s	upstream
UWWTD	Urban Waste Water Treatment Directive