Institute of Freshwater Ecology

Water quality monitoring on the Rivacre Brook

Interim Report (3)

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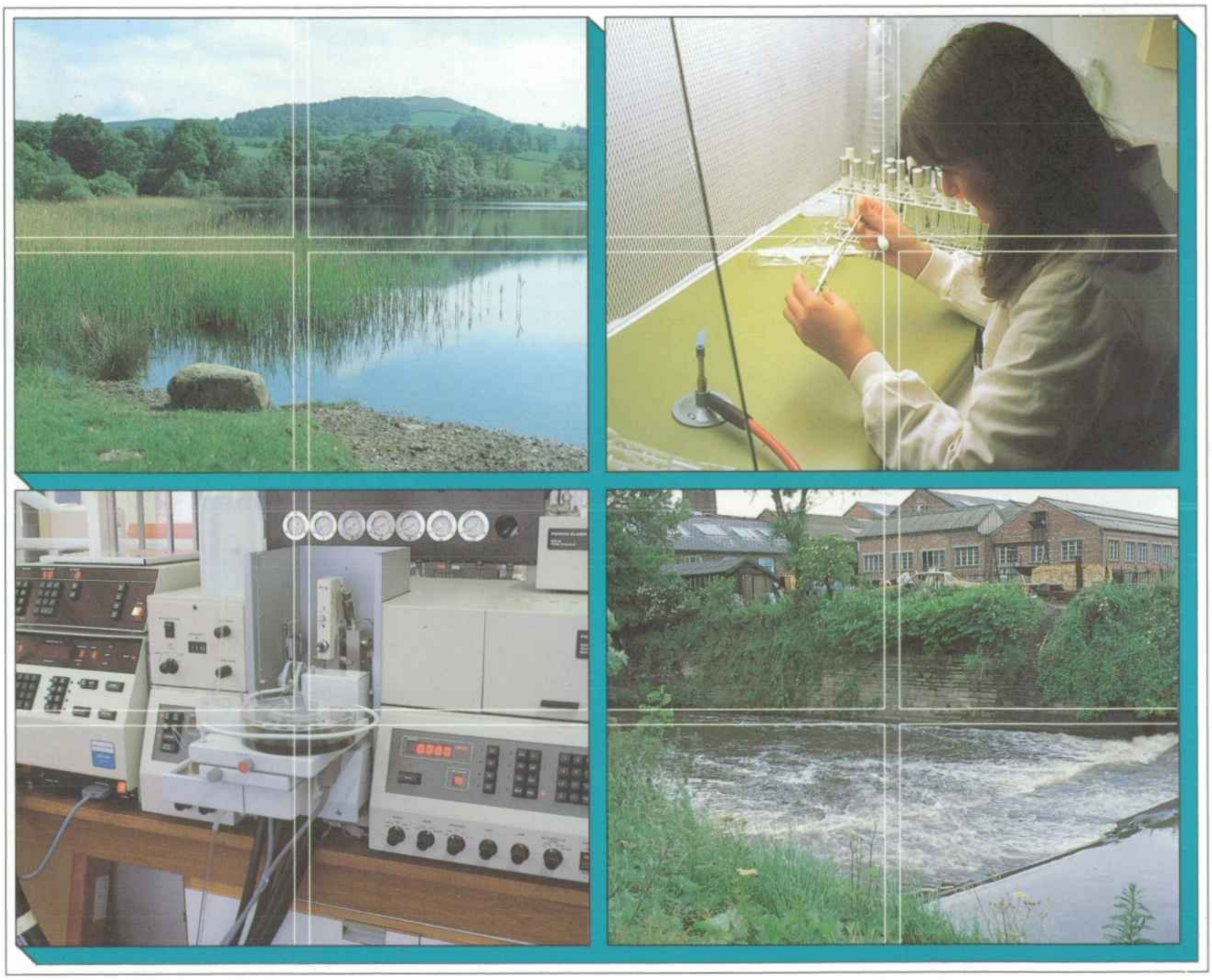

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WATER QUALITY MONITORING ON THE RIVACRE BROOK

Interim Report (3)
February 1993

By Jon Bass & David Leach

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Report to: British Nuclear Fuels plc, Capenhurst
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1. SUMMARY

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

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 (3) compares data collected in September 1992 with that obtained in March 1992, September 1991 (Bass & Leach,(1 & 2) 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 in September 1992 and those previously obtained in spring (1989,1990,1992) and autumn (1989,1991).

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 & spring 1992 are given.

