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Analysis of Natural and Polluted River Communities in Great Britain

Progress Report for the period January-December 1987

by

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The Freshwater Biological Association is part of the Terrestrial and Freshwater Sciences Directorate of the Natural Environment Research Council.

1. Introduction

This brief report to the Advisory Group follows the format adopted in previous years. Its main purpose is to inform members of the committee of progress over the past 12 months and our plans for the future. The current four-year contract ends in March 1988, when a full report will be made available to the funding agencies (Natural Environment Research Council, Department of the Environment, Scottish Development Department and Welsh Office).

This phase of the project has four major objectives. They are:-

1. Development of the classification and prediction facilities into a practical working system.
2. Enlargement of the classification to include additional sites on large rivers and small streams.
3. Examination of a series of sites on polluted streams to explore changes in community structure.
4. Strategic research on the structure and functioning of river communities.

The bar chart at the end of the report shows the approximate timing of the various elements of the work over the past four years. Progress in each major objective is reviewed in items 2-5 below whilst item 6 deals with publicity and publications.

2. Development of the classification and prediction facilities

The preliminary version of RIVPACS (River Invertebrate Prediction and Classification System) was made available to biologists in the Water Industry for testing in 1986 and the results were collated by means of a questionnaire. By autumn 1987 a total of 16 questionnaires had been returned from 9 Water Authorities and 5 River Purification Boards. The full results will be presented in the final report but the main points to emerge were as follows:-

a) The facility to predict the fauna from site features was of greater interest than the option of classifying a site using the fauna.
b) Prediction of the invertebrates to be expected in a single season (as opposed to the fauna expected in spring + summer + autumn) would make the system more relevant to the daily needs of the Water Industry. A number of WA/RPB's found some difficulty in testing the preliminary version rigorously because they did not have invertebrate data for three seasons against which to check the accuracy of the predictions. However, the option of single season prediction will be available in the new version of RIVPACS to be produced at the end of the current contract.
c) In general, unpolluted sites showed a good match between the observed and predicted BMWP families.
d) In addition, differences between observed and predicted ASPT values were small at clean sites, whilst a low observed/predicted ASPT ratio was found by many to be a useful way of highlighting organically polluted sites. Ideally, an objective method is required for flagging those cases where the observed fauna differs sufficiently from the predicted to warrant action. This area is under investigation using data from both the Moors/Uddens catchment and the polluted streams studies (item 4). Results will be reported in March 1988.
e) A large majority of the WA/RPB's intend to use the new version of RIVPACS in their regular work.

f) Almost all see a need to implement the system on their own computers and a preference was expressed for putting the new version onto an IBM-PC. This would allow both biological and environmental data for a site to be held on computer prior to use in the RIVPACS programme and avoid the need for time-consuming manual entry.

These and other considerations have been the subject of preliminary discussions with several Water Authorities. Dr G. Mance of Severn-Trent WA is now collating the views of all interested parties so that a coordinated response can be made on the future requirements of the Water Industry.

Within the FBA, further testing of the prediction system has been undertaken using a comprehensive set of both environmental and macroinvertebrate data for 28 sites throughout the Moors River/Uddens Water catchment. It includes both clean and polluted sites on a variety of small streams and larger sites which drain contrasting geology. Four environmental options (5/11 physical and 5/11 physical + chemical variables) have been used for prediction of BMWP families (+ scores and ASPT), families (qualitative and log. categories of abundance) and species (qualitative). All analyses are complete and the results are being examined.

3. Enlargement of the Classification

The preliminary version of RIVPACS is based on data for 370 sites on 61 river systems. In 1984 further sampling took place on some large rivers (Thames, Severn, Wye, Great Ouse, Exe, Dorset Stour) and a number of small streams to extend the scope of the system. Sampling undertaken on other programmes in 1985 and 1986 is also relevant to this objective. It includes 7 sites on tributaries of the R. Axe in Devon sampled under contract to South-West Water and approximately half of the 28 sites in the Moors catchment which are considered to be free from pollution.

In 1986 a further group of 20 sites were sampled in Scotland under contract to the Nature Conservancy Council. There is merit in adding a majority of these to the Phase 3 version of RIVPACS since the density and range of rivers sampled in Scotland is limited. The samples taken for the NCC were comparable to standard FBA samples with the exception that oligochaetes and chironomids were not identified to species. Funding for this extra work was confirmed by the Scottish Development Department in autumn 1987 and identifications, data collation and transfer of both biological and environmental data to computer were undertaken as rapidly as possible.

