

Environmental RTDI Programme 2000–2006

**WATER FRAMEWORK DIRECTIVE –
Characterisation of Reference Conditions and
Testing of Typology of Rivers
(2002-W-LS-7)**

Final Report

Prepared for the Environmental Protection Agency

by

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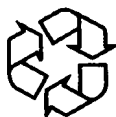
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Executive Summary

To fulfil the obligations of the Water Framework Directive, a river typology within Ecoregion 17 had to be produced. The objective of this study was to survey 50 sites within the Republic of Ireland that had been previously classified as high quality by the Irish EPA, to determine whether they were of high ecological status (and thus could be used as reference conditions) and to use these spatial reference sites to develop the river typology.

The biological elements (macroinvertebrates, phytobenthos and macrophytes) were surveyed at all 50 sites during 2002/2003. Chemistry (ammonia, phosphate, nitrate, nitrite, hardness, alkalinity, dissolved oxygen, pH, temperature, calcium, magnesium, potassium, chloride and sulphate) and basic hydromorphological variables (sediment, bank slope, etc.) were measured during the same period to ensure reference status. Q-values, TDI and MTR scores were applied to the biological elements to judge reference status, although it was acknowledged that these methods may not be appropriate since different river types cannot be directly compared using these measures.

Potential deviations from reference status were identified by the biological elements, chemistry and

hydromorphology at 23 sites, although coincidence of impact indication from the different elements only occurred at six sites. Agreement of a biological response with chemistry only occurred at one site (MOY2). Despite potential minor impacts, it was considered that the development of the typology would suffer more from the omission of river types than from the effect of the potential impacts. Thus, no sites were excluded, though the status of MOY2 and OGLIN1 should be reviewed in future developments.

Several typologies were developed from this dataset: Expert based, Canonical Correspondence Analysis (CCA) based, the WFD System A Typology, and typologies developed from permutations of different environmental variables and variable boundaries. The permutation-based typologies best segregated the biological elements across all groups, and with combined biological data. A 12-category permutation-based typology was recommended as the best typology, and has now been accepted by the EPA. Categorisation of the 50 sites, indicator species, and the frequency of different species are shown for the 12 different river types within this typology.

1 Introduction

The Water Framework Directive (WFD) requires Member States to measure the ecological status of surface waters by comparison of monitoring sites with unimpacted reference conditions specific to that river or lake type. Reference conditions must be of high ecological status and thus show “*no, or only very minor, evidence of distortion*” (Council of the European Communities, 2000). Ecological status for biological quality elements is to be a measure of “*changes in the composition and abundance*” of different taxonomic groups.

The RIVTYPE project addressed the development of reference conditions and a typology for rivers within the Republic of Ireland (part of Ecoregion 17). The specific objectives were:

1. To describe the composition and abundance of the macroinvertebrate, macrophyte and phytobenthos

communities of 50 potential reference river sites, which were designated by the EPA.

2. To verify that these sites are of high biological, chemical and hydromorphological status and thereby could be used as reference conditions.
3. To determine and validate a river typology. River types should have distinct biological communities and a range of environmental variables which would be expected under unimpacted conditions.

1.1 Sites Surveyed

Fifty potential reference sites, which were likely to be of high ecological status, were selected by the EPA for macroinvertebrate, phytobenthos and macrophyte surveys. The locations of these sites are shown in [Fig. 1.1](#) and [Table 1.1](#) provides the Irish grid references.



Figure 1.1. Location of the 50 potential reference sites chosen by the EPA.

Table 1.1. Irish Grid References (IGR) of the 50 potential reference sites.

EPA code	River name	Location	Site code	IGR
09D010010	Dodder	1.3 km u/s Reservoir u/s distributary	DODDE1	O11015 20233
09L010250	Liffey	0.5 km d/s Ballyward Br.	LIFFY1	O02276 16126
10G010200	Glencree	Bridge u/s Dargle River confl	GCREE1	O20272 14884
10G050100	Glenealo	Ford u/s Upper Lake	GNEAL1	T08822 96227
12L020100	Little Slaney	Ford S of Coan	LSLAN1	S98485 91766
12L020400	Little Slaney	Ford d/s Rostyduff Br.	LSLAN2	S94946 92339
12S020400	Slaney	Waterloo Br.	SLANY1	S90222 93468
12U010050	Urrin	Ballycrystal Br.	URRN1	S86396 48578
18F050030	Funshion	Brackbaun Br. – NE of Kilbeheny	FUNSH1	R88965 16817
19S020400	Sullane	Linnamilla Br.	SULLA1	W31293 72793
21B030100	Blackwater (Kerry)	Gearha Br.	BLKWA1	V78267 72138
21G030100	Glengarriff	Bridge W of Skehil	GGARF1	V89708 58327
22C020600	Caragh	Blackstones Br.	CARAG1	V70947 86350
22F020100	Flesk (Kerry)	Bridge nr Glenflesk – Curreal Br.	FLESK1	W06619 85385
22F040100	Finow	Bridge 0.3 km u/s L. Guitane – Finow Br.	FINOW1	W01152 85692
22O030400	Owenreagh	Bridge u/s Upper Lake (Lord Brandon's cottage)	OREAG1	V88412 82085
23O030300	Owenmore (Kerry)	Bridge at Boherboy	OMORE1	Q51307 10690
25B030080	Bilboa	Bridge u/s Blackboy Br. – Bilboa Br.	BILBO1	R81537 51863
25B100100	Bow	Bow River Br.	BOW1	R66568 87096
25D070400	Duniry	Just u/s Cappagh River confl, SW of Duniry	DUNIR1	M72142 09014
25G040025	Graney (Shannon)	Caher Br., S of L. Graney	GRANE1	R55410 90143
25G210010	Camcor	Bridge 3 km E of Longford	CAMCO1	N20100 01428
25N020060	Newport (Tipperary)	Bridge nr Glanculloo Old School	NPORT1	R83753 68327
27B020300	Broadford	Just u/s South Branch confl – Scott's Br.	BROAD1	R61044 72104
27G020600	Gourna	Bridge u/s Owenogarney River confl	GOURN1	R48104 64137
27S030200	Spancelhill	Bridge NW, near Spancelhill	SHILL1	R38640 80848
28C010200	Caher (Clare)	Bridge 2 km d/s Formoyle	CAHRE1	M16322 08228
28G020200	Glendine (Clare)	Knockloskeraun Br., S of Milltown Malbay	GDINE1	R05316 77429
29B040300	Boleyneendorrish	Bridge N of Doonally West – Kenny's Br.	BOLND1	M51419 05626
29O010700	Owendalulleagh	Ford at Inchamore, N of L. Graney	OWDAL1	R56160 99594
30A020110	Aille (Mayo)	Bridge NW of Claureen – E of Killavally	AILLE1	M12252 80132
32O030200	Owenglin	Bridge SW of Clifden Lodge	OGLIN1	L67737 50422
33K010200	Keerglen	Bridge NE of Doondragon	KEERG1	G09386 33317
34B080300	Behy (North Mayo)	Bridge SW of Oatlands House	BEHYM1	G32513 17108
34C050030	Clydagh (Castlebar)	Bridge u/s confl of East Branch	CLYDA1	M14276 96564
34M020100	Moy	Bridge SE of Cloonacool	MOY1	G49380 16842
34M020750	Moy	At Bleanmore	MOY2	G26177 00854
34O030050	Owengarve (Sligo)	Ford NW of Srah Upper	OWGAR1	G55121 03986
35B060010	Bonet	Bridge u/s Glenade Lough	BONET1	G82228 47138
35D060100	Dunneill	Bridge 2 km u/s Dromore West	DUNNE2	G43769 32718
35D060200	Dunneill	Donaghintraine Br.	DUNNE1	G43852 34411
35G030100	Gowlan (Sligo)	Ford u/s Easky River confl	GOWLA1	G38816 26532
35O010070	Owenbeg (Coolaney)	700 m u/s Ford SW Shancough (Bridge)	OWBEG1	G56983 23193
36S010100	Swanlinbar	Commas Br. (Br. nr Altbrean/Tullydermot)	SWANL1	H14890 24876
37E020150	Eanymore Water	Bridge SW of Letterbarra	EANYM2	G88298 82357
37E020250	Eanymore Water	Eanymore Br.	EANYM1	G84570 81582
37E030300	Eany Water	Just d/s Eany Beg/More confl	EANYW1	C84054 81396
38C060100	Cronaniv Burn	Bridge u/s Dunlewy Lough	CBURN1	B92899 18963
38G020100	Gweebarra	Pollglass Br.	GWBAR1	B94839 13968
40B010200	Ballyhallan	Bridge u/s Clonmany River	BHALL1	C36887 46019

2 Sampling Procedures

2.1 Macroinvertebrates

2.1.1 Sampling method

Macroinvertebrate samples were taken at each of the 50 sites in autumn (9 October 2002 to 29 November 2002), spring (10 February 2003 to 19 March 2003) and summer (3 June 2003 to 3 July 2003). Due to flooding in the autumn of 2002, additional samples were taken in the following autumn (7 and 8 October 2003).

Macroinvertebrates were collected using a 3-min, multi-habitat kick-sampling technique (Wright, 1995). This involved surveying a 50-m reach for different habitat types – riffle, glide, pool, backwater, vegetated area and margin. The time allotted to sampling each habitat type depended upon the percentage representation of each in the 50-m reach. Habitats contributing less than 5% of the stable habitat in the reach were generally not sampled (Barbour *et al.*, 1997). Three replicate samples were collected, labelled and preserved in 70% alcohol. Hand searches were also undertaken to provide intact specimens for species confirmation.

2.1.2 Laboratory procedures

In the laboratory, samples were sieved through an 850- μ m sieve and transferred to a white tray. All macroinvertebrates were removed and stored in labelled glass tubes containing 70% alcohol. The macroinvertebrates were counted and identified to the lowest possible taxon using standard Freshwater Biological Association (FBA) identification keys. Species/genus-level identification was achieved for all groups with the exception of some dipteran larvae and immature Oligochaeta.

2.2 Phytobenthos

Benthic diatoms were sampled and analysed following draft CEN methodologies (EN 13946, 2002; prEN 14407, 2003). Macroalgal sampling also followed draft CEN guidelines (CEN/TC230/WG2/TG3, 2003). All three draft guidelines have since been updated (but not yet accepted) (EN 13946, 2003; CEN/TC230/WG2/TG3, 2004; EN 14407, 2004).

2.2.1 Sampling method

Diatoms

Diatoms were sampled from cobbles which were free from sediments and filamentous algal growths. Benthic diatoms were removed from approximately five cobbles at each site by brushing with a toothbrush and washing with distilled water into a plastic tray. Up to ten cobbles were sampled on some occasions when the sample appeared to be too dilute. The bulk sample from each site was stored in a plastic tube. Each sample was oxidised in the laboratory with concentrated sulphuric acid, oxalic acid and potassium permanganate. The resulting diatom solutions were mounted onto glass microscope slides using Naphrax® (RI = 1.7, Northern Biological Supplies, UK).

The guidance standard on the identification, enumeration and pre-treatment of benthic diatoms (prEN 14407, 2003) recommends that 300–500 diatom units (valves in this case) are enumerated for diatom surveys. It was decided after preliminary examination of the diatom component to enumerate 500 diatom valves due to the dominance of one particular taxon. This ensured that the chance of encountering rarer species would be increased. One permanent diatom slide was prepared for each river site sampled in each season. Identifications of prepared diatoms were made primarily with the monographs of Krammer and Lange-Bertalot (1986, 1988, 1991a,b).

Counting also followed the draft CEN standard (prEN 14407, 2003):

1. Random fields of view were chosen using the vernier scales on the microscope and counted in traverses. Diatoms valves that were more than half in view at the edges of a field of view were counted, while those with less than half the valve in view were not counted. Broken valves were included if approximately three-quarters of the valve were present.
2. Treatment of unidentifiable diatoms: a diatom may be difficult to identify for a number of reasons, including orientation in girdle view, and the presence of obscuring material and overlapping valves. If many valves were obscured, more dilute

suspensions were prepared, or the sample was re-oxidised. Unidentified girdle views were recorded at the lowest taxonomic level to which they could be assigned with confidence (e.g. '*Achnanthes* sp. 1' or 'unidentified, pennate girdle view').

3. Photographs of identified and unidentified species were also taken and recorded for future reference. Characteristics such as shape and dimensions of the diatom, striae density and arrangement (at centre and poles), shape and size of central area, number and position of punctae and arrangement of raphe endings were recorded. Taxonomic verification was sought for a number of diatom slides (see Acknowledgements).

Macroalgae

All visible algae in a 20-m stretch at each site were collected and preserved in Lugol's iodine in plastic tubes. Algae from both depositing and eroding habitats were included. The recent draft standard recommends that samples be collected from the permanently submerged zone in the main flow of the river and that the flood zone should be avoided. A visual estimate of the percentage abundance of visible macroalgae was made in the field using a six-point scale (Table 2.1) and detailed notes on the appearance, colour and abundance of the visible macroalgae were made at each site. The composition of the macroalgal assemblage, primarily to genus level, was determined by microscopic examination of preserved samples in the laboratory using manuals by John *et al.* (2002), Whitton *et al.* (2002, 2003) and Wehr and Sheath (2003). In the laboratory, a semi-quantitative estimate of the abundance of phytobenthos (minus the diatoms) was also carried out based on the six-point scale. Filamentous algae are well known as being difficult to identify to species level. As a result, operational taxa were employed in this study, identifying taxa to genus level and also defining filament width. A similar approach has been adopted in other studies (Kinross *et al.*, 1993).

Table 2.1. Abundance scale estimates for macroalgae (CEN, 2003b).

Scale	Abundance	% Cover in the field
1	Occasional	<1%
2	Rare	1–5%
3	Common	5.01–10%
4	Abundant	10.01–25%
5	Very abundant	25.01–50%
6	Dominating	>50%

2.3 Macrophytes

2.3.1 Sampling method

Macrophyte surveying followed the draft CEN standard (CEN, 2002), which has now been accepted (CEN, 2003a). The survey included all aquatic vascular plants, bryophytes, Characeae and macroalgae. They were surveyed at all locations at or below the normal water level. Also, bank species which are strongly influenced by the river channel were separately recorded. Cover was recorded as categories in accordance with CEN guidelines (Table 2.2).

Table 2.2. Macrophyte cover categories (CEN, 2003a).

Value	Visual cover estimate (% of channel or bank)
0	0
1	<0.1
2	0.1–1
3	1–5
4	5–10
5	>10

The sites were assessed by surveying two 50-m lengths along representative sections of the channel. One stretch, where possible, coincided with the invertebrate sampling location and one was nearby, but at a section which appeared to have a different character. Often these two stretches covered each of a pool/riffle or an open/shaded reach. Sites where physical impact was evident were avoided and sections with a more natural character located up or downstream were selected (although the distance between the stretches was short enough to ensure that they were of similar altitude, had similar chemistry and did not have interceding tributaries).

All sites permitted wading, although this was restricted to shallow areas near the bank for a few deep-water sites. The sampling season was from June to August (inclusive) although there was a minor overrun into September. River flows tended to decrease throughout this period. Reduced visibility due to heavy rainfall and subsequent high flows was not a problem during this survey period. Low flows permitted high visibility, especially of mosses in large rivers, where they are usually less obvious.

A species survey sheet, organised by habitat type, was used to record species although additional aquatic macrophytes were recorded. Vouchers were retained for laboratory identification on the rare occasions where field

identification was not possible, particularly with *Ranunculus* spp. Taxonomic confirmations were sought for certain species (see Acknowledgements).

Macrophyte data for channel and bank species were combined for subsequent analyses. Bank species cover was estimated as a percentage of the bank to be regularly (more than annually) flooded and it was believed that certain bank species could aid with the identification of hydromorphological impacts if their low reliability is down-weighted, e.g. in methods such as CBAS (Dodkins *et al.*, 2005). Bank species were also considered to be an important aspect of the riverine ecology.

2.4 Hydrochemistry

2.4.1 Sampling method

In order to validate the chemical and pollution status of each site it was decided that at least two sets of chemical analyses would be completed per site. Physico-chemical measurements such as water temperature, dissolved oxygen, % oxygen saturation, pH and conductivity were recorded in the field using automatic probes.

Water was collected in 1-litre polyethylene bottles, which were pre-rinsed with water from the site prior to sample collection. Two separate snap-cap vials were filled with water for anion and cation analyses. In the laboratory,

analyses for alkalinity, total hardness, cations: sodium (Na^+), magnesium (Mg^{2+}), calcium (Ca^{2+}) and potassium (K^+), anions: sulphate (SO_4^{2-}), chloride (Cl^-) and nitrate (NO_3^-) and nutrients: orthophosphate, ammonia, nitrite and nitrate were carried out using the methodologies listed in Table 2.3.

2.5 Hydromorphology

2.5.1 Sampling method

Hydromorphological survey methods were not developed in time so instead simple hydromorphological observations were recorded in the field. All variables were estimated by eye and therefore accuracy may be low. The hydromorphological survey locations coincided with the macrophyte monitoring locations, and therefore were also conducted along two representative 50-m stretches at each site. Physically impacted stretches were avoided. The data collected in the field included shade (four categories), connection with bank (bank slope; five categories), estimated stream power (nine categories) and mean substrate diameter (phi scale). Additional hydromorphological and geographical data were derived from Geographical Information Systems and provided by the EPA and Compass Informatics. These included slope, distance from source, altitude, catchment area, stream order and valley slope.

Table 2.3. Standard methods used for chemical analysis.

Parameter	Units	Method
Temperature	°C	Thermistor
Conductivity	µS/cm	Electrometric
Dissolved oxygen	mg/l O_2	Electrometric
Oxygen saturation	% Sat.	Electrometric
pH	pH	Electrometric
Alkalinity	mg CaCO_3 /l	Acid Titration Method
Total hardness	mg CaCO_3 /l	Calculation
Total ammonia	mg N/l	Colorimetry (Phenol-Hypochlorite Method)
Nitrate	mg N/l	Dionex (Filtered)
Nitrite	mg N/l	Colorimetry (Sulphanilamide–N-1-Naphthylethylenediamine Dihydrochloride Method)
Orthophosphate	mg P/l	Colorimetry (Ascorbic Acid Method)
Chlorinity	mg Cl^- /l	Dionex
Sulphate	mg SO_4^{2-} /l	Dionex
Calcium	mg Ca^{2+} /l	Dionex
Magnesium	mg Mg^{2+} /l	Dionex
Sodium	mg Na^{2+} /l	Dionex
Potassium	mg K^+ /l	Dionex

Note: all samples for Dionex analyses were filtered.

3 Verification of Ecological Status

3.1 Macroinvertebrates

Q-values were assigned to all sites for each season (Tables 3.1, 3.2 and 3.3). The majority of sites scored a Q5 value indicating that these sites were of good or excellent quality. Seasonal differences were obvious at some sites.

In autumn, the number of Class A scoring taxa (genus level) ranged from three (AILLE1, CARAG1) to 11 (GGARF1). Only one Class A taxon was observed at OGLIN1 in autumn 2003, whereas four taxa were observed at this site in the previous autumn but in low numbers (eight). Sites BLKWA1 and OWDAL1 both had ten Class A taxa. The percentage abundance of Class A taxa varied between the sites, ranging from 0.11% (OGLIN1) to >60% abundance at sites such as CAMCO1, FUNSH1 and DODDE1. Class A abundance at 18 of the 50 sites was less than 20% of the total fauna, while ten of those sites had less than 10% Class A representatives.

As expected, the number of Class A taxa increased in spring at most sites, due mainly to the Ephemeroptera. The number of taxa ranged from five (AILLE1) to 12 (MOY1). Forty-three of the sites had at least six Class A taxa. Five sites, including FLESK1, GOWLA1, KEERG1, OWGAR1 and MOY1, had at least ten Class A scoring taxa. The percentage abundance of Class A taxa ranged from 0.80% (AILLE1) to >50% (FUNSH1 and DODDE1). Thirteen of the sites had less than 10% total Class A taxa representation.

In the summer, the total Class A taxa recorded ranged from two (EANYM1, EANYW1) to ten (DODDE1). Only one Class A taxon was again observed at OGLIN1. Furthermore, a lower percentage abundance of Class A taxa was recorded, ranging from 0.17% (AILLE1) to 38% (BROAD1). Thirty-three of the 50 sites had less than 10% Class A abundance, while 20 of these sites had less than 5% representation of Class A taxa.

In summary, the majority of sites scored a Q5 value indicating that these sites were of good quality. Several sites deviated slightly from the expected Q5 status during some sampling seasons. Site AILLE1 always exhibited a low percentage abundance of Class A taxa, although at

least three taxa were observed in each season (five in spring) resulting in a Q4–5 score. Five sites (CARAG1, EANYM1, EANYW1, FINOW1 and OREAG1) were given a Q4–5 in the summer season due to low percentage abundances of Class A taxa and/or in some sites where less than three Class A taxa occurred. The status of the biological community at the OGLIN1 site remains questionable. Here, the Q-values ranged from Q4–5 (autumn 2002) to Q5 in spring 2003, falling to Q4 in the summer and to the lowest value (Q3–4) in autumn 2003. The difficulty associated with taking kick-samples at this site may have contributed in part to the low scores. However, additional information obtained from discussions with Martin McGarrigle, EPA, and Fiona Kelly, Central Fisheries Board, lead to the conclusion that this site may be deviating from reference condition.

3.2 Phytobenthos

To assess ecological status the Trophic Diatom Index (TDI) (Kelly and Whitton, 1995; Kelly *et al.*, 2001) was used. There are three drawbacks to this method: (i) it utilises only the diatom component of the phytobenthos, (ii) it was designed for the purposes of the Urban Waste Water Treatment Directive and may not be valid in less nutrient-rich rivers, and (iii) it was developed in the UK and may not be applicable to Ireland. However, as there are no complete phytobenthos methods available in Europe and there is no equivalent to the TDI in Ireland, this was the best available method for indicating departure from reference status.

The DARES project (Diatom Assessment of River Ecological Status – Environment Agency (England and Wales), the Scottish Environmental Protection Agency, Bowburn Consultancy, the Natural History Museum, and the Universities of Bristol, Newcastle and Ulster) is evaluating past diatom collections on the basis of the TDI and has so far agreed that good status sites have a TDI score between 0 and 50 and impacted sites have a TDI score between 50 and 100 (Dr Martyn Kelly, Bowburn Consultancy, personal communication).

The TDI was applied to the combined spring and summer diatom data set. Results are presented in Table 3.4. Five sites had low diatom species richness and density,

Table 3.1. Autumn EPA Q-value ratings at the potential reference sites (Q-value scores less than Q5 are highlighted in bold).

Site	% of scoring taxa in each class (zero decimal places)					Number of Class A:		Q-value
	A	B	C	D	E	Species	Genera	
AILLE1	0	2	93	1	0	3	3	Q4–5
BEHYM1	22	2	73	0	0	7	7	Q5
BHALL1	12	14	71	0	0	4	4	Q5
BILBO1	25	4	69	0	0	9	8	Q5
BLKWA1	19	9	49	1	1	10	10	Q5
BOLND1	26	8	64	1	0	8	8	Q5
BONET1	37	6	55	0	0	8	8	Q5
BOW1	38	6	56	0	0	8	7	Q5
BROAD1	45	7	44	1	0	8	8	Q5
CAHER1	7	12	63	0	0	5	5	Q5
CAMCO1	65	11	21	0	0	8	8	Q5
CARAG1	5	14	77	1	0	3	3	Q5
CARAG1A2*	9	12	75	3	0	4	4	Q5
CBURN1	25	26	37	0	0	9	7	Q5
CLYDA1	30	12	54	0	0	7	7	Q5
DODDE1	68	9	20	0	0	7	7	Q5
DUNIR1	11	18	65	1	1	10	9	Q5
DUNNE1	3	2	95	0	0	6	6	Q5
DUNNE2	5	3	89	0	0	8	8	Q5
EANYM1	12	7	72	1	0	8	7	Q5
EANYM2	4	7	83	0	0	8	7	Q5
EANYW1	8	10	66	1	10	7	6	Q5
FINOW1	9	19	58	2	0	7	7	Q5
FLESK1	7	9	79	1	0	10	9	Q5
FUNSH1	67	6	24	0	0	9	8	Q5
GCREE1	46	16	34	0	0	7	7	Q5
GDINE1	16	7	75	1	1	6	5	Q5
GGARF1	28	17	50	0	0	12	11	Q5
GNEAL1	28	29	41	0	0	8	7	Q5
GOURN1	6	6	83	0	0	7	7	Q5
GOWLA1	11	4	80	0	0	9	8	Q5
GRANE1	38	6	51	1	2	8	7	Q5
GWBAR1	26	25	42	0	0	7	7	Q5
KEERG1	18	4	75	0	0	6	6	Q5
LIFFY1	35	4	54	0	0	8	7	Q5
LSLAN1	53	9	36	0	0	7	7	Q5
LSLAN2	32	14	48	0	0	6	6	Q5
MOY1	19	6	71	0	1	8	8	Q5
MOY2	6	4	88	1	0	7	7	Q5
NPORT1	30	10	54	2	0	9	8	Q5
OGLIN1	1	17	72	1	0	4	4	Q4–5
OGLIN1A2*	0	5	81	1	1	1	1	Q3–4
OMORE1	4	6	85	3	0	8	8	Q5
OREAG1	5	15	68	2	0	8	7	Q5
OWBEG1	27	4	65	0	0	9	9	Q5
OWDAL1	12	16	69	0	0	10	10	Q5
OWGAR1	7	5	85	1	0	9	8	Q5
SHILL1	10	5	81	2	0	5	5	Q5
SLANY1	7	6	69	1	0	6	6	Q5
SULLA1	19	7	70	1	0	9	9	Q5
SWANL1	44	6	46	0	0	8	7	Q5

*Indicates the scores for the additional autumn sample at this site.

Table 3.2. Spring EPA Q-value ratings at the potential reference sites (Q-value scores less than Q5 are highlighted in bold).

