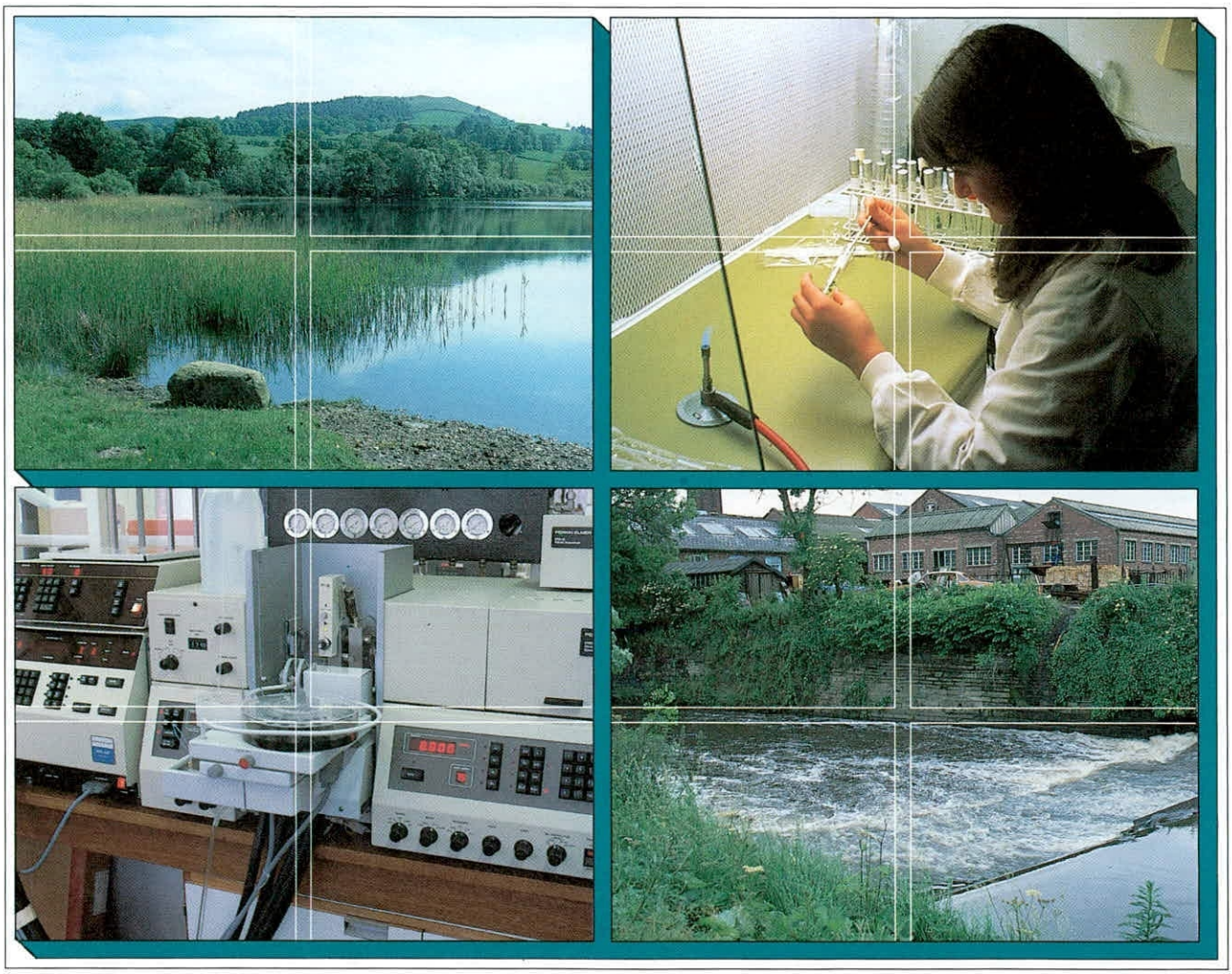
Institute of Freshwater Ecology

# Water quality monitoring on the Rivacre Brook

## Interim report (2)

**J.A.B. Bass**
**D.V. Leach**



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NERC Institute of Freshwater Ecology

Eastern Rivers Group
Monks wood, Abbots Ripton,
Huntingdon P17 2LS

# WATER QUALITY MONITORING ON THE RIVACRE BROOK

Interim Report (2)
August 1992

By Jon Bass & David Leach

Project Leader: J.A.B.Bass
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Interim Report (2): August 92
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CONTENTS

## 1. Summary

Interim Report (2) August 1992

The analysis of macroinvertebrate and water samples from the Rivacre Brook system (March 1992), adjacent to the Capenhurst site are compared and contrasted with the results of earlier monitoring carried out by the Institute of Freshwater Ecology in 1989, 1990 and 1991.

Changes in water quality, as indicated by the invertebrates and water samples, appear to be minor.

