

Testing and Further Development of RIVPACS (Phase 2)

Progress Report for the Period  
October 1992-December 1992

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January 1993

Progress Report 243/3/Y



**NRA**

*National Rivers Authority*

## TESTING AND FURTHER DEVELOPMENT OF RIVPACS (PHASE 2) PROGRESS REPORT FOR THE PERIOD OCTOBER-DECEMBER 1992

### 1. INTRODUCTION AND BACKGROUND TO PHASE 2

This project is in two phases. Phase 1 had two objectives -

- To undertake a comprehensive testing of RIVPACS II
- To formulate a series of bands to express river quality in biological terms.

The main results of this research were presented to the National Rivers Authority in an Interim Report (R&D 243/1/Y) in December 1991. This was followed by an additional report (R&D 243/2/Y) in May 1992 giving a comparison of single, paired and 3 seasons combined macro-invertebrate samples for the biological banding of river quality.

The essential elements for Phase 2 of the project are to enhance the robustness of RIVPACS and undertake the further development of the system to ensure that a more comprehensive and reliable system (RIVPACS III) will be in place for the 1995 River Quality Survey (RQS).

The research programme for Phase 2 was detailed in a PIA from the NRA in February 1992. After further discussion between the IFE and the NRA Project Leader, Mr Brian Hemsley-Flint, at a meeting at the River Laboratory on 12 March 1992, the IFE provided costings for the project later that month.

During this period, progress was also required in the selection of ~50 new sites of high quality within England and Wales for inclusion in RIVPACS III. This was to ensure that there would be sufficient time for the processing of samples in 1992/93 and 1993/94 in time for the analysis phase in 1994/95.

Letters were sent to each NRA region in February 1992 indicating those sites currently in RIVPACS II, additional good quality sites already sampled which were available for RIVPACS III and requesting views on any important river types which were not as yet included in the provisional RIVPACS III listing.

On receipt of the responses, IFE prepared a list of the sites for further consideration by the NRA Project Leader. Following discussions between IFE and Brian Hemsley-Flint, the list was narrowed down to ~50 sites and the proposal was put to a meeting of NRA biologists in June 1992. After further minor amendments, a list of sites for processing was agreed. In general, use was made of samples collected during the 1990 RQS and therefore very little new sampling was required. IFE had all the 1990 RQS samples in storage and once decisions had been made, the relevant samples were retrieved for subsequent processing.

Changes in the NRA R&D administration during the summer 1992 resulted in the need to produce a modified PIA for Phase 2 which then required approval from both NRA and DoE. Work on the project was stopped and not restarted until 24 September 1992, without alteration to the proposed end date.

The specific objectives of the Phase 2 project are as follows.

- To evaluate a number of additional procedures for enhancing the robustness of RIVPACS. Some of these analyses will involve further examination of the 1990 River Quality Survey data.
- To undertake the further development of RIVPACS as follows.
  - include additional sites to make the data-base more comprehensive
  - examine alternative methods of classification and prediction with the objective of increasing the accuracy of the prediction system
  - collate the data, undertake new analyses and incorporate improvements in methodology, leading to the development of RIVPACS III.

## 2. TECHNICAL PROGRESS AND INTERIM RESULTS

This section gives a more detailed version of the work programme together with an indication of the areas where effort is currently being directed. The timing of each section of the work can be seen by reference to the activity schedule at the end of the report. Since the project has only just started, any relevant interim results are noted within this section.

### 2.1 Enhancement of the robustness of RIVPACS

The PIA lists six separate items (i-vi), of which four (i, iii, iv and v) are new investigations, as follows.

- i. Investigate the relative merits of using the average or the minimum of single season values of O/E and bands, over the 3 seasons combined data equivalent, to provide a summary of biological quality.
- iii. Evaluate a method to provide a fixed value of "E" (Expected) for a site as opposed to reapplying RIVPACS each year.
- iv. Evaluate procedures for comparing the presence of individual taxa observed in samples with those predicted by RIVPACS as a means of supplementing quality assessments based on O/E ratios.