Site	% of scoring taxa in each class (zero decimal places)					Number of Class A:		Q-value
	A	B	C	D	E	Species	Genera	
AILLE1	1	6	90	0	0	5	5	Q4-5
BEHYM1	12	9	77	0	1	10	10	Q5
BHALL1	12	18	65	1	0	8	8	Q5
BILBO1	20	7	71	0	1	8	8	Q5
BLKWA1	5	10	72	1	1	8	8	Q5
BOLND1	40	4	52	1	0	11	10	Q5
BONET1	42	7	50	0	0	10	10	Q5
BOW1	47	5	47	1	0	9	9	Q5
BROAD1	27	12	54	3	3	9	9	Q5
CAHER1	19	15	53	0	0	6	6	Q5
CAMCO1	47	11	41	0	0	10	10	Q5
CARAG1	6	21	66	0	0	7	7	Q5
CBURN1	23	26	45	0	0	10	9	Q5
CLYDA1	21	10	67	0	0	8	8	Q5
DODDE1	63	13	22	0	0	10	10	Q5
DUNIR1	25	16	55	2	1	8	8	Q5
DUNNE1	10	4	84	0	0	7	7	Q5
DUNNE2	4	4	91	0	0	10	10	Q5
EANYM1	15	15	56	1	1	10	10	Q5
EANYM2	9	7	76	2	2	10	10	Q5
EANYW1	10	14	71	1	1	8	8	Q5
FINOW1	10	26	41	5	0	8	8	Q5
FLESK1	4	10	78	1	2	11	11	Q5
FUNSH1	57	6	36	0	0	10	10	Q5
GCREE1	44	8	46	0	0	8	8	Q5
GDINE1	32	5	58	0	0	10	10	Q5
GGARF1	22	10	57	5	6	6	6	Q5
GNEAL1	21	24	54	0	0	10	10	Q5
GOURN1	16	4	76	1	1	6	6	Q5
GOWLA1	8	8	80	0	2	11	11	Q5
GRANE1	35	10	54	0	0	9	9	Q5
GWBAR1	21	11	60	0	0	8	8	Q5
KEERG1	17	6	76	0	0	11	11	Q5
LIFFY1	27	5	66	0	0	9	9	Q5
LSLAN1	38	8	50	0	0	10	10	Q5
LSLAN2	38	12	48	0	0	7	7	Q5
MOY1	23	10	62	0	3	12	12	Q5
MOY2	2	4	88	4	0	8	8	Q5
NPORT1	21	8	67	1	1	8	8	Q5
OGLIN1	2	7	85	0	1	8	8	Q5
OMORE1	2	7	84	1	0	7	7	Q5
OREAG1	5	7	70	2	2	9	9	Q5
OWBEG1	35	6	56	0	2	10	9	Q5
OWDAL1	13	6	78	0	1	10	10	Q5
OWGAR1	14	3	79	0	1	11	11	Q5
SHILL1	12	7	78	3	0	6	6	Q5
SLANY1	7	1	64	0	5	7	7	Q5
SULLA1	15	11	60	1	1	10	10	Q5
SWANL1	40	7	51	0	0	10	10	Q5

Table 3.3. Summer EPA Q-value ratings at the potential reference sites (Q-value scores less than Q5 are highlighted in bold).

Site	% of scoring taxa in each class (zero decimal places)					Number of Class A:		Q-value
	A	B	C	D	E	Species	Genera	
AILLE1	0	1	97	0	0	5	4	Q4–5
BEHYM1	6	8	79	0	0	7	6	Q5
BHALL1	3	22	74	0	0	4	3	Q5
BILBO1	9	2	85	0	0	5	4	Q5
BLKWA1	5	3	88	0	0	4	4	Q5
BOLND1	12	3	83	1	0	6	5	Q5
BONET1	23	20	56	0	0	8	8	Q5
BOW1	17	2	78	1	0	6	5	Q5
BROAD1	38	1	57	1	0	6	6	Q5
CAHER1	3	22	62	0	0	4	4	Q5
CAMCO1	12	6	74	0	0	9	7	Q5
CARAG1	1	3	95	1	0	3	3	Q4–5
CBURN1	9	12	67	0	0	6	6	Q5
CLYDA1	17	13	66	0	0	7	7	Q5
DODDE1	14	14	71	0	0	10	10	Q5
DUNIR1	10	13	73	0	0	5	4	Q5
DUNNE1	7	3	87	0	0	5	4	Q5
DUNNE2	6	7	82	0	0	4	3	Q5
EANYM1	5	11	82	0	0	3	2	Q4–5
EANYM2	4	5	89	0	0	6	5	Q5
EANYW1	1	8	89	0	0	2	2	Q4–5
FINOW1	1	8	83	0	0	3	3	Q4–5
FLESK1	1	8	90	0	0	7	5	Q5
FUNSH1	24	3	69	0	0	8	8	Q5
GCREE1	6	5	86	0	0	7	7	Q5
GDINE1	11	11	76	0	0	8	8	Q5
GGARF1	11	4	83	2	0	3	3	Q5
GNEAL1	9	13	73	0	0	8	8	Q5
GOURN1	6	5	86	0	0	7	6	Q5
GOWLA1	5	4	88	0	0	6	4	Q5
GRANE1	12	4	82	1	0	7	7	Q5
GWBAR1	5	19	68	0	0	5	5	Q5
KEERG1	12	7	79	0	0	7	5	Q5
LIFFY1	9	9	73	2	0	8	7	Q5
LSLAN1	10	4	76	0	0	9	8	Q5
LSLAN2	3	5	88	0	0	7	6	Q5
MOY1	3	2	94	0	0	6	6	Q5
MOY2	3	7	87	0	0	6	5	Q5
NPORT1	6	4	88	1	0	7	6	Q5
OGLIN1	8	1	89	0	0	1	1	Q4
OMORE1	2	2	93	0	0	6	5	Q5
OREAG1	1	6	89	1	1	5	5	Q4–5
OWBEG1	4	3	91	0	0	6	5	Q5
OWDAL1	15	6	77	0	0	6	6	Q5
OWGAR1	8	6	82	0	0	5	4	Q5
SHILL1	4	7	86	1	0	7	6	Q5
SLANY1	2	2	93	0	0	5	4	Q5
SULLA1	13	4	82	0	0	7	7	Q5
SWANL1	19	6	74	0	0	6	6	Q5

Table 3.4. Results for the Trophic Diatom Index.

River	TDI	Comments
AILLE1	50	
BHALL1	28	
BEHYM1	30	
<u>BILBO1</u>	53	<i>Achnanthes minutissimum</i> 51%. <i>Gomphonema minutum</i> and <i>Gomphonema olivaceum</i> reached 7.8% and 8.5% in spring and summer, respectively
BLKWA1	31	
<u>BOLND1</u>	56	<i>A. minutissimum</i> 47%. <i>Navicula lanceolata</i> 16%. <i>Gomphonema parvulum</i> 5%
BONET1	37	
<u>BOW1</u>	63	<i>A. minutissimum</i> 40%. <i>N. lanceolata</i> 29%
BROAD1	*	
CAHRE1	*	
CAMCO1	36	
CARAG1	32	
<u>CLYDA1</u>	52	<i>A. minutissimum</i> 48%. <i>Reimeria sinuata</i> 30%
CBURN1	33	
DODDE1	28	
<u>DUNIR1</u>	40	High abundance of <i>C. glomerata</i> in spring and summer
<u>DUNNE1</u>	70	<i>A. minutissimum</i> 16%. <i>G. olivaceum</i> 25% (1 season only)
DUNNE2	43	
EANYW1	33	
EANYM1	30	
EANYM2	34	
FINOW1	26	
FLESK1	29	
FUNSH1	37	
<u>GCREE1</u>	76	<i>G. olivaceum</i> 29% (1 season only)
GDINE1	*	
GNEAL1	21	
GGARF1	27	
<u>GOURN1</u>	72**	<i>Navicula gregaria</i> 16%. <i>A. minutissimum</i> 10% (1 season only)
GOWLA1	28	
<u>GRANE1</u>	71	<i>G. olivaceum</i> 20%. <i>A. minutissimum</i> 13% (1 season only)
GWBAR1	28	
KEERG1	32	
LIFFY1	43	
LSLAN1	29	
LSLAN2	42	
MOY1	33	
MOY2	49	
NPORT1	46	
OWBEG1	29	
OWDAL1	44	
OWGAR1	42	
OGLIN1	25	
OMORE1	33	
OREAG1	27	
<u>SLANY1</u>	67	<i>A. minutissimum</i> 9%. <i>N. lanceolata</i> 14% (1 season only)
SHILL1	*	High abundance of <i>Hildenbrandia rivularis</i>
SULLA1	47	
SWANL1	*	
URRN1	44	

*Indicates river samples with low diatom density such that quantitative counts could not be made and TDI could not be calculated. Underlined sites indicate rivers with questionable high quality status.

precluding the calculation of a TDI value. Rivers with TDI scores of 50 or less were presumed to be of 'good' quality. Rivers with TDI scores greater than 50, and therefore of questionable quality, were BILBO1, BOLND1, BOW1, CLYDA1, DUNNE1, GCREE1, GOURN1, GRANE1 and SLANY1. Sites underlined had TDI scores only slightly above 50, and therefore were considered acceptable. BOW1 scored above 50 in spring but not in summer. For all the other sites, the TDI could not be calculated in summer due to the low density of diatom valves, making a quantitative count impossible. It may be possible that these rivers would score within the acceptable limits in future surveys. All sites were included in the data analysis and the determination of typology, but it is recommended that the status of the sites listed above be reviewed as part of future monitoring.

Little work has been carried out on the use of macroalgae for water quality monitoring. An exception is *Cladophora*, which is tolerant of high nutrient concentrations, and thus an increase in abundance has often been considered to signal eutrophication (Whitton, 1970; Bolas and Lund, 1974), although, at lower population densities, it is a natural component of many water systems (Whitton, 1970). *Cladophora glomerata* was abundant at DUNNE1 during the summer, and attained a high abundance at DUNIR1 in both spring and summer, indicating that both of these sites may be of questionable quality. DUNNE1 also scored above 50 in the TDI. The status of both these sites should be further reviewed.

Filamentous algae including *Spirogyra* spp., *Mougeotia* spp., *Oedogonium* spp. and *Zygnema* spp. did reach high abundance at some of these sites, but there is little evidence of their relationship with water quality. They are

commonly found at the littoral edges of rivers and are favoured by the lower flows and higher water temperatures that prevail during the summer.

The diatom *Didymosphenia geminata*, which forms visible brownish mats, was found in a number of rivers in Donegal, Mayo and Sligo, particularly during summer sampling, but rarely reached over 5% abundance. Although this species thrives in clear, warm, shallow and nutrient-poor water, an increase in its abundance may reduce rearing habitats for salmonids due to changes in invertebrate communities, physical impacts such as gill irritations and clogging, and displacement of fish species (Ministry of Water, Land and Air, British Columbia, 2004).

3.3 Macrophytes

Within Ecoregion 17 (specifically N. Ireland), the Mean Trophic Rank (MTR) (Holmes *et al.*, 1999) has been shown to have only a weak relationship with phosphate: $r^2 = 0.239$ with a significance of $P = 0.1$ (Dawson *et al.*, 1999). Also, macrophytes are strongly affected by the physical environment (Haurly, 1996; Wilby *et al.*, 1998), which is why the MTR is not recommended when comparing sites that are physically dissimilar (Dawson *et al.*, 1999). In addition, MTR scores would naturally be lower for lowland rivers, and thus cannot be directly compared between different river types. Despite this, MTR values are presented in Table 3.5. The five sites identified in this table as likely to be affected by eutrophication (i.e. having an MTR score below 45) are all lowland sites, below an altitude of 55 m with slopes less than 0.016 m/m (mean slope for the 50 sites being 0.03 m/m). High silt cover in the channel can falsely suggest eutrophication within the MTR, which is likely to be the case with BROAD1 (100% silt) and SHILL1 (38% silt).

Table 3.5. MTR scores for the 50 sites. Sites in bold have an MTR score below 45 and “are likely to be affected by eutrophication” (Holmes *et al.*, 1999).

Site	MTR	Site	MTR	Site	MTR	Site	MTR	Site	MTR
AILLE1	56	CAMCO1	67	EANYW1	64	GRANE1	55	OMORE1	72
BEHYM1	42	CARAG1	74	FINOW1	75	GWBAR1	93	OREAG1	68
BHALL1	58	CBURN1	71	FLESK1	65	KEERG1	59	OWBEG1	78
BILBO1	51	CLYDA1	58	FUNSH1	68	LIFFY1	73	OWDAL1	57
BLKWA1	74	DODDE1	87	GCREE1	74	LSLAN1	77	OWGAR1	57
BOLND1	52	DUNIR1	68	GDINE1	55	LSLAN2	68	SHILL1	40
BONET1	65	DUNNE1	62	GGARF1	67	MOY1	66	SLANY1	73
BOW1	70	DUNNE2	53	GNEAL1	81	MOY2	44	SULLA1	59
BROAD1	30	EANYM1	71	GOURN1	57	NPORT1	53	SWANL1	83
CAHER1	62	EANYM2	57	GOWLA1	59	OGLIN1	44	URRN1	76

Sites MOY2, OGLIN1 and BEHYM1 recorded MTR scores only slightly below 45, and despite being lowland sites they may have minor nutrient impacts and should be considered for review in future studies.

Due to the shortcomings of evaluating the sites with MTR, a site-by-site ecological assessment was also undertaken. It was apparent that *Fuchsia* and *Crocsmia* (Montbretia) were invasive species along many river banks, including many of the reference sites, throughout Ireland. Finding spatial reference sites without these species would be difficult; however, the species were not considered to have had a large effect on the cover of naturally occurring species. These species together with the invasive aliens *Impatiens glandulifera* and *Reynoutria japonica* were removed from the survey data (Table 3.6).

Access to the river channel by cattle and sheep was also evident at many sites (from faeces and hoof prints), and, although attempts were made to avoid these areas, it was not always possible. These sites included GGARF1, GOWLA1, KEERG1, LIFFY1, MOY2 and OWBEG1. The growth of *Fontinalis antipyretica* at some sites may suggest that some local and mild eutrophication may be occurring (AILLE 1 and OWDAL1). Although some sites had species that may be indicative of eutrophication, this was not supported by the water chemistry data, suggesting that either low summer flows or a localised event resulted in their growth. Despite invasive species and local enrichment, it was considered that all of the chosen sites had only very minor anthropogenic alterations and should be retained within subsequent analyses.

Table 3.6. Impacts on reference sites indicated from the macrophytes; (a) and (b) are each of the two 50-m stretches surveyed at the sites.

Site	Invasive species*
BILBO1a	<0.1% <i>I. glandulifera</i>
BILBO1b	0.1–1% <i>I. glandulifera</i> ; 1–5% <i>R. japonica</i>
BOW1a	<0.1% <i>R. japonica</i>
BOW1b	<0.1% <i>R. japonica</i>
BROAD1b	0.1–1% <i>R. japonica</i>
DUNNE2a	<i>Fuchsia</i>
OGLIN1a	<i>Fuchsia</i> , <i>Crocsmia</i>
OGLIN1b	0.1–1% <i>I. glandulifera</i>
OMORE1b	<i>Crocsmia</i>

*Removed from survey data prior to data analysis.

3.3.1 Representativeness of sites

A total of 114 aquatic macrophyte species (not including invasive aliens) were found during this survey and are used in the analyses. To determine whether a sufficient range of species was detected, species from this survey were compared with species lists previously surveyed in Northern Ireland by the Environment and Heritage Service (EHS) and also by Dodkins (2003). Species missing from this survey and suggested reasons why they were missing are listed in Table 3.7.

The absence of several species suggests that the extreme ranges of habitat have not been represented. *Nardia compressa*, characteristic of very acidic areas, did not occur. *Rumex hydrolapathum* and *Potamogeton lucens*, which are both found in lowland calcareous rivers, were also not found. In addition, species that occur in rivers with associated wetlands were not found, i.e. *Menyanthes trifoliata* and *Veronica anagallis-aquatica*. The relatively low number of reference sites may have reduced the chance of finding less common species.

Agrostis stolonifera, *Barbarea vulgaris*, *Cardamine* spp., *Cirsium palustre*, *Epilobium hirsutum*, *Epilobium palustre*, *Galium palustre* and *Rhytidadelphus* were not considered sufficiently associated with waterbodies for this survey and were not recorded. Riparian trees (e.g. alder and willow) were also ignored during surveying.

3.4 Hydrochemistry

In order to determine whether these 50 sites represent reference conditions, the chemical status of each was assessed paying particular attention to the level of nutrients: ammonia, nitrite, nitrate and phosphate (McGarrigle et al., 2002).

3.4.1 Ammonia

Total ammonia levels were generally below 0.01 mg/l N for the majority of sites. Nine sites had higher ammonia values ranging from 0.0014 (CAMCO1) to 0.126 mg/l N (EANYW1) mostly occurring on single occasions (Table 3.8). The MOY2 site, however, recorded ammonia values ranging from 0.017 to 0.037 mg/l N on three of the four sampling occasions. However, all of the sites contained less than 0.025 mg/l N as unionised ammonia.

3.4.2 Nitrite and nitrate

Nitrite levels in unpolluted waters are normally low, below 0.01 mg/l N (Flanagan, 1992). Concentrations were below this value at the majority of the sites (Table 3.8) except for

Table 3.7. Species found in N. Ireland surveys but not found within the RIVTYPE survey, with suggested reasons for differences.

Species missing from survey	Suggested reason for omission
<i>Azolla filiformis</i>	Invasive alien and characteristic of eutrophic waters
<i>Barbarea vulgaris</i>	Not considered sufficiently associated with waterbodies for this survey
<i>Cicuta virosa</i>	
<i>Elodea nuttallii</i>	Characteristic of eutrophic waters
<i>Glyceria maxima</i>	Often on nutrient-rich substrates
<i>Heracleum mantagazzianum</i>	Invasive alien
<i>Hydrocharis morsus-ranae</i>	Tends to exist in ponds
<i>Lemna gibba</i>	Characteristic of eutrophic waters
<i>Lemna polyrhiza</i>	Base-rich lowlands, often eutrophic, not common in the Republic of Ireland
<i>Menyanthes trifoliata</i>	At fringes of slow rivers/lakes
<i>Nardia compressa</i>	Liverwort associated with very acidic conditions
<i>Orthotrichum rivulare</i>	Quite a rare upland moss
<i>Phragmites australis</i>	Associated with slow-flowing lowland areas which don't have a fluctuating water level. Unusual that it wasn't found
<i>Potamogeton gramineus</i>	Found in slow-flowing meso–eutrophic base-rich sites, though not ubiquitous
<i>Potamogeton lucens</i>	Calcareous slow-flowing locations
<i>Ranunculus aquatilis</i>	Still or slow-flowing marginal. Not common in Ireland
<i>Rumex hydrolapathum</i>	Calcareous, slow-flowing locations, though not common in Ireland
<i>Sagittaria sagittifolia</i>	Associated with eutrophic waters
<i>Schistidium alpicola</i>	Moss of basic rocks
<i>Sium latifolium</i>	Lowland, rare in Ireland
<i>Solanum dulcamara</i>	Marginal plant whose omission unlikely to be important
<i>Symphytum officinale</i>	Marginal plant whose omission unlikely to be important
<i>Veronica anagallis-aquatica</i>	Lowland plant of shallow margins

EANYW1 (0.0258 mg/l N) where the recommended limit of 0.015 mg/l N set in the Freshwater Fish Directive (78/659/EEC) for Salmonid Waters was exceeded on a single occasion. All readings were, however, below the newly proposed limit of 0.061 mg/l N (EPA, 1997). Nitrate is a plant growth promoter and therefore can contribute to eutrophication. Nitrate levels were low, ranging from 1.04 mg/l N (GGARF1) to a moderate 9.08 mg/l N (which was maximum concentration recorded at MOY2).

3.4.3 Phosphate

Phosphate concentrations generally remained below the 0.01 mg/l P detection level at the majority of sites on most occasions (Table 3.8). Twelve sites had phosphate values greater than the Q5 – 0.015 mg/l P limit (EPA, 1997). Seven of these sites (AILLE1, BOLND1, DODDE1, DUNNE1, GDINE1, GOURN1 and OWGAR1) had

phosphate values greater than 0.02 mg/l P on single occasions.

3.4.4 Chemical status of the 50 sites

The majority of sites exhibited a low nutrient content and therefore a high quality chemical status. Most of the higher nutrient readings occurred on single occasions in the summer or autumn 2003 sampling period. Three sites (GDINE1, OWGAR1 and MOY2) in particular may warrant further investigation. The phosphate value at GDINE1 ranged from 0.0409 mg/l P in the summer to 0.0281 mg/l P in the autumn. At the OWGAR1 site, the phosphate value was elevated at 0.0516 mg/l P in the summer while the ammonia value (0.0280 mg/l N) was also high in the autumn 2003 period. Finally, the MOY2 site had high ammonia (0.0333 mg/l N), nitrate (9.08 mg/l N) and phosphate (0.0165 mg/l P) values in the summer sampling period in comparison to the remaining sites. As

Table 3.8. Summary results of nutrients: ammonia, nitrite, nitrate and phosphate^a.

Site		Ammonia mg/l N	Nitrite mg/l N	Nitrate mg/l N	Phosphate mg/l P	Site		Ammonia mg/l N	Nitrite mg/l N	Nitrate mg/l N	Phosphate mg/l P
AILLE1	Mean	0.0031	0.0059	1.77	0.0193	DUNNE1	Mean				
	Min	0.0005	0.002	1.32	0.0055		Min	<0.01	<0.001	<5	<0.01
	Max	0.0083	0.0121	2.32	0.0453		Max	0.0052	0.0085		0.0287
BEHYM1	Mean			6.33		DUNNE2	Mean				
	Min	0.0144	0.0011	4.82	<0.01		Min	<0.01	0.0074	1.31	0.0132
	Max			7.85			Max				
BHALL1	Mean					EANYM1	Mean				
	Min	<0.01	<0.001	<5	<0.01		Min	<0.01	<0.001	<5	<0.01
	Max	0.0022	0.0017		0.0093		Max	0.0049	0.0041		0.0117
BILBO1	Mean			2.69		EANYM2	Mean				
	Min	<0.01	<0.001	2.51	<0.01		Min	<0.01	<0.001	<5	<0.01
	Max	0.0001	0.0006	2.87	0.0028		Max	0.0017	0.0034		0.0115
BLKWA1	Mean					EANYW1	Mean				
	Min	<0.01	<0.001	<5	<0.01		Min	<0.01	<0.001	<5	<0.01
	Max	0.0083	0.0008		0.001		Max	0.0054	0.0258		0.013
BOLND1	Mean	<0.01	0.0074		0.0313	FINOW1	Mean				
	Min	<0.01	0.0053	<5	0.0166		Min	<0.01	<0.001	<5	<0.01
	Max	<0.01	0.0095		0.0459		Max	0.0044	<0.001		<0.01
BONET1	Mean			1.92		FLESK1	Mean				
	Min	<0.01	<0.001	1.35	<0.01		Min	0.0001	<0.001	1.17	<0.01
	Max	0.002	0.0015	2.49	0.0062		Max	0.0093	<0.001		<0.01
BOW1	Mean					FUNSH1	Mean			2.1	
	Min	<0.01	<0.001	<5	<0.01		Min	<0.01	<0.001	1.91	<0.01
	Max	0.0022	0.0032		0.0141		Max	<0.01	<0.001	2.29	<0.01
BROAD1	Mean			3.83		GCREE1	Mean				
	Min	n/r	<0.001	3.42	<0.01		Min	<0.01	0.0018	1.68	0.0054
	Max	0.003	0.0011	4.24	0.0087		Max				
CAHER1	Mean					GDINE1	Mean	0.0036	0.0069	1.59	0.0345
	Min	<0.01	<0.001	<5	<0.01		Min	0.0008	<0.001	1.21	<0.01
	Max	0.0218	<0.001	2.05	<0.01		Max	0.0063	0.0082	1.97	0.0409
CAMCO1	Mean					GGARF1	Mean			1.54	
	Min	<0.01	<0.001	n/a	<0.01		Min	<0.01	<0.001	1.04	<0.01
	Max	0.0014	<0.001	1.64	<0.01		Max			2.04	
CARAG1	Mean					GNEAL1	Mean				
	Min	<0.01	<0.001	<5	<0.01		Min	<0.01	<0.001	1.78	<0.01
	Max	0.0012	0.0003		0.0047		Max	0.0206	0.0032		0.0072
CBURN1	Mean					GOURN1	Mean				
	Min	<0.01	<0.001	<5	<0.01		Min	<0.01	<0.001	1.53	<0.01
	Max	<0.01	0.0014		0.004		Max	0.0092	0.0043	<5	0.0244
CLYDA1	Mean					GOWLA1	Mean	0.1258	0.0052		0.014
	Min	0.0002	0.0101	<5	0.0188		Min	<0.01	<0.001	1.7	<0.01
	Max						Max	0.1258	0.0068	<5	0.0197
DODDE1	Mean					GRANE1	Mean				
	Min	<0.01	0.0028	<5	0.026		Min	0.0015	0.0032	1.52	0.0084
	Max						Max			<5	
DUNIR1	Mean			1.48		GWBAR1	Mean				
	Min	<0.01	<0.001	1.38	<0.01		Min	<0.01	<0.001	2.81	<0.01
	Max	0.0018	0.0031	1.59	0.0036		Max	<0.01	0.002		0.0051

Table 3.8. *Contd*

Site		Ammonia mg/l N	Nitrite mg/l N	Nitrate mg/l N	Phosphate mg/l P	Site		Ammonia mg/l N	Nitrite mg/l N	Nitrate mg/l N	Phosphate mg/l P
KEERG1	Mean					OREAG1	Mean				
	Min	<0.01	<0.001	<5	<0.01		Min	<0.01	<0.001	<5	<0.01
	Max	<0.01	0.0068		0.009						
LIFFY1	Mean					OWBEG1	Mean				
	Min	<0.01	0.0027	2.52	0.0085		Min	<0.01	<0.001	<5	<0.01
	Max			<5			Max	<0.01	0.0022		<0.01
LSLAN1	Mean					OWDAL1	Mean				
	Min	<0.01	0.001	1.29	0.0028		Min	<0.01	0.0078	<5	0.0165
LSLAN2	Mean					OWGAR1	Mean	0.0121	0.0071		0.0297
	Min	<0.01	0.0044	2.26	0.0175		Min	0.0003	<0.001	2.86	0.0077
MOY1	Mean					SHILL1	Mean	0.0156		4.75	
	Min	<0.01	<0.001	2.18	<0.01		Min	0.005	<0.001	2.39	<0.01
MOY2	Mean	0.0188	0.0058	5.08	0.0125	SLANY1	Mean			3.42	
	Min	0.007	0.0038	1.89	0.006		Min	<0.01	<0.001	2.13	<0.01
NPORT1	Mean			1.5		SULLA1	Mean			4.79	
	Min	<0.01	<0.001	1.3	<0.01		Min	0.0003	0.0018	4.57	0.0054
OGLIN1	Mean					SWANL1	Mean				
	Min	<0.01	0.0015	<5	0.0022		Min	<0.01	<0.001	2.62	<0.01
OMORE1	Mean					URRN1	Mean			2.88	
	Min	<0.01	<0.001	<5	<0.01		Min	<0.01	<0.001	2.11	0.0074

^aWhere only a minimum value is reported, only one sample was available for that particular analysis; otherwise two or three samples were analysed to produce the mean value.

most of the sites exhibiting the higher nutrient values did so only on single occasions and our sampling protocol only allowed two to four sampling periods, it was decided that no sites should be omitted from the analysis unless impact was also indicated by the biological status. From these sites only MOY2 may have a biological impact (for macrophytes) (see [Section 3.6](#)).