The Rivacre Brook continues to be classified as "Poor" when the invertebrate communities are equated with the NRA water quality status.

## 2. Introduction

### BACKGROUND

The Institute of Freshwater Ecology was contracted by BNFL to investigate aspects of water quality in the Rivacre Brook system (Gledhill, 1990). In April 1991 at the Windermere Laboratory (Institute of Freshwater Ecology) it was agreed that a continued, but reduced, programme of water quality monitoring using macroinvertebrates was desirable.

Macroinvertebrate and water samples are to be taken at five sites, September (Autumn) 1991 & 1992 and March (Spring) 1992 & 1993.

This interim report (2) provides a comparison between data collected in March 1992, Autumn 1991 (Bass & Leach,1992) and the earlier study (Gledhill, (1990).

### METHODS

The five sampling stations (Fig. 1) include three (1-3) from the stream draining the Capenhurst site; Station 9 - a short distance downstream from the confluence with Rivacre Brook; Station 6, upstream from the confluence (a site sampled for the first time in Autumn 1991). Station numbers and positions (except 6) correspond to those used by Gledhill (1990).

Sampling techniques and processing followed the protocol required for the application of RIVPACS (River InVertebrate Prediction and Classification System), additional information on the abundance of invertebrate species, species diversity and the community structure, permit direct comparison with the earlier study (Gledhill, 1990). Water analyses were undertaken at the Windermere Laboratory.

## 3. INTERIM RESULTS

### Water Analyses

Table 1 permits a direct comparison between water chemistry samples taken on 19 March 1992 and those previously obtained in spring and autumn.

These are single spot-samples and are not assumed to describe average conditions.

### Substrates and Plant Cover

Table 2 lists the visual estimates of stream bed substrate types, in terms of % cover and the area occupied by plant material at each station. Where available, corresponding data from 1989, 1990 & 1991 are given.

### Macroinvertebrates Recorded

Tables 3-7 (Stations 1,2,3,6,9) present lists of species occurring in March 1992 with their corresponding common names and the invertebrate family to which they belong. The number of each species and family are shown for each station and the BMWP score (a numerical scale of sensitivity to pollution) is included. The format follows that of the earlier reports.

### Diversity Indices and ASPTs

Two diversity indices have been calculated -

Simpson Index and Shannon-Weaver Index (see Gledhill,1990 for details).

The ASPT (average score per taxon) for each station is calculated by dividing the total score (BMWP) by the number of scoring taxa. This index reflects the balance between pollution-tolerant and pollution-intolerant invertebrates found.

Index values in March 1992 and previous results are presented in Table 8.

### Predicted v. Observed Total Scores (BMWP)

Physical and chemical characteristics of each site were used to generate predictions of faunal composition on a seasonal basis (using the IFE RIVPAC System). As the values of variables used were similar in March 1992 to those used in the earlier study, predicted values are as for "Spring 1989" (Gledhill, 1990), except in the case of station 6, for which appropriate predictions were generated. The corresponding total scores (mean values) and their error estimates are presented with the observed total scores (Table 9).

## Environmental Quality Index (EQI)

The assessment of water quality, as used by the NRA, is likely to change shortly. The new proposals include a grading system which incorporates an "ecological override". This would operate when EQI values fall outside their permitted range corresponding to the observed chemical water quality class (Table 10).

Results from earlier samples are presented for comparison with March 1992 data. The consequences of the proposed new EQI approach are set out in Table 11.

## 4. INTERIM CONCLUSIONS

Water Analyses (Table 1)

Stations 1-3; in March 1992 ammonia levels are intermediate between those previously found, the three "spring" and two "autumn" data sets show a tendency for a downstream (stations 1 to 3) fall in concentration over about 300m of stream length. Soluble reactive phosphorus and total oxidised nitrogen were elevated at all stations, chloride was higher at station 1 and lower than previously recorded at 2 & 3, pH was high (9.2) at station 1 while other results appear similar or within the same ranges as previously found.

Station 6; noticeably more flow at this site, than in the previous autumn, organic debris and a sewage treatment works upstream continue to give high values for soluble phosphate (expressed as phosphorus), total oxidised nitrogen and total organic carbon.

Station 9; generally determinands were in the range recorded previously, though phosphorus and chloride had comparatively low values.

Substrates and Plant Cover (Table 2)

Substrate composition (in terms of visual allocation to particle size designation) has been fairly consistent at stations 1-3 on all sampling occasions.

For station 6 only a comparison with Autumn 1991 is possible, but the continuing low flow rate is thought likely to have contributed to the relatively high percentage of fine silt / clay recorded.

Station 9 was more silty than reported on previous occasions (Gledhill,1990; Bass & Leach,1992). One or two recently introduced large concrete slabs raised the percentage of boulder-cobble substrate recorded.