Items i, iii and iv are to be undertaken and completed by the end of June 1993 and reported on by the end of September 1993.

Item v is a more substantial investigation to be undertaken in the 1993/94 financial year and is as follows.

- v. Evaluate procedures for comparing the relative abundance of individual taxa observed in samples with those predicted by RIVPACS as a means of supplementing quality assessments based on O/E ratios.

Two items remain.

Item vi is the integration of the findings of items i and iii-v into RIVPACS III where applicable.

Item ii is the integration of the findings of a separate research proposal on quantifying errors, to provide rules for the detection of change in biological quality.

This research proposal, developed by R.T. Clarke and M.T. Furse, and entitled 'Assessment of biological sampling errors in RIVPACS site predictions of biological water quality' was originally planned for the period April 1992-March 1994. Unfortunately, funding was not available for an April 1992 start. However, following a meeting at the River Laboratory on 17 December 1992, in which the NRA were represented by Dr R. Dines and Dr R. Sweeting, an amended proposal will be submitted by IFE with the expectation of an April 1993 start. The consequence of this rescheduling will be that whereas the results will be available for use in the 1995 RQS, they will not be ready in time for the planned release of the RIVPACS III software in June 1994. These additions to the software will be added in fulfilment of item ii early in 1995 for use in the 1995 RQS.

The plan for the current financial year (1992/93) is to undertake item i and start item iv. The first three months of the 1993/94 financial year will then be used to complete item iv, and undertake item iii. As yet this work has not commenced due to other contract commitments.

## **2.2 Further Development of RIVPACS**

### **2.2.1 Inclusion of additional sites to make the data-base more comprehensive**

To provide the widest range of good quality stream types for RIVPACS III we will use species level data already available from ~103 sites previously sampled for the former Nature Conservancy Council. In addition, we plan to use data for ~53 sites (33 headwater and 20 main river sites) from the NRA project 'The faunal richness of headwater streams (Project 242)'. Identification of this material is now complete except for the Oligochaeta and Chironomidae for the 20 main river sites and this will be undertaken within the RIVPACS programme in 1993/94.

The distribution by NRA region of RIVPACS II sites, the NCC sites, the headwater stream project sites and finally the additional ~50 sites chosen after consultation with each NRA region are detailed below. Also shown are the number of sites in Scotland in order to generate the totals for Great Britain.

## Regional allocation of RIVPACS sites

England and Wales	RIVPACS II sites	'NCC' sites	Headwaters project sites	New sites	Totals
<u>NRA regions</u>					
Anglian	43	8	1 + 5	8	65
Northumbrian	22	5		6 (+ 3)	33 (+ 3)
North-West	27	1		7	35
Severn-Trent	33	12		7	52
Southern	42	3		2	47
South-West	33	16		10	59
Thames	25	3		8	36
Welsh	44	12	8 + 5	5	74
Wessex	48	12	10 + 5	0	75
Yorkshire	19	14	14 + 5	0	52
NRA totals	336	86	53	53 (+ 3)	528 (+ 3)
<u>Scotland</u>					
RPB totals	102	17		34	153
GB totals	438	103		87 (+ 3)	681 (+ 3)

The number of sites potentially available in Great Britain will increase from 438 (RIVPACS II) to ~681 in RIVPACS III. Note, however, that a small number of sites, including some previously used in RIVPACS II, are likely to be removed due to inadequate quality.

In 1990, RIVPACS II was also used for assessing the quality of sites in Northern Ireland, thereby giving full UK coverage, despite the lack of sites from Northern Ireland in the dataset used for generating predictions. To improve the reliability of the system in Northern Ireland, samples from a minimum of 50 sites are currently being processed and will be integrated into RIVPACS III for use in the next survey.

The 53 new sites in England and Wales chosen for sample processing are listed in Appendix I. Northumbrian region requested the inclusion of a further three sites but the NRA Project Leader has indicated that these should only be processed if they can be accommodated within the available time.