Macroinvertebrates Recorded

Tables 3-7 (Stations 1,2,3,6,9) present lists of species occurring in September 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 September 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 September 1992 to those used in the earlier study, predicted values are as for "Autumn 1989" (Gledhill, 1990), in the case of station 6, predicted values were generated in 1991. 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 September 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 September 1992 ammonia (N) levels are intermediate between those previously found. The "spring" and "autumn" data sets show station 1 has consistently produced higher values than stations 2 & 3, it is also noted that higher and more variable concentrations have been recorded at stations 1-3 in 1991 & 1992. Soluble reactive phosphorus was present at the lowest recorded levels, while total oxidised nitrogen and total organic carbon had intermediate concentrations, for all three, the between-station variability has been consistently low on each sampling occasion. Chloride (and by association conductivity) has exhibited higher and more variable concentrations on both visits in 1992 at stations 1-3. While other results appear similar or within the same ranges as previously found.

Station 6; high values for soluble phosphate (expressed as phosphorus), ammonia (N) and total organic carbon were noteworthy. Recent storm flows may have temporarily overloaded the sewage treatment works upstream.

Station 9; generally determinands were in the range recorded previously, though phosphorus had a low concentration, following the trend of sites 1-3. There appeared to be little impact from the contribution derived from station 6, upstream.

<u>Substrates and Plant Cover</u> (Table 2)

Substrate composition (in terms of visual allocation to particle size designation) has shown shifts in dominance between sand and silt/clay at stations 1-3. It is considered that localised scouring and deposition around temporary accumulations of debris in the ditch bottom has been responsible. Intermittent high flows after heavy rainfall, followed by a return to stagnant conditions maintain an unstable environment for aquatic life.

For station 6, predominately stagnant conditions and a broad channel leads to the high percentage of fine silt / clay recorded, even shortly after flood events.

Station 9 remained the most diverse, in terms of substrates, and in-stream plant growth.

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 has 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 : bivalve species(Pisidium casertanum - station 1 & 2, P.subtruncatum - station 2): psychomyiid and limnephilid caddis larvae (station 2).

Station 6.

With limited previous data, it is worth stating that 6 of the 8 families recorded were present on both previous occasions, three of the four most numerous taxa were also dominant at stations 1,2 & 3.

Station 9.

The limpet, Acroloxus lacustris, mayflies (Baetidae), water boatmen (Corixidae) and a beetle (Haliplidae) were recorded for the first time.

Striking changes in abundance -

Increases

Stations 1,2 & 3: a freshwater shrimp, _Crangonyx pseudogracilis_ (Gammaridae), showed a return to high numbers at these stations.

Station 6: the freshwater hoglouse, _Asellus aquaticus_ (Asellidae), was present in extremely high numbers.

Station 9: the small snail, _Potamopyrgus jenkinsi_, had undergone a population explosion. This species reproduces parthenogenetically and rapidly changing population densities are recorded frequently. _Simulium ornatum_ (Simuliidae) is associated with the increase in suitable attachment sites, (_Elodea_ plants).

Decreases

Station 1,2 & 3: no exceptional declines in faunal components were evident.

Station 6: worms (oligochaetes), showed a small decline in numbers.

Station 9. Few of the groups present showed declines when compared with Autumn 1991 and Spring 1992 data, the leech (_Erpobdella octoculata_) and caddis larvae (Psychomyiidae) being the exceptions.

In addition, a range of less common fauna were absent or reoccurred at all stations, as on previous occasions this may be attributed to chance.

Diversity Indices & ASPTs (Table 8)

The Simpson Index and the Shannon-Weaver Index utilise the number of different invertebrate taxa and the numbers of individuals within each taxon. In Autumn 1992 the index values at stations 1,2,3 & 9 were intermediate between those recorded previously. In contrast the extremely high relative density of *Asellus* at station 6, with few other invertebrates, gave the lowest values recorded up to the present.

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. It is noteworthy that, over the monitoring programme, the highest ASPT score (station 2) and the lowest ASPT score (station 3) were recorded in Autumn 1992. With the close proximity of these stations to one another it can be inferred that these results do not reflect contrasting conditions moulding the community but result from chance presence/absence of a small number of less common taxa.

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, as illustrated by stations 2 & 3 (Tables 4 & 5). On five of the six sampling occasions station 9 has achieved a higher score than stations 1,2 & 3. It is considered that increased habitat diversity at station 9 (see Table 2), rather than a downstream improvement in water quality may be the cause.

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

Over the six 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 (Spring and Autumn) & 1990. At station 2 this occurred in Spring 1992 and at stations 3 and 6 in Autumn 1992. The ecological override raised the designation to Class 2 ("fair") when applied to station 3 in Spring 1989.