Before the classifications using the enlarged data-set were undertaken, the 370 sites used in the preliminary classification were reassessed. A small number of sites which showed organic enrichment and which failed to approach their predicted ASPT were excluded. An initial classification was then undertaken based on 446 sites. After careful examination, a further 8 sites were removed due to unacceptably low BMWP score or ASPT. This screening procedure will ensure that high standards can be set when predicting the fauna to be expected at unpolluted sites using environmental features.

Classification exercises based on 438 and also 437 sites have been made and a final decision on the classification to be used in the new system is imminent. Multiple discriminant analysis (MDA) using 28

environmental variables has been carried out on both classifications and will be used in deciding which classification to adopt and how many groups of sites will be generated. After the most appropriate classification has been chosen, the next step will be to decide on the environmental variables to be used for prediction. The new version of RIVPACS will then be implemented on the BBC B Microcomputer, together with the new facilities to allow for prediction of the fauna to be expected in single seasons. In addition, the accompanying manual will be updated.

4. Examination of Polluted Streams

This sampling programme was undertaken on 5 river systems subject to organic pollution. 'Control', 'impact' and 'recovery' sites were chosen for detailed monitoring. A monthly programme of biological and chemical sampling took place at 16 sites for one year between April 1985 and April 1986. Further samples were taken in July and October 1986 to permit between-year comparisons for April, July and October of 1985 and 1986.

This substantial body of BMWP family-level data, together with the accompanying physical and chemical data, were transferred to computer and validated in autumn 1987. Seasonal and between-year changes in the macroinvertebrate families, BMWP scores and ASPT are now being examined for the control, impact and recovery sites on each river. The availability of comprehensive environmental data for each site has allowed us to predict the fauna using four combinations of environmental variables, but also using data for different combinations of months. Thus, a prediction based on environmental data collected in April, June and October may be compared with the results obtained by using data for May, July and November etc. Methods for comparing observed and expected values of BMWP score, ASPT and no. scoring taxa are being examined, as are the relative merits of these three indicators of river quality.

5. Strategic Research

i) Analyses and publications which explore RIVPACS and the Phase 2 data-set.

Several papers have been published in the last 12 months, whilst further manuscripts have been submitted and others are in various stages of preparation. Progress on some manuscripts has been slower than we would have wished due to the need to concentrate effort on other aspects of the project to ensure their completion on time.

Papers appeared on the new methodology developed for prediction of the fauna (Moss et al. 1987), the use of the prediction system to assess macroinvertebrate response to river regulation (Armitage et al. 1987) and freshwater site assessment for conservation using multivariate techniques (Furse et al. 1987). A manuscript on the use of the prediction system for biological surveillance has been accepted (Wright et al. in press) and a short account of the River Communities Project and its practical applications was also published (Wright 1987) during the year.

Dr Armitage was invited to write a chapter on the prediction system for a book entitled 'Alternatives in Regulated River Management' to be published by CRC. The manuscript is now in press. A paper documenting the recent spread of an American flatworm, Dugesia

tigrina in British rivers was published (Wright 1987) and Mr R. Gunn is currently completing a manuscript on the known distribution of the mayfly, Baetis digitatus. This species is now known to be more widely distributed than was previously realised, and many of the new records have been accumulated by the River Communities Project.

Some time ago, a series of classification exercises were undertaken on a group of 168 running-water sites for which there were both macrophyte (NCC) and macroinvertebrate + environmental (FBA) data. In the last year the FBA has been contracted by the NCC to undertake further analyses and a review of the literature on the association between invertebrates and macrophytes. This is a prelude to a more detailed study which will include sampling for macroinvertebrates on specified macrophytes in a range of lowland rivers.

The analyses on variation in species richness and predator/prey ratios across the 370 sites are complete but as yet little further progress has been made in writing up this manuscript.