1990 RQS samples are being examined in all cases except for a minority of sites in Anglian, Severn-Trent and South-West regions. In these areas, and for a variety of reasons, new samples have been or are still to be taken. Unfortunately, sampling agreed for four sites in summer/autumn 1992 was not undertaken and must now await summer/autumn 1993. However, in view of the small number of samples involved, this should not delay overall completion of sample processing and identification.

Of the total of 153 samples currently available, just over 100 have already been sorted and it is anticipated that most of the remainder will have been sorted by the end of March 1993. To date, ~40 of these samples have been identified to species (except for Sphaeriidae) and the target is for this figure to rise to ~75 samples by the end of this financial year.

By the end of January 1993 we hope to send the Sphaeriidae from most spring samples to Mr J. Bass (IFE Eastern Rivers Laboratory) for species level identifications. If there are problems with the identification of specimens due to the long period of sample preservation, it may be necessary to ask for new spring samples to be taken by NRA biologists in selected cases and the Sphaeriidae removed for identification by Mr Bass.

Recently we have been alerted to the fact that one site (Brightley Stream in S-W region) is affected by heavy metal pollution and should not have been proposed for inclusion in RIVPACS III. Once sample identification is complete, one or two other sites may also have to be excluded on grounds of inadequate biological quality.

In the next financial year (1993/94) the emphasis will be on sorting the few remaining samples, full identification of 75+ samples and also the identification of Oligochaeta and Chironomidae from a further 60 headwater stream project samples.

### 2.2.2 Alternative methods of classification and prediction

The interim report produced at the end of Phase 1 (R&D 243/1/Y) highlighted a number of deficiencies in the prediction system of RIVPACS II. In the next version of RIVPACS there will be a need to

- remove a small number of poor quality sites
- improve the site groupings (eg avoid having chalk stream sites dispersed across several groups)
- avoid having very heterogenous groups (eg Gp 1)
- reduce the tendency for low O/E ratios at the extremes of the classification and high O/E ratios in the middle range
- seek the optimum number of end groups
- move towards a more even distribution of sites between groups or have a minimum group size.

The combination of TWINSPAN for the classification system and the use of MDA for linking biological with environmental attributes has produced a workable prediction system. However, there is now a window of opportunity for examining other methods of site classification and looking at variations to our prediction techniques prior to the development of RIVPACS III.

This task was started in the last quarter of the 1991/92 financial year when time was available to test out an alternative classification system and its consequences for MDA prediction to site group. In contrast to TWINSPAN, which is a divisive technique, an agglomerative technique (Ward's Method) was chosen. This method involves minimum variance clustering using the Czeckanowski Index of Similarity and 25 groups were requested, as in the TWINSPAN classification.

Ward's Method gave between 4 and 41 sites per group (cp 6-36 in TWINSPAN) but use of MDA to predict the group membership of the 438 RIVPACS II sites was slightly higher than that achieved using TWINSPAN. It also appeared that there was a greater tendency for sites on one river to group together than in the TWINSPAN classification. However, in an external test of the system using the 65 NCC sites, there was some evidence that O/E ratios for chalk stream sites were less extreme (ie closer to unity) than those produced by RIVPACS II based on the TWINSPAN classification.

It was therefore apparent that a totally different strategy for site classification involving new site groupings could be used to develop a prediction system which rivals the existing one. In view of this the search for improvement in the classification and prediction system appears to be a worthwhile exercise.

In October 1992 we were made aware of a new software package called PATN, developed by the CSIRO in Australia, which consists of a collection of over 30 modules for multivariate data analysis. It offers a wide variety of classification, ordination and other techniques which will provide new opportunities for determining whether significant improvements are possible in the classification of the 438 sites, leading to more reliable predictions using MDA. Clearly, both internal tests on the 438 sites, together with the external tests using the NCC sites, will be required to demonstrate genuine benefits.

The software package PATN has now been purchased and the discs and accompanying manuals arrived from Australia in mid-December. Dr D. Moss is now familiarizing himself with the options before we decide on the techniques to be examined.