3.4.5 Representativeness of the sites

Various other chemical parameters were measured to characterise the sites. The frequency distribution of key measurements across the 50 sites is illustrated in [Fig. 3.1](#).

Temperature and pH

The temperature readings were typical of the sampling season ranging from 3.0°C (OWGAR1) in the spring to 17.9°C (OREAG1) in the summer. The pH values ranged from 4.80 (URRN1) to 8.78 (CAHRE1), both recorded in

autumn 2002. The majority of the sites studied had pH values >7 ([Fig. 3.1](#)).

Dissolved oxygen

The dissolved oxygen concentrations were satisfactory at all sites, ranging from 9.26 mg/l O₂ (OREAG1) in the summer to 17.6 mg/l O₂ at OWDAL1 in the spring. Each of the sites had oxygen saturation readings above the 9 mg/l level required for salmonid waters (Salmonid Water Regulations, 1988). Values ranged from 90% (BHALL1) in the autumn to 139% (OWDAL1) in the spring. The high values at OWDAL1 are indicative of eutrophication.

Conductivity

Conductivity values ranged from 24 µS/cm at GNEAL1, which is influenced by hard geology and nutrient-poor peaty soils, to high values of 489 µS/cm at SHILL1, which is influenced by underlying limestone and fertile soils. The majority of sites had a mean conductivity value below

Table 3.9. Potential hydromorphological impacts at potential reference sites.

Site	Potential hydromorphological impact
DUNIR1a	Over-widened?
DUNIR1b	Over-widened?
EANYM1b	Disturbed bank; may be cause of <i>Petasites</i> occurrence
LIFFY1a	Banks altered/eroded?
LIFFY1b	Banks altered/eroded?
OGLIN1a	Old wall forms part of bank
OGLIN1b	Evidence of management for fisheries (boulders across channel to create pools)
MOY2	Arterial drainage – spoil heaps on banks

200 $\mu\text{S}/\text{cm}$. The low representation of high conductivity waters is apparent in [Fig. 3.1](#).

Alkalinity

The mean alkalinity values ranged from below 1 mg/l CaCO_3 at sites such as GWBAR1 (–0.19 mg/l CaCO_3) and CBURN (0.17 mg/l CaCO_3) where there is a low buffering capacity, to values above 200 mg/l CaCO_3 at sites such as DUNNE1 (247.5 mg/l CaCO_3), BEHYM1, CAHRE1, MOY2 and SHILL1. The majority of the sites (43) had mean alkalinity values below 100 mg/l CaCO_3 , with 34 of these sites having mean alkalinity values below 50 mg/l CaCO_3 ([Fig. 3.1](#)). Eleven of these sites had alkalinity values of 10 mg/l or less. These sites were all influenced by peat deposits in their catchments and included CBURN1, DODDE1, FINOW1, GNEAL1, GWBAR1, LSLAN1, URRN1 (flowing over siliceous rock formations), BLKWA1, CARAG1, GGARF1 and OREAG1 (with calcareous formations in their catchments).

Total hardness

The total hardness values ranged from 3.24 mg/l CaCO_3 (DODDE1) to 427 mg/l CaCO_3 (MOY2). The majority of sites (46) sampled were soft waters with total hardness values below 100 mg/l CaCO_3 ([Fig. 3.1](#)).

The calcium, magnesium, potassium, sodium and chloride values for all the sites sampled fell within the ranges expected given the geological and geographical conditions. Limestone sites with high alkalinity and total hardness values were however under-represented in the study.

3.5 Hydromorphology

Each of the two stretches at the 50 sites was visually assessed for suitability as reference conditions based on their hydromorphology. Major alterations (weirs, bridges, channelised sections) were avoided but some minor bank

and channel modifications could not be avoided. It was considered that anything greater than a minor alteration would also affect the biology. The sites listed in [Table 3.9](#) were determined as potentially having hydromorphological impacts.

It was difficult to determine whether the DUNIR1 has been affected by over-widening. OGLIN1a was considered to have only a very minor alteration. OGLIN1b had pools that had been formed by boulders being placed across the channel, presumably for fisheries. However, it was also possible to survey a riffle section (OGLIN1a) and therefore, despite the exact location having a different character to that which would normally be expected, the two sections were still representative of a pool/riffle sequence which would be characteristic within this type of river. Natural boulders were also evident at the banks, and therefore the substrate was not artificial, even though its arrangement was. Impacts were considered to be very minor at these sites and therefore none was rejected.

The LIFFY stretches were probably the most impacted in this survey. Flood flows appeared to have eroded the banks on the outside of the river bends. Although the flood flows may have been natural, the level of erosion could be from destabilisation of the bank due to removal of the natural riparian vegetation. Apart from these areas, the river seemed to possess a natural character that may be unlikely to be replicated by other cobble rivers of this size. Therefore, the retention of this site as a potential reference site is recommended, although future development on the reference network may suggest its removal at a later date. Silt cover may have been elevated in these sections, but at the locations surveyed the hydromorphological impact could be considered minor.

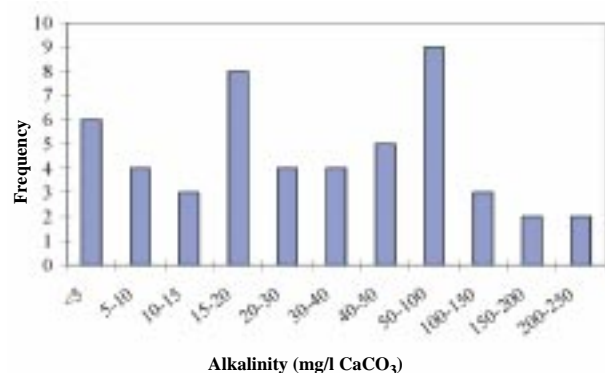
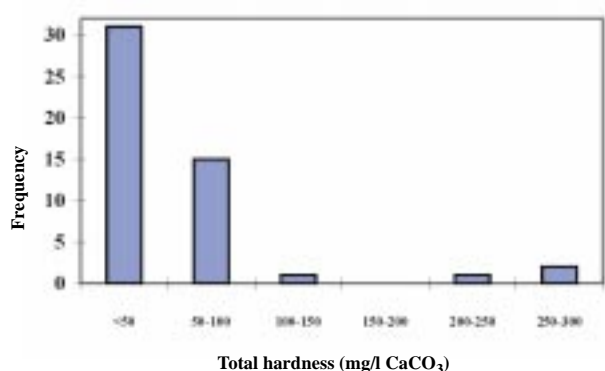
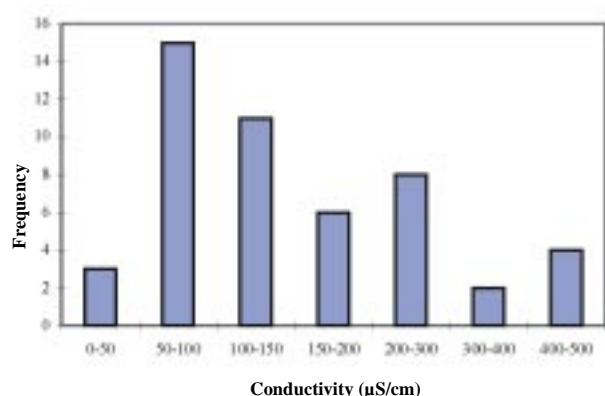
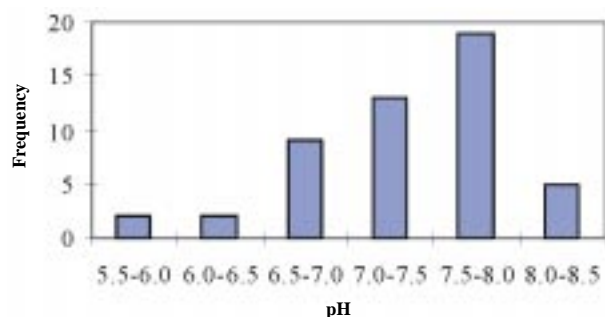


Figure 3.1. Frequency distributions for the mean pH, conductivity, alkalinity and hardness values.

Table 3.10. A summary of sites which potentially have minor impacts within this survey (suggested impacts indicated by ☑).

Site	Macroinvertebrates	Phytobenthos	Macrophytes	Hydrochemistry	Hydromorphology
AILLE1	☑		☑		
BEHYM1			☑		
BILBO1		☑			
BOLND1		☑			
BOW1		☑			
CARAG1	☑				
CLYDA1		☑			
DUNIR1		☑			☑
DUNNE1		☑			
EANYM1	☑				☑
EANYW1	☑				
FINOW1	☑				
GCREE1		☑			
GDINE1				☑	
GOURN1		☑			
GRANE1		☑			
LIFFY1					☑
MOY2			☑	☑	☑
OGLIN1	☑		☑		☑
OREAG1	☑				
OWDAL1			☑	☑	
OWGAR1				☑	
SLANY1		☑			

3.6 Reference Site Validation Summary

Sites can only be accepted for reference conditions if they have “no or only very minor anthropogenic alteration” for all of the biological elements, and for chemistry and hydromorphology (WFD, Annex V, Table 1.2). Several sites were identified as potentially having minor impacts within the surveys (Table 3.10). It was considered that the spatial reference network would suffer more from the removal of sites representative of different river types than from the effects of the possible minor impacts occurring at these sites. There was agreement of potential impacts between two different elements at six sites (AILLE1, DUNIR1, EANYM1, EANYM2, OGLIN1 and MOY2) and agreement between three elements at only two sites (OGLIN1 and MOY2).

A difficulty with using measures of trophic status such as TDI, Q-values and MTR is that they were not designed for use within a typology, i.e. lowland rivers would normally be expected to be naturally more enriched than upland rivers, and conversely upland rivers which appear to pass the standard may still be relatively impacted. Therefore, direct comparisons cannot be made until a river typology is developed. From the experience with RIVPACS (Reynoldson and Wright, 2000; Wright, 2000) it is evident that any spatial reference network should, over time, be iteratively improved by both removing and including additional sites. RIVTYPE should be no exception, and the sites listed in [Table 3.10](#) in particular should be considered for replacement by higher quality sites within the same river type, if they can be found.

Fifty reference sites were also considered to be a low number for representing the complete biological diversity of high ecological status sites. Some of the chosen survey sites were also quite close together and on the same river system. This could result in pseudo-replication of reference conditions and a lower range of species and

habitats being detected. The spatial reference network should be expanded in future to include more sites, particularly more acidic upland rivers and large lowland rivers with adjacent wetlands.

3.7 Artificial Intelligence

Artificial intelligence, specifically MIR-max (O'Connor, 2002), was used to classify the biological data. An attempt was made to produce a River Pollution Diagnostic System (RPDS) model like that produced for the Environment Agency (Walley *et al.*, 2002); however, there were insufficient data to produce an effective model. Classification of biological data with MIR-max tended to be slightly worse than that produced by TWINSpan (Hill and Minchin, 1997). A typology based on this classification method was considered to be inappropriate for species prediction, although prediction with any classification method was brought into question, given the limited range of variables available within the WFD and the high temporal variation in species.

4 Typology Production

A System A Typology (based on fixed boundaries of altitude, size and geology) is defined in the WFD, but there is allowance for development of alternative (System B) typologies which can use additional optional factors to delineate river types. If a System B Typology is used, it must achieve “*at least the same degree of differentiation as would be achieved using System A*” (WFD, Annex II 1.1 (iv)).

Four methods of classifying the sites into river types were evaluated:

1. The System A Typology.
2. Typologies based on expert opinion of the North South Technical Advisory Group (NSTAG) for rivers which included *inter alia* river biologists from the EPA and EHS (referred to as Expert-64, 32, 16, etc.).
3. A typology developed by examining the most important environmental gradients within the biological data using CCA.
4. Typologies derived from permutation tests; assessment of biological similarities within and between groups of many different typologies.

4.1 Combining Taxonomic Data

As well as assessing the biological differentiation achieved within each biological group, it is important to combine all the biological elements to determine the overall ability of each typology to segregate distinct biological communities.

4.1.1 Method

If the numbers of taxa in one biological element greatly exceed that in the others, analysis following a combination of these elements would unduly weight the analysis towards that group. Therefore, phytobenthos data were reduced to 129 taxa, and macroinvertebrates to 122 taxa, to combine with the 114 macrophyte taxa. The phytobenthos taxa number was reduced by removing all unidentified taxa, only including taxa which occurred in five or more river samples, and including taxa that reached an abundance level of two or more in the combined spring and summer data set. The reduced

macroinvertebrate data set contained only spring data, identified predominantly to the genus level.

The abundance data for the different biological elements also had to be at the same scale. This is especially important for CCA as it utilises relative abundances. The abundance values recorded for macrophytes and phytobenthos were already approximately equivalent to a log transformation. A square-root transformation was applied to the macroinvertebrate data since it was desirable to retain the zero values; the phytobenthos and macrophyte data also had zero values. The maximum values for the macrophyte, phytobenthos and invertebrate (square-root transformed) abundance data were 5, 6 and 46, respectively; the minimum was 0. The data for these taxonomic groups were therefore standardised to the same scale by multiplying by 10/5, 10/6 and 10/46, respectively, to ensure that the abundance values for each taxonomic group ranged from 0 to 10.

4.2 Developing the CCA Typology

A site conditional bi-plot with the combined taxonomic group species data was constructed using only those variables which are available within WFD System B and which enable simple visualisation within a typology (Fig. 4.1). Temperature, chloride and substrate were not included since they were considered to be subject to impacts and therefore unsuitable for determining a river typology. Rare species were down-weighted to make the CCA more robust (Cao and Larsen, 2001; Marchant, 2002).

Forward selection was performed on the combined data set to determine the variables that explained the most additional variance, and thus are likely to be the best at structuring the typology. This was only done with the first four variables to ensure that the typology was kept simple. Environmental boundaries were to be determined by visually assessing clusters; however, peat and calcareous variables were the first to be selected, which are already coded as binary categories.

4.2.1 Results

Figure 4.1 shows the site-conditional CCA biplot created from the combined macrophyte, phytobenthos and

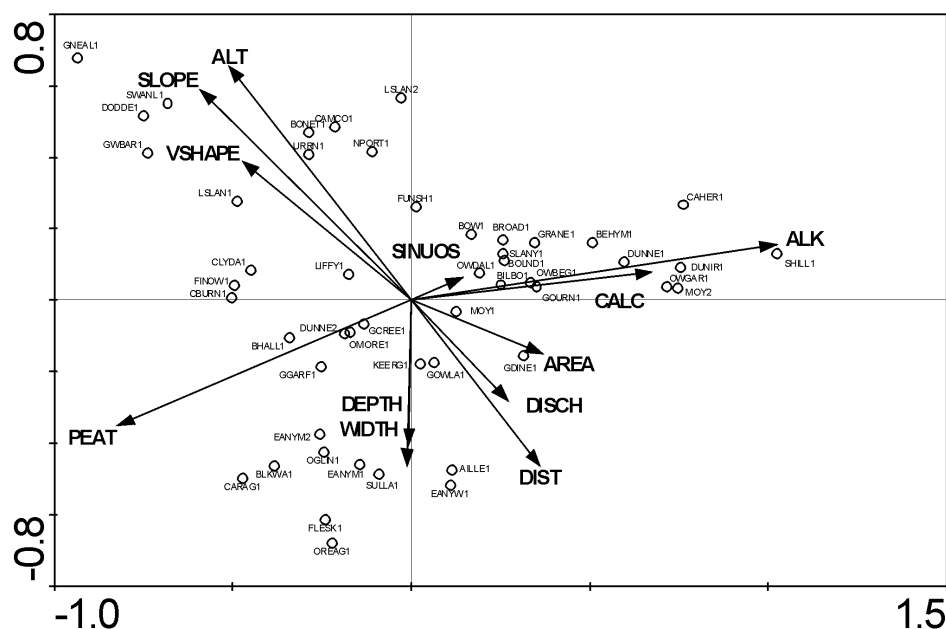


Figure 4.1. CCA site conditional bi-plot of combined biological data, using appropriate WFD variables. For the first two axes, the eigenvalues are 0.176 and 0.107, respectively, % variance explained out of total inertia is 7.1 and 4.3, respectively, and % variance explained out of canonical axes is 22.7 and 13.8, respectively. ALK, alkalinity; ALT, altitude of site; AREA, catchment area draining to site; CALC, binary calcareous category; DEPTH, channel depth; DISCH, discharge category; DIST, distance from source; PEAT, binary peat category; SINUOUS, sinuosity; VSHAPE, valley shape category; WIDTH, channel width.

invertebrate data and the appropriate WFD variables. Clearly defined clusters cannot be distinguished in the ordination, and therefore distinct river types are not evident.

Alkalinity was most correlated with the biological variance (eigenvalue = 0.136, explaining 5.5% of the variation). However, the combined (binary) categories of peat and calcareousness were selected instead (explaining together 7.5%) since it was difficult within the analysis to determine where appropriate boundaries may lie along an alkalinity gradient. Table 4.1 shows the results of the manual forward selection, following the removal of alkalinity in preference for calcareousness.

Categorical divisions were kept the same as those used in the Expert-64 Typology (Table 4.2). Catchment area boundaries were determined such that they produced a

better segregation of the sites than the System A catchment area boundaries. Figure 4.2 shows the allocation of sites to the CCA Typology.

In total, 14.2% variance (out of total species variance) was explained using the variables selected from the CCA Typology.

4.3 Typologies Derived from Permutation Tests

Choosing the best category boundaries for a fixed typology is highly subjective. The choice of category boundaries for one variable may influence the best choice of category boundaries for another variable, or even the next choice of variable. The method applied here in developing the Permutation-48 Typology overcomes this by using a large number of permutation tests with different combinations of variables and category boundaries.

Table 4.1. Condition effects (additional variance explained) in manual forward selection of WFD environmental variables and combined biological data, without alkalinity.

	Eigenvalue (total variance = 2.484)	% of additional variance explained
Geology (peat and calcareousness)	0.187	7.5
Slope	0.096	3.9
Area	0.069	2.8

Table 4.2. The CCA Typology variables derived from forward selection of the combined taxonomic group data.

Peat	(1/0)
Calcareous	(1/0)
Slope (using the same categories as the NSTAG Typology)	<0.005 m/m
	0.05–0.02 m/m
	0.02–0.04 m/m
	0.04 m/m
Catchment area (using a spread of categories more appropriate to the 50 sites)	<20 km ²
	21–100 km ²
	101–1000 km ²
	>1000 km ² (none present in data)

Olden and Jackson (2000) found that permutation tests are more likely to select inappropriate variables than forward selection within gradient analysis. However, permutation tests enable different combinations of category boundaries to be assessed simultaneously, which cannot be achieved within gradient analysis.

The BIOENV routine within PRIMER (Clarke and Gorley, 2001) was used to carry out the permutation tests in this method. A similarity matrix for the biological data is first prepared. This is calculated as the similarity between different sites based on the species found at the sites. Data for all the environmental variables that could be associated with the biology are also provided, with corresponding site names. The BIOENV routine produces a similarity matrix based on all the different combinations of the environmental variables, i.e. the similarity between sites based on the environmental variables at the site. Rank correlation coefficients between each environmental similarity matrix and the similarity matrix based on species are calculated. Rank coefficients are appropriate since the environmental and species similarities that are being compared are based on entirely different similarity coefficients (in our case, Bray–Curtis and Euclidean, respectively). The correlation coefficient is reported as a rho (ρ) value. Once the ρ values for all the possible combinations of environmental variables have been calculated, the results are ordered and displayed with the highest correlation at the top. The combination of environmental variables with the highest ρ value is that which best explains the similarities in species between sites. Therefore, it is likely that these variables are the most strongly associated with the species distributions.

4.3.1 Method

The number of potential variables for producing the typology had to be reduced since the computing power

increases exponentially with the number of variables within permutation tests. Therefore, continuous data for the variables listed in Table 4.3 were selected as the environmental data, and the combined biological data were selected as biological data. The BIOENV routine was used to find the combination of variables that best explained the Bray–Curtis similarities between sites. Variables that were repeatedly important in explaining the species similarities between sites were selected for subsequent analysis.

Once the important environmental variables had been determined, each of these variables could be divided into a range of different category types. The category boundaries were selected by considering where ecological changes would occur or enabling an even number of sites in categories. Based on the CCA analysis, it was considered that specific ecological boundary conditions did not exist, except perhaps for alkalinity and hardness. The alkalinity classes were <25 mg CaCO₃/l and >100 mg CaCO₃/l boundaries. A scatter plot of alkalinity against hardness for the site data suggested that the equivalent boundaries for hardness are <35 mg CaCO₃/l and >100 mg CaCO₃/l. Table 4.4 shows the environmental variables with their category boundaries.

A single BIOENV analysis was applied to the combined biological data (with Bray–Curtis similarity) and the complete set of categorised environmental data (with Euclidean distance similarity). Different categorical classifications of a single variable were not analysed separately; they were all included in this single permutation test. A maximum of four variable combinations was selected for the routine, although two and three variable combinations occurred within the top ten correlations.

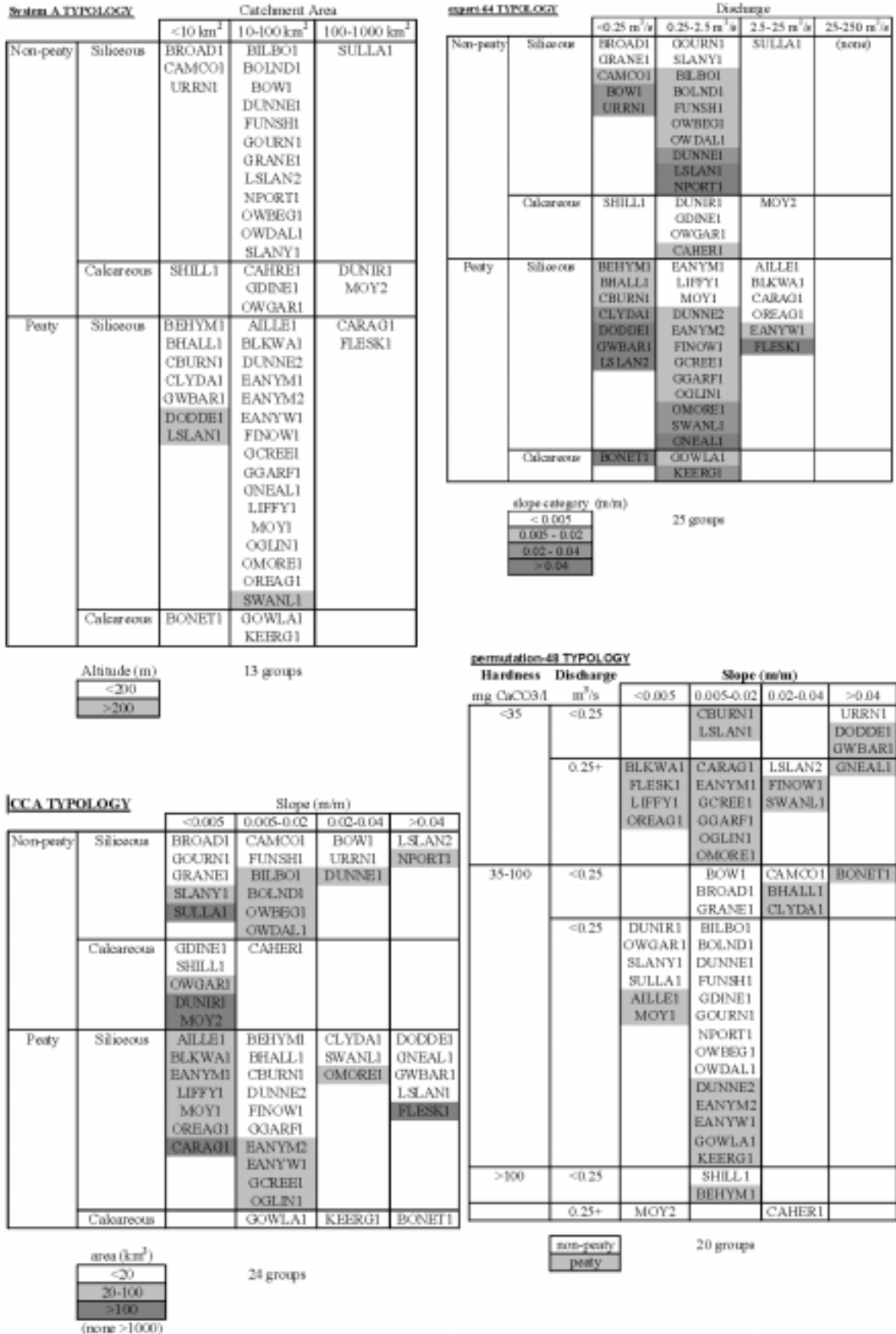


Figure 4.2. The 50 sites classified by the System A, expert-64, CCA and permutation-48 typologies.