Plants were recorded only at station 9. As on the previous autumn visits, a small quantity of filamentous algae was present. The small bed of canadian pondweed (Elodea sp.) recorded in Autumn 1991 had remained established at station 9.

Macroinvertebrates Recorded (tables 3-7)

Species (or families) previously unrecorded -

Stations 1,2 & 3.

New taxa recorded for these stations were : a dytiscid beetle

(station 1): psychomyiid caddis larvae (station 3).

Station 6.
With limited previous data, it is worth stating that 7 of the 11 families recorded were present on both occasions, the same three taxa were numerically dominant as for stations 1,2 & 3.
Flatworms (Planariidae) and a leech (Erpobdellidae) were additions to the fauna found in Autumn 1991, while larvae of dytiscid beetles and mayflies (Caenidae) were absent in Spring 1992.

Station 9.
Flatworms (Planariidae) were absent for the first time at this station (though numbers had been below 10 on all previous visits).
A small snail (Anisus vortex) and mites were recorded for the first time.

Striking changes in abundance -

Increases

At all Stations large increases in midge larvae (Chironomidae) were evident, corresponding to numbers recorded in Spring 1989 (Gledhill,1990).

Stations 1,2 & 3. No other taxa showed a clear increase in numbers.

Station 6. No other previously recorded taxa showed clear increases in numbers, the hoglouse (Asellus) was less numerous.

Station 9. The pond snail (Lymnaea peregra) and the shrimp (Crangonyx pseudogracilis) were more numerous than on all previous sampling occasions.

Decreases

Station 1,2 & 3.
The range and numbers of invertebrates were reduced when compared with those recorded in Autumn 1991, corresponding more closely with data obtained in 1989 & 1990, but with molluscs and leeches almost entirely absent in Spring 1992.

Station 6.
The hoglouse (Asellidae) and shrimp (Crangonyx pseudogracilis) showed clear declines in numbers.

Station 9. Few of the groups present showed declines when compared with Autumn 1991 data, the leech (Erpobdella octoculata), hoglouse (Asellidae) and caddis larvae (Psychomyiidae) being the exceptions.

Diversity Indices & ASPTs (Table 8)

The Simpson Index and the Shannon-Weaver Index utilise the number of different taxa and the numbers of individuals within each taxon. In Spring 1992 there was a reversal of the downward trend in the indices (produced by the striking predominance of Asellidae at all stations in Autumn 1991), a more balanced distribution of numbers between the taxa resulted in values intermediate between those for Autumn 1991 and 1989/1990.

Changes in ASPT values reflect particularly small shifts in the presence/absence of invertebrate families when the number of families is quite low, as in the Rivacre Brook system. Consequently no clear trends are apparent at individual stations or between stations.

Predicted v. Observed Total Scores (BMWP) (Table 9)

As with the ASPT values, the low total scores are fluctuating in response to the loss or gain of one or two scoring taxa. On four of the five sampling occasions station 9 has achieved a higher score than stations 1,2 & 3. It is considered that increased habitat diversity at station 9, rather than a downstream improvement in water quality may be the cause (eg, the downstream fall in ammonia concentrations between stations 1 and 3 are not apparent at station 9)

Environmental Quality Index (EQI) (Table 10 & 11)

Over the five sampling occasions invertebrate community index values have generally been within their appropriate range corresponding to Class 3 ("poor") (predicted from chemical water quality criteria). At station 1 the ecological override dropped the designation to Class 4 ("bad") in 1989 & 1990. At station 2 this occurred in Spring 1992. The ecological override raised the designation to Class 2 ("fair") when applied to station 3 in Spring 1989.

## 5. Acknowledgements

Staff at the Windermere and Wareham laboratories of the Institute of Freshwater Ecology analyzed water samples and ran RIVPACS predictions, respectively.

## 6. References

Bass,J.A.B. & Leach,D.V. (1992) Water quality monitoring on the Rivacre Brook.: interim report (1). Report to: British Nuclear Fuels plc, Capenhurst. 22pp.

Gledhill,T. (1990) An assessment and comparison of water quality using macroinvertebrate animals at selected sites on the Rivacre Brook, The Wirral, Cheshire. Report to: British Nuclear Fuels plc, Capenhurst. 36pp (+Appendices).

NRA (1991) Proposals for Statutory Water Quality Objectives. Water Quality Series No. 5, 100pp.