We have also been in correspondence with Dr Richard Johnson of Uppsala University in Sweden concerning the possible relevance of objective techniques which allow you to relocate sites which appear to have been misplaced during their initial classification. Such a relocation program might generate a series of classification groups with lower within-group and higher between-group variance which, in turn, might offer greater predictive capability. These and other ideas will be investigated later in this financial year and also in the first nine months of the 1993/94 financial year.

### 3. FINANCIAL STATEMENTS

This information will be made available by the IFE Finance Officer in due course.

### 4. FACTORS LIKELY TO AFFECT THE SATISFACTORY COMPLETION OF THE WORK

Time has been allotted within this financial year (1992/93) for

1. Enhancing the robustness of RIVPACS
2. Sample processing
3. Examination of alternative methods of classification and prediction

Due to other commitments, work has not yet started on item 1 other than internal discussions on our approach. Some progress is expected before the end of March and this, along with the time allotted in the next financial year, will ensure that the various items in this section proceed to plan.

Work on item 2 is well on schedule and no major problems are anticipated in sample processing. If some spring samples prove to be very deficient in identifiable Sphaeriidae, then there will be time to forewarn of the need for new sampling in selected cases.

As indicated, some preparatory work has already been done on alternative methods of classification and prediction. Further progress within this financial year is timed for February/March and work then continues up to December 1993.



APPENDIX I. Listing of the 53 running-water sites in England and Wales chosen for sample processing at species level in each of three seasons. (Note: an additional three sites in Northumbrian region will only be processed if time allows.)

REGION/RIVER	SITE	NGR	SPRING	SUMMER	AUTUMN
<u>Anglian</u>					
Gwash	Belmesithorpe	TF 042104	expect 93	28 Aug 90	13 Nov 90
Cringle Brook	Thunderbridge	SK 920287	5 Apr 90	17 Sep 90	16 Nov 90
Reach Lode	Hallards Fen Road	TL 557678	14 Mar 90	27 Jun 90	1 Oct 90
Monks Lode	Eternity Hall Bridge	TL 212858	2 May 90	2 Aug 90	30 Oct 90
16 Foot Drain	Horseways Corner	TL 421875	25 Apr 90	14 Aug 90	13 Nov 90
Rase	Bully Hills	TF 168918	20 Mar 90	17 Sep 90	30 Nov 90
Orford Beck	Kirmond Le Mire	TF 189926	20 Mar 90	17 Sep 90	30 Nov 90
Bain	Biscathorpe	TF 231849	8 May 90	17 Sep 90	30 Nov 90
<u>Northumbria</u>					
Till	Etal	NT 926395	5 Mar 90	20 Jun 90	14 Oct 90
Till	Chatton	NU 059299	11 May 90	19 Jul 90	24 Oct 90
Glen	Ewart	NT 955302	5 Mar 90	4 Jun 90	4 Oct 90
Glanton Burn	Rothill	NU 069126	8 Mar 90	14 Jun 90	5 Oct 90
Gate Burn	Framlington Gate	NU 118037	8 Mar 90	2 Jul 90	9 Oct 90
Kilton Beck	Lodge Wood	NZ 695160	16 Mar 90	9 Aug 90	12 Oct 90
Balder	U/S Balderhead Reservoir	(NY 969195)	-	-	-
College Burn	Hethpool	(NT 896281)	-	-	-
Harthorpe Burn	Coronation Wood	(NT 973248)	-	-	-
<u>North West</u>					
Lune	Old Tebay	NY 618056	23 Apr 90	31 Jul 90	17 Oct 90
Lune	Rigmaden	SD 616846	2 Apr 90	7 Aug 90	5 Nov 90
Lune	Forge Wear	SD 512646	21 Mar 90	23 Jul 90	18 Oct 90
Eden	Temple Sowerby	NY 604282	27 Mar 90	2 Aug 90	26 Oct 90
Eden	Appleby	NY 683206	20 Mar 90	2 Aug 90	23 Oct 90
Eden	Warwick Bridge	NY 470567	29 Mar 90	17 Jul 90	22 Oct 90
Waver	Waver Bridge	NY 223491	12 Mar 90	17 Jul 90	18 Oct 90
<u>Severn-Trent</u>					
Severn	Llandinam	SO 025885	30 Apr 90	expect 93	24 Oct 90
Severn	Isle of Bicton	SJ 468164	22 Mar 90	23 Aug 90	9 Nov 90
Sher Brook	Shugborough	SJ 988213	4 Apr 90	26 Aug 92	16 Oct 90