Table 4.3. Full variable set used in the initial BIOENV analysis.

Alkalinity	Catchment slope	Peaty
Altitude	Depth	Relief ratio
Bank slope	Discharge	Sinuosity
Calcareous	Distance from source	Slope
Catchment altitude	Drainage density	Stream order
Catchment area	Elongation ratio	Temperature
Catchment shape	Hardness	Width

Table 4.4. Reduced variable set used in the BIOENV analysis with category boundaries.

Variable code	Variable	Categories	Units
1	3 Alkalinity	<25, 25–100, >100	mg CaCO ₃ /l
2	2 Alkalinity	<25, 25+	mg CaCO ₃ /l
3	4 Hardness	<20, 20–50, 50–100, >100	mg CaCO ₃ /l
4	3 Hardness	<35, 35–100, >100	mg CaCO ₃ /l
5	2 Hardness	<35, 35+	mg CaCO ₃ /l
6	2 Geology (calcareous)	Calcareous/non-calcareous	–
7	2 Peat	Peaty/non-peaty	–
8	4 Discharge	<0.25, 0.25–2.5, 2.5–25, >25*	m ³ /s
9	2 Discharge	<0.25, 0.25 +	m ³ /s
10	3 Catchment area	<10, 10–100, >100	km ²
11	3 Altitude	<50, 50–150, 150+	m
12	2 Altitude	<50, 50+	m
13	3 Catchment slope	<10, 10–25, >25	m/km
14	2 Catchment slope	<10, 10+	m/km
15	4 Drainage density	0, 1, 2, 3	
16	3 Distance from source	< 10, 10–30, >30	km
17	2 Distance from source	<10, 10+	km
18	4 Slope	<0.005, 0.005–0.02, 0.02–0.04, >0.04	m/m
19	3 Slope	<0.005, 0.005–0.02, >0.02	m/m
20	2 Slope	<0.02, 0.02+	m/m

*Only three discharge categories are actually represented by the site data.

It is possible that the same variable is selected twice for a single typology if the boundaries between the categories do not coincide. This suggests that both sets of boundaries are important and a different set of boundary conditions or an increased categorisation of that variable should be used. This occurred with two hardness variables (Nos 3 and 5), but could not occur with any other variables since, even though there were different numbers of categories, they had coincident boundaries. BIOENV analyses using only one of the categorical hardness variables in turn showed the three category hardness variable to repeatedly explain the most

variance, so this was retained. Table 4.5 shows the results of the BIOENV analysis.

4.3.2 Results

Hardness (var. 4), was the most important variable occurring in every suggested combination. Four-category slope (var. 18), also occurred in all of the top six results, suggesting that this is the next most important variable.

The highest correlation between the species and environment data was found to be with hardness (var. 4), slope (var. 18), peat (var. 7) and discharge (var. 9), producing a 48-category Typology. Coincidentally, the best three-variable combination was the same excluding

peat, and the best two-variable combination was the same excluding both peat and discharge. Therefore, in order of importance the typology structure (Permutation-48) is:

3 hardness categories: <35, 35–100, >100

4 slope categories: <0.005, 0.005–0.02, 0.02–0.04, >0.04

2 discharge categories: <0.25, 0.25+

2 peat categories: 1/0.

Based on the BIOENV results in Table 4.5, a typology with fewer river types is produced by removing the variables consecutively from the bottom of the 48-Typology hierarchy, i.e. a 24-category Typology is formed by removing peat, and a 12-category Typology is formed by removing peat and discharge.

The allocation of sites to the Permutation-48 Typology is shown in Fig. 4.2. The allocation of sites for the 24- and 12-category typologies can also be derived from this figure.

4.3.3 Conclusions

Hardness was found to be more important in forming a typology than either alkalinity or geology

Table 4.5. BIOENV results showing correlations of variable combinations with species similarities between sites, using the combined species data set. The variable set was restricted to a maximum of four variables. Variable codes are listed in Table 4.4.

Number of variables	Correlation	Selections
4	0.477	4, 7, 9, 18
4	0.473	2, 4, 9, 18
3	0.470	4, 9, 18
3	0.463	4, 8, 18
4	0.460	4, 7, 8, 18
4	0.460	1, 4, 8, 18
3	0.459	4, 8, 20
4	0.458	4, 7, 9, 20
2	0.458	4, 18
4	0.458	4, 7, 8, 20

(calcareousness). Slope was the next most important variable, and requires all four categories to optimise the typology. Discharge, which is estimated from catchment area and rainfall, only required two categories. Possibly this allows differentiation between the small lowland, low-slope streams and the large lowland, low-slope rivers. Peat amount has some use in the typology, but could be ignored if a smaller typology is required.

5 Assessing Typology Performance

5.1 Introduction

The performance of the typologies was determined by assessing how well they predict type-specific reference conditions. It is important to remember that classifications are subjective since a decision always has to be made on the elements of a community which have to be classified, e.g. changes in ecological integrity could be represented by changes at the family level, changes in ratios of one functional group of species to another or other assessments of the ecological functioning (Angermeier and Karr, 1994) rather than species change. However, species are usually the most sensitive indicators of impact (Angermeier and Karr, 1994) and, within the WFD, measurement of composition and abundance within the taxonomic group is specified. Classifications also depend on a similarity measure for comparing sites or groups of sites. Within TWINSpan (and ordination methods) this is the chi-squared value, whereas within other traditional classifications the more biologically applicable Bray–Curtis similarity measure is usually used. The MIR-max artificial intelligence classification utilises Mutual Information as a similarity measure. Classifications assessed using the similarity index that was used to create them are inevitably going to appear to perform better and so care must be taken in interpretation.

5.2 Methods

Concordance between the typologies and the biological data can be assessed using the method of Paavola *et al.* (2003) with ANOSIM (Clarke and Warwick, 1994; Clarke

and Gorley, 2001). The hypothesis is that if a classification is imposed on species data the within-group variability should be less than the between-group variability if there is any concordance between the classification and the biological community.

Each typology under test was used to classify the sites and ANOSIM (using Bray–Curtis similarity) was used to determine whether the within-group variability was greater than the between-group variability for each of these typologies. The typologies being tested were the Permutation-48 Typology and the 23 and 12 river type derivatives of this, the Expert-64 Typology, determined by the NSTAG, and the 32 and 16 river type derivatives, the CCA-based Typology (48 potential river types) and the System A Typology from the WFD (24 potential river types in Ecoregion 17) (Fig. 4.2).

5.3 Results

The CCA, expert-32 and expert-16 typologies did not produce a significant classification of the invertebrate biology (Table 5.1). Although the Expert-64 Typology produced good results for combined and individual taxonomic group data, the Permutation-48 Typology and its derivatives out-performed all other typologies. There was not a large decrease in effectiveness between the Permutation-48 and Permutation-12 typologies, except for phytobenthos. The Expert-64 Typology and the Permutation-48, -24 and -12 typologies all performed better than the System A Typology.

Table 5.1. Effectiveness of the typologies in segregating the biological data. Values are Global-R values from ANOSIM. Significance (Sig.) is calculated from 999 permutations. Only spring data were used for the macroinvertebrates. Results are ordered by effectiveness with the combined data.

Typology	Biological data							
	Combined		Macrophyte		Phytobenthos		Macroinvertebrates	
		Sig.		Sig.		Sig.		Sig.
Permutation-48	0.489	0.001	0.333	0.001	0.464	0.001	0.365	0.001
Permutation-24	0.467	0.001	0.333	0.001	0.384	0.001	0.383	0.001
Permutation-12	0.402	0.001	0.276	0.001	0.333	0.001	0.382	0.001
Expert-64	0.333	0.001	0.224	0.012	0.299	0.002	0.195	0.015
System A	0.330	0.001	0.173	0.015	0.349	0.001	0.145	0.042
Expert-32	0.308	0.001	0.185	0.010	0.346	0.001	0.049	0.265
CCA	0.304	0.001	0.193	0.023	0.308	0.002	0.111	0.103
Expert-16	0.251	0.002	0.152	0.032	0.291	0.001	0.059	0.229

5.4 Discussion

Although the Expert-64 Typology performed better than the System A Typology, by far the best were the Permutation-48, -24 and -12 typologies (in that order). The Permutation-24 Typology only had a minor drop in Global-R values compared to the Permutation-48 Typology. The CCA, Expert-32 and Expert-16 typologies performed very poorly in the concordance test with the combined and individual taxonomic data and none of these significantly segregated macroinvertebrate data.

There was only a single site in a large proportion of the river types within the typologies examined. Therefore, the biological range within this river type may not be represented. Also, since there was only one site, statistical analyses will suggest that there is no biological variation within these river types and therefore may over-estimate the ability to classify or predict the biology.

The 50 sites may be too few or too unevenly distributed throughout the biological response gradients to represent all the different river types. RIVPACS in Northern Ireland uses 110 reference sites to characterise a much smaller and less diverse area. The typologies have been optimised for the 50 sites, and the reliability of the analyses when extrapolated to the whole of Ireland is highly dependent on the representativeness of this sub-sample.

5.5 Additional Comments

It is not likely that a typology will lead directly to the derivation of species lists for each river type, but measures of biological condition could be derived. Any single typology is likely to be sub-optimal for species prediction for one or more of the taxonomic groups. Although species are often good early indicators of impacts, more robust predictions could be made by using simpler biological elements such as functional groups of species (Willby *et al.*, 2000), family-level predictions, or the prediction of metrics (Dodkins *et al.*, 2005). If metrics are used, characterisation of the river types by metric values would require far fewer river types. However, in this case the typology would be best optimised by reducing the variance in metric scores for a river type, rather than the variance in species.

The Trophic Diatom Index (Kelly, 1998), Mean Trophic Ranking (Holmes *et al.*, 1999), BMWP scores (Armitage *et al.*, 1983) or other metrics (Dodkins *et al.*, 2005) could be used to produce characteristic scores for each river

type within a typology. It is unlikely that a simple typology will be useful in a RIVPACS (Wright *et al.*, 1984) modelling approach, since WFD-required typologies use only a small number of variables, and are fixed rather than probabilistic. Characterisation of metric values for even quite a large number of river types into five ecological status classes seems feasible. Interpolation of reference conditions using the same variables as the accepted (fixed-boundary) typology could improve metric predictions whilst still enabling the submission of ecological status values to the EU within the structure of the (fixed-boundary) typology.

5.6 Conclusions and Recommendations

There is little difference in performance between the best three typologies, which are the permutation-48, 24 and 12 Typologies. These typologies were substantially better than any other environmental typologies in segregating the biological data and they performed equally well with each of the taxonomic groups. The only other typology to perform better than the System A Typology was the Expert-64 Typology.

Typology optimisation was only carried out using 50 sites. Validation with biological data for all the taxonomic groups from additional sites may be required to ensure that the best typologies work well on a larger scale. Some sites, particularly MOY2, GDINE1 and OGLIN1, have questionable status as reference sites. Potentially the typology may have to be expanded for river types that are dissimilar to the 50 reference sites used in this study and additional high status sites should be examined within Ecoregion 17.

Out of the top three performing typologies it is suggested that the Permutation-12 Typology is adopted since (i) there is little difference in performance compared to the Permutation-48 and -24 typologies and (ii) there are far fewer river types than the other typologies. Adopting a low number of river types within a typology also suggests that some form of metric scores will need to be used to assess impact, rather than species predictions.

5.7 Recent Developments

The Permutation-12 Typology was adopted by the EPA for the purposes of the WFD Article 5 Characterisation Report. Table 5.2 presents the assignment of sites in the Permutation-12 Typology based on GIS-derived slope values.

Table 5.2. Assignment of sites in the Permutation-12 Typology based on GIS-derived slope values. Code refers to the two-digit code used to define the river type, the first digit indicating geology and the second digit the river slope (e.g. River Type 23 has a hardness value in the range 35–100 mg/l CaCO₃ and a slope of 0.02–0.04 m/m).

Hardness code	Code values	Slope			
		1	2	3	4
		≤0.005 m/m	0.005–0.02 m/m	0.02–0.04 m/m	>0.04 m/m
1	<35 mg/l	BLKWA1	CARAG1	CBURN1	DODDE1
		EANYM1	GGARF1	GWBAR1	LSLAN1
		FINOW1	LSLAN2	OMORE1	
		FLESK1	OGLIN1	SWANL1	
		GCREE1		URRN1	
		GNEAL1			
		LIFFY1			
		OREAG1			
2	35–100 mg/l	AILLE1	BHALL1	BOW1	BONET1
		BROAD1	BILBO1	CLYDA1	
		DUNIR1	BOLND1	DUNNE1	
		EANYW1	CAMCO1	KEERG1	
		GOURN1	DUNNE2		
		GRANE1	EANYM2		
		MOY1	FUNSH1		
		OWGAR1	GDINE1		
		SLANY1	GOWLA1		
		SULLA1	NPORT1		
			OWBEG1		
			OWDAL1		
3	>100 mg/l	MOY2	BEHYM1		
			CAHER1		
			SHILL1		

6 Composition of Biological Elements within River Types

Species occurring at the 50 sites that characterise river types within the Permutation-12 Typology are summarised in [Table 6.1](#).

INDVAL within PC-ORD (McCune and Mefford, 1999) was used to determine the indicator species associated with the different river types for each biological element ([Table 6.1](#)) (based on the new allocation of sites). For each river type, these are ordered as macroinvertebrates, phytobenthos, then macrophytes. Indicator species cannot be derived for river types with zero or one site. Indicator values range from 0 to 100, indicating the strength of the association with the river type (100 being a perfect indicator of that river type). All the species listed are significant indicators at $P = 0.05$.

[Table 6.2](#) shows the range of chemistry associated with these river types. Ranges are likely to vary less with river

types that have fewer sites, and therefore may not reflect the true range of high status sites within the whole of Ireland. Where the sample was below the limit of detection (LoD), a value equal to half the LoD value was used to enable mean values to be generated.

An expected species list is difficult to construct for river types since natural variation (e.g. due to natural disturbance) is likely to result in some species not occurring. Also, perfect indicator species are unlikely to exist since biological communities are not discrete, but more likely to be a patchy continuum (Poole, 2002), and thus an environmental typology with discrete boundaries can never precisely define the communities. Therefore, lists were constructed which show frequency of occurrence of species within each different river type ([Appendix](#)).

Table 6.1. Indicator species (from INDVAL) for each river type. Macrophyte species in bold are confined to banks, and are likely to be more indicative of neighbouring landscape and land-use than type-specific river chemistry or hydromorphology.

12-Typology group	Indicator species	Indicator value	P-value
11	<i>Phormidium fragile</i>	27	0.032
	<i>Tabellaria flocculosa</i>	32	0.042
12	<i>Rhyacophila munda</i>	40	0.041
	<i>Gomphonema clavatum</i>	35	0.050
13	<i>Lyngbya aestuarii</i>	49	0.018
14	<i>Plectrocnemia</i> spp.	39	0.015
	<i>Diura bicaudata</i>	92	0.000
	<i>Ameletus inopinatus</i>	100	0.000
	<i>Achnanthes peterserii</i>	41	0.046
	<i>Eunotia bidentula</i>	50	0.015
	<i>Racometrium</i>	35	0.048
	<i>Lemanea</i>	50	0.040
	<i>Scapania undulata</i>	57	0.003
21	<i>Limnium volckmari</i>	18	0.039
	<i>Nitzschia dissipata</i>	23	0.013
	<i>Navicula gregaria</i>	28	0.032
	<i>Cladophora glomerata</i>	37	0.034
22	<i>Cocconeis placentula</i>	23	0.006
23	<i>Lasiocephala basalis</i>	36	0.034
	<i>Rhynchostegium ripariodes</i>	26	0.035
	<i>Plagiomnium rostratum</i>	44	0.031
24	INSUFFICIENT SITES	–	–
31	INSUFFICIENT SITES	–	–
32	<i>Chironominae</i>	25	0.025
	<i>Sericostoma personatum</i>	26	0.033
	<i>Tanypodinae</i>	26	0.041
	<i>Baetis muticus</i>	32	0.002
	<i>Chelifera</i> spp.	36	0.033
	<i>Gongrosira</i> sp.	34	0.017
	<i>Heribaudiella fluviatilis</i>	41	0.049
	<i>Amphora pediculus</i>	42	0.017
	<i>Rhoicosphenia abbreviata</i>	45	0.010
	<i>Phormidium ambiquum</i>	50	0.042
	<i>Navicula</i> sp. 7	50	0.043
	<i>Stephanodiscus hantzschii</i>	50	0.043
	<i>Hildenbrandia rivularis</i>	78	0.004
	<i>Filipendula ulmaria</i>	24	0.044
	<i>Angelica sylvestris</i>	33	0.037
	<i>Hypericum tetrapterum</i>	42	0.029
	<i>Amblystegium riparium</i>	56	0.012
	<i>Veronica beccabunga</i>	60	0.001
	<i>Apium nodiflorum</i>	64	0.002
	<i>Rorippa nasturtium-aquaticum</i>	80	0.001
33	INSUFFICIENT SITES	–	–
34	INSUFFICIENT SITES	–	–
		= macroinvertebrates	
		= phytobenthos	
		= macrophytes	

Table 6.2. Chemistry at each of the river types from the Permutation-12 Typology. Mean values are presented, with ranges (minimum to maximum) in parentheses.

River type	pH		Ammonia (mg/l N)		Phosphate (mg/l P)		Nitrite (mg/l N)		Nitrate (mg/l N)	
11	6.81	(5.11–8.08)	0.006	(<0.01– 0.021)	0.005	(<0.01– 0.012)	0.001	(<0.001– 0.004)	2.216	(<5)
12	7.06	(6.45–8.47)	0.005	(0.001–0.005)	0.006	(0.002–0.017)	0.001	(<0.001– 0.004)	2.139	(<5)
13	6.90	(4.8–7.91)	0.005	(0.001–0.005)	0.006	(0.004–0.014)	0.002	(0.001–0.007)	2.698	(<5)
14	6.08	(4.97–6.64)	0.005	(0.005–0.005)	0.014	(0.003–0.026)	0.002	(0.001–0.003)	2.096	(<5)
21	7.58	(6.31–8.43)	0.007	(<0.01– 0.028)	0.012	(0.004–0.052)	0.004	(0.001–0.026)	2.647	(<5–5.017)
22	7.55	(6.51–8.51)	0.009	(<0.01– 0.126)	0.011	(0.003–0.046)	0.003	(0.001–0.010)	2.050	(<5)
23	7.92	(7.15–8.69)	0.004	(<0.01– 0.005)	0.012	(0.005–0.029)	0.004	(0.001–0.010)	2.500	(<5)
24	8.27	(8.17–8.43)	0.004	(0.002–0.005)	0.006	(0.005–0.006)	0.001	(0.001–0.002)	1.919	(<5)
31	8.23	(8.06–8.46)	0.019	(0.007–0.033)	0.011	(0.005–0.016)	0.004	(0.001–0.008)	5.078	(<5–9.081)
32	8.00	(7.46–8.78)	0.014	(0.005–0.026)	0.005	(0.005–0.005)	0.001	(0.001–0.002)	4.454	(<5–7.847)

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Appendix Species Frequencies for Each River Type

River Type 11 (8 sites).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq
<i>Ancylus fluviatilis</i>	100	<i>Chloroperla tripunctata</i>	75	<i>Mystacides azurea</i>	38	<i>Diura bicaudata</i>	13
<i>Lumbriculus variegatus</i>	100	<i>Plectrocnemia conspersa</i>	75	<i>Oecetis testacea</i>	38	<i>Calopteryx splendens</i>	13
Tubificidae indet.	100	<i>Agapetus</i> spp.	75	<i>Ecclisopteryx guttulata</i>	38	<i>Velia caprai</i>	13
Enchytraeidae indet.	100	<i>Athripsodes</i> spp.	75	<i>Halesus digitatus</i>	38	<i>Gerris najas</i>	13
Lumbricidae indet.	100	<i>Eloeophila</i> spp.	75	<i>Atherix marginata</i>	38	<i>Micronecta poweri</i>	13
<i>Serratella ignita</i>	100	<i>Hemerodromia</i> spp.	75	<i>Chelifera</i> spp.	38	<i>Hydraena testacea</i>	13
<i>Baetis rhodani</i>	100	<i>Lymnaea peregra</i>	63	<i>Simulium variegatum</i>	38	<i>Gyrinus caspius</i>	13
<i>Centroptilum luteolum</i>	100	<i>Glossiphonia complanata</i>	63	Tricladidia indet.	25	<i>Dryops</i> spp.	13
<i>Ecdyonurus venosus</i>	100	<i>Heptagenia sulphurea</i>	63	<i>Bathymphalus contortus</i>	25	<i>Halipilus lineatocollis</i>	13
<i>Protonemura meyeri</i>	100	<i>Ecdyonurus insignis</i>	63	<i>Lymnaea truncatula</i>	25	<i>Hydroporus pubescens</i>	13
<i>Leuctra hippopus</i>	100	<i>Brachyptera risi</i>	63	<i>Pisidium nitidum</i>	25	<i>Hydroporus discretus</i>	13
<i>Elmis aenea</i>	100	<i>Nemoura</i> spp.	63	<i>Pisidium personatum</i>	25	<i>Stictonectes lepidus</i>	13
<i>Oulimnius tuberculatus</i>	100	<i>Oreodytes septentrionalis</i>	63	<i>Margaritifera margaritifera</i>	25	<i>Agabus paludosus</i>	13
<i>Limnius volckmari</i>	100	<i>Hydrocyphon</i> spp.	63	<i>Aulodrilus plurisetus</i>	25	<i>Nebrioporus depressus elegans</i>	13
<i>Hydraena gracilis</i>	100	<i>Polycentropus kingi</i>	63	<i>Tubifex ignotus</i>	25	<i>Nebrioporus depressus elegans complex</i>	13
<i>Orectochilus villosus</i>	100	<i>Antocha</i> spp.	63	<i>Glossiphonia hereroclita</i>	25	<i>Helophorus</i> spp.	13
<i>Hydropsyche siltalai</i>	100	<i>Simulium argyreatum/</i> <i>variegatum</i> group	63	<i>Procladius bifidus</i>	25	<i>Osmylus fulvicephalus</i>	13
<i>Lepidostoma hirtum</i>	100	Prodiamesinae indet.	63	<i>Ecdyonurus dispar</i>	25	<i>Wormaldia occipitalis</i>	13
<i>Halesus radiatus</i>	100	Chironominae indet.	63	<i>Paraleptophlebia cincta</i>	25	<i>Wormaldia subnigra</i>	13
<i>Sericostoma personatum</i>	100	<i>Pisidium casertanum</i>	50	<i>Caenis luctuosa</i>	25	<i>Chimarra marginata</i>	13
<i>Tipula</i> spp.	100	Nematoda indet.	50	<i>Calopteryx virgo</i>	25	<i>Neureclipsis bimaculata</i>	13
Ceratopogonidae indet.	100	<i>Erpobdella octoculata</i>	50	<i>Hydraena riparia</i>	25	<i>Plectrocnemia geniculata</i>	13
Simuliidae indet.	100	<i>Nemoura avicularis</i>	50	<i>Limnobia truncatellus</i>	25	<i>Polycentropus irrorata</i>	13
Tanyptodinae indet.	100	<i>Perla bipunctata</i>	50	<i>Gyrinus urinator</i>	25	<i>Holocentropus dubius</i>	13
Orthocladinae indet.	100	<i>Oreodytes davisii</i>	50	<i>Hydroporus tessellatus</i>	25	<i>Cheumatopsyche lepida</i>	13
<i>Potamopyrgus antipodarum</i>	88	<i>Psychomyia pusilla</i>	50	Curculionidae indet.	25	<i>Hydropsyche instabilis/</i> <i>pellucidula</i>	13
<i>Baetis muticus</i>	88	<i>Lype phaeopa</i>	50	<i>Agapetus ochripes</i>	25	<i>Glossosoma boltoni</i>	13
<i>Rhithrogena semicolorata</i>	88	<i>Glossosoma</i> spp.	50	<i>Lasiocephala basalis</i>	25	<i>Agapetus fuscipes</i>	13
<i>Amphimura sulciollis</i>	88	<i>Goera pilosa</i>	50	<i>Athripsodes cinereus</i>	25	<i>Silo nigricornis</i>	13
<i>Isoperla grammica</i>	88	<i>Ithytrichia</i> spp.	50	<i>Chaetopteryx villosa</i>	25	<i>Agraylea</i> spp.	13
<i>Siphonoperla torrentium</i>	88	<i>Odontocerus albicorne</i>	50	<i>Limnephilus</i> spp.	25	<i>Crunoecia irrorata</i>	13
<i>Esolus parallelepipedus</i>	88	<i>Pisidium subtruncatum</i>	38	<i>Potamophylax latipennis</i>	25	<i>Anabolia nervosa</i>	13
<i>Oreodytes sanmarkii</i>	88	<i>Rhyacodrilus coccineus</i>	38	<i>Pedicia</i> spp.	25	<i>Drusus annulatus</i>	13
<i>Rhyacophila dorsalis</i>	88	<i>Spirosperma ferox</i>	38	<i>Limnophora</i> spp.	25	<i>Limnephilus lunatus</i>	13
<i>Polycentropus flavomaculatus</i>	88	<i>Helobdella stagnalis</i>	38	<i>Simulium dunfellenense/</i> <i>urbanum</i> group	25	<i>Limnephilus marmoratus</i>	13
<i>Hydropsyche pellucidula</i>	88	<i>Asellus aquaticus</i>	38	<i>Simulium reptans</i>	25	<i>Beraea maurus</i>	13
<i>Silo pallipes</i>	88	<i>Siphonurus lacustris</i>	38	<i>Lymnaea palustris</i>	13	<i>Limonia</i> spp.	13
<i>Oxyethira</i> spp.	88	<i>Baetis vernus</i>	38	<i>Pisidium hibernicum</i>	13	<i>Dixa puberula</i>	13
<i>Hydroptila</i> spp.	88	<i>Ecdyonurus torrentis</i>	38	<i>Pisidium milium</i>	13	<i>Ptychoptera</i> spp.	13
<i>Potamophylax cingulatus</i>	88	<i>Nemoura cinerea</i>	38	<i>Sphaerium corneum</i>	13	Stratiomyidae indet.	13
<i>Dicranota</i> spp.	88	<i>Halipilus</i> spp.	38	<i>Limnodrilus hoffmeisteri</i>	13	Athericidae indet.	13
Psychodidae indet.	88	<i>Stictotarsus duodecimpustulatus</i>	38	<i>Theromyzon tessulatum</i>	13	Empididae indet.	13
<i>Stylodrilus heringianus</i>	75	<i>Elodes</i> spp.	38	<i>Piscicola geometra</i>	13	<i>Simulium vernum</i>	13
<i>Gammarus duebeni</i>	75	<i>Rhyacophila munda</i>	38	<i>Haemopsis sanguisuga</i>	13	<i>Simulium argyreatum</i>	13
Hydracarina indet.	75	<i>Philopotamus monatus</i>	38	<i>Gammarus pulex</i>	13	<i>Simulium noelleri</i>	13
<i>Baetis scambus</i>	75	<i>Cynurus trimaculatus</i>	38	<i>Austropotamobius pallipes</i>	13	<i>Simulium rostratum</i>	13
<i>Electrogena lateralis</i>	75	<i>Lype reducta</i>	38	<i>Ameletus inopinatus</i>	13	<i>Eukiefferiella coerulescens</i>	13
<i>Caenis rivulorum</i>	75	<i>Tinodes waeneri</i>	38	<i>Leptophlebia vespertina</i>	13	<i>Microtendipes pedellus</i>	13
<i>Leuctra inermis</i>	75	<i>Agapetus delicatulus</i>	38	<i>Nemurella picteti</i>	13	<i>Stictochironomus</i> spp.	13