Production of maps showing the distribution of macroinvertebrates in British rivers based on River Communities project data was given a low priority. Possible ways forward are only now being given tentative consideration. The information on species distribution is undoubtedly of great interest both within the Water Industry and for conservation. One option would be to use the existing BRC 10-km square system since lists of grid references for any given species can be processed within NERC to produce the familiar dot maps. This would ensure maximum compatibility with any existing maps showing species distribution, but the name of the river on which a given record was obtained could only be deduced by the use of an appropriate overlay showing all major rivers.

ii) New Field Studies

As indicated under item 2, samples taken in spring, summer and autumn from all 28 sites within the Moors River/Uddens Water catchment have been identified to species level. The biological and environmental data have been transferred to computer and validated. The use of the prediction system on this varied data-set is an important test of RIVPACS, but the information on the fauna expected and the fauna observed is also of direct relevance to the management of this particular catchment. We are now undertaking various classification and ordination exercises on the 28 sites before examining changes in community structure in relation to environmental change.

A paper on the observed and predicted occurrence of blackflies (Diptera: Simuliidae) at 50 reservoir outlets in Britain was published during the year (Bass & Armitage 1987).

6. Publicity and Publications

Two talks were presented on the project during the year:

J.F. Wright, 23rd SIL Congress, Hamilton, New Zealand, February 1987
J.F. Wright, Joint Meeting of the Royal Geographical Society and British Hydrological Society, London, 9 April 1987.

In July 1987 the FBA River Laboratory 'Open Days' took place at which the River Communities Project provided an exhibit and demonstrated RIVPACS to visitors.

Dr Armitage has represented the FBA on the British Standards Institution Committee on Water Quality-Biological Methods. Dr Armitage, Mr Furse and Dr Wright have all had opportunities to make or maintain contacts with scientists from the EC countries of Spain and Portugal to provide help and advice in the field of biological monitoring.

Further talks to be given on the project in the next few months include:-

J.F. Wright, 'Water and the Environment' Conference organised by Anglian Water, Lincoln Cathedral, 6-8 April 1988.
J.F. Wright, talk on the project to members of the DHSS Committee on the Medical Aspects of the Contamination of Air, Soil and Water, 16 June 1988.

The following papers have appeared, been accepted or submitted during the year and several other manuscripts are in preparation.

Armitage P.D. (1987) The classification of tailwater sites receiving residual flows from upland reservoirs in Great Britain, using macroinvertebrate data. In: Regulated Streams - Advances in Ecology (J.F. Craig & J.B. Kemper, eds), Plenum, New York, 131-144.

Armitage P.D., Gunn R.J.M., Furse M.T., Wright J.F. & Moss D. (1987) The use of prediction to assess macroinvertebrate response to river regulation. Hydrogiologia, 144, 25-32.

Armitage P.D. (in press) The application of a classification and prediction technique based on macroinvertebrates to assess the effects of river regulation. In: Alternatives in Regulated River Management (J.A. Gore & G.E. Petts, eds), CRC Press, Boca Raton, Florida.

Bass J.A.B. & Armitage P.D. (1987) Observed and predicted occurrence of blackflies (Diptera: Simuliidae) at fifty reservoir outlets in Britain. Regulated Rivers: Research & Management, 1, 247-255.

Furse M.T., Moss D., Wright J.F. & Armitage P.D. (1987) Freshwater site assessment using multivariate techniques. In: The use of invertebrates in site assessment for conservation (ed M.L. Luff), Proceedings of a meeting held at the University of Newcastle-upon-Tyne, 7 January 1987. Agricultural Environment Research Group, University of Newcastle-upon-Tyne.

Moss D., Furse M.T., Wright J.F. & Armitage P.D. (1987) The prediction of the macro-invertebrate fauna of unpolluted running-water sites in Great Britain using environmental data. Freshwater Biology, 17, 41-52.

Rodriguez P. & Wright J.F. Biological evaluation of the quality of three Basque water courses. (Submitted to the Conference on Environmental Biology of the II World Basque Congress, Bilbao, November 1987.)

Wright J.F. (1987) Colonisation of rivers and canals in Great Britain by Dugesia tigrina (Girard) (Platyhelminthes: Tricladida). Freshwater Biology, 17, 69-78.

Wright J.F. (1987) The River Communities Project. In: Water Projects: Environmental and Social Aspects. Joint Meeting of the Royal Geographical Society and British Hydrological Society, London, 9 April 1987. Regulated Rivers: Research & Management, 1, 369-371.

Wright J.F., Armitage P.D., Furse M.T. & Moss D. (in press) A new approach to the biological surveillance of river quality using macroinvertebrates. Verh. int. Verein. theor. angew. Limnol.

ANALYSIS OF NATURAL AND POLLUTED RIVER COMMUNITIES IN GREAT BRITAIN

PROGRAMME OF WORK, APRIL 1984 - MARCH 1988