Final Report **Project WFD46**

RIVPACS Pressure Data Analysis

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EXECUTIVE SUMMARY

WFD46: RIVPACS Database & WFD Screening (February, 2007)

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Background to research

RIVPACS is a model that predicts the freshwater macroinvertebrate fauna expected to occur at a site in the absence of pollution. The four current RIVPACS models are based on 835 reference sites from streams and rivers through the United Kingdom. With the advent of the Water Framework Directive (WFD) the concept of the 'reference condition' has become explicit within the legislative framework of the European Union. Reference condition has been established as a quality standard against which assessments of biological degradation must be compared. It is therefore essential that Member States can demonstrate that the biological datasets used to define reference conditions meet the criteria of the WFD. The UK RIVPACS models were originally based on minimally impacted sites. These sites were sampled over various phases of RIVPACS development over some 20 years. There is therefore a requirement to reappraise the levels of anthropogenic pressure acting at the RIVPACS reference sites at the time of sampling and where necessary to identify particular sites that fail to meet these new standards.

The Environment Agency, the Scottish Environment Protection Agency and the Environment and Heritage Service are engaged in a European WFD intercalibration process that is currently underway within several Geographical Intercalibration Groups (GIGs). These Agencies therefore need to gain full access to the RIVPACS dataset and its associated pressure data to contribute to the process of setting common standards for reference sites at a European level. As the data underpinning the RIVPACS system is central to the setting of reference conditions for UK streams and rivers, the UK agencies also require the RIVPACS dataset to be available to the public so that their site assessments for WFD monitoring are open and transparent.

Objectives of research

- To conduct an analysis of pressure data for the RIVPACS reference sites and to identify any sites that fail to satisfy the new WFD definition of reference condition.

- To summarise anthropogenic pressures acting at RIVPACS classification groups and WFD System-A stream types.

A separate Database Documentation report describes the collation of pressure data, the structure of the RIVPACS database, agreements to release the dataset to the public domain and the Internet download page.

Key findings and recommendations

Anthropogenic pressure levels at all 835 RIVPACS reference sites have been summarised by WFD system-A stream types, separately for WFD Ecoregion 17 (Northern Ireland) and Ecoregion 18 (Great Britain). Pressure levels have also been summarised by RIVPACS classification groups and compared to appropriate biotic index values. Forty sites (4.8%) out of the current 835 UK RIVPACS reference sites were identified as potentially unsuitable across the four RIVPACS models (Great Britain 33 (5.4%), Northern Ireland 4 (3.6%), Scottish Highlands 3 (2.7%) and Scottish Islands 1 (1.8%) – one site being in both the Great Britain and Scottish

Highlands models). Of these, 29 sites were identified as having either excessive organic or nutrient pollution (or both) relative to other sites in their group, 8 had excessive metals concentrations and 3 had unacceptably low flows. No sites were judged to have unacceptably low pH. Steps should be taken to either remove these sites from future models or to statistically correct for their influence. No sites were judged to have unacceptable levels of morphological degradation, thermal pollution, sedimentation or communities adversely affected by non-native species.

The selection of potential new RIVPACS reference sites must now take account of the WFD definition of reference condition. Any potential new RIVPACS reference sites must be selected in consultation with the UK agencies and be based on a thorough appraisal of environmental stresses to ensure that none of these lie outside the appropriate range for that stream type.

Key words: RIVPACS database, pressure data analysis, Water Framework Directive

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1. INTRODUCTION

RIVPACS is a model that predicts the freshwater macroinvertebrate fauna expected to occur at a site in the absence of pollution. The four current RIVPACS models are based on 835 reference sites from streams and rivers through the United Kingdom. With the advent of the Water Framework Directive, (Council of the European Communities, 2000) hereafter referred to as the WFD, the concept of the 'reference condition' has become explicit within the legislative framework of the European Union. Reference condition has been established as a quality standard against which assessments of biological degradation must be compared. It is therefore essential that Member States can demonstrate that the biological datasets used to define their reference conditions meet the criteria of the WFD. The UK RIVPACS reference sites and predictive models were selected and developed prior to the WFD. The RIVPACS models were based on sites considered to be minimally impacted at the time of sampling. These were sampled over various phases of RIVPACS development over some 20 years. There is therefore a requirement to reappraise the levels of anthropogenic pressure acting at RIVPACS reference sites at the time that they were sampled.

It is crucial to realise that that although we refer to 'reference sites', and being in 'reference condition', the sites used in the RIVPACS predictive models only need to be acceptable terms of their anthropogenic pressure at the time they were sampled. The levels of anthropogenic pressure and the biological conditions of the reference sites after the time of sampling are of no relevance to their suitability within the RIVPACS models. Thus, although we recommend continuing with the established term 'reference sites', the term 'reference samples' might be more accurate.

The WFD 'normative definitions' of biological, physico-chemical and hydromorphological quality for high, good and moderate status classes are given in Table 1 while the specific definitions relating to river invertebrates are given in Table 2.

