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Using Diatoms and Macrophytes to Assess the Trophic Status of Rivers



ENVIRONMENT
AGENCY

A Workshop Summary,
Lancaster, 7-8 March 1996

NERC Institute of Freshwater Ecology
IACR Centre for Aquatic Plant Management

February 1997

R&D Progress Report E1/i694/01



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PROGRESS REPORT

Using Diatoms and Macrophytes to Assess the Trophic Status of Rivers

A report of a workshop held at Lancaster, 7-8 March 1996

J.R. Newman, F.H. Dawson, K.J. Rouen

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This report is the third output from Project 694, IFE Document Reference number RL/T4073Q/2. It summarises the findings of a workshop to discuss the applicability of the Mean Trophic Rank System and the Trophic Diatom Index to assessment of trophic status of rivers. It is to be used for information as to the findings and recommendations of the workshop.

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1. EXECUTIVE SUMMARY

- 1.1 This Progress Report summarises the main conclusions of a workshop held at Lancaster on 7-8 March 1996 to discuss the application of biological methods, namely the Trophic Diatom Index and the Mean Trophic Rank system, to monitor eutrophication under the direction of the EU Urban Waste Water Treatment Directive.
- 1.2 A more detailed report discussing the rationale behind the methods and the general applicability of the methods is available from the NW Region of the Environment Agency, entitled "Using Diatoms and Macrophytes to Assess the Trophic Status of Rivers: A report of a workshop held at Lancaster, 7-8 March 1996", R&D Interim Report 694/NW/02. The latter document acts as a working document for Project 694.

2. PURPOSE OF THIS DOCUMENT

This Progress Report sets out the main recommendations from a Workshop held in Lancaster in March 1996 to discuss the application of the Mean Trophic Rank System (MTR) and the Trophic Diatom Index (TDI) to biological monitoring for the purposes of designating areas sensitive to eutrophication (SA[E]s) under the requirements of the Urban Waste Water Treatment Directive (UWWTD).

This document is the third report produced under R&D Project 694 - Assessment of the trophic status of rivers using macrophytes. This Report falls under Stage I of the Project.

3. SUMMARY AND RECOMMENDATIONS

3.1 Objectives and aims of the workshop

The workshop served both R&D Project 694 and Project 618, the latter project being the testing of the TDI in NRA Regions (Project leader A. Lewis, North East Region).

The objectives of the workshop were to exchange experiences and ideas on the MTR and TDI; to discern the usefulness of the methods for both the UWWTD and other applications; to digest the most recent findings from the two projects and; to feed recommendations into R&D Projects 618 and 694 and into the management of trophic status monitoring programmes within the Environment Agency. This was achieved by integrating practical experiences of the MTR and TDI from National Rivers Authority (now Environment Agency) Staff with comments from the authors of the two methods and other interested parties from English Nature, the Institute of Freshwater Ecology, the Centre for Aquatic Plant Management, the Clyde River Purification Board and the Industrial Research and Technology Unit (Northern Ireland). A list of participants is given in Appendix 1 to this report. Participants included both those engaged in the practical application of the methods and those with responsibility for subsequent management decisions. The programme of the workshop is given in Appendix 2. This was organised to allow both formal presentations, group feedback, structured and more general discussion. The workshop produced a list of priorities for further action and research and a list of recommendations on the implementation and further use of the two methods in biological monitoring programmes. A summary of these is given below.

3.2 Definition of Eutrophication

It was suggested that the working definition of eutrophication used within the Environment Agency should be clarified and standardised. It should be expressed in terms which are measurable and achievable. Improvements could be measured against the criteria set out in the definition. A clear statement of what is included in the definition (water column, sediment, holistic picture of river system) should be made. The definition used for the purposes of the UWWTD states:

"Enrichment of water by nutrients, especially compounds of N and/or P, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned."

There are two other definitions of eutrophication in current use, one for the Nitrates Directive and one used by the Toxic and Persistent Substances centre of the Environment Agency. It is envisaged that one definition will be adopted for all purposes.

3.3 Success of the methods to date

Both the TDI and MTR are capable of detecting differences in the trophic status downstream of qualifying STW discharges, although the sensitivity of the methods may be dependent upon the concentration of P and/or other nutrients upstream of the discharge. The importance of complicating factors such as direct organic pollution is separable with the TDI but not at present with the MTR and should be investigated in the latter. In addition, it is recommended that the introduction of a system of weighted averages into the MTR system be investigated. Weighted averages would take account of regionally rare species and species with a known defined tolerance of organic pollution. This should allow a more comprehensive environmental appraisal to be made.

3.4 Broader application of the methods

It was recognised that the TDI and the MTR have much wider applications than monitoring eutrophication for the purposes of the UWWTD.