As with other scores and indices (discussed previously) the comparatively small range of taxa occurring gives rise to large fluctuations in values. Some of the downgrading (and the upgrade) may be dismissed as chance, but the system is deliberately robust to incorporate the wide variation encountered in faunal communities.

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.

Bass,J.A.B. & Leach,D.V. (1992) Water quality monitoring on the Rivacre Brook.: interim report (2). 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.

Table 1. Water chemistry data* for Autumn (Au) 1992, with corresponding results from earlier reports (Bass & Leach,1992 & Gledhill,1990).

Station - Date	Ammonia NH3.N mg 1	Total Oxidised Nitrogen mg 1	Soluble Reactive Phosphorus mg 1	Chloride Cl mg 1
1 - Au 92	**0.237**	**3.77**	**0.153**	**38.6**
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 - Au 92	**0.153**	**3.36**	**0.188**	**93.2**
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 - Au 92	**0.274**	**3.67**	**0.108**	**299.4**
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 - Au 92	**1.054**	**4.74**	**8.939**	**59.5**
6 - Sp 92	0.063	23.58	1.043	62.5
6 - Au 91	0.032	4.99	10.060	67.3
9 - Au 92	**0.132**	**2.84**	**0.292**	**172.3**
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

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Table 1 (conti.)

Station - Date	Calcium Carbonate mg l	Total Organic Carbon mg l	Conductivity uS/cm	pH units
1 - Au 92	40.40	3.29	410	7.1
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 - Au 92	43.75	3.33	572	7.2
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 - Au 92	37.20	3.38	1100	7.1
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 - Au 92	150.95	9.65	668	7.4
6 - Sp 92	135.70	10.72	833	7.4
6 - Au 91	137.30	9.55	722	7.6
9 - Au 92	48.79	3.61	737	7.4
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, 1992 & 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.	**Au. 92**	**-**	**5**	**5**	**90**	**-**	**-**
	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.	**Au. 92**	**-**	**80**	**10**	**10**	**-**	**-**
	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.	**Au. 92**	**10**	**30**	**50**	**10**	**-**	**-**
	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.	**Au. 92**	**15**	**-**	**-**	**85**	**-**	**-**
	Sp. 92	20	-	-	80	20	-
	Au. 91	20	-	20	60	-	-
9.	**Au. 92**	**30**	**50**	**30**	**10**	**15**	**15**
	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 29.9.92

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Worms	Oligochaeta	411	"Oligochaeta"	411	1
Snails	**Lymnaea peregra**	18	Lymnaeidae	18	3
	Physidae	1	Physidae	1	3
Bivalves	**Sphaerium corneum**	1	Sphaeriidae	76	3
	Pisidium nitidum	13			
	P. subtruncatum	50			
	P. casertanum	5			
	P. personatum	7			
Freshwater shrimps	**Crangonyx pseudogr.**	579	Gammaridae	579	6
Water-hoglouse	**Asellus aquaticus**	403	Asellidae	403	3
Bugs	Corixidae	1	Corixidae	1	5
Fly larvae	Diptera sp	1	Diptera	1	-
Midge larvae	Chironomidae	107	Chironomidae	107	2

Number of different taxa = 9 (8 Scoring taxa)

Total number of specimens N = 1597

BMWP score = 26 ASPT = 3.25

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 29.9.92

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Worms	Oligochaeta	210	"Oligochaeta"	210	1
Leeches	**Erpobdella octoculata**	39	Erpobdellidae	39	3
	Glossiphonia complanata	1	Glossiphoniidae	1	3
Snail	**Lymnaea peregra**	1	Lymnaeidae	1	3
Pea mussels	**Pisidium nitidum**	6	Sphaeriidae	21	3
	P. subtruncatum	11			
	P. casertanum	4			
Freshwater shrimps	**Crangonyx pseudogr.**	78	Gammaridae	78	6
Water-hoglouse	**Asellus aquaticus**	384	Asellidae	384	3
Caddisfly	**Tinodes waeneri**	1	Psychomyiidae	1	8
	Limnephilidae	1	Lymnephilidae	1	7
Midge larvae	Chironomidae	33	Chironomidae	33	2

Number of different taxa = 10

Total number of specimens N = 769

BMWP score = 39 ASPT = 3.90

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 29.9.92

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Worms	Oligochaeta	80	"Oligochaeta"	80	1
Leeches	**Glossiphonia complanata**	1	Glossiphoniidae	1	3
Freshwater shrimps	**Crangonyx pseudogr.**	83	Gammaridae	83	6
Water-hoglouse	**Asellus aquaticus**	440	Asellidae	440	3
Midge larvae	Chironomidae	17	Chironomidae	17	2