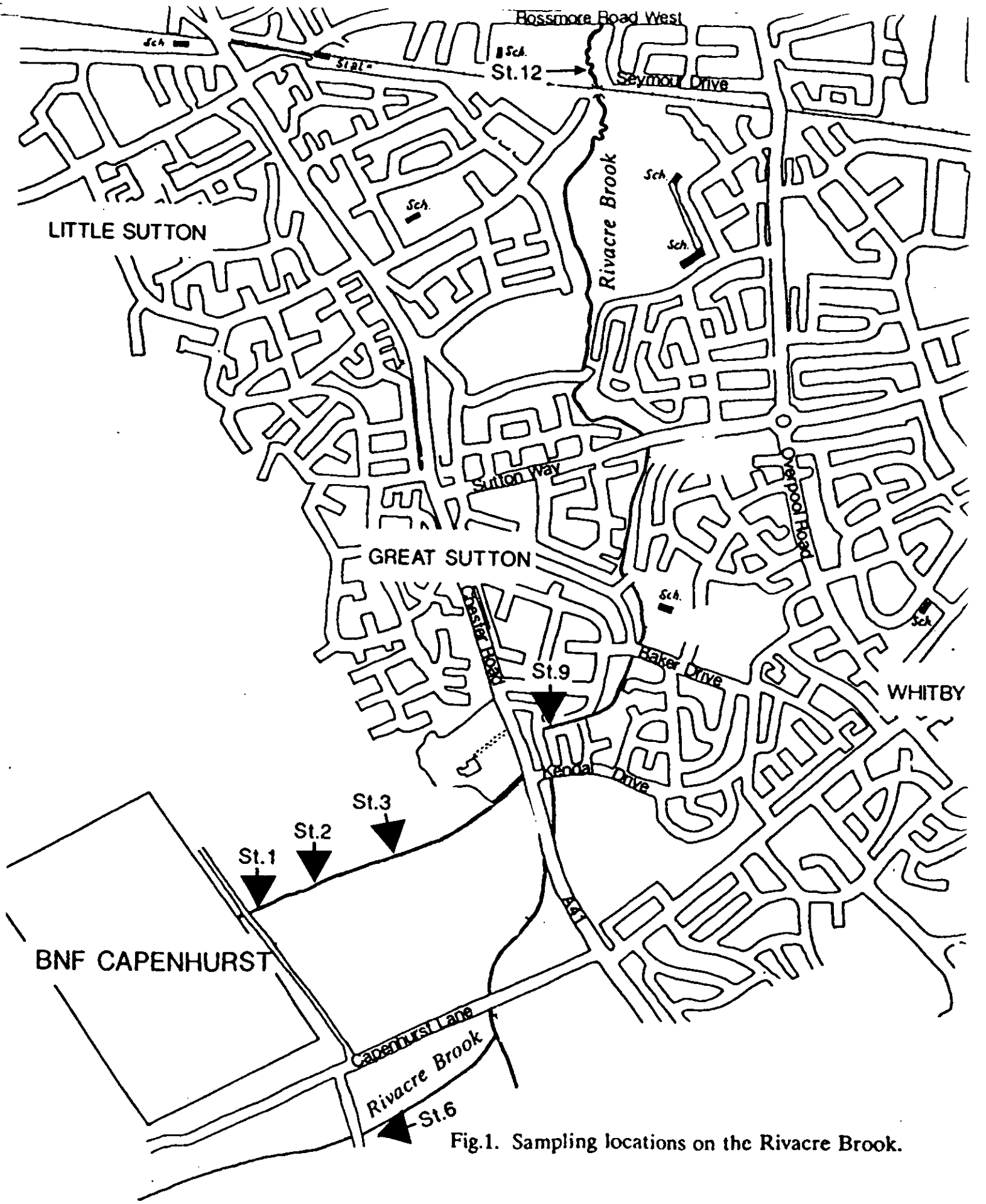


Fig.1. Sampling locations on the Rivacre Brook.

Table 1. Water chemistry data* for Spring (Sp) 1992, with corresponding results for Autumn,1991 (Bass & Leach,1992) and from the initial report (Gledhill,1990).

| Station - Date | Ammonia NH3.N mg l | Total Oxidised Nitrogen mg l | Soluble Reactive Phosphorus mg l | Chloride Cl mg l |
|---|---|---|---|---|
| 1 - Sp 92 | 0.256 | 5.81 | 0.677 | 120.5 |
| 1 - Au 91 | 0.336 | 3.34 | 0.532 | 64.8 |
| 1 - Sp 90 | 0.092 | 3.96 | 0.457 | 62.0 |
| 1 - Au 89 | 0.162 | 3.31 | 0.356 | 50.9 |
| 1 - Sp 89 | 0.007 | 3.70 | 0.593 | 67.2 |
| 2 - Sp 92 | 0.198 | 5.39 | 0.682 | 33.7 |
| 2 - Au 91 | 0.135 | 2.44 | 0.348 | 81.7 |
| 2 - Sp 90 | 0.081 | 3.96 | 0.470 | 59.0 |
| 2 - Au 89 | 0.090 | 3.89 | 0.400 | 53.0 |
| 2 - Sp 89 | 0.006 | 2.87 | 0.515 | 74.1 |
| 3 - Sp 92 | 0.204 | 5.98 | 0.637 | 32.2 |
| 3 - Au 91 | 0.330 | 3.69 | 0.511 | 75.2 |
| 3 - Sp 90 | 0.069 | 3.48 | 0.450 | 61.0 |
| 3 - Au 89 | 0.051 | 4.33 | 0.416 | 53.1 |
| 3 - Sp 89 | 0.008 | 3.13 | 0.504 | 77.5 |
| 6 - Sp 92 | 0.063 | 23.58 | 1.043 | 62.5 |
| 6 - Au 91 | 0.032 | 4.99 | 10.060 | 67.3 |
| 9 - Sp 92 | 0.154 | 4.63 | 0.408 | 27.2 |
| 9 - Au 91 | 0.471 | 3.25 | 0.678 | 66.5 |
| 9 - Sp 90 | 0.228 | 3.09 | 0.630 | 201.2 |
| 9 - Au 89 | 0.050 | 2.63 | 0.586 | 261.0 |
| 9 - Sp 89 | 0.085 | 2.90 | 0.656 | 46.7 |