English Nature has used macrophyte-based survey methods successfully in typing riverine SSSIs in order to categorise rivers into 10 distinct plant community types. It has also investigated the use of the MTR in assessing the impact of non-qualifying sewage discharges.

The Industrial Research and Technology Unit (Northern Ireland) has used the MTR system for tracking non-point source pollution and measuring improvements in the aquatic habitat. The timescale of response of macrophyte communities to improved water quality was identified as an unknown factor requiring further investigation. It is envisaged that post P-stripping monitoring might contribute to increased knowledge of this factor. This might allow the MTR (and TDI) to be used as a predictive tool to estimate the direction and extent of recovery (or deterioration) in aquatic ecosystems subject to eutrophication.

3.5 Quality Assurance

The importance of Quality Assurance as an integral part of both methods was emphasised. It is important that data derived from these methods should be right and robust. Suggestions for inclusion in the training element of a Quality Assurance programme were made. In Anglian Region, a successful programme of internal AQC has been carried out, with a random selection of MTR sites being re-surveyed by another survey team. There are several components to a successful Quality Assurance system.

- Standardised Training for all surveyors and auditors:
 - to include a mandatory training course and annual refresher days in plant identification, methodology and database input;
- A procedural manual;
- Re-surveys;
- Appropriate site selection.

Recommendations for a QA system are described within the "Standard Methodology for the assessment of Freshwater Riverine Macrophytes for the purposes of the Urban Waste Water Treatment Directive" (Environment Agency, May 1996).

3.6 Presentation of results

It was emphasised that results should be presented in a clear, easily understandable format. Both the TDI and the MTR should operate on the same scale and in the same direction. Actual scores and percentage downstream change in scores will be used for the purposes of the UWWTD. For other purposes, such as large scale national maps of eutrophication, a banding system will be developed, if appropriate.

3.7 Identification of future needs

Areas where the MTR method requires further testing were identified. Situations in which the MTR gives values which do not correspond to the hypothesis of decreasing scores with increasing P-loading should be investigated further and recommendations made for improving the MTR method. Priorities for the TDI system are presented in the outputs from R&D Project 618.

Research priorities not already included in the programme of R&D Project 694 are to be fed into the Project. Improvements to the method were identified and recommendations made for their implementation. Further trialing of both the TDI and MTR is necessary in all Environment Agency Regions, to establish the relationship between the two methods.

3.8 Modifications of the MTR Method

Minor revisions to, and clarifications of, the way MTR data is collected and recorded are necessary. This will be achieved by amendment of the standard methodology produced by the NRA for UWWTD macrophyte surveys. These amendments form part of a revised methodology produced by the Environment Agency in May 1996 in a document entitled "Standard Methodology for the Assessment of Freshwater Riverine Macrophytes for the Purposes of the Urban Waste Water Treatment Directive", Version 2, (produced subsequent to the workshop).

3.9 Post-P-stripping monitoring

It was recognised that monitoring of trophic status should be continued after the introduction of P-stripping at designated qualifying discharges using both TDI and MTR, to determine the ability of the methods to demonstrate changes in aquatic plant communities. This is dependent on the

availability of a reliable and consistent historical data set. Lack of such a data set may limit the application of methods to demonstrate an improvement in a historical context. However post-P-stripping monitoring may be able to show measured improvements from 1996 data. Data from the 1996 surveys should be used as the baseline for improvement.

An examination of the time series of change to establish baseline variation in MTR scores should be carried out. Any changes due to P-reductions will be superimposed on this natural change.

3.10 Further Research on the MTR system

It is recommended that in addition to the issues included within the project specification the following questions require further research.

The project should examine the use of regional weightings for local taxa (nationally rare) and for taxa at the edge of their geographical range.

The application of a weighted average value should be considered (indicator value, cf. TDI).

The validity of 100 m reaches for survey purposes should be established. Consecutive 100 m reaches should be surveyed within 500 m of the discharge (or in the recovery zone where appropriate).

Consideration should be given to identifying those taxa which respond quickly to nutrient inputs and/or changes in nutrient levels. The changes would be measured on a temporal and spatial scale of response.

Consideration should be given to the reproducibility of biomass estimates. Guidance on how and when to record this, plus interpretation, is required.

The inherent variability of the method should be defined.

Consideration should be given to ensuring that changes in MTR scores are due to nutrient enrichment rather than other factors. Investigation of the use of a grid to facilitate interpretation of results, taking into account the influence of organic pollution, should be devised for MTR, as has been developed for TDI.

The use of composite data from different seasons, or from different surveys within the same season, should be investigated to establish trends or patterns of eutrophication and susceptibility of species.

3.11 Other Research Areas

Other recommended areas for future research are as follows.