REGION/RIVER	SITE	NGR	SPRING	SUMMER	AUTUMN
<u>Severn-Trent</u>					
Bradgate Brook	Newton Linford	SK 523098	17 Apr 90	18 Jul 90	29 Oct 90
Derwent	Baslow	SK 252722	17 May 90	22 Aug 90	18 Nov 90
Derwent	Cromford Meadows	SK 301572	expect 93	13 Aug 92	expect 93
Wye (Derwent trib.)	Ashford	SK 194690	26 Apr 90	1 Aug 90	5 Nov 90
<u>Southern</u>					
Ditton Stream	Ditton	TQ 710585	19 Mar 90	4 Jul 90	19 Oct 90
Sutton Stream	Road Bridge	SU 986175	2 May 90	15 Aug 90	19 Oct 90
<u>South-West</u>					
Bodilly Stream	Bodilly Bridge	SW 670318	19 Mar 91	13 Jun 91	3 Sep 91
Newlyn River	Skimmel Bridge	SW 433302	1 Mar 90	5 Jun 90	expect 93
Bala Brook	100 m U/S Zeal Bridge	SX 678625	26 Apr 90	25 Jul 90	16 Oct 90
Poltesco River	Poltesco Bridge	SW 724157	15 May 90	8 Jun 90	11 Sep 90
Stithians Stream	Seaurough Moor	SW 734374	9 Nov 90	13 Jun 90	20 Sep 90
Trevaylor Stream	Tryhogga	SW 476318	2 Mar 90	5 Jun 90	5 Sep 90
Gweek River	Mether-Uny-Mill Bridge	SW 704292	7 Mar 90	13 Jun 90	18 Sep 90
Manaccan River	Polkanoggo	SW 755222	6 Mar 90	11 Jun 90	11 Sep 90
St Keverne Stream	Porthoustock Bridge	SW 805218	6 Mar 90	11 Jun 90	expect 93
Brightley Stream	Brightley Mill	SX 597970	16 Mar 90	12 Jun 90	10 Sep 90
<u>Thames</u>					
Kennet	U/S Aldershot Water	SU 544659	17 May 90	28 Aug 90	24 Oct 90
Lambourn	Bagnor	SU 453691	6 Mar 90	7 Aug 90	16 Nov 90
Lyde	Deanlands Farm	SU 696542	21 Mar 90	2 Jul 90	14 Sep 92
Coln	Fosse Bridge	SP 081112	28 Mar 90	5 Jun 90	5 Sep 90
Windrush	D/S Dickler	SP 178177	26 Mar 90	6 Jul 90	26 Sep 90
Clayhill Brook	U/S Burghfield STW	SU 655684	5 Apr 90	3 Jul 90	22 Nov 90
Ash	Easneye	TL 377133	26 Mar 90	18 Jun 90	25 Sep 90
Chess	U/S R. Colne	TQ 066943	2 Apr 90	3 Jul 90	10 Oct 90
<u>Welsh</u>					
Cynfal	Pont Newydd	SH 140409	27 Mar 90	12 Jul 90	2 Oct 90
Seiont	Pont Y Gromlech	SH 628568	29 Mar 90	12 Jul 90	25 Sep 90
Caseg	Braichmelyn	SH 630663	28 Mar 90	13 Jul 90	24 Oct 90
Braint	Pont Mynach	SH 455668	27 Mar 90	6 Jul 90	25 Sep 90
Morlas Brook	D/S Glyn Morlas	SJ 312381	9 Apr 90	19 Jul 90	17 Oct 90



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