continued overleaf

Table 1 (conti.)

| Station - Date | Calcium Carbonate mg l | Total Organic Carbon mg l | Conductivity uS/cm | pH units |
|---|---|---|---|---|
| 1 - Sp 92 | 72.00 | 4.23 | 702 | 9.2 |
| 1 - Au 91 | 45.95 | 3.55 | 460 | 7.3 |
| 1 - Sp 90 | 77.35 | 3.26 | - | - |
| 1 - Au 89 | 56.90 | - | - | - |
| 1 - Sp 89 | - | 3.35 | - | - |
| 2 - Sp 92 | 49.20 | 3.16 | 372 | 7.4 |
| 2 - Au 91 | 43.70 | 3.79 | 490 | 7.3 |
| 2 - Sp 90 | 78.85 | 3.43 | - | - |
| 2 - Au 89 | 56.30 | - | - | - |
| 2 - Sp 89 | - | 3.43 | - | - |
| 3 - Sp 92 | 48.00 | 3.35 | 370 | 7.4 |
| 3 - Au 91 | 43.45 | 4.00 | 487 | 7.3 |
| 3 - Sp 90 | 80.60 | 3.51 | - | - |
| 3 - Au 89 | 53.75 | - | - | - |
| 3 - Sp 89 | - | 3.44 | - | - |
| 6 - Sp 92 | 135.70 | 10.72 | 833 | 7.4 |
| 6 - Au 91 | 137.30 | 9.55 | 722 | 7.6 |
| 9 - Sp 92 | 60.80 | 4.71 | 369 | 7.5 |
| 9 - Au 91 | 52.35 | 4.45 | 465 | 7.5 |
| 9 - Sp 90 | 81.75 | 3.97 | - | - |
| 9 - Au 89 | 66.25 | - | - | - |
| 9 - Sp 89 | - | 4.38 | - | - |

* These are single spot samples and are not assumed to describe average conditions. This should be born in mind as the values are compared with earlier analyses (Bass & Leach, 1991 & Gledhill,1990).

Table 2. Estimates of stream bed substrate type and plant % cover for Rivacre Brook sampling stations, with corresponding data from earlier studies (Gledhill,1990; Bass & Leach,1992).

Substrate and vegetation cover (%).

| STATION | DATE | Boulder/ Cobble | Pebble/ Gravel | Sand | Silt/ Clay | Algal cover | Macro-phyte |
|---|---|---|---|---|---|---|---|
| 1. | Sp. 92 | - | 5 | 20 | 75 | - | - |
| | Au. 91 | - | 10 | 70 | 20 | - | - |
| | Sp. 90 | - | 10 | 60 | 30 | - | - |
| | Au. 89 | - | 10 | 60 | 30 | - | - |
| | Sp. 89 | - | 10 | 60 | 30 | - | - |
| 2. | Sp. 92 | - | 30 | 20 | 50 | - | - |
| | Au. 91 | - | 60 | 30 | 10 | - | - |
| | Sp. 90 | - | 65 | 25 | 10 | 3 | - |
| | Au. 89 | - | 65 | 25 | 10 | - | - |
| | Sp. 89 | - | 70 | 20 | 10 | 20 | - |
| 3. | Sp. 92 | 5 | 15 | 30 | 50 | - | - |
| | Au. 91 | 10 | 50 | 20 | 20 | - | - |
| | Sp. 90 | - | 60 | 30 | 10 | 40 | - |
| | Au. 89 | - | 60 | 30 | 10 | - | - |
| | Sp. 89 | - | 80 | 10 | 10 | - | - |
| 6. | Sp. 92 | 20 | - | - | 80 | 20 | - |
| | Au. 91 | 20 | - | 20 | 60 | - | - |
| | Sp. 90 | - | - | - | - | - | - |
| | Au. 89 | - | - | - | - | - | - |
| | Sp. 89 | - | - | - | - | - | - |
| 9. | Sp. 92 | 30 | 50 | 10 | 10 | 10 | 5 |
| | Au. 91 | 20 | - | 20 | 60 | 10 | 10 |
| | Sp. 90 | 2 | 75 | 18 | 5 | 40 | - |
| | Au. 89 | 2 | 80 | 10 | 8 | 10 | - |
| | Sp. 89 | 2 | 80 | 10 | 8 | 50 | - |