River Type 11 *contd.*

Phytobenthos	% freq	Phytobenthos <i>contd.</i>	% freq	Macrophytes	% freq	Macrophytes <i>contd.</i>	% freq
<i>Achnanthes oblongella</i>	100	<i>Achnanthes lanceolata</i>	25	<i>Juncus articulatus</i>	75	<i>Montia fontana</i>	13
<i>Achnanthidium minutissimum</i>	100	<i>Cladophora glomerata</i>	25	<i>Juncus effusus</i>	75	<i>Myriophyllum alternifolium</i>	13
<i>Fragilaria capucina</i>	100	<i>Cyclotella meneghiniana</i>	25	<i>Racomitrium</i>	75	<i>Persicaria hydropiper</i>	13
<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	100	<i>Cymbella microcephala</i>	25	<i>Ranunculus flammula</i>	75	<i>Petasites hybridus</i>	13
<i>Gomphonema parvulum</i>	100	<i>Diatoma mesodon</i>	25	<i>Chiloscyphus polyanthos</i>	63	<i>Phalaris arundinacea</i>	13
<i>Tabellaria flocculosa</i>	100	<i>Diatoma tenuis</i>	25	<i>Oenanthe crocata</i>	63	<i>Plagiomnium undulatum</i>	13
<i>Cymbella silesiaca</i>	88	<i>Eunotia minor</i>	25	<i>Pellia epiphylla</i>	63	<i>Polytrichum commune</i>	13
<i>Nitzschia palea</i>	88	<i>Gomphonema acuminatum</i>	25	<i>Callitriche hamulata</i>	50	<i>Potamogeton filiformis</i>	13
<i>Cymbella minuta</i>	75	<i>Gomphonema angustum</i>	25	<i>Cladophora</i> spp.	50	<i>Ranunculus peltatus</i>	13
<i>Navicula cryptotenella</i>	75	<i>Gomphonema gracile</i>	25	<i>Filipendula ulmaria</i>	50	<i>Rorippa amphibia</i>	13
<i>Nitzschia dissipata</i>	75	<i>Meridion circulare</i>	25	<i>Fontinalis antipyretica</i>	50	<i>Sphagnum</i>	13
<i>Phormidium fragile</i>	75	<i>Navicula halophila</i>	25	<i>Lythrum salicaria</i>	50	<i>Spirogyra</i>	13
<i>Synedra ulna</i>	75	<i>Navicula rhynchocephala</i>	25	<i>Angelica sylvestris</i>	38	<i>Stachys palustris</i>	13
<i>Brachysira vitrea</i>	63	<i>Oedogonium</i> W2	25	<i>Callitriche stagnalis</i>	38	<i>Valeriana</i>	13
<i>Chamaesiphon incrustans</i>	63	<i>Oedogonium</i> W4	25	<i>Conocephalum conicum</i>	38		
<i>Cymbella gracilis</i>	63	<i>Oedogonium</i> W5	25	<i>Glyceria fluitans</i>	38		
<i>Eunotia implicata</i>	63	<i>Oscillatoria agardhii</i>	25	<i>Mnium hornum</i>	38		
<i>Gomphonema minutum</i>	63	<i>Oscillatoria brevis</i>	25	<i>Rhizomnium punctatum</i>	38		
<i>Gomphonema olivaceum</i>	63	<i>Oscillatoria sancta</i>	25	<i>Scapania undulata</i>	38		
<i>Hannea arcus</i>	63	<i>Spirogyra</i> W2	25	<i>Butomus umbellatus</i>	25		
<i>Lemanea fluviatilis</i>	63	<i>Stigeoclonium</i> sp.	25	<i>Calliergon cuspidatum</i>	25		
<i>Monostroma</i> sp.	63	<i>Tabellaria fenestrata</i>	25	Filamentous green algae	25		
<i>Navicula gregaria</i>	63	<i>Ulothrix tenerrima</i>	25	<i>Fontinalis squamosa</i>	25		
<i>Audouinella hermannii</i>	50	<i>Zygnema</i> W1	25	<i>Hycomium armoricum</i>	25		
<i>Bulbochaete</i> sp.	50	<i>Zygnema</i> W3	25	<i>Jungermannia</i>	25		
<i>Diatoma moniliformis</i>	50	<i>Caloneis bacillum</i>	13	<i>Lychnis</i>	25		
<i>Fragilaria capucina</i> var. <i>perminuta</i>	50	<i>Chamaesiphon confervicolus</i>	13	<i>Mentha aquatica</i>	25		
<i>Gomphonema truncatum</i>	50	<i>Cocconeis pediculus</i>	13	<i>Potamogeton natans</i>	25		
<i>Mougeotia</i> W4	50	<i>Cyclotella radiosa</i>	13	<i>Rhynchosstegium ripariodes</i>	25		
<i>Phormidium favosum</i>	50	<i>Cymbella affinis</i>	13	<i>Riccardia</i>	25		
<i>Phormidium retzii</i>	50	<i>Diatoma vulgaris</i>	13	<i>Riccia</i>	25		
<i>Reimeria sinuata</i>	50	<i>Didymosphenia geminata</i>	13	<i>Senecio aquaticus</i>	25		
<i>Spirogyra</i> W1	50	<i>Eunotia arcus</i>	13	<i>Alisma plantago-aquatica</i>	13		
<i>Achnanthes flexella</i>	38	<i>Eunotia bilunaris</i>	13	<i>Berula erecta</i>	13		
<i>Achnanthidium biasoletiana</i>	38	<i>Eunotia pectinalis</i>	13	<i>Blindia acuta</i>	13		
<i>Ankistrodesmus falcatus</i>	38	<i>Fragilaria pulchella</i>	13	<i>Brachythecium rivulare</i>	13		
<i>Cocconeis placentula</i>	38	<i>Gomphonema micropus</i>	13	<i>Bryum pseudotriquetrum</i>	13		
<i>Frustulia rhomboides</i>	38	<i>Lyngbya martensiana</i>	13	<i>Callitriche platycarpa</i>	13		
<i>Frustulia rhomboides</i> var. <i>viridula</i>	38	<i>Microspora irregularis</i>	13	<i>Caltha palustris</i>	13		
<i>Gomphonema clavatum</i>	38	<i>Microspora tumidula</i>	13	<i>Carex rostrata</i>	13		
<i>Gongrosira</i> sp.	38	<i>Mougeotia</i> W1	13	<i>Dichodontium</i>	13		
<i>Meridion circulare</i> var. <i>constrictum</i>	38	<i>Mougeotia</i> W5	13	<i>Dicranella palustris</i>	13		
<i>Mougeotia</i> W3	38	<i>Navicula tripunctata</i>	13	<i>Eleocharis</i>	13		
<i>Navicula cryptocephala</i>	38	<i>Nitzschia fonticola</i>	13	<i>Equisetum fluviatile</i>	13		
<i>Navicula lanceolata</i>	38	<i>Nitzschia linearis</i>	13	<i>Geum rivulare</i>	13		
<i>Oedogonium</i> W3	38	<i>Oedogonium</i> W7	13	<i>Hydrocotyle vulgaris</i>	13		
<i>Rhoicosphenia abbreviata</i>	38	<i>Phormidium autumnale</i>	13	<i>Juncus bulbosus</i>	13		
<i>Spirogyra</i> W3	38	<i>Pinnularia subcapitata</i>	13	<i>Littorella uniflora</i>	13		
<i>Surirella brebissonii</i>	38	<i>Surirella angusta</i>	13	<i>Lunularia</i>	13		
<i>Ulothrix zonata</i>	38	<i>Zygnema</i> W5	13	<i>Marsupella emarginata</i>	13		

River Type 12 (4 sites).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq
<i>Lumbriculus variegatus</i>	100	<i>Simulium argyreatum</i>	75	<i>Piscicola geometra</i>	25
<i>Stylodrilus heringianus</i>	100	<i>Tricladidia</i> indet.	50	<i>Siphonurus lacustris</i>	25
Tubificidae indet.	100	<i>Pisidium subtruncatum</i>	50	<i>Baetis vernus</i>	25
Enchytraeidae indet.	100	Nematoda indet.	50	<i>Centroptilum luteolum</i>	25
Lumbricidae indet.	100	<i>Glossiphonia complanata</i>	50	<i>Heptagenia sulphurea</i>	25
<i>Serratella ignita</i>	100	<i>Erpobdella octoculata</i>	50	<i>Ecdyonurus torrentis</i>	25
<i>Baetis rhodani</i>	100	<i>Asellus aquaticus</i>	50	<i>Nemurella picteti</i>	25
<i>Rhithrogena semicolorata</i>	100	<i>Baetis scambus</i>	50	<i>Nemoura</i> spp.	25
<i>Ecdyonurus venosus</i>	100	<i>Baetis muticus</i>	50	<i>Perla bipunctata</i>	25
<i>Protonemura meyeri</i>	100	<i>Electrogena lateralis</i>	50	<i>Dinocras cephalotes</i>	25
<i>Esolus parallelepipedus</i>	100	<i>Ecdyonurus dispar</i>	50	<i>Ischnura elegans</i>	25
<i>Elmis aenea</i>	100	<i>Ecdyonurus insignis</i>	50	<i>Pyrrhosoma nymphula</i>	25
<i>Oulimnius tuberculatus</i>	100	<i>Paraleptophlebia cincta</i>	50	<i>Velia</i> spp.	25
<i>Limnius volckmari</i>	100	<i>Caenis luctuosa</i>	50	<i>Dryops</i> spp.	25
<i>Elodes</i> spp.	100	<i>Caenis rivulorum</i>	50	<i>Haliphus</i> spp.	25
<i>Rhyacophila dorsalis</i>	100	<i>Leuctra inermis</i>	50	<i>Brychius</i> sp.	25
<i>Polycentropus flavomaculatus</i>	100	<i>Chloroperla tripunctata</i>	50	<i>Hydroporus</i> sp.	25
<i>Hydropsyche siltalai</i>	100	<i>Calopteryx virgo</i>	50	<i>Stictonectes lepidus</i>	25
<i>Lepidostoma hirtum</i>	100	<i>Oreodytes sanmarkii</i>	50	<i>Helophorus</i> spp.	25
<i>Halesus radiatus</i>	100	<i>Oreodytes septentrionalis</i>	50	<i>Chimarra marginata</i>	25
<i>Sericostoma personatum</i>	100	<i>Stictotarsus duodecimpustulatus</i>	50	<i>Plectrocnemia geniculata</i>	25
<i>Tipula</i> spp.	100	<i>Hydrocyphon</i> sp.	50	<i>Polycentropus irrorata</i>	25
<i>Dicranota</i> spp.	100	<i>Wormaldia occipitalis</i>	50	<i>Tinodes waeneri</i>	25
Ceratopogonidae indet.	100	<i>Philopotamus monatus</i>	50	<i>Hydropsyche instabilis</i>	25
<i>Hemerodromia</i> spp.	100	<i>Plectrocnemia conspersa</i>	50	<i>Glossosoma</i> spp.	25
<i>Simulium argyreatum/variegatum</i> group	100	<i>Polycentropus kingi</i>	50	<i>Goera pilosa</i> (Fbr)	25
Tanypodinae indet.	100	<i>Lype reducta</i>	50	<i>Ithytrichia</i> spp.	25
Orthocladinae indet.	100	<i>Hydroptila</i> spp.	50	<i>Oxyethira</i> spp.	25
Chironominae indet.	100	<i>Mystacides</i> spp.	50	<i>Crunoecia irrorata</i>	25
<i>Potamopyrgus antipodarum</i>	75	<i>Chaetopteryx villosa</i>	50	<i>Lasiocephala basalis</i>	25
<i>Ancylus fluviatilis</i>	75	<i>Limnephilus rhombicus</i>	50	<i>Athripsodes</i> spp.	25
<i>Lymnaea peregra</i>	75	<i>Odontocerum albicorne</i>	50	<i>Oecetis testacea</i>	25
<i>Pisidium casertanum</i>	75	<i>Eloeophila</i> spp.	50	<i>Ceraclea</i> spp.	25
<i>Gammarus duebeni</i>	75	<i>Antocha</i> spp.	50	<i>Anabolia nervosa</i>	25
Hydracarina indet.	75	<i>Atherix marginata</i>	50	<i>Drusus annulatus</i>	25
<i>Brachyptera risi</i>	75	<i>Limnophora</i> spp.	50	<i>Halesus digitatus</i>	25
<i>Amphinemura sulciollis</i>	75	<i>Simulium cryophilum</i>	50	<i>Limnephilus flavicornis</i>	25
<i>Leuctra hippopus</i>	75	<i>Simulium vernum</i>	50	<i>Limnephilus lunatus</i>	25
<i>Isoperla grammatica</i>	75	<i>Simulium armoricanum</i>	50	<i>Potamophylax latipennis</i>	25
<i>Siphonoperla torrentium</i>	75	<i>Simulium reptans</i>	50	<i>Pedicia</i> spp.	25
<i>Hydraena gracilis</i>	75	Prodiamesinae indet.	50	<i>Tricyphona</i> spp.	25
<i>Orectochilus villosus</i>	75	<i>Valvata piscinalis</i>	25	<i>Helius</i> spp.	25
<i>Rhyacophila munda</i>	75	<i>Pisidium milium</i>	25	<i>Euphyllidorea/Phyllidorea</i> spp.	25
<i>Hydropsyche pellucidula</i>	75	<i>Pisidium nitidum</i>	25	Dolichopodidae indet.	25
<i>Agapetus</i> spp.	75	<i>Margaritifera margaritifera</i>	25	Syrphidae indet.	25
<i>Silo pallipes</i> (Fabricius)	75	<i>Spirosperma ferox</i>	25	<i>Simulium ornatum/intermedium/trifasciatum</i>	25
<i>Potamophylax cingulatus</i>	75	<i>Stylaria lacustris</i>	25	<i>Eukiefferiella</i> spp.	25
Psychodidae indet.	75	Naididae indet.	25	<i>Microtendipes pedellus</i>	25
<i>Chelifera</i> spp.	75	<i>Glossiphonia hereroclita</i>	25		

River Type 12 *contd.*

Phytobenthos	% freq	Phytobenthos <i>contd.</i>	% freq	Macrophytes	% freq
<i>Achnanthes oblongella</i>	100	<i>Oedogonium</i> W2	25	<i>Conocephalum conicum</i>	75
<i>Achnanthidium minutissimum</i>	100	<i>Oedogonium</i> W7	25	<i>Filipendula ulmaria</i>	75
<i>Cymbella minuta</i>	100	<i>Oscillatoria sancta</i>	25	<i>Fortinalis squamosa</i>	75
<i>Cymbella silesiaca</i>	100	<i>Phormidium autumnale</i>	25	<i>Oenanthe crocata</i>	75
<i>Fragilaria capucina</i>	100	<i>Phormidium favosum</i>	25	<i>Rhynchostegium ripariodes</i>	75
<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	100	<i>Stigeoclonium</i> sp.	25	<i>Angelica sylvestris</i>	50
<i>Gomphonema parvulum</i>	100	<i>Surirella angusta</i>	25	<i>Brachythecium plumosum</i>	50
<i>Tabellaria flocculosa</i>	100	<i>Surirella brebissonii</i>	25	<i>Bryum pseudotriquetrum</i>	50
<i>Gomphonema angustum</i>	75	<i>Tabellaria fenestrata</i>	25	<i>Dichodontium</i>	50
<i>Hanea arcus</i>	75	<i>Ulothrix tenerrima</i>	25	<i>Fontinalis antipyretica</i>	50
<i>Nitzschia dissipata</i>	75			<i>Hyocomium armonicum</i>	50
<i>Nitzschia palea</i>	75			<i>Iris pseudacorus</i>	50
<i>Reimeria sinuata</i>	75			<i>Juncus articulatus</i>	50
<i>Achnanthes lanceolata</i>	50			<i>Juncus effusus</i>	50
<i>Achnanthidium biasolettiana</i>	50			<i>Lythrum salicaria</i>	50
<i>Audouinella hermannii</i>	50			<i>Mnium hornum</i>	50
<i>Chamaesiphon incrustans</i>	50			<i>Myriophyllum alternifolium</i>	50
<i>Cocconeis placentula</i>	50			<i>Pellia epiphylla</i>	50
<i>Eunotia implicata</i>	50			<i>Racomitrium</i>	50
<i>Gomphonema acuminatum</i>	50			<i>Ranunculus flammula</i>	50
<i>Gomphonema clavatum</i>	50			<i>Rhizomnium punctatum</i>	50
<i>Gomphonema minutum</i>	50			<i>Scapania undulata</i>	50
<i>Gongrosira</i> sp.	50			<i>Senecio aquaticus</i>	50
<i>Lemanea fluviatilis</i>	50			<i>Thamnobryum</i>	50
<i>Oedogonium</i> W5	50			<i>Valeriana</i>	50
<i>Phormidium fragile</i>	50			<i>Alisma plantago-aquatica</i>	25
<i>Spirogyra</i> W1	50			<i>Apium nodiflorum</i>	25
<i>Spirogyra</i> W3	50			<i>Brachythecium rivulare</i>	25
<i>Spirogyra</i> W4	50			<i>Brachythecium rutabulum</i>	25
<i>Synedra ulna</i>	50			<i>Callitriche hamulata</i>	25
<i>Ulothrix zonata</i>	50			<i>Callitriche stagnalis</i>	25
<i>Achnanthes flexella</i>	25			<i>Chiloscyphus polyanthos</i>	25
<i>Brachysira vitrea</i>	25			<i>Cladophora</i> spp.	25
<i>Bulbochaete</i> sp.	25			<i>Equisetum arvense</i>	25
<i>Cladophora glomerata</i>	25			Filamentous green algae	25
<i>Cymbella affinis</i>	25			<i>Glyceria fluitans</i>	25
<i>Cymbella gracilis</i>	25			<i>Hygrohypnum</i>	25
<i>Diatoma moniliformis</i>	25			<i>Littorella uniflora</i>	25
<i>Frustulia rhomboides</i> var. <i>viridula</i>	25			<i>Mentha aquatica</i>	25
<i>Gomphonema gracile</i>	25			<i>Montia fontana</i>	25
<i>Gomphonema micropus</i>	25			<i>Myosotis scorpioides</i>	25
<i>Gomphonema olivaceum</i>	25			<i>Myriophyllum spicatum</i>	25
<i>Gomphonema truncatum</i>	25			<i>Nuphar lutea</i>	25
<i>Hildenbrandia rivularis</i>	25			<i>Persicaria hydropiper</i>	25
<i>Meridion circulare</i>	25			<i>Phalaris arundinacea</i>	25
<i>Meridion circulare</i> var. <i>constrictum</i>	25			<i>Plagiomnium rostratum</i>	25
<i>Microspora crassior</i>	25			<i>Potamogeton alpinus</i>	25
<i>Monostroma</i> sp.	25			<i>Potamogeton natans</i>	25
<i>Mougeotia</i> W4	25			<i>Ranunculus peltatus</i>	25
<i>Navicula gregaria</i>	25			<i>Ranunculus penicillatus</i>	25
<i>Navicula lanceolata</i>	25			<i>Riccardia</i>	25
<i>Navicula rhynchocephala</i>	25			<i>Veronica beccabunga</i>	25

River Type 13 (5 sites).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq
<i>Lumbriculus variegatus</i>	100	<i>Electrogena lateralis</i>	60	<i>Paraleptophlebia cincta</i>	20
<i>Stylodrilus heringianus</i>	100	<i>Velia caprai</i>	60	<i>Nemoura cinerea</i>	20
Tubificidae indet.	100	<i>Oreodytes sanmarkii</i>	60	<i>Nemurella picteti</i>	20
Enchytraeidae indet.	100	<i>Philopotamus monatus</i>	60	<i>Chloroperla tripunctata</i>	20
Lumbricidae indet.	100	<i>Glossosoma boltoni</i>	60	<i>Hesperoconixa sahlbergi</i>	20
<i>Serratella ignita</i>	100	<i>Agapetus</i> spp.	60	<i>Haliphus lineatocollis</i>	20
<i>Baetis rhodani</i>	100	<i>Sericostoma personatum</i>	60	<i>Hydroporus nigrita</i>	20
<i>Rhithrogena semicolorata</i>	100	<i>Odontocerum albicorne</i>	60	<i>Hydroporus planus</i>	20
<i>Ecdyonurus venosus</i>	100	<i>Tipula</i> spp.	60	<i>Hydroporus tessellatus</i>	20
<i>Protonemura meyeri</i>	100	<i>Pedicia</i> spp.	60	<i>Oreodytes septentrionalis</i>	20
<i>Leuctra hippopus</i>	100	<i>Eloeophila</i> spp.	60	<i>Anacaena limbata</i>	20
<i>Leuctra inermis</i>	100	<i>Chelifera</i> spp.	60	Galerucinae indet.	20
<i>Isoperla grammatica</i>	100	<i>Simulium argyreatum</i>	60	<i>Wormaldia occipitalis</i>	20
<i>Siphonoperla torrentium</i>	100	Chironominae indet.	60	<i>Plectrocnemia geniculata</i>	20
<i>Esolus parallelepipedus</i>	100	<i>Potamopyrgus antipodarum</i>	40	<i>Lype reducta</i>	20
<i>Elmis aenea</i>	100	<i>Aulodrilus pluriset</i>	40	<i>Tinodes waeneri</i>	20
<i>Oulimnius tuberculatus</i>	100	Collembola indet.	40	<i>Diplectrona felix</i>	20
<i>Limnius volckmari</i>	100	<i>Heptagenia sulphurea</i>	40	<i>Glossosoma conformis</i>	20
<i>Hydraena gracilis</i>	100	<i>Ecdyonurus torrentis</i>	40	<i>Ithytrichia</i> spp.	20
<i>Elodes</i> spp.	100	<i>Caenis rivulorum</i>	40	<i>Oxyethira</i> spp.	20
<i>Rhyacophila dorsalis</i>	100	<i>Nemoura avicularis</i>	40	<i>Drusus annulatus</i>	20
<i>Plectrocnemia conspersa</i>	100	<i>Perla bipunctata</i>	40	<i>Ecclisopteryx guttulata</i>	20
<i>Polycentropus flavomaculatus</i>	100	<i>Limnebius truncatellus</i>	40	<i>Halesus digitatus</i>	20
<i>Hydropsyche siltalai</i>	100	<i>Orectochilus villosus</i>	40	Micropterna/Stenophylax group	20
<i>Hydropsyche pellucidula</i>	100	<i>Agabus</i> spp.	40	<i>Dicronomyia/Neolimonia</i> spp.	20
<i>Chaetopteryx villosa</i>	100	<i>Helophorus</i> spp.	40	<i>Dixa puberula</i>	20
<i>Halesus radiatus</i>	100	<i>Anacaena globulus</i>	40	Ceratopogonidae indet.	20
<i>Dicranota</i> spp.	100	<i>Hydrocyphon</i> spp.	40	<i>Dasyhelea</i> spp.	20
<i>Wiedemannia/Clinocera</i> spp.	100	<i>Wormaldia subnigra</i>	40	Culicidae indet.	20
Simuliidae indet.	100	<i>Psychomyia pusilla</i>	40	Rhagionidae indet.	20
Tanypodinae indet.	100	<i>Hydropsyche instabilis</i>	40	<i>Limnophora</i> spp.	20
Orthocladiinae indet.	100	<i>Potamophylax cingulatus</i>	40	<i>Simulium cryophilum</i>	20
Tricladidia indet.	80	<i>Antocha</i> spp.	40	<i>Simulium vernum</i>	20
<i>Ancylus fluviatilis</i>	80	Dolichopodidae indet.	40	<i>Simulium armoricanum</i>	20
<i>Pisidium casertanum</i>	80	<i>Hemerodromia</i> spp.	40	<i>Simulium angustipes/velutinum</i> group	20
<i>Brachyptera risi</i>	80	<i>Simulium dunfellenense/urbanum</i> group	40		
<i>Amphinemura sulciatilis</i>	80	<i>Simulium ornatum/intermedium</i> group	40		
<i>Rhyacophila munda</i>	80	<i>Simulium tuberosum</i>	40		
<i>Polycentropus kingi</i>	80	Prodiamesinae indet.	40		
<i>Silo pallipes</i>	80	<i>Lymnaea peregra</i>	20		
<i>Hydroptila</i> spp.	80	<i>Pisidium personatum</i>	20		
<i>Lepidostoma hirtum</i>	80	<i>Pisidium subtruncatum</i>	20		
Psychodidae indet.	80	<i>Margaritifera margaritifera</i>	20		
<i>Simulium argyreatum/variegatum</i> group	80	<i>Spirosperma ferox</i>	20		
<i>Simulium variegatum</i>	80	<i>Glossiphonia complanata</i>	20		
<i>Gammarus duebeni</i>	60	<i>Siphonurus lacustris</i>	20		
Hydracarina indet.	60	<i>Centroptilum luteolum</i>	20		
<i>Baetis scambus</i>	60	<i>Ecdyonurus insignis</i>	20		
<i>Baetis muticus</i>	60	<i>Leptophlebia vespertina</i>	20		

River Type 13 contd.