Table 1 - WFD normative definitions (general)

Status class	Description
High	There are no, or only very minor, anthropogenic alterations to the values of the physico-chemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions. The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion. These are the type-specific conditions and communities.
Good	The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.
Moderate	The values of the biological quality elements for the surface water body type deviate moderately from those normally associated with the surface water body type under undisturbed conditions. The values show moderate signs of distortion resulting from human activity and are significantly more disturbed than under conditions of good status.

Table 2 - WFD normative definitions (river invertebrates)

Status class	Description
High	The taxonomic composition and abundance correspond totally or nearly totally to undisturbed conditions. The ratio of disturbance sensitive taxa to insensitive taxa shows no signs of alteration from undisturbed levels. The level of diversity of invertebrate taxa shows no sign of alteration from undisturbed levels. The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion. These are the type-specific conditions and communities.
Good	There are slight changes in the composition and abundance of invertebrate taxa from the type-specific communities The ratio of disturbance-sensitive taxa to insensitive taxa shows slight alteration from type-specific levels. The level of diversity of invertebrate taxa shows slight signs of alteration from type-specific levels.
Moderate	The composition and abundance of invertebrate taxa differ moderately from the type-specific communities. Major taxonomic groups of the type-specific community are absent. The ratio of disturbance-sensitive taxa to insensitive taxa, and the level of diversity, are substantially lower than the type-specific level and significantly lower than for good status.

In addition to the WFD definitions of status classes, a working group set up as part of the EU Water Framework Directive common implementation strategy has also published further guidance on how Member States should define reference states and how class boundaries should be set (Wallin et al., 2005), hereafter referred to as the REFCOND guidance notes. The REFCOND guidance notes show Member States how much emphasis should be placed on biological quality elements and how much should be placed on physicochemical and hydromorphological elements. The REFCOND guidance notes state:

'…while pressure criteria might be a proxy measure for assessing risk or screening for sites or values, their role in defining good status is secondary. Ultimately, as mentioned above, it is the biological data assessed against the normative definitions in Annex V 2.1, which will definitively assign water bodies to status classes.'

The REFCOND guidance notes also provide proposed pressure screening criteria for selecting potential reference condition sites. Table 3 reproduces these criteria (only those parts relevant to rivers). The criteria proposed elaborate the degree of anthropogenic pressure allowable for sites of high ecological status class.

Table 3 - REFCOND pressure screening criteria for high status class

General statement	• High status or reference conditions is a state in the present or in the past corresponding to very low pressure, without the effects of major industrialization, urbanization and intensification of agriculture, and with only very minor modification of physicochemistry, hydromorphology and biology.
Diffuse source pollution	
Land-use intensification: Agriculture, forestry	• Pre-intensive agriculture or impacts compatible with pressures pre-dating any recent land-use intensification. • Pressures pre-dating any recent intensification in airborne inputs that could lead to water acidification.
Point source pollution	
Specific synthetic pollutants	• Pressures resulting in concentrations close to zero or at least below the limits of detection of the most advanced analytical techniques in general use (a selection process for relevant pollutants in a river basin is presented as an example of best practice in section 6 of the guidance document from Working Group 2.1, IMPRESS).
Spec. non-synthetic pollutants	• Natural background level/load (see reference above)
Other effluents/discharges	• No or very local discharges with only very minor ecological effects.
Morphological alterations	
River morphology	• Level of direct morphological alteration, e.g. artificial in stream and bank structures, river profiles, and lateral connectivity compatible with ecosystem adaptation and recovery to a level of biodiversity and ecological functioning equivalent to unmodified, natural water bodies
Water abstraction	
River water abstraction	• Levels of abstraction resulting in only very minor reductions in flow levels or lake level changes having no more than very minor effects on the quality elements.
Flow regulation	
River flow regulation	• Levels of regulation resulting in only very minor reductions in flow levels or lake level changes having no more than very minor effects on the quality elements.
Riparian zone vegetation	
	• Having adjacent natural vegetation appropriate to the type and geographical location of the river.
Biological pressures	
Introductions of alien species	• Introductions compatible with very minor impairment of the indigenous biota by introduction of fish, crustacea, mussels or any other kind of plants and animals. • No impairment by invasive plant or animal species.
Fisheries and aquaculture	• Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends

	• Stocking of non-indigenous fish should not significantly affect the structure and functioning of the ecosystem. • No impact from fish farming.
Biomanipulation	• No biomanipulation.
Other pressures	
Recreation uses	• No intensive use of reference sites for recreation purposes (no intensive camping, swimming, boating, etc.)

The REFCOND guidance notes also state:

'A prerequisite for the use of pressure screening criteria is that the relationship between pressure and ecological impact is well established and that the impacts correspond to the normative definitions in the Directive (Annex V: 1.2).'

This point is important in that it helps to determine which pressure criteria need to be considered when screening sites to see if they are of reference quality.