Table 3. Invertebrates recorded from Station 1, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St. 1 19.3.92

| Common name | Scientific name | Number in sample | Family | No. per family | Score (BMWP) |
|---|---|---|---|---|---|
| Worms | Oligochaeta | 73 | "Oligochaeta" | 73 | 1 |
| Pea mussel | Pisidium henslowanum | 1 | Sphaeriidae | 1 | 3 |
| Water-hoglouse | Asellus aquaticus | 24 | Asellidae | 24 | 3 |
| Freshwater shrimps | Crangonyx pseudogr. | 8 | Gammaridae | 8 | 6 |
| Beetle | Dytiscus marginalis | 1 | Dytiscidae | 1 | 5 |
| Midge larvae | Chironomidae | 99 | Chironomidae | 99 | 2 |

Number of different taxa = 6

Total number of specimens N = 206

BMWP score = 20 ASPT = 3.33

Table 4. Invertebrates recorded from Station 2, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St. 2 19.3.92

| Common name | Scientific name | Number in sample | Family | No. per family | Score (BMWP) |
|---|---|---|---|---|---|
| Worms | Oligochaeta | 21 | "Oligochaeta" | 21 | 1 |
| Water-hoglouse | Asellus aquaticus | 52 | Asellidae | 52 | 3 |
| Freshwater shrimps | Crangonyx pseudogr. | 2 | Gammaridae | 2 | 6 |
| Midge larvae | Chironomidae | 128 | Chironomidae | 128 | 2 |
| Crane Fly larva | Tipulidae | 1 | Tipulidae | 1 | 5 |

Number of different taxa = 5

Total number of specimens N = 204

BMWP score = 17 ASPT = 3.04

Table 5. Invertebrates recorded from Station 3, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St. 3 19.3.92

| Common name | Scientific name | Number in sample | Family | No. per family | Score (BMWP) |
|---|---|---|---|---|---|
| Worms | Oligochaeta | 74 | "Oligochaeta" | 74 | 1 |
| Leeches | Glossiphonia complanata | 1 | Glossiphoniidae | 1 | 3 |
| Snail | Lymnaea peregra | 1 | Lymnaeidae | 1 | 3 |
| Water-hoglouse | Asellus aquaticus | 170 | Asellidae | 170 | 3 |
| Freshwater shrimps | Crangonyx pseudogr. | 31 | Gammaridae | 31 | 6 |
| Caddisfly | Tinodes waeneri | 2 | Psychomyiidae | 2 | 8 |
| Midge larvae | Chironomidae | 88 | Chironomidae | 88 | 2 |
| Crane Fly larvae | Tipulidae | 2 | Tipulidae | 2 | 5 |

Number of different taxa = 8

Total number of specimens N = 369

BMWP score = 31 ASPT = 3.87

Table 6. Invertebrates recorded from Station 6, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St. 6 19.3.92

| Common name | Scientific name | Number in sample | Family | No. per family | Score (BMWP) |
|---|---|---|---|---|---|
| Worms | Oligochaeta | 69 | "Oligochaeta" | 69 | 1 |
| Flatworms | Polycelis nigra gp. | 32 | Planariidae | 32 | 5 |
| Leeches | Glossiphonia complanata | 14 | Glossiphoniidae | 14 | 3 |
| | Erpobdella octoculata | 1 | Erpobdellidae | 1 | 3 |
| Pea mussel | Pisidium sp. | 1 | Sphaeriidae | 1 | 3 |
| Water-hoglouse | Asellus aquaticus | 866 | Asellidae | 866 | 3 |
| Freshwater shrimps | Crangonyx pseudogr. | 1 | Gammaridae | 1 | 6 |
| Midge larvae | Chironomidae | 272 | Chironomidae | 272 | 2 |
| Diptera | | 1 | Diptera | 1 | - |

Number of different taxa = 8

Total number of specimens N = 1257

BMWP score = 26 ASPT = 3.25

Table 7. Invertebrates recorded from Station 9, with numbers of individual taxa, their BMWP score, number of different taxa and the average score per taxon (ASPT).