Phytobenthos	% freq	Phytobenthos contd.	% freq	Macrophytes	% freq
<i>Achnanthes oblongella</i>	100	<i>Cosmarium</i> sp.17	20	<i>Juncus articulatus</i>	100
<i>Achnanthidium minutissimum</i>	100	<i>Cymbella helvetica</i>	20	<i>Fontinalis squamosa</i>	80
<i>Fragilaria capucina</i>	100	<i>Cymbella microcephala</i>	20	<i>Racomitrium</i>	80
<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	100	<i>Diatoma mesodon</i>	20	<i>Rhynchostegium ripariodes</i>	80
<i>Gomphonema parvulum</i>	100	<i>Eunotia minor</i>	20	<i>Brachythecium plumosum</i>	60
<i>Cymbella gracilis</i>	80	<i>Fragilaria pulchella</i>	20	<i>Brachythecium rivulare</i>	60
<i>Eunotia bilunaris</i>	80	<i>Gomphonema clavatum</i>	20	<i>Chiloscyphus polyanthos</i>	60
<i>Hanea arcus</i>	80	<i>Gongrosira</i> sp.	20	<i>Conocephalum conicum</i>	60
<i>Nitzschia dissipata</i>	80	<i>Lemanea fluviatilis</i>	20	<i>Hygrohypnum</i>	60
<i>Tabellaria flocculosa</i>	80	<i>Meridion circulare</i> var. <i>constrictum</i>	20	<i>Polytrichum commune</i>	60
<i>Brachysira vitrea</i>	60	<i>Microspora</i> sp.8	20	<i>Ranunculus flammula</i>	60
<i>Bulbochaete</i> sp.	60	<i>Navicula gregaria</i>	20	<i>Rhizomnium punctatum</i>	60
<i>Cocconeis placentula</i>	60	<i>Navicula rhynchocephala</i>	20	<i>Blindia acuta</i>	40
<i>Cymbella silesiaca</i>	60	<i>Oedogonium</i> W3	20	<i>Callitriche stagnalis</i>	40
<i>Frustulia rhomboides</i>	60	<i>Oedogonium</i> W4	20	<i>Dicranella palustris</i>	40
<i>Gomphonema olivaceum</i>	60	<i>Oedogonium</i> W5	20	<i>Fissidens</i>	40
<i>Lyngbya martensiana</i>	60	<i>Oscillatoria brevis</i>	20	<i>Hyocomium armonicum</i>	40
<i>Mougeotia</i> W4	60	<i>Phormidium autumnale</i>	20	<i>Juncus effusus</i>	40
<i>Navicula lanceolata</i>	60	<i>Phormidium favosum</i>	20	<i>Oenanthe crocata</i>	40
<i>Audouinella hermannii</i>	40	<i>Phormidium retzii</i>	20	<i>Pellia epiphylla</i>	40
<i>Chamaesiphon incrustans</i>	40	<i>Pinnularia subcapitata</i>	20	<i>Scapania undulata</i>	40
<i>Cymbella minuta</i>	40	<i>Staurostrum</i> sp.6	20	<i>Alisma plantago-aquatica</i>	20
<i>Diatoma moniliformis</i>	40	<i>Surirella angusta</i>	20	<i>Angelica sylvestris</i>	20
<i>Diatoma tenuis</i>	40	<i>Ulothrix tenerima</i>	20	<i>Bryum pseudotriquetrum</i>	20
<i>Eunotia implicata</i>	40	<i>Ulothrix zonata</i>	20	<i>Butomus umbellatus</i>	20
<i>Frustulia rhomboides</i> var. <i>viridula</i>	40	<i>Zygnema</i> W1	20	<i>Callitriche platycarpa</i>	20
<i>Gomphonema angustum</i>	40	<i>Zygnema</i> W4	20	<i>Carex rostrata</i>	20
<i>Gomphonema minutum</i>	40			<i>Carex versicaria</i>	20
<i>Gomphonema truncatum</i>	40			<i>Cladophora</i> spp.	20
<i>Meridion circulare</i>	40			<i>Dichodontium</i>	20
<i>Microspora tumidula</i>	40			<i>Equisetum arvense</i>	20
<i>Monostroma</i> sp.	40			Filamentous green algae	20
<i>Mougeotia</i> W3	40			<i>Filipendula ulmaria</i>	20
<i>Mougeotia</i> W5	40			<i>Fontinalis antipyretica</i>	20
<i>Navicula cryptotenella</i>	40			Globular algae	20
<i>Nitzschia palea</i>	40			<i>Jungermannia</i>	20
<i>Oscillatoria agardhii</i>	40			<i>Lunularia</i>	20
<i>Oscillatoria limosa</i>	40			<i>Lythrum salicaria</i>	20
<i>Reimeria sinuata</i>	40			<i>Marsipella emarginata</i>	20
<i>Spirogyra</i> W2	40			<i>Mentha aquatica</i>	20
<i>Synedra ulna</i>	40			<i>Mnium hornum</i>	20
<i>Tabellaria fenestrata</i>	40			<i>Montia fontana</i>	20
<i>Achnanthes flexella</i>	20			<i>Pellia endiviifolia</i>	20
<i>Achnanthes petersenii</i>	20			<i>Persicaria hydropiper</i>	20
<i>Achnanthidium biasolettiana</i>	20			<i>Senecio aquaticus</i>	20
<i>Ankistrodesmus falcatus</i>	20			<i>Sphagnum</i>	20
<i>Calothrix</i> sp.3	20			<i>Valeriana</i>	20
<i>Closterium parvulum</i>	20				
<i>Cocconeis pediculus</i>	20				

River Type 14 (2 sites).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Phytobenthos	% freq	Macrophytes	% freq
<i>Ancylus fluviatilis</i>	100	<i>Stylodrilus heringianus</i>	50	<i>Achnanthes oblongella</i>	100	<i>Fortinalis squamosa</i>	100
<i>Lumbriculus variegatus</i>	100	Nematoda indet.	50	<i>Achnanthidium minutissimum</i>	100	<i>Hyocomium armoricum</i>	100
Enchytraeidae indet.	100	<i>Asellus aquaticus</i>	50	<i>Audouinella hermannii</i>	100	<i>Racomitrium</i>	100
Lumbricidae indet.	100	Hydracarina indet.	50	<i>Chamaesiphon incrustans</i>	100	<i>Scapania undulata</i>	100
<i>Ameletus inopinatus</i>	100	<i>Siphonurus lacustris</i>	50	<i>Diatoma mesodon</i>	100	<i>Brachythecium plumosum</i>	50
<i>Serratella ignita</i>	100	<i>Baetis scambus</i>	50	<i>Fragilaria capucina</i>	100	<i>Brachythecium rivulare</i>	50
<i>Baetis vernus</i>	100	<i>Baetis muticus</i>	50	<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	100	Globular algae	50
<i>Baetis rhodani</i>	100	<i>Ecdyonurus dispar</i>	50	<i>Gomphonema parvulum</i>	100	<i>Hygrohypnum</i>	50
<i>Rhithrogena semicolorata</i>	100	<i>Velia caprai</i>	50	<i>Gongrosira</i> sp.	100	<i>Juncus effusus</i>	50
<i>Electrogena lateralis</i>	100	<i>Helophorus</i> spp.	50	<i>Meridion circulare</i>	100	<i>Lemanea</i>	50
<i>Ecdyonurus venosus</i>	100	<i>Wormaldia occipitalis</i>	50	<i>Microspora tumidula</i>	100	<i>Marsupella emarginata</i>	50
<i>Brachyptera risi</i>	100	<i>Plectrocnemia conspersa</i>	50	<i>Mougeotia</i> W3	100	<i>Mnium hornum</i>	50
<i>Amphimura sulciollis</i>	100	<i>Hydropsyche pellucidula</i>	50	<i>Mougeotia</i> W4	100	<i>Pellia epiphylla</i>	50
<i>Protonemura meyeri</i>	100	<i>Agapetus</i> spp.	50	<i>Synedra ulna</i>	100	<i>Polytrichum commune</i>	50
<i>Leuctra hippopus</i>	100	<i>Oxyethira</i> spp.	50	<i>Tabellaria flocculosa</i>	100	<i>Rhizomnium punctatum</i>	50
<i>Leuctra inermis</i>	100	<i>Hydroptila</i> spp.	50	<i>Zygnema</i> W3	100	<i>Thamnobryum</i>	50
<i>Isoperla grammatica</i>	100	<i>Lepidostoma hirtum</i>	50	<i>Achnanthes petersenii</i>	50		
<i>Diura bicaudata</i>	100	<i>Drusus annulatus</i>	50	<i>Brachysira vitrea</i>	50		
<i>Chloroperla tripunctata</i>	100	<i>Halesus digitatus</i>	50	<i>Bulbochaete</i> sp.	50		
<i>Siphonoperla torrentium</i>	100	<i>Beraea maurus</i>	50	<i>Chamaesiphon confervicolus</i>	50		
<i>Esolus parallelepipedus</i>	100	<i>Tipula</i> spp.	50	<i>Cladophora glomerata</i>	50		
<i>Elmis aenea</i>	100	<i>Pedicia</i> spp.	50	<i>Cymbella gracilis</i>	50		
<i>Oulimnius tuberculatus</i>	100	<i>Cheilotrichia</i> spp.	50	<i>Cymbella minuta</i>	50		
<i>Limnius volckmari</i>	100	Dolichopodidae indet.	50	<i>Cymbella silesiaca</i>	50		
<i>Hydraena gracilis</i>	100	<i>Hemerodromia</i> spp.	50	<i>Eunotia bilunaris</i>	50		
<i>Dryops</i> spp.	100	<i>Simulium cryophilum</i>	50	<i>Eunotia implicata</i>	50		
<i>Oreodytes sanmarkii</i>	100	<i>Simulium armoricanum</i>	50	<i>Eunotia minor</i>	50		
Curculionidae indet.	100	Chironominae indet.	50	<i>Eunotia</i> sp.1	50		
<i>Elodes</i> spp.	100			<i>Frustulia rhomboides</i>	50		
<i>Rhyacophila dorsalis</i>	100			<i>Frustulia rhomboides</i> var. <i>viridula</i>	50		
<i>Rhyacophila munda</i>	100			<i>Gomphonema clavatum</i>	50		
<i>Philopotamus monatus</i>	100			<i>Gomphonema gracile</i>	50		
<i>Plectrocnemia geniculata</i>	100			<i>Gomphonema olivaceum</i>	50		
<i>Polycentropus flavomaculatus</i>	100			<i>Gomphonema truncatum</i>	50		
<i>Tinodes waeneri</i>	100			<i>Microspora</i> sp.5	50		
<i>Hydropsyche siltalai</i>	100			<i>Monostroma</i> sp.	50		
<i>Silo pallipes</i>	100			<i>Mougeotia</i> W5	50		
<i>Chaetopteryx villosa</i>	100			<i>Nitzschia dissipata</i>	50		
<i>Halesus radiatus</i>	100			<i>Nitzschia palea</i>	50		
<i>Potamophylax cingulatus</i>	100			<i>Oedogonium</i> W3	50		
<i>Sericostoma personatum</i>	100			<i>Oedogonium</i> W4	50		
<i>Odontocerum albicorne</i>	100			<i>Oscillatoria agardhii</i>	50		
<i>Dicranota</i> spp.	100			<i>Oscillatoria brevis</i>	50		
<i>Eloeophila</i> spp.	100			<i>Oscillatoria limosa</i>	50		
Psychodidae indet.	100			<i>Phormidium fragile</i>	50		
<i>Wiedemannia/Clinocera</i> spp.	100			<i>Pinnularia subcapitata</i>	50		
<i>Chelifera</i> spp.	100			<i>Spirogyra</i> W1	50		
<i>Simulium argyreatum</i> / <i>variegatum</i> group	100			<i>Surirella angusta</i>	50		
Tanypodinae indet.	100			<i>Ulothrix tenerrima</i>	50		
Orthocladinae indet.	100			<i>Zygnema</i> W1	50		

River Type 21 (10 sites).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq
<i>Potamopyrgus antipodarum</i>	100	<i>Ecdyonurus insignis</i>	70	<i>Ecdyonurus dispar</i>	30	<i>Gyraulus albus</i>	10
<i>Ancylus fluviatilis</i>	100	<i>Amphinemura sulcicollis</i>	70	<i>Paraleptophlebia cincta</i>	30	<i>Arminger crista</i>	10
Tubificidae indet.	100	<i>Oreodytes septentrionalis</i>	70	<i>Caenis luctuosa</i>	30	<i>Pisidium hibernicum</i>	10
Enchytraeidae indet.	100	Curculionidae indet.	70	<i>Brychius elevatus</i>	30	<i>Pisidium milium</i>	10
Lumbricidae indet.	100	<i>Agapetus</i> spp.	70	<i>Cyrnus trimaculatus</i>	30	Lumbricidae indet.	10
<i>Gammarus duebeni</i>	100	<i>Potamophylax latipennis</i>	70	<i>Plectrocnemia geniculata</i>	30	<i>Aulodrilus plurisetus</i>	10
<i>Serratella ignita</i>	100	<i>Odontocerum albicorne</i>	70	<i>Lype reducta</i>	30	<i>Tubifex ignotus</i>	10
<i>Baetis rhodani</i>	100	Psychodidae indet.	70	<i>Lasiocephala basalis</i>	30	<i>Stylaria lacustris</i>	10
<i>Baetis muticus</i>	100	<i>Wiedemannia/Clinocera</i> spp.	70	<i>Anabolia nervosa</i>	30	Gordioidae indet.	10
<i>Rhithrogena semicolorata</i>	100	Prodiamesinae indet.	70	<i>Drusus annulatus</i>	30	<i>Asellus meridianus</i>	10
<i>Ecdyonurus venosus</i>	100	<i>Bathymophalus contortus</i>	60	<i>Limnephilus lunatus</i>	30	Collembola indet.	10
<i>Protonemura meyeri</i>	100	<i>Lymnaea peregra</i>	60	<i>Beraeodes minutus</i>	30	<i>Nemurella picteti</i>	10
<i>Leuctra hippopus</i>	100	<i>Asellus aquaticus</i>	60	<i>Antocha</i> spp.	30	<i>Leuctra nigra</i>	10
<i>Esolus parallelepipedus</i>	100	<i>Centroptilum luteolum</i>	60	<i>Simulium cryophilum</i>	30	<i>Dinocras cephalotes</i>	10
<i>Elmis aenea</i>	100	<i>Heptagenia sulphurea</i>	60	<i>Simulium variegatum</i>	30	<i>Gerris lacustris</i>	10
<i>Limnius volckmari</i>	100	<i>Nemoura avicularis</i>	60	<i>Ansius leucostoma</i>	20	<i>Gerris najas</i>	10
<i>Hydraena gracilis</i>	100	<i>Orectochilus villosus</i>	60	<i>Lymnaea truncatula</i>	20	<i>Notonecta glauca</i>	10
<i>Rhyacophila dorsalis</i>	100	<i>Stictotarsus duodecimpustulatus</i>	60	<i>Pisidium nitidum</i>	20	<i>Callicorixa praeusta</i>	10
<i>Hydropsyche pellucidula</i>	100	<i>Elodes</i> spp.	60	<i>Pisidium personatum</i>	20	<i>Hydraena puchella</i>	10
<i>Silo pallipes</i>	100	<i>Rhyacophila munda</i>	60	<i>Spirosperma ferox</i>	20	<i>Gyrinus caspius</i>	10
<i>Halesus radiatus</i>	100	<i>Polycentropus flavomaculatus</i>	60	<i>Gordius</i> sp.	20	<i>Hydroporus pubescens</i>	10
<i>Potamophylax cingulatus</i>	100	<i>Psychomyia pusilla</i>	60	<i>Siphonurus lacustris</i>	20	<i>Hydroporus tessellatus</i>	10
<i>Tipula</i> spp.	100	<i>Glossosoma</i> spp.	60	<i>Ephemera danica</i>	20	<i>Hydroporus obsoletus</i>	10
<i>Dicranota</i> spp.	100	<i>Athripsodes</i> spp.	60	<i>Capnia bifrons</i>	20	<i>Stictometes lepidus</i>	10
Simuliidae indet.	100	<i>Simulium ornatum/intermedium/trifasciatum</i> group	60	<i>Calopteryx virgo</i>	20	<i>Nebiroporus depressus elegans</i> complex	10
Orthocladinae indet.	100	<i>Simulium argyreatum/variegatum</i> group	60	<i>Hesperocorixa sahlbergi</i>	20	<i>Megasternum obscurum</i>	10
<i>Pisidium casertanum</i>	90	Tricladidae indet.	50	<i>Micronecta poweri</i>	20	<i>Laccobius sinuatus</i>	10
<i>Caenis rivulorum</i>	90	<i>Pisidium subtruncatum</i>	50	<i>Gyrinus substriatus</i>	20	<i>Paracymus scutellaris</i>	10
<i>Leuctra inermis</i>	90	<i>Rhyacodrilus coccineus</i>	50	<i>Gyrinus urinator</i>	20	<i>Osmylus fulvicephalus</i>	10
<i>Perla bipunctata</i>	90	Nematoda indet.	50	<i>Dryops</i> spp.	20	<i>Wormaldia subnigra</i>	10
<i>Siphonoperla torrentium</i>	90	<i>Helobdella stagnalis</i>	50	<i>Dytiscus</i> spp.	20	<i>Polycentropus irrorata</i>	10
<i>Oulimnius tuberculatus</i>	90	<i>Velia</i> spp.	50	<i>Helophorus</i> spp.	20	<i>Tinodes waeneri</i>	10
<i>Hydropsyche siltalai</i>	90	<i>Haliphus lineatocollis</i>	50	<i>Anacaena globulus</i>	20	<i>Tinodes maculicornis</i>	10
<i>Sericostoma personatum</i>	90	<i>Plectrocnemia conspersa</i>	50	Chrysomelidae indet.	20	<i>Hydropsyche angustipennis</i>	10
Ceratopogonidae indet.	90	<i>Hydropsyche instabilis</i>	50	<i>Hydrocyphon</i> spp.	20	<i>Crunoecia irrorata</i>	10
<i>Chelifera</i> spp.	90	<i>Goera pilosa</i>	50	<i>Philopotamus monatus</i>	20	<i>Glyptotaelius pellicidus</i>	10
Tanyptodinae indet.	90	<i>Chaetopteryx villosa</i>	50	<i>Polycentropus kingi</i>	20	<i>Beraea maurus</i>	10
<i>Lumbriculus variegatus</i>	80	<i>Limnophora</i> spp.	50	<i>Lype phaeopa</i>	20	<i>Pedicia</i> spp.	10
<i>Stylodrilus heringianus</i>	80	<i>Glossiphonia hereroclita</i>	40	<i>Diplectrona felix</i>	20	<i>Dixa</i> spp.	10
Hydracarina indet.	80	<i>Piscicola geometra</i>	40	<i>Silo nigricornis</i>	20	Syrphidae indet.	10
<i>Brachyptera risi</i>	80	<i>Electrogena lateralis</i>	40	<i>Mystacides</i> spp.	20	<i>Atherix marginata</i>	10
<i>Isoperla grammatica</i>	80	<i>Chloroperla tripunctata</i>	40	<i>Oecetis testacea</i>	20	<i>Simulium vernum</i>	10
<i>Oreodytes sanmarkii</i>	80	<i>Hydraena riparia</i>	40	<i>Ecclisopteryx guttulata</i>	20	<i>Simulium armoricanum</i>	10
<i>Ithytrichia</i> spp.	80	<i>Limnobia truncatellus</i>	40	<i>Limnephilus rhombicus</i>	20	<i>Simulium equinum/lineatum</i> group	10
<i>Lepidostoma hirtum</i>	80	<i>Nebiroporus depressus elegans</i>	40	<i>Micropterna/Stenophylax</i> group	20	<i>Simulium argyreatum</i>	10
<i>Eloeophila</i> spp.	80	<i>Hydroptila</i> spp.	40	<i>Orimarga</i> spp.	20	<i>Simulium tuberosum</i>	10
<i>Hemerodromia</i> spp.	80	<i>Halesus digitatus</i>	40	<i>Dixa nebulosa</i>	20	<i>Brilla</i> spp.	10
Chironominae indet.	80	<i>Simulium ornatum/intermedium</i> group	40	<i>Dixa maculata/nubilipennis</i>	20	<i>Eukiefferiella gracei</i>	10
<i>Glossiphonia complanata</i>	70	<i>Simulium reptans</i>	40	Stratiomyidae indet.	20	<i>Psectrocladius (Psectrocladius) sordidellus</i>	10
<i>Erpobdella octoculata</i>	70	<i>Limnodrilus hoffmeisteri</i>	30	<i>Simulium equinum</i>	20	<i>Microtendipes pedellus</i>	10
<i>Baetis scambus</i>	70	<i>Ecdyonurus torrentis</i>	30	<i>Eukiefferiella claripennis</i>	20		

River Type 21 *contd.*

Phytobenthos	% freq	Phytobenthos <i>contd.</i>	% freq	Macrophytes	% freq	Macrophytes <i>contd.</i>	% freq
<i>Achnanthyidium minutissimum</i>	100	<i>Didymosphenia geminata</i>	20	<i>Filipendula ulmaria</i>	100	<i>Sparganium emersum</i>	20
<i>Cocconeis placentula</i>	100	<i>Frustulia rhomboides</i>	20	<i>Valeriana</i>	80	<i>Thamnobryum</i>	20
<i>Cymbella minuta</i>	100	<i>Gomphonema micropus</i>	20	<i>Chiloscyphus polyanthos</i>	70	<i>Alisma lanceolatum</i>	10
<i>Gomphonema parvulum</i>	100	<i>Heribaudiella fluviatilis</i>	20	<i>Cinclidotus fontinaloides</i>	70	<i>Alisma plantago-aquatica</i>	10
<i>Navicula gregaria</i>	100	<i>Hildenbrandia rivularis</i>	20	<i>Conocephalum conicum</i>	70	<i>Brachythecium rivulare</i>	10
<i>Nitzschia palea</i>	100	<i>Lemanea fluviatilis</i>	20	<i>Juncus effusus</i>	70	<i>Callitriche hamulata</i>	10
<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	90	<i>Microspora crassior</i>	20	<i>Angelica sylvestris</i>	60	<i>Cladophora</i> spp.	10
<i>Navicula lanceolata</i>	90	<i>Monostroma</i> sp.	20	<i>Equisetum arvense</i>	60	<i>Dichodontium</i>	10
<i>Nitzschia dissipata</i>	90	<i>Phormidium retzii</i>	20	<i>Fontinalis antipyretica</i>	60	<i>Eleocharis</i>	10
<i>Reimeria sinuata</i>	90	<i>Surirella angusta</i>	20	<i>Mentha aquatica</i>	60	<i>Equisetum palustre</i>	10
<i>Cymbella silesiaca</i>	80	<i>Tabellaria flocculosa</i>	20	<i>Oenanthe crocata</i>	60	<i>Glyceria plicata</i>	10
<i>Gomphonema olivaceum</i>	80	<i>Achnanthes petersenii</i>	10	<i>Rhynchostegium ripariodes</i>	60	<i>Hyocomium armoricum</i>	10
<i>Meridion circulare</i>	80	<i>Brachysira vitrea</i>	10	<i>Apium nodiflorum</i>	50	<i>Lemna minor</i>	10
<i>Achnanthes oblongella</i>	70	<i>Cymbella helvetica</i>	10	<i>Caltha palustris</i>	50	<i>Mnium hornum</i>	10
<i>Fragilaria capucina</i>	70	<i>Cymbella proxima</i>	10	<i>Juncus articulatus</i>	50	<i>Myosotis scorpioides</i>	10
<i>Gomphonema angustum</i>	70	<i>Diatoma ehrenbergii</i>	10	<i>Glyceria fluitans</i>	40	<i>Pellia epiphylla</i>	10
<i>Synedra ulna</i>	70	<i>Eunotia arcus</i>	10	<i>Butomus umbellatus</i>	30	<i>Potamogeton crispus</i>	10
<i>Ulothrix zonata</i>	70	<i>Eunotia bilunaris</i>	10	<i>Callitriche stagnalis</i>	30	<i>Scapania undulata</i>	10
<i>Achnanthes lanceolata</i>	60	<i>Fragilaria capucina</i> var. <i>capitellata</i>	10	Filamentous green algae	30	<i>Senecio palustre</i>	10
<i>Amphora pediculus</i>	60	<i>Fragilaria capucina</i> var. <i>perminuta</i>	10	<i>Geum rivulare</i>	30	<i>Sparganium erectum</i>	10
<i>Audouinella hermannii</i>	60	<i>Frustulia rhomboides</i> var. <i>viridula</i>	10	<i>Hypericum tetrapterum</i>	30	<i>Stachys palustris</i>	10
<i>Chamaesiphon incrustans</i>	60	<i>Gomphonema acuminatum</i>	10	<i>Lychnis</i>	30		
<i>Cladophora glomerata</i>	60	<i>Meridion circulare</i> var. <i>constrictum</i>	10	<i>Lythrum salicaria</i>	30		
<i>Navicula cryptotenella</i>	60	<i>Microspora irregularis</i>	10	<i>Marchantia polymorpha</i>	30		
<i>Navicula halophila</i>	60	<i>Mougeotia</i> W3	10	<i>Myriophyllum alternifolium</i>	30		
<i>Navicula tripunctata</i>	60	<i>Mougeotia</i> W5	10	<i>Phalaris arundinacea</i>	30		
<i>Surirella brebissonii</i>	60	<i>Navicula cryptocephala</i>	10	<i>Rhizomnium punctatum</i>	30		
<i>Cocconeis pediculus</i>	50	<i>Oedogonium</i> W3	10	<i>Scrophularia</i>	30		
<i>Gomphonema minutum</i>	50	<i>Oedogonium</i> W4	10	<i>Veronica beccabunga</i>	30		
<i>Phormidium fragile</i>	50	<i>Oedogonium</i> W5	10	<i>Amblystegium riparium</i>	20		
<i>Achnanthes flexella</i>	40	<i>Oscillatoria agardhii</i>	10	<i>Brachythecium plumosum</i>	20		
<i>Achnanthyidium biasolettiana</i>	40	<i>Oscillatoria limosa</i>	10	<i>Calliergon cuspidatum</i>	20		
<i>Diatoma moniliformis</i>	40	<i>Oscillatoria sancta</i>	10	<i>Callitriche obtusangula</i>	20		
<i>Hanea arcus</i>	40	<i>Spirogyra</i> W3	10	<i>Callitriche platycarpa</i>	20		
<i>Phormidium favosum</i>	40	<i>Stigeoclonium</i> sp.	10	<i>Carex versicaria</i>	20		
<i>Cymbella affinis</i>	30			<i>Equisetum fluviatile</i>	20		
<i>Cymbella gracilis</i>	30			<i>Fissidens</i>	20		
<i>Diatoma vulgare</i>	30			<i>Fontinalis squamosa</i>	20		
<i>Fragilaria pulchella</i>	30			<i>Hygrohypnum</i>	20		
<i>Gomphonema truncatum</i>	30			<i>Juncus inflexus</i>	20		
<i>Gongrosira</i> sp.	30			<i>Persicaria hydropiper</i>	20		
<i>Microspora tumidula</i>	30			<i>Plagiomnium undulatum</i>	20		
<i>Navicula rhynchocephala</i>	30			<i>Potamogeton natans</i>	20		
<i>Nitzschia linearis</i>	30			<i>Racomitrium</i>	20		
<i>Oscillatoria brevis</i>	30			<i>Ranunculus flammula</i>	20		
<i>Phormidium autumnale</i>	30			<i>Ranunculus peltatus</i>	20		
<i>Rhoicosphenia abbreviata</i>	30			<i>Riccia</i>	20		
<i>Caloneis bacillum</i>	20			<i>Rorippa amphibia</i>	20		
<i>Cyclotella meneghiniana</i>	20			<i>Rorippa nasturtium-aquaticum</i>	20		
<i>Diatoma tenuis</i>	20			<i>Senecio aquaticus</i>	20		