3.11.1 Development of an alkaline phosphatase assay

This system is based on a cheap and easy assay of alkaline phosphatase activity of aquatic plants. It reflects the nutrient status of submerged plants. The surface enzyme activity of mosses, some angiosperms and algae can be assessed. The phosphatase activity in the plant is a measure of the phosphate concentration, or the availability of phosphate, at the time of the assay, or over an indeterminate time in the recent past.

3.11.2 Funding of Freshwater Algal Flora project

This project is under the direction of a committee of the British Phycological Society. It requires substantial extra funding if it is to achieve its goal of publication by the year 2000. It will encompass CD-Rom technology and allow easy identification of every algal species in the UK.

3.11.3 Macrophyte sediment interactions and ecology

Underpinning research on the relationship between river macrophyte communities and nutrients, including the influence of sediment chemistry is urgently required to support some of the contentions within this project. The influence of accumulation of nutrients in sediments has not been adequately addressed in this context.

APPENDIX 1: LIST OF PARTICIPANTS

C.S. Adams	NRA Anglian Region
D. Balbi	NRA Anglian Region
Dr S.M. Chadd	NRA Anglian Region
Dr A.J.D. Ferguson	NRA TAPS (Anglian Region)
L.J. Sharp	NRA Anglian Region
E.M. Clegg	NRA Northumbria & Yorkshire Region
R.J. Jennings	NRA Northumbria & Yorkshire Region
A. Lewis	NRA Northumbria & Yorkshire Region
E.M. Oliver	NRA North-West Region
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K. Williams	NRA North-West Region
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Dr J.P.C. Harding	NRA Severn-Trent Region
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H.J. Webb	NRA Severn-Trent Region
K. Friend	NRA Southern Region
K. Taylor	NRA Southern Region
Dr A. Hicklin	NRA South-Western Region
W.E. Olsen	NRA South-Western Region
A. Hutchings	NRA Thames Region
A. MacQueen	NRA Thames Region
Dr R.A. Sweeting	NRA Thames Region
K.L. Jenkins	NRA Welsh Region
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Dr N.T.H. Holmes	Alconbury Environmental Consultants
Dr E.Y. Howarth	Institute of Freshwater Ecology
Dr M.G. Kelly	Bowburn Consultancy
Dr J.R. Newman	Centre for Aquatic Plant Management
S. Pritchard	Clyde R.P.B.
J. Southey	English Nature
Dr B.A. Whitton	University of Durham

APPENDIX 2: WORKSHOP PROGRAMME

DAY ONE

Arrival		Time	
1.	Assemble. Coffee/tea.	1230	
2.	Lunch	1300	
A. General Introduction		Time	Chair: Roger Sweeting
1.	Purpose of Meeting	1400	Roger Sweeting
2.	Requirements to monitor trophic status ¹		
a	NRA: UWWTD	1410	Simon Leaf
b	English Nature	1425	Mary Gibson
B. TDI		Time	Chair: Anne Lewis
1.	Introduction	1435	Martyn Kelly
2.	Results of Assessments by NRA Staff ¹		
i	Anglian Region, Northern Area	1450	Dave Balbi
ii	Anglian Region, Eastern Area	1500	Chris Adams
iii	Severn-Trent Region	1510	Ruth Maddocks
iv	Thames Region	1520	Anna McQueen/ Alison Hutchings
3.	Tea	1530	
4.	Use of artificial substrates ¹	1600	Ben Goldsmith (UCL)
5.	Analytical Quality Control procedures ¹	1610	Martyn Kelly
6.	Feedback & Discussion ²	1620	Chair: Anne Lewis
	Summary and Recommendations		
	Finish	1800	
8.	Evening meal	1900	

DAY TWO

C. MTR		Time	Chair: Phil Harding
1.	Introduction & Latest Developments ¹	0915	Nigel Holmes
2.	Feedback from practitioners: NRA Regions ³ (Chair: Karen Rouen)	0935	One representative from each NRA region
3.	Coffee	1030	
4.	Feedback from external organisations ¹	1100	
a.	English Nature		Jane Southey
b.	IRTU (Northern Ireland)		Peter Hale

5.	Discussion (including Quality Assurance) ² Summary and Recommendations	1115	Chair: Phil Harding
6.	Lunch	1230	
D.	General Discussion	Time	Chair: Roger Sweeting
1.	Discussion ²	1345	
2.	Summary and Recommendations	1510	Roger Sweeting/ Karen Rouen
3.	Tea	1530	
	Finish	1600	

Notes:

1. Formal presentation(s)
2. General discussion session
3. Group feedback session. A panel of MTR practitioners, one per NRA region, addressed a series of pre-circulated questions regarding the practicalities of the MTR methodology. Questions regarding the performance of the MTR were open to discussion by all participants at the workshop. A list of the questions addressed is given in the full workshop report (R&D Interim Report 694/NW/02).

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