RIVACRE BROOK St. 9 19.3.92

| Common name | Scientific name | Number in sample | Family | No. per family | Score (BMWP) |
|---|---|---|---|---|---|
| Worms | Oligochaeta | 92 | "Oligochaeta" | 92 | 1 |
| Leeches | Glossiphonia complanata | 14 | Glossiphoniidae | 14 | 3 |
| | Helobdella stagnalis | 1 | | | |
| | Erpobdella octoculata | 16 | Erpobdelliidae | 16 | 3 |
| Snails | Potamopyrgus jenkinsi | 1 | Hydrobiidae | 1 | 3 |
| | Lymnaea peregra | 38 | Lymnaeidae | 38 | 3 |
| | Lymnaea sp. | 2 | | 2 | |
| | Anisus vortex | 1 | Planorbidae | 1 | 3 |
| | Physidae sp | 2 | Physidae | 2 | 3 |
| Pea Mussels | Pisidium subtruncatum | 2 | Sphaeriidae | 2 | 3 |
| Water-hoglouse | Asellus aquaticus | 1134 | Asellidae | 1134 | 3 |
| Freshwater shrimps | Crangonyx psuedogr. | 158 | Gammaridae | 158 | 6 |
| Mites | Hydracarina | 4 | "Hydracarina" | 2 | - |
| Caddis | Tinodes waeneri | 3 | Psychomyiidae | 3 | 8 |
| Midge larvae | Chironomidae | 266 | Chironomidae | 266 | 2 |
| Blackfly | Simulium ornatum | 3 | Simuliidae | 3 | 5 |

Number of different taxa = 13

Total number of specimens N = 1734

BMWP score = 46 ASPT = 3.54

Table 8. Macroinvertebrate diversity indices and BMWP average score per taxon (ASPT) for Rivacre Brook sampling stations in spring 1992, a comparison with values obtained previously (Gledhill,1990; Bass & Leach,1992) are shown.

RIVACRE BROOK.

| STATION | DATE | SIMPSON INDEX | SHANNON-WEAVER INDEX | ASPT |
|---|---|---|---|---|
| 1. | Spring 92 | 0.63 | 1.66 | 3.33 |
| | Autumn 91 | 0.55 | 1.56 | 3.40 |
| | Spring 90 | 0.66 | 1.77 | 2.40 |
| | Autumn 89 | 0.67 | 1.92 | 3.00 |
| | Spring 89 | 0.26 | 0.83 | 2.50 |
| 2. | Spring 92 | 0.53 | 1.37 | 3.04 |
| | Autumn 91 | 0.48 | 1.37 | 3.25 |
| | Spring 90 | 0.86 | 2.93 | 3.64 |
| | Autumn 89 | 0.85 | 2.99 | 3.45 |
| | Spring 89 | 0.81 | 2.60 | 3.50 |
| 3. | Spring 92 | 0.69 | 1.90 | 3.87 |
| | Autumn 91 | 0.33 | 1.02 | 3.22 |
| | Spring 90 | 0.81 | 2.59 | 3.25 |
| | Autumn 89 | 0.85 | 3.00 | 3.42 |
| | Spring 89 | 0.77 | 2.58 | 3.69 |
| 6. | Spring 92 | 0.48 | 1.32 | 3.25 |
| | Autumn 91 | 0.15 | 0.56 | 3.75 |
| | Spring 90 | - | - | - |
| | Autumn 89 | - | - | - |
| | Spring 89 | - | - | - |
| 9. | Spring 92 | 0.54 | 1.68 | 3.54 |
| | Autumn 91 | 0.17 | 0.68 | 4.06 |
| | Spring 90 | 0.86 | 2.88 | 3.56 |
| | Autumn 89 | 0.74 | 2.42 | 3.64 |
| | Spring 89 | 0.83 | 2.81 | 3.75 |

Table 9. RIVPACS predictions of mean Total Scores (BMWP), error limits and observed Total Scores for each Rivacre Brook station (sd - standard deviation, lcl - lower confidence limit, ucl - upper confidence limit). Values are compared with those of the previous studies (Gledhill,1990; Bass & Leach,1992).