River Type 22 (12 sites).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq
<i>Ancyclus fluviatilis</i>	100	<i>Glossosoma</i> spp.	75	<i>Gyrinus urinator</i>	25	<i>Lype phaeopa</i>	8
Lumbricidae indet.	100	<i>Lepidostoma hirtum</i>	75	<i>Stictotarsus duodecimpustulatus</i>	25	<i>Tinodes waeneri</i>	8
<i>Gammarus duebeni</i>	100	<i>Drusus annulatus</i>	75	<i>Helophorus</i> spp.	25	<i>Diplectrona felix</i>	8
<i>Ephemerella ignita</i>	100	<i>Hemerodromia</i> spp.	75	<i>Wormaldia occipitalis</i>	25	<i>Hydropsyche contubernalis</i>	8
<i>Baetis rhodani</i>	100	<i>Pisidium casertanum</i>	67	<i>Cymus trimaculatus</i>	25	<i>Goera pilosa</i>	8
<i>Baetis muticus</i>	100	<i>Perla bipunctata</i>	67	<i>Pedicia</i> spp.	25	<i>Oxyethira</i> spp.	8
<i>Rhithrogena semicolorata</i>	100	<i>Orectochilus villosus</i>	67	<i>Simulium cryophilum</i>	25	<i>Lasiocephala basalis</i>	8
<i>Ecdyonurus venosus</i>	100	<i>Oreodytes septentrionalis</i>	67	<i>Simulium reptans</i>	25	<i>Limnephilus lunatus</i>	8
<i>Protonemura meyeri</i>	100	<i>Rhyacophila munda</i>	67	<i>Lymnaea peregra</i>	17	<i>Stenophylax permistus</i>	8
<i>Leuctra hippopus</i>	100	<i>Ithytrichia</i> spp.	67	<i>Pisidium personatum</i>	17	<i>Beraea pullata</i>	8
<i>Leuctra inermis</i>	100	<i>Athripsodes</i> spp.	67	<i>Limnodrilus hoffmeisteri</i>	17	<i>Pilaria</i> spp.	8
<i>Isoperla grammatica</i>	100	<i>Odontocerum albicorne</i>	67	<i>Glossiphonia hereroclita</i>	17	<i>Orimarga</i> spp.	8
<i>Siphonoperla torrentium</i>	100	Psychodidae indet.	67	<i>Ecdyonurus dispar</i>	17	<i>Lipsothrix</i> spp.	8
<i>Esolus parallelepipetus</i>	100	Tricladidia indet.	58	<i>Ephemera danica</i>	17	<i>Rhypholophus varius</i>	8
<i>Elmis aenea</i>	100	<i>Rhyacodrilus coccineus</i>	58	<i>Leuctra nigra</i>	17	<i>Dixa puberula</i>	8
<i>Limnius volckmari</i>	100	<i>Electrogena lateralis</i>	58	<i>Gerris najas</i>	17	Rhagionidae indet.	8
<i>Hydraena gracilis</i>	100	<i>Psychomyia pusilla</i>	58	<i>Gyrinus substriatus</i>	17	Muscidae indet.	8
<i>Rhyacophila dorsalis</i>	100	<i>Simulium argyreatum</i>	58	<i>Haliphus lineatocollis</i>	17	Empididae indet.	8
<i>Hydropsyche pellucidula</i>	100	<i>Heptagenia sulphurea</i>	50	<i>Brychius elevatus</i>	17	Sciomyzidae indet.	8
<i>Agapetus</i> spp.	100	<i>Ecdyonurus torrentis</i>	50	<i>Agabus</i> spp.	17	<i>Simulium armoricanum</i>	8
<i>Silo pallipes</i>	100	<i>Paraleptophlebia cincta</i>	50	Curculionidae indet.	17	<i>Simulium ornatum/intermedium</i> group	8
<i>Halesus radiatus</i>	100	<i>Limnebius truncatellus</i>	50	<i>Plectrocnemia geniculata</i>	17	<i>Simulium tuberosum</i>	8
<i>Sericostoma personatum</i>	100	<i>Hydroptila</i> spp.	50	<i>Lype reducta</i>	17		
Simuliidae indet.	100	<i>Chaetopteryx villosa</i>	50	<i>Halesus digitatus</i>	17		
Tanypodinae indet.	100	Ceratopogonidae indet.	50	<i>Micropterna/Stenophylax</i> group	17		
Orthocladiinae indet.	100	<i>Pisidium subtruncatum</i>	42	<i>Beraea maurus</i>	17		
Tubificidae indet.	92	Nematoda indet.	42	<i>Simulium vernum</i>	17		
<i>Ecdyonurus insignis</i>	92	<i>Glossiphonia complanata</i>	42	<i>Lymnaea palustris</i>	8		
<i>Oreodytes sanmarkii</i>	92	<i>Erpobdella octoculata</i>	42	<i>Pisidium nitidum</i>	8		
<i>Elodes</i> spp.	92	<i>Centropilum luteolum</i>	42	<i>Aulodrilus plurisetia</i>	8		
<i>Hydropsyche siltalai</i>	92	<i>Chloroperla tripunctata</i>	42	<i>Stylaria lacustris</i>	8		
<i>Potamophylax cingulatus</i>	92	<i>Philopotamus monatus</i>	42	<i>Gordius</i> spp.	8		
<i>Dicranota</i> spp.	92	<i>Ecdiisopteryx guttulata</i>	42	<i>Erpobdella testacea</i>	8		
<i>Eloeophila</i> spp.	92	<i>Limnophora</i> spp.	42	<i>Asellus aquaticus</i>	8		
Chironominae indet.	92	<i>Simulium ornatum/intermedium/trifasciatum</i> group	42	<i>Siphonurus</i> spp.	8		
<i>Lumbriculus variegatus</i>	83	<i>Baetis scambus</i>	33	<i>Caenis luctuosa</i>	8		
Enchytraeidae indet.	83	<i>Nemoura avicularis</i>	33	<i>Nemoura cinerea</i>	8		
Hydracarina indet.	83	<i>Hydraena riparia</i>	33	<i>Nemurella picteti</i>	8		
<i>Caenis rivulorum</i>	83	<i>Dryops</i> spp.	33	<i>Capnia bifrons</i>	8		
<i>Brachyptera risi</i>	83	<i>Hydrocyphon</i> spp.	33	<i>Hesperocorixa sahlbergi</i>	8		
<i>Amphinemura sulciollis</i>	83	<i>Polycentropus kingi</i>	33	<i>Micronecta poweri</i>	8		
<i>Tipula</i> spp.	83	<i>Hydropsyche instabilis</i>	33	<i>Hydraena minutissima</i>	8		
<i>Wiedemannia/Clinocera</i> spp.	83	<i>Potamophylax latipennis</i>	33	<i>Hydraena testacea</i>	8		
<i>Chelifera</i> spp.	83	<i>Antocha</i> spp.	33	<i>Ochthebius exsculptus</i>	8		
<i>Simulium argyreatum/variegatum</i> group	83	<i>Simulium variegatum</i>	33	<i>Gyrinus caspius</i>	8		
<i>Potamopyrgus antipodarum</i>	75	Prodiamesinae indet.	33	<i>Haliphus confinis</i>	8		
<i>Stylodrilus heringianus</i>	75	<i>Lymnaea truncatula</i>	25	<i>Hydroporus erythrocephalus</i>	8		
<i>Oulimnius tuberculatus</i>	75	<i>Spirosperma ferox</i>	25	<i>Anacaena globulus</i>	8		
<i>Plectrocnemia conspersa</i>	75	<i>Dinocras cephalotes</i>	25	<i>Laccobius</i> spp.	8		
<i>Polycentropus flavomaculatus</i>	75	<i>Velia</i> spp.	25	<i>Wormaldia subnigra</i>	8		

River Type 22 *contd.*

Phytobenthos	% freq	Phytobenthos <i>contd.</i>	% freq	Macrophytes	% freq	Macrophytes <i>contd.</i>	% freq
<i>Achnanthyrium minutissimum</i>	100	<i>Oscillatoria sancta</i>	25	<i>Rhynchosostegium ripariodes</i>	100	<i>Riccia</i>	17
<i>Cocconeis placentula</i>	100	<i>Stigeoclonium</i> sp.	25	<i>Conocephalum conicum</i>	83	<i>Rorippa amphibia</i>	17
<i>Cymbella minuta</i>	100	<i>Achnanthyrium biasolettiana</i>	17	<i>Filipendula ulmaria</i>	75	<i>Scapania undulata</i>	17
<i>Fragilaria capucina</i>	100	<i>Chamaesiphon confervicolus</i>	17	<i>Fontinalis antipyretica</i>	67	<i>Sparganium erectum</i>	17
<i>Cymbella silesiaca</i>	92	<i>Cymbella helvetica</i>	17	<i>Angelica sylvestris</i>	58	<i>Amblystegium fluviatile</i>	8
<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	92	<i>Cymbella microcephala</i>	17	<i>Chiloscyphus polyanthos</i>	58	<i>Carex riparia</i>	8
<i>Gomphonema parvulum</i>	92	<i>Diatoma mesodon</i>	17	<i>Juncus effusus</i>	58	<i>Carex versicaria</i>	8
<i>Navicula gregaria</i>	83	<i>Eunotia minor</i>	17	<i>Mentha aquatica</i>	58	<i>Eleocharis</i>	8
<i>Nitzschia dissipata</i>	83	<i>Frustulia rhomboides</i> var. <i>viridula</i>	17	<i>Cladophora</i> spp.	50	<i>Fissidens</i>	8
<i>Nitzschia palea</i>	83	<i>Gomphonema acuminatum</i>	17	<i>Equisetum arvense</i>	50	<i>Hydrocotyle vulgaris</i>	8
<i>Reimeria sinuata</i>	83	<i>Hildenbrandia rivularis</i>	17	<i>Juncus articulatus</i>	50	<i>Hycomium armoricum</i>	8
<i>Achnanthes oblongella</i>	75	<i>Lemanea fluviatilis</i>	17	<i>Marchantia polymorpha</i>	50	<i>Juncus inflexus</i>	8
<i>Navicula lanceolata</i>	75	<i>Meridion circulare</i> var. <i>constrictum</i>	17	<i>Brachythecium rivulare</i>	42	<i>Jungermannia</i>	8
<i>Phormidium fragile</i>	75	<i>Microspora crassior</i>	17	<i>Cinclidotus fontinaloides</i>	42	<i>Lychnis</i>	8
<i>Gomphonema angustum</i>	67	<i>Mougeotia</i> W3	17	<i>Pellia endiviifolia</i>	42	<i>Lysimachia vulgaris</i>	8
<i>Gomphonema olivaceum</i>	67	<i>Mougeotia</i> W4	17	<i>Pellia epiphylla</i>	42	<i>Mimulus guttatus</i>	8
<i>Achnanthes flexella</i>	58	<i>Mougeotia</i> W5	17	<i>Ranunculus flammula</i>	42	<i>Montia fontana</i>	8
<i>Achnanthes lanceolata</i>	58	<i>Navicula cryptocephala</i>	17	<i>Brachythecium plumosum</i>	33	<i>Myosotis scorpioides</i>	8
<i>Cladophora glomerata</i>	58	<i>Navicula halophila</i>	17	<i>Callitriche stagnalis</i>	33	<i>Phalaris arundinacea</i>	8
<i>Gomphonema minutum</i>	58	<i>Navicula rhynchocephala</i>	17	<i>Brachythecium rutabulum</i>	25	<i>Philonotis fontana</i>	8
<i>Surirella brebissonii</i>	58	<i>Navicula tripunctata</i>	17	<i>Caltha palustris</i>	25	<i>Senecio aquaticus</i>	8
<i>Synedra ulna</i>	58	<i>Oedogonium</i> W2	17	<i>Dichodontium</i>	25	<i>Senecio palustre</i>	8
<i>Chamaesiphon incrustans</i>	50	<i>Oedogonium</i> W5	17	Filamentous green algae	25	<i>Sparganium emersum</i>	8
<i>Cocconeis pediculus</i>	50	<i>Oscillatoria brevis</i>	17	Globular algae	25		
<i>Diatoma moniliformis</i>	50	<i>Oscillatoria limosa</i>	17	<i>Hygrohypnum</i>	25		
<i>Fragilaria pulchella</i>	50	<i>Phormidium autumnale</i>	17	<i>Iris pseudacorus</i>	25		
<i>Gongrosira</i> sp.	50	<i>Phormidium retzii</i>	17	<i>Lythrum salicaria</i>	25		
<i>Ulothrix zonata</i>	50	<i>Spirogyra</i> W3	17	<i>Oenanthe crocata</i>	25		
<i>Amphora pediculus</i>	42	<i>Surirella angusta</i>	17	<i>Persicaria hydropiper</i>	25		
<i>Audouinella hermannii</i>	42	<i>Ulothrix tenuissima</i>	17	<i>Racomitrium</i>	25		
<i>Gomphonema truncatum</i>	42	<i>Achnanthes exigua</i>	8	<i>Rhizomnium punctatum</i>	25		
<i>Lyngbya martensiana</i>	42	<i>Bulbochaete</i> sp.	8	<i>Rorippa nasturtium-aquaticum</i>	25		
<i>Meridion circulare</i>	42	<i>Caloneis bacillum</i>	8	<i>Stachys palustris</i>	25		
<i>Oscillatoria agardhii</i>	42	<i>Closterium parvulum</i>	8	<i>Thamnobryum</i>	25		
<i>Phormidium favosum</i>	42	<i>Diatoma vulgare</i>	8	<i>Valeriana</i>	25		
<i>Tabellaria flocculosa</i>	42	<i>Eunotia bilunaris</i>	8	<i>Veronica beccabunga</i>	25		
<i>Cymbella gracilis</i>	33	<i>Eunotia pectinalis</i>	8	<i>Apium nodiflorum</i>	17		
<i>Diatoma tenuis</i>	33	<i>Fragilaria capucina</i> var. <i>perminuta</i>	8	<i>Bryum pseudotriquetrum</i>	17		
<i>Nitzschia linearis</i>	33	<i>Frustulia rhomboides</i>	8	<i>Carex rostrata</i>	17		
<i>Rhoicosphenia abbreviata</i>	33	<i>Gomphonema micropus</i>	8	<i>Equisetum fluviatile</i>	17		
<i>Spirogyra</i> W1	33	<i>Microspora irregularis</i>	8	<i>Fontinalis squamosa</i>	17		
<i>Spirogyra</i> W2	33	<i>Microspora</i> sp.11	8	<i>Geum rivulare</i>	17		
<i>Brachysira vitrea</i>	25	<i>Monostroma</i> sp.	8	<i>Glyceria fluitans</i>	17		
<i>Cymbella affinis</i>	25	<i>Navicula</i> sp.12	8	<i>Mnium hornum</i>	17		
<i>Didymosphenia geminata</i>	25	<i>Nitzschia fonticola</i>	8	<i>Myriophyllum alternifolium</i>	17		
<i>Eunotia arcus</i>	25	<i>Oedogonium</i> W3	8	<i>Plagiomnium rostratum</i>	17		
<i>Hanea arcus</i>	25	<i>Oedogonium</i> W4	8	<i>Plagiomnium undulatum</i>	17		
<i>Microspora tumidula</i>	25			<i>Ranunculus peltatus</i>	17		
<i>Navicula cryptotenella</i>	25			<i>Ranunculus penicillatus</i>	17		

River Type 23 (4 sites).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq
<i>Potamopyrgus antipodarum</i>	100	<i>Polycentropus flavomaculatus</i>	75	<i>Gyrinus substriatus</i>	25
Lumbricidae indet.	100	<i>Psychomyia pusilla</i>	75	<i>Gyrinus caspius</i>	25
<i>Gammarus duebeni</i>	100	<i>Hydropsyche pellucidula</i>	75	<i>Dryops</i> spp.	25
<i>Ephemerella ignita</i>	100	<i>Ithytrichia</i> spp.	75	<i>Halipus lineatocollis</i>	25
<i>Baetis rhodani</i>	100	<i>Odontocerum albicorne</i>	75	<i>Hydroporus nigrita</i>	25
<i>Baetis muticus</i>	100	Tricladidia indet.	50	<i>Stictonectes lepidus</i>	25
<i>Rhithrogena semicolorata</i>	100	<i>Lymnaea peregra</i>	50	<i>Stictotarsus duodecimpustulatus</i>	25
<i>Electrogena lateralis</i>	100	<i>Pisidium casertanum</i>	50	<i>Agabus bipustulatus</i>	25
<i>Ecdyonurus venosus</i>	100	Enchytraeidae indet.	50	<i>Helophorus</i> spp.	25
<i>Ecdyonurus insignis</i>	100	Nematoda indet.	50	<i>Laccobius striatulus</i>	25
<i>Caenis rivulorum</i>	100	<i>Heptagenia sulphurea</i>	50	<i>Cyrnus trimaculatus</i>	25
<i>Brachyptera risi</i>	100	<i>Paraleptophlebia cincta</i>	50	<i>Polycentropus kingi</i>	25
<i>Protonemura meyeri</i>	100	<i>Limnebius truncatellus</i>	50	<i>Lype reducta</i>	25
<i>Leuctra hippopus</i>	100	<i>Orectochilus villosus</i>	50	<i>Tinodes waeneri</i>	25
<i>Leuctra inermis</i>	100	<i>Oreodytes septentrionalis</i>	50	<i>Tinodes maculicornis</i>	25
<i>Isoperla grammatica</i>	100	Curculionidae indet.	50	<i>Hydropsyche instabilis</i>	25
<i>Perla bipunctata</i>	100	<i>Hydrocyphon</i> spp.	50	<i>Silo nigricornis</i>	25
<i>Esolus parallelepipedus</i>	100	<i>Wormaldia</i> spp.	50	<i>Ecclisopteryx guttulata</i>	25
<i>Elmis aenea</i>	100	<i>Agapetus fuscipes</i>	50	<i>Potamophylax latipennis</i>	25
<i>Limnius volckmari</i>	100	<i>Oxyethira</i> spp.	50	<i>Tricyphona</i> spp.	25
<i>Hydraena gracilis</i>	100	<i>Hydroptila</i> spp.	50	<i>Antocha</i> spp.	25
<i>Oreodytes sanmarkii</i>	100	<i>Lepidostoma hirtum</i>	50	<i>Dixa puberula</i>	25
<i>Elodes</i> spp.	100	<i>Lasiocephala basalis</i>	50	<i>Ceratopogonidae</i> indet.	25
<i>Rhyacophila dorsalis</i>	100	<i>Chaetopteryx villosa</i>	50	<i>Stratiomyidae</i> indet.	25
<i>Plectrocnemia conspersa</i>	100	<i>Drusus annulatus</i>	50	<i>Limnophora</i> spp.	25
<i>Hydropsyche siltalai</i>	100	<i>Sericostoma personatum</i>	50	<i>Chelifera</i> spp.	25
<i>Glossosoma</i> spp.	100	<i>Pedicia</i> spp.	50	<i>Scatophagidae</i> indet.	25
<i>Silo pallipes</i>	100	<i>Eloeophila</i> spp.	50	<i>Simulium vernum</i>	25
<i>Halesus radiatus</i>	100	<i>Hemerodromia</i> spp.	50	<i>Simulium armoricanum</i>	25
<i>Potamophylax cingulatus</i>	100	Sciomyzidae indet.	50	<i>Simulium ornatum/intermedium/trifasciatum</i> group	25
<i>Tipula</i> spp.	100	<i>Simulium cryophilum</i>	50	<i>Simulium ornatum/intermedium</i> group	25
<i>Dicranota</i> spp.	100	<i>Simulium argyreatum</i>	50	<i>Simulium tuberosum</i>	25
Psychodidae indet.	100	<i>Simulium variegatum</i>	50	<i>Simulium noelleri</i>	25
<i>Wiedemannia/Clinocera</i> spp.	100	<i>Pisidium personatum</i>	25	<i>Prodiamesinae</i> indet.	25
<i>Simulium argyreatum/variegatum</i> group	100	<i>Pisidium subtruncatum</i>	25	<i>Eukiefferiella claripennis</i>	25
Tanypodinae indet.	100	<i>Stylodrilus heringianus</i>	25		
Orthocladinae indet.	100	<i>Rhyacodrilus coccineus</i>	25		
Chironomidae indet.	100	<i>Erpobdella octoculata</i>	25		
Chironominae indet.	100	<i>Piscicola geometra</i>	25		
<i>Ancylus fluviatilis</i>	75	<i>Haemopsis sanguisuga</i>	25		
<i>Lymnaea truncatula</i>	75	<i>Siphonurus lacustris</i>	25		
<i>Lumbriculus variegatus</i>	75	<i>Centropitilum luteolum</i>	25		
Tubificidae indet.	75	<i>Ecdyonurus torrentis</i>	25		
Hydracarina indet.	75	<i>Ecdyonurus dispar</i>	25		
<i>Baetis scambus</i>	75	<i>Nemoura avicularis</i>	25		
<i>Amphinemura sulciollis</i>	75	<i>Leuctra nigra</i>	25		
<i>Siphonoperla torrentium</i>	75	<i>Dinocras cephalotes</i>	25		
<i>Oulimnius tuberculatus</i>	75	<i>Velia</i> spp.	25		
<i>Rhyacophila munda</i>	75	<i>Gerris lacustris</i>	25		
<i>Philopotamus monatus</i>	75	<i>Callicorixa praeusta</i>	25		