Number of different taxa = 6

Total number of specimens N = 621

BMWP score = 15 ASPT = 2.50

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 29.9.92

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Flatworms	**Polycelis sp.**	1	Planariidae	1	5
Worms	Oligochaeta	19	"Oligochaeta"	19	1
Leeches	**Glossiphonia complanata**	11	Glossiphoniidae	11	3
Freshwater shrimps	**Crangonyx pseudogr.**	9	Gammaridae	9	6
Water-hoglouse	**Asellus aquaticus**	6204	Asellidae	6204	3
Beetles	Dytiscidae	5	Dytiscidae	5	5
Midge larvae	Chironomidae	195	Chironomidae	195	2
True fly	Diptera	3	Diptera	3	-

Number of different taxa = 8 (7 scoring taxa)

Total number of specimens N = 6447

BMWP score = 20 ASPT = 2.86

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 29.9.92

Common name	Scientific name	Number in sample	Family	No. per family	Score (BMWP)
Worms	Oligochaeta	95	"Oligochaeta"	95	1
Leeches	**Glossiphonia complanata**	18	Glossiphoniidae	18	3
	Erpobdella octoculata	8	Erpobdelliidae	8	3
Snails	**Potamopyrgus jenkinsi**	1100	Hydrobiidae	1100	3
	Lymnaea peregra	2	Lymnaeidae	2	3
	Physa sp.	3	Physidae	3	3
Limpet	**Acroloxus lacustris**	2	Ancylidae	2	6
Mite	Hydracarina	1	Hydracarina	1	-
Freshwater shrimps	**Crangonyx psuedogr.**	39	Gammaridae	39	6
Water-hoglouse	**Asellus aquaticus**	1079	Asellidae	1079	3
Mayfly	Baetidae	2	Baetidae	2	4
Water boatman	Corixidae	1	Corixidae	1	5
Beetles	Haliplidae	1	Haliplidae	1	5
	Dytiscidae	6	Dytiscidae	6	5
Diptera	Tipulidae	3	Tipulidae	3	5
Midge larvae	Chironomidae	22	Chironomidae	22	2
Blackfly	**Simulium ornatum**	108	Simuliidae	108	5

Number of different taxa = 17 (16 scoring taxa)

Total number of specimens N = 2489

BMWP score = 62 ASPT = 3.87

Table 8. Macroinvertebrate diversity indices and BMWP average score per taxon (ASPT) for Rivacre Brook sampling stations in autumn 1992, a comparison with values obtained previously (Gledhill,1990; Bass & Leach,1991 & 1992) are shown.

RIVACRE BROOK.

STATION	DATE	SIMPSON INDEX	SHANNON-WEAVER INDEX	ASPT
1.	**Autumn 92**	**0.73**	**1.56**	**3.25**
	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.	**Autumn 92**	**0.66**	**1.43**	**3.90**
	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.	**Autumn 92**	**0.46**	**0.89**	**2.50**
	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.	**Autumn 92**	**0.07**	**0.18**	**2.86**
	Spring 92	0.48	1.32	3.25
	Autumn 91	0.15	0.56	3.75
	Spring 90	-	-	-
	Autumn 89	-	-	-
	Spring 89	-	-	-
9.	**Autumn 92**	**0.61**	**1.19**	**3.87**
	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,1991 & 1992).

BMWP Total Scores

Stn.	date	mean	sd	lcl	ucl	OBSERVED
		predicted				
1.	**Au. 92**	**115**	**20.67**	**74.48**	**155.52**	**26**
	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.	**Au. 92**	**96**	**17.97**	**60.78**	**131.22**	**39**
	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.	**Au. 92**	**107**	**18.72**	**70.31**	**143.69**	**15**
	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.	**Au. 92**	**90.4**	**17.31**	**56.46**	**124.30**	**20**
	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.	**Au. 92**	**156**	**20.95**	**114.94**	**197.06**	**62**
	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 mean quality classes		Proposed grading system	Corresponding 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 1992 are compared with spring and autumn 1991 & 1990 (Bass & Leach), and 1989/90 (Gledhill,1990).

Environmental Quality Index		**stn.1**	**stn.2**	**stn.3**	**stn.6**	**stn.9**
EQIs						
	Au 1992	**0.23**	**0.41**	**0.14**	**0.22**	**0.40**
	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						
	Au 1992	**0.59**	**0.75**	**0.45**	**0.56**	**0.61**
	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						
	Au 1992	**0.64**	**0.72**	**0.46**	**0.39**	**0.86**
	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)						
	Au 1992	**0.49**	**0.63**	**0.35***	**0.39***	**0.62**
	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.

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