BMWP Total Scores

| | | --------- predicted ---------- | | | | |
|---|---|---|---|---|---|---|
| Stn. | date | mean | sd | lcl | ucl | OBSERVED |
| 1. | Sp. 92 | 122 | 21.54 | 79.48 | 164.22 | 20 |
| | Au. 91 | 115 | 20.67 | 74.48 | 155.52 | 34 |
| | Sp. 90 | 122 | 21.54 | 79.78 | 164.22 | 12 |
| | Au. 89 | 115 | 20.67 | 74.48 | 155.52 | 24 |
| | Sp. 89 | 122 | 21.54 | 79.78 | 164.22 | 12 |
| 2. | Sp. 92 | 114 | 18.63 | 77.49 | 150.51 | 17 |
| | Au. 91 | 96 | 17.97 | 60.78 | 131.22 | 26 |
| | Sp. 90 | 114 | 18.63 | 77.49 | 150.51 | 40 |
| | Au. 89 | 96 | 17.97 | 60.78 | 131.22 | 38 |
| | Sp. 89 | 114 | 18.63 | 77.49 | 150.51 | 35 |
| 3. | Sp. 92 | 122 | 20.07 | 82.67 | 161.33 | 31 |
| | Au. 91 | 107 | 18.72 | 70.31 | 143.69 | 29 |
| | Sp. 90 | 122 | 20.07 | 82.67 | 161.33 | 26 |
| | Au. 89 | 107 | 18.72 | 70.31 | 143.69 | 41 |
| | Sp. 89 | 122 | 20.07 | 82.67 | 161.33 | 48 |
| 6. | Sp. 92 | 105.8 | 18.42 | 69.74 | 141.95 | 26 |
| | Au. 91 | 90.4 | 17.31 | 56.46 | 124.30 | 30 |
| | Sp. 90 | - | - | - | - | - |
| | Au. 89 | - | - | - | - | - |
| | Sp. 89 | - | - | - | - | - |
| 9. | Sp. 92 | 158 | 20.37 | 118.07 | 197.93 | 46 |
| | Au. 91 | 156 | 20.95 | 114.94 | 197.06 | 61 |
| | Sp. 90 | 158 | 20.37 | 118.07 | 197.93 | 32 |
| | Au. 89 | 156 | 20.95 | 114.94 | 197.06 | 51 |
| | Sp. 89 | 158 | 20.37 | 118.07 | 197.93 | 45 |

Table 10. Water quality classification, a proposed new system (NRA, 1991) and the corresponding ranges of Environmental Quality Indices (EQIs).

| Current water quality classes | Proposed grading system | Corresponding mean EQI ranges |
|---|---|---|
| 1A "excellent" | A | 0.90 - |
| 1B "good" | B | 0.65 - 0.99 |
| 2 "fair" | C | 0.60 - 0.85 |
| 3 "poor" | D | 0.40 - 0.65 |
| 4 "Bad" | E | - 0.55 |

Table 11. Environmental quality index (EQI) expressed as BMWP score (Observed/Predicted = EQIs), ASPT (= EQIa), total of scoring taxa (= EQIt) and mean EQI (EQIs+EQIa+EQIt/3). Data for autumn 1991 and spring 1992 are compared with 1989/90 data (Gledhill,1990).

| Environmental Quality Index | | stn.1 | stn.2 | stn.3 | stn.6 | stn.9 |
|---|---|---|---|---|---|---|
| EQIs | | | | | | |
| | Sp 1992 | 0.16 | 0.15 | 0.25 | 0.26 | 0.29 |
| | Au 1991 | 0.30 | 0.27 | 0.27 | 0.33 | 0.39 |
| | Sp 1990 | 0.10 | 0.35 | 0.21 | - | 0.20 |
| | Au 1989 | 0.21 | 0.40 | 0.38 | - | 0.33 |
| | Sp 1989 | 0.12 | 0.31 | 0.39 | - | 0.28 |
| EQIa | | | | | | |
| | Sp 1992 | 0.62 | 0.58 | 0.70 | 0.60 | 0.56 |
| | Au 1991 | 0.62 | 0.62 | 0.58 | 0.75 | 0.74 |
| | Sp 1990 | 0.42 | 0.64 | 0.55 | - | 0.55 |
| | Au 1989 | 0.55 | 0.66 | 0.62 | - | 0.58 |
| | Sp 1989 | 0.44 | 0.61 | 0.62 | - | 0.58 |
| EQIt | | | | | | |
| | Sp 1992 | 0.48 | 0.36 | 0.61 | 0.41 | 0.70 |
| | Au 1991 | 0.80 | 0.58 | 0.69 | 0.44 | 0.81 |
| | Sp 1990 | 0.40 | 0.80 | 0.72 | - | 0.49 |
| | Au 1989 | 0.32 | 0.43 | 0.61 | - | 0.38 |
| | Sp 1989 | 0.48 | 0.72 | 0.96 | - | 0.65 |
| mean EQI (EQIs + EQIa + EQIt /3) | | | | | | |
| | Sp 1992 | 0.42 | 0.36* | 0.52 | 0.42 | 0.52 |
| | Au 1991 | 0.57 | 0.49 | 0.51 | 0.51 | 0.65 |
| | Sp 1990 | 0.31* | 0.60 | 0.49 | - | 0.41 |
| | Au 1989 | 0.36* | 0.50 | 0.54 | - | 0.43 |
| | Sp 1989 | 0.35* | 0.55 | 0.66+ | - | 0.50 |

* - value below range for water quality class 3 ("poor"), override system downgrades to class 4 ("bad").
+ - value above range for water quality class 3 ("poor"), override system upgrades to class 2 ("fair").
The remaining mean EQI values fall within the range corresponding to class 3.