River Type 23 *contd.*

Phytobenthos	% freq	Phytobenthos <i>contd.</i>	% freq	Macrophytes	% freq
<i>Achnanthes minutissimum</i>	100	<i>Meridion circulare</i> var. <i>constrictum</i>	25	<i>Rhynchosstegium ripariodes</i>	100
<i>Cocconeis pediculus</i>	100	<i>Mougeotia</i> W4	25	<i>Chiloscyphus polyanthos</i>	75
<i>Cocconeis placentula</i>	100	<i>Navicula cryptotenella</i>	25	<i>Cladophora</i> spp.	75
<i>Cymbella minuta</i>	100	<i>Navicula</i> sp.12	25	<i>Conocephalum conicum</i>	75
<i>Cymbella silesiaca</i>	100	<i>Navicula</i> sp.8	25	<i>Filipendula ulmaria</i>	75
<i>Gomphonema olivaceum</i>	100	<i>Oscillatoria agardhii</i>	25	<i>Mnium hornum</i>	75
<i>Gomphonema parvulum</i>	100	<i>Phormidium fragile</i>	25	<i>Plagiomnium rostratum</i>	75
<i>Navicula lanceolata</i>	100	<i>Phormidium retzii</i>	25	<i>Thamnobryum</i>	75
<i>Reimeria sinuata</i>	100	<i>Rhoicosphenia abbreviata</i>	25	<i>Brachythecium rivulare</i>	50
<i>Achnanthes oblongella</i>	75	<i>Spirogyra</i> W1	25	<i>Calliergon cuspidatum</i>	50
<i>Audouinella hermannii</i>	75	<i>Surirella brebissonii</i>	25	<i>Cinclidotus fontinaloides</i>	50
<i>Cladophora glomerata</i>	75	<i>Tabellaria fenestrata</i>	25	<i>Equisetum arvense</i>	50
<i>Fragilaria capucina</i>	75	<i>Ulothrix tenuissima</i>	25	<i>Pellia epiphylla</i>	50
<i>Gomphonema angustum</i>	75			<i>Riccardia</i>	50
<i>Hildenbrandia rivularis</i>	75			<i>Amblystegium fluviatile</i>	25
<i>Meridion circulare</i>	75			<i>Angelica sylvestris</i>	25
<i>Monostroma</i> sp.	75			<i>Apium nodiflorum</i>	25
<i>Navicula gregaria</i>	75			<i>Brachythecium plumosum</i>	25
<i>Navicula halophila</i>	75			<i>Dichodontium</i>	25
<i>Nitzschia dissipata</i>	75			<i>Dicranella palustris</i>	25
<i>Nitzschia palea</i>	75			Filamentous green algae	25
<i>Synedra ulna</i>	75			<i>Fontinalis antipyretica</i>	25
<i>Ulothrix zonata</i>	75			<i>Geum rivulare</i>	25
<i>Amphora pediculus</i>	50			<i>Hygrohypnum</i>	25
<i>Diatoma moniliformis</i>	50			<i>Hyocomium armoricum</i>	25
<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	50			<i>Juncus articulatus</i>	25
<i>Fragilaria pulchella</i>	50			<i>Juncus effusus</i>	25
<i>Gomphonema minutum</i>	50			<i>Lunularia</i>	25
<i>Gomphonema truncatum</i>	50			<i>Lychnis</i>	25
<i>Gongrosira</i> sp.	50			<i>Marchantia polymorpha</i>	25
<i>Navicula tripunctata</i>	50			<i>Myosotis scorpioides</i>	25
<i>Tabellaria flocculosa</i>	50			<i>Oenanthe crocata</i>	25
<i>Achnanthes flexella</i>	25			<i>Pellia endiviifolia</i>	25
<i>Achnanthes lanceolata</i>	25			<i>Philonotis fontana</i>	25
<i>Achnanthidium biasolettiana</i>	25			<i>Ranunculus flammula</i>	25
<i>Ankistrodesmus falcatus</i>	25			<i>Rorippa amphibia</i>	25
<i>Caloneis bacillum</i>	25				
<i>Chamaesiphon confervicolus</i>	25				
<i>Cymbella helvetica</i>	25				
<i>Cymbella microcephala</i>	25				
<i>Cymbella proxima</i>	25				
<i>Diatoma tenuis</i>	25				
<i>Didymosphenia geminata</i>	25				
<i>Eunotia bilunaris</i>	25				
<i>Eunotia minor</i>	25				
<i>Fragilaria construens</i> aff. <i>F. construens</i>	25				
<i>Gomphonema micropus</i>	25				
<i>Hanea arcus</i>	25				
<i>Lyngbya martensiana</i>	25				

River Type 24 (1 site).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Phytobenthos	% freq	Macrophytes	% freq
<i>Potamopyrgus antipodarum</i>	100	<i>Allotrichia</i> spp.	100	<i>Achnanthes lanceolata</i>	100	<i>Calliergon cuspidatum</i>	100
<i>Ancylus fluviatilis</i>	100	<i>Chaetopteryx villosa</i>	100	<i>Achnanthes petersenii</i>	100	<i>Chiloscyphus polyanthos</i>	100
<i>Lymnaea truncatula</i>	100	<i>Drusus annulatus</i>	100	<i>Achnantheidium minutissimum</i>	100	<i>Cinclidotus fontinaloides</i>	100
<i>Pisidium casertanum</i>	100	<i>Halesus radiatus</i>	100	<i>Amphora pediculus</i>	100	<i>Cladophora</i> spp.	100
<i>Stylodrilus heringianus</i>	100	<i>Potamophylax cingulatus</i>	100	<i>Aulacoseira granulata</i>	100	<i>Dichodontium</i>	100
Tubificidae indet.	100	<i>Beraea maurus</i>	100	<i>Cocconeis pediculus</i>	100	<i>Filipendula ulmaria</i>	100
Enchytraeidae indet.	100	<i>Sericostoma personatum</i>	100	<i>Cocconeis placentula</i>	100	<i>Hygrohypnum</i>	100
Lumbricidae indet.	100	<i>Odontocerum albicorne</i>	100	<i>Cyclotella radiosia</i>	100	<i>Hyocomium armoricum</i>	100
<i>Gammarus duebeni</i>	100	<i>Dicranota</i> spp.	100	<i>Cymbella minuta</i>	100	<i>Iris pseudacorus</i>	100
Hydracarina indet.	100	<i>Dixa puberula</i>	100	<i>Cymbella silesiaca</i>	100	<i>Juncus articulatus</i>	100
Collembola indet.	100	Ceratopogonidae indet.	100	<i>Diatoma moniliformis</i>	100	<i>Juncus effusus</i>	100
<i>Serratella ignita</i>	100	Psychodidae indet.	100	<i>Diatoma tenuis</i>	100	<i>Juncus inflexus</i>	100
<i>Baetis scambus</i>	100	<i>Limnophora</i> spp.	100	<i>Fragilaria capucina</i>	100	<i>Lychnis</i>	100
<i>Baetis rhodani</i>	100	<i>Wiedemannia/Clinocera</i> spp.	100	<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	100	<i>Marchantia polymorpha</i>	100
<i>Baetis muticus</i>	100	<i>Simulium argyreatum/</i> <i>variegatum</i> group	100	<i>Gomphonema angustum</i>	100	<i>Pellia endiviifolia</i>	100
<i>Rhithrogena semicolorata</i>	100	Tanypodinae indet.	100	<i>Gomphonema gracile</i>	100	<i>Plagiommium undulatum</i>	100
<i>Electrogena lateralis</i>	100	Orthocladiinae indet.	100	<i>Gomphonema olivaceum</i>	100	<i>Polytrichum commune</i>	100
<i>Ecdyonurus venosus</i>	100	Chironominae indet.	100	<i>Gomphonema parvulum</i>	100	<i>Rhynchostegium ripariodes</i>	100
<i>Caenis rivulorum</i>	100			<i>Heribaudiella fluviatilis</i>	100	<i>Thamnobryum</i>	100
<i>Brachyptera risi</i>	100			<i>Hildenbrandia rivularis</i>	100		
<i>Amphinemura sulciollis</i>	100			<i>Navicula cryptotenella</i>	100		
<i>Protonemura meyeri</i>	100			<i>Nitzschia dissipata</i>	100		
<i>Leuctra hippopus</i>	100			<i>Nitzschia linearis</i>	100		
<i>Leuctra inermis</i>	100			<i>Nitzschia palea</i>	100		
<i>Isoperla grammatica</i>	100			<i>Synedra ulna</i>	100		
<i>Dinocras cephalotes</i>	100						
<i>Chloroperla tripunctata</i>	100						
<i>Siphonoperla torrentium</i>	100						
<i>Esolus parallelepipedus</i>	100						
<i>Elmis aenea</i>	100						
<i>Oulimnius tuberculatus</i>	100						
<i>Limnius volckmari</i>	100						
<i>Hydraena gracilis</i>	100						
<i>Limnebius truncatellus</i>	100						
<i>Gyrinus substriatus</i>	100						
<i>Anacaena globulus</i>	100						
Galerucinae indet.	100						
<i>Elodes</i> spp.	100						
<i>Hydrocyphon</i> spp.	100						
<i>Rhyacophila dorsalis</i>	100						
<i>Rhyacophila munda</i>	100						
<i>Philopotamus monatus</i>	100						
<i>Plectrocnemia conspersa</i>	100						
<i>Polycentropus</i> spp.	100						
<i>Tinodes dives</i>	100						
<i>Diplectrona felix</i>	100						
<i>Hydropsyche instabilis</i>	100						
<i>Agapetus fuscipes</i>	100						
<i>Silo pallipes</i>	100						
<i>Hydroptila</i> spp.	100						

River Type 31 (1 site).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Phytobenthos	% freq	Macrophytes	% freq
<i>Theodoxus fluviatilis</i>	100	<i>Oulimnius tuberculatus</i>	100	<i>Achnanthes lanceolata</i>	100	<i>Alisma plantago-aquatica</i>	100
<i>Bithynia tentaculata</i>	100	<i>Limnius volckmari</i>	100	<i>Achnanthes oblongella</i>	100	<i>Amblystegium riparium</i>	100
<i>Potamopyrgus antipodarum</i>	100	<i>Hydraena riparia</i>	100	<i>Achnantheidium biasoletiana</i>	100	<i>Brachythecium rivulare</i>	100
<i>Ancylus fluviatilis</i>	100	<i>Orectochilus villosus</i>	100	<i>Achnantheidium minutissimum</i>	100	<i>Butomus umbellatus</i>	100
<i>Gyraulus albus</i>	100	<i>Dryops</i> spp.	100	<i>Amphora pediculus</i>	100	<i>Callitriche platycarpa</i>	100
<i>Lymnaea peregra</i>	100	<i>Brychius elevatus</i>	100	<i>Caloneis bacillum</i>	100	<i>Caltha palustris</i>	100
<i>Physa fontinalis</i>	100	<i>Hydroporus tessellatus</i>	100	<i>Chamaesiphon incrustans</i>	100	<i>Cinclidotus fontinaloides</i>	100
<i>Pisidium casertanum</i>	100	<i>Oreodytes sanmarkii</i>	100	<i>Chamaesiphon confervicolus</i>	100	<i>Cladophora</i> spp.	100
<i>Pisidium nitidum</i>	100	<i>Nebrioporus depressus elegans</i>	100	<i>Cladophora glomerata</i>	100	<i>Eleocharis</i>	100
<i>Pisidium subtruncatum</i>	100	<i>Rhyacophila dorsalis</i>	100	<i>Cocconeis pediculus</i>	100	<i>Elodea canadensis</i>	100
<i>Lumbriculus variegatus</i>	100	<i>Rhyacophila munda</i>	100	<i>Cocconeis placentula</i>	100	<i>Equisetum arvense</i>	100
<i>Stylodrilus heringianus</i>	100	<i>Polycentropus flavomaculatus</i>	100	<i>Cyclotella meneghiniana</i>	100	<i>Filipendula ulmaria</i>	100
<i>Limnodrilus hoffmeisteri</i>	100	<i>Psychomyia pusilla</i>	100	<i>Cymbella helvetica</i>	100	<i>Fissidens</i>	100
<i>Spirosperma ferox</i>	100	<i>Cheumatopsyche lepida</i>	100	<i>Cymbella silesiaca</i>	100	<i>Fontinalis antipyretica</i>	100
<i>Tubifex ignotus</i>	100	<i>Hydropsyche siltalai</i>	100	<i>Diatoma tenue</i>	100	<i>Hygrohypnum</i>	100
<i>Stylaria lacustris</i>	100	<i>Hydropsyche angustipennis</i>	100	<i>Diatoma vulgare</i>	100	<i>Juncus articulatus</i>	100
Lumbricidae indet.	100	<i>Hydropsyche pellucidula</i>	100	<i>Eunotia bilunaris</i>	100	<i>Juncus inflexus</i>	100
Nematoda indet.	100	<i>Hydropsyche contubernalis</i>	100	<i>Fragilaria capucina</i>	100	<i>Lythrum salicaria</i>	100
<i>Glossiphonia complanata</i>	100	<i>Glossosoma</i> spp.	100	<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	100	<i>Mentha aquatica</i>	100
<i>Helobdella stagnalis</i>	100	<i>Goera pilosa</i>	100	<i>Gomphonema minutum</i>	100	<i>Persicaria amphibia</i>	100
<i>Erpobdella octoculata</i>	100	<i>Ithytrichia</i> spp.	100	<i>Gomphonema olivaceum</i>	100	<i>Phalaris arundinacea</i>	100
<i>Gammarus duebeni</i>	100	<i>Lepidostoma hirtum</i>	100	<i>Gomphonema parvulum</i>	100	<i>Potamogeton pectinatus</i>	100
<i>Asellus aquaticus</i>	100	<i>Lasiocephala basalis</i>	100	<i>Hannea arcus</i>	100	<i>Potamogeton perfoliatus</i>	100
Hydracarina indet.	100	<i>Athripsodes cinereus</i>	100	<i>Meridion circulare</i>	100	<i>Potamogeton pusillus</i>	100
<i>Serratella ignita</i>	100	<i>Drusus annulatus</i>	100	<i>Meridion circulare</i> var. <i>constrictum</i>	100	<i>Rhynchostegium ripariodes</i>	100
<i>Baetis scambus</i>	100	<i>Halesus radiatus</i>	100	<i>Navicula cryptocephala</i>	100	<i>Riccia</i>	100
<i>Baetis rhodani</i>	100	<i>Limnephilus lunatus</i>	100	<i>Navicula cryptotenella</i>	100	<i>Schoenoplectus lacustris</i>	100
<i>Baetis atrebatinus</i>	100	<i>Stenophylax permistus</i>	100	<i>Navicula gregaria</i>	100	<i>Senecio palustre</i>	100
<i>Baetis muticus</i>	100	<i>Sericostoma personatum</i>	100	<i>Navicula halophila</i>	100	<i>Valeriana</i>	100
<i>Centroptilum luteolum</i>	100	<i>Dicranota</i> spp.	100	<i>Navicula lanceolata</i>	100		
<i>Rhithrogena semicolorata</i>	100	<i>Antocha</i> spp.	100	<i>Navicula tripunctata</i>	100		
<i>Heptagenia sulphurea</i>	100	Ceratopogonidae indet.	100	<i>Nitzschia dissipata</i>	100		
<i>Ecdyonurus venosus</i>	100	<i>Limnophora</i> spp.	100	<i>Nitzschia palea</i>	100		
<i>Ecdyonurus insignis</i>	100	<i>Hemerodromia</i> spp.	100	<i>Rhoicosphenia abbreviata</i>	100		
<i>Ephemera danica</i>	100	<i>Wiedemannia/Clinocera</i> spp.	100	<i>Surirella angusta</i>	100		
<i>Caenis luctuosa</i>	100	<i>Chelifera</i> spp.	100	<i>Surirella brebissonii</i>	100		
<i>Caenis rivulorum</i>	100	<i>Simulium ornatum/intermedium/trifasciatum</i> group	100	<i>Synedra ulna</i>	100		
<i>Amphinemura sulcipectus</i>	100	<i>Simulium ornatum/intermedium</i> group	100	Unidentified	100		
<i>Nemoura avicularis</i>	100	Tanyptodinae indet.	100				
<i>Protonemura meyeri</i>	100	Prodiamesinae indet.	100				
<i>Leuctra hippopus</i>	100	Orthocladinae indet.	100				
<i>Leuctra inermis</i>	100	Chironominae indet.	100				
<i>Perla bipunctata</i>	100						
<i>Siphonoperla torrentium</i>	100						
<i>Calopteryx splendens</i>	100						
<i>Velia</i> spp.	100						
<i>Aphelocheirus aestivalis</i>	100						
<i>Callicorixa praeusta</i>	100						
<i>Esolus parallelepipeds</i>	100						
<i>Elmis aenea</i>	100						

River Type 32 (3 sites).

Macroinvertebrates	% freq	Macroinvertebrates contd.	% freq	Macroinvertebrates contd.	% freq
<i>Pisidium casertanum</i>	100	<i>Caenis rivulorum</i>	67	<i>Velia caprai</i>	33
Tubificidae indet.	100	<i>Brachyptera risi</i>	67	<i>Nepa cinerea</i>	33
Lumbricidae indet.	100	<i>Amphinemura sulcicollis</i>	67	<i>Hesperocorixa sahlbergi</i>	33
<i>Erpobdella octoculata</i>	100	<i>Leuctra inermis</i>	67	<i>Gyrinus substriatus</i>	33
<i>Gammarus duebeni</i>	100	<i>Siphonoperla torrentium</i>	67	<i>Brychius elevatus</i>	33
<i>Serratella ignita</i>	100	<i>Hydraena gracilis</i>	67	<i>Hydroporus tessellatus</i>	33
<i>Baetis rhodani</i>	100	<i>Hydrocyphon</i> spp.	67	<i>Oreodytes sanmarkii</i>	33
<i>Baetis muticus</i>	100	<i>Wormaldia</i> spp.	67	<i>Oreodytes septentrionalis</i>	33
<i>Ecdyonurus venosus</i>	100	<i>Plectrocnemia conspersa</i>	67	<i>Stictotarsus duodecimpustulatus</i>	33
<i>Protonemura meyeri</i>	100	<i>Polycentropus kingi</i>	67	<i>Agabus</i> spp.	33
<i>Leuctra hippopus</i>	100	<i>Psychomyia pusilla</i>	67	<i>Nebrioporus depressus elegans</i>	33
<i>Isoperla grammatica</i>	100	<i>Lype reducta</i>	67	<i>Helophorus</i> spp.	33
<i>Esolus parallelepipedus</i>	100	<i>Agapetus</i> spp.	67	<i>Sialis lutaria</i>	33
<i>Elmis aenea</i>	100	<i>Hydroptila</i> spp.	67	<i>Rhyacophila munda</i>	33
<i>Oulimnius tuberculatus</i>	100	<i>Chaetopteryx villosa</i>	67	<i>Polycentropus irrorata</i>	33
<i>Limnius volckmari</i>	100	<i>Halesus digitatus</i>	67	<i>Metatype fragilis</i>	33
<i>Orectochilus villosus</i>	100	<i>Potamophylax cingulatus</i>	67	<i>Lype phaeopa</i>	33
<i>Elodes</i> spp.	100	<i>Tipula</i> spp.	67	<i>Hydropsyche instabilis</i>	33
<i>Rhyacophila dorsalis</i>	100	<i>Dixa nebulosa</i>	67	<i>Hydropsyche pellucidula</i>	33
<i>Polycentropus flavomaculatus</i>	100	<i>Wiedemannia</i> spp.	67	<i>Glossosoma</i> spp.	33
<i>Hydropsyche siltalai</i>	100	<i>Simulium</i> <i>ornatum/intermedium/trifasciatum</i> group	67	<i>Goera pilosa</i>	33
<i>Silo pallipes</i>	100	<i>Ancyclus fluvialilis</i>	33	<i>Silo nigricornis</i>	33
<i>Ithytrichia</i> spp.	100	<i>Planorbis planorbis</i>	33	<i>Lepidostoma hirtum</i>	33
<i>Halesus radiatus</i>	100	<i>Bathymphalus contortus</i>	33	<i>Lasiocephala basalis</i>	33
<i>Sericostoma personatum</i>	100	<i>Lymnaea palustris</i>	33	<i>Athripsodes</i> spp.	33
<i>Odontocerum albicorne</i>	100	<i>Lymnaea truncatula</i>	33	<i>Drusus annulatus</i>	33
<i>Dicranota</i> spp.	100	<i>Physa fontinalis</i>	33	<i>Ecclisopteryx guttulata</i>	33
<i>Eloeophila</i> spp.	100	<i>Aplexa hypnorum</i>	33	<i>Limnephilus lunatus</i>	33
Psychodidae indet.	100	<i>Pisidium milium</i>	33	<i>Limnephilus marmoratus</i>	33
<i>Limnophora</i> spp.	100	<i>Pisidium nitidum</i>	33	<i>Potamophylax latipennis</i>	33
<i>Hemerodromia</i> spp.	100	<i>Pisidium subtruncatum</i>	33	<i>Beraea maurus</i>	33
<i>Chelifera</i> spp.	100	<i>Stylodrilus heringianus</i>	33	<i>Pedicia</i> spp.	33
<i>Simulium argyreatum/variegatum</i> group	100	<i>Rhyacodrilus coccineus</i>	33	<i>Tricyphona</i> spp.	33
Tanypodinae indet.	100	<i>Spirosperma ferox</i>	33	<i>Pilaria</i> spp.	33
Orthocladinae indet.	100	<i>Gordius</i> spp.	33	<i>Antocha</i> spp.	33
Chironominae indet.	100	<i>Glossiphonia complanata</i>	33	<i>Erioptera</i> spp.	33
Tricladidia indet.	67	<i>Asellus aquaticus</i>	33	Ceratopogonidae indet.	33
<i>Potamopyrgus antipodarum</i>	67	<i>Asellus meridianus</i>	33	Syrphidae indet.	33
<i>Lymnaea peregra</i>	67	Hydracarina indet.	33	<i>Simulium angustitarse</i>	33
<i>Pisidium pulchellum</i>	67	<i>Baetis scambus</i>	33	<i>Simulium cryophilum</i>	33
<i>Lumbriculus variegatus</i>	67	<i>Heptagenia sulphurea</i>	33	<i>Simulium armoricanum</i>	33
Enchytraeidae indet.	67	<i>Electrogena lateralis</i>	33	<i>Simulium ornatum/intermedium</i> group	33
Nematoda indet.	67	<i>Paraleptophlebia cincta</i>	33	<i>Simulium argyreatum</i>	33
<i>Helobdella stagnalis</i>	67	<i>Caenis luctuosa</i>	33	<i>Simulium variegatum</i>	33
<i>Piscicola geometra</i>	67	<i>Nemoura cinerea</i>	33	Prodiamesinae indet.	33
<i>Haemopis sanguisuga</i>	67	<i>Perla bipunctata</i>	33		
<i>Centroptilum luteolum</i>	67	<i>Dinocras cephalotes</i>	33		
<i>Rhithrogena semicolorata</i>	67	<i>Chloroperla tripunctata</i>	33		
<i>Ecdyonurus insignis</i>	67	<i>Calopteryx virgo</i>	33		
Leptophlebiidae indet.	67	Coenagrionidae indet.	33		

River Type 32 *contd.*

Phytobenthos	% freq	Phytobenthos <i>contd.</i>	% freq	Macrophytes	% freq
<i>Achnanthyrium minutissimum</i>	100	<i>Spirogyra</i> W1	33	<i>Angelica sylvestris</i>	100
<i>Amphora pediculus</i>	100	<i>Ulothrix zonata</i>	33	<i>Apium nodiflorum</i>	100
<i>Cocconeis placentula</i>	100			<i>Filipendula ulmaria</i>	100
<i>Cymbella minuta</i>	100			<i>Fontinalis antipyretica</i>	100
<i>Gongrosira</i> sp.	100			<i>Juncus articulatus</i>	100
<i>Reimeria sinuata</i>	100			<i>Rorippa nasturtium-aquaticum</i>	100
<i>Achnanthes lanceolata</i>	67			<i>Veronica beccabunga</i>	100
<i>Achnanthyrium biasolettiana</i>	67			<i>Amblystegium riparium</i>	67
<i>Audouinella hermannii</i>	67			<i>Caltha palustris</i>	67
<i>Cladophora glomerata</i>	67			<i>Cladophora</i> spp.	67
<i>Cymbella silesiaca</i>	67			<i>Conocephalum conicum</i>	67
<i>Diatoma moniliformis</i>	67			<i>Hypericum tetrapterum</i>	67
<i>Fragilaria capucina</i>	67			<i>Mentha aquatica</i>	67
<i>Gomphonema angustum</i>	67			<i>Rhynchostegium ripariodes</i>	67
<i>Gomphonema olivaceum</i>	67			<i>Thamnobryum</i>	67
<i>Hildenbrandia rivularis</i>	67			<i>Valeriana</i>	67
<i>Navicula cryptotenella</i>	67			<i>Brachythecium rivulare</i>	33
<i>Navicula gregaria</i>	67			<i>Butomus umbellatus</i>	33
<i>Navicula lanceolata</i>	67			<i>Callitriche obtusangula</i>	33
<i>Nitzschia dissipata</i>	67			<i>Callitriche platycarpa</i>	33
<i>Rhoicosphenia abbreviata</i>	67			<i>Chara</i>	33
<i>Synedra ulna</i>	67			<i>Chiloscyphus polyanthos</i>	33
<i>Achnanthes flexella</i>	33			<i>Cinclidotus fontinaloides</i>	33
<i>Achnanthes oblongella</i>	33			<i>Dicranella palustris</i>	33
<i>Brachysira vitrea</i>	33			<i>Equisetum arvense</i>	33
<i>Chamaesiphon confervicolus</i>	33			<i>Equisetum fluviatile</i>	33
<i>Cocconeis pediculus</i>	33			Filamentous green algae	33
<i>Cymbella affinis</i>	33			Globular algae	33
<i>Cymbella helvetica</i>	33			<i>Glyceria fluitans</i>	33
<i>Cymbella microcephala</i>	33			<i>Hygrohypnum</i>	33
<i>Diatoma tenuis</i>	33			<i>Iris pseudacorus</i>	33
<i>Dichothrix gypsophila</i>	33			<i>Juncus effusus</i>	33
<i>Fragilaria capucina</i> var. <i>vaucheriae</i>	33			<i>Juncus inflexus</i>	33
<i>Gomphonema acuminatum</i>	33			<i>Jungermannia</i>	33
<i>Gomphonema minutum</i>	33			<i>Lemna minor</i>	33
<i>Gomphonema parvulum</i>	33			<i>Lemna trisulca</i>	33
<i>Heribaudiella fluviatilis</i>	33			<i>Lythrum salicaria</i>	33
<i>Lyngbya martensiana</i>	33			<i>Myosotis scorpioides</i>	33
<i>Meridion circulare</i>	33			<i>Pellia endiviifolia</i>	33
<i>Meridion circulare</i> var. <i>constrictum</i>	33			<i>Pellia epiphylla</i>	33
<i>Microspora irregularis</i>	33			<i>Petasites hybridus</i>	33
<i>Mougeotia</i> W4	33			<i>Phalaris arundinacea</i>	33
<i>Navicula cryptocephala</i>	33			<i>Philonotis fontana</i>	33
<i>Navicula halophila</i>	33			<i>Plagiomnium rostratum</i>	33
<i>Navicula tripunctata</i>	33			<i>Plagiomnium undulatum</i>	33
<i>Nitzschia fonticola</i>	33			<i>Potamogeton lanceolatus</i>	33
<i>Nitzschia palea</i>	33			<i>Ranunculus flammula</i>	33
<i>Oscillatoria brevis</i>	33			<i>Rorippa amphibia</i>	33
<i>Rivularia biasolettiana</i>	33				