While the specific details of how sites should be assigned to status classes are undecided, the WFD and the REFCOND guidance notes show the relative emphasis that should be placed on biological and physico-chemical and hydromorphological elements and broadly which physico-chemical and hydromorphological variables should be considered. However it is not possible as yet to obtain status class threshold values for particular physico-chemical and hydromorphological variables. The screening of the RIVPACS reference sites carried out in this project has therefore, by necessity, been based on identifying sites that are atypical of the group to which they belong in terms of both one or more pressures and their observed biota.

Defining the levels of anthropogenic pressure acting at the RIVPACS reference sites at the time they were sampled has been difficult. Nevertheless, this project has used a variety of readily available electronic datasets to interpret the levels of anthropogenic stress acting at each RIVPACS reference site. This project has also sought to gather data on the current levels of stress acting at the RIVPACS reference sites. This may assist the UK Agencies in deciding whether the RIVPACS sites might also be suitable reference sites for other quality elements such as macrophytes, diatoms or fish.

This report describes the analysis of pressure data and the overall assessment of all of the RIVPACS sites in terms of both their biological communities and their levels of anthropogenic pressure (both currently and at the time the RIVPACS samples were collected). This leads to the identification of reference sites that had (or have) unacceptably high levels of anthropogenic pressure (in terms of the WFD of reference state). While the WFD and REFCOND guidance notes do not identify specific physico-chemical, hydrological or hydromorphological variables, this project (WFD46) has gathered data on specific variables that can be grouped under the following headings:

- Organic pollution
- Nutrient pollution
- Acidification
- Synthetic toxic pollutants
- Toxic metals
- Hydrological stress
- Morphological degradation
- Thermal pollution

- Sedimentation stress
- Non-native species
- Land cover

In addition to summarising the available data on the above types of pressures for each reference site, this report also summarises pressure data by RIVPACS classification end groups and by the WFD physical stream typology as applied to the UK (WFD system-A). Those river types (in terms of RIVPACS end groups) where sites are considered to have had unacceptable levels of anthropogenic stress are also identified.

The origin of the data used to screen the RIVPACS sites is presented separately in the RIVPACS database documentation report.

2. CHEMICAL PRESSURE

Screening of the RIVPACS reference sites to highlight sites with abnormal chemical parameters should involve identification of sites that have abnormal chemical values for their respective stream type. The TWINSPAN classifications of sites into groups underpinning each of the four RIVPACS models were considered to be the most useful means of distinguishing biologically meaningful stream types and were therefore used as the basis for partitioning the reference sites into types. To identify sites with abnormal chemical stress values we first needed to make estimates of the normal range of values for the chemical stress variables in each site group. The four current RIVPACS models (Great Britain, Northern Ireland, Scottish Highlands and Scottish Islands) comprise TWINSPAN classifications with 35, 11, 10 and 5 end groups respectively. However, in order to increase the confidence in our type specific estimates of mean chemical stress variables, we needed to work at a higher level within each TWINSPAN classification. We therefore made reference condition estimates of type-specific chemical stress levels at the 9-group level in Great Britain, the 3-group level in Northern Ireland, the 2-group level in the Scottish Highlands and for all sites as one group in the Scottish Islands. For each of these groups of sites we calculated thirteen descriptive statistics for each chemical stress variable:

- Mean
- Median
- 10 percentile
- 25 percentile (Q_1)
- 75 percentile (Q_3)
- 90 percentile
- Upper outlier limit
- Lower outlier limit
- Minimum
- Maximum
- Number of sites in the group
- Number of sites in the group with data for the chemical stress variable
- Percentage of sites in the group with data for the chemical stress variable

These descriptive statistics describe the mean (or median) chemical stress levels at reference sites in each group and also identify the normal range of variability expected to occur for each chemical variable in each group. Sites in each end group where a chemical stress variable was outside the 10 or 90%ile limit (depending on the particular chemical variable) could then be distinguished. Because many of the chemical stress variables we attempted to gather could only be obtained for a small number of sites (e.g.

most of the metals, and all of the organic chemicals and pesticides), and because in several cases we had collated complementary variables (e.g. dissolved oxygen as % saturation and dissolved Oxygen as mg/l), we have only calculated descriptive statistics for eleven chemical stress determinands:

- pH (-log H^+)
- Oxygen (%sat)
- BOD ATU (mg/l O_2)
- Soluble Reactive Phosphorus (mg/l P)
- Nitrate (mg/l N)
- Nitrite (mg/l N)
- Free & Saline Ammonia (mg/l N)
- Total Oxidised Nitrogen (mg/l N)
- Suspended Solids (mg/l 105°C)
- Copper (dissolved) (mg/l)
- Zinc (dissolved/total) (mg/l)

The descriptive statistics for the chemical variables above are given in Appendix I together with box and whisker plots showing outlier sites (and their RIVPACS site codes). The descriptive statistics in Appendix I serve to identify which RIVPACS sites in each of their respective TWINSPAN groups have mean chemical values that lie outside the normal range suggested by the rest of the sites in that group. The 'normal' range of a variable within a site group is defined here as the range either below $Q_1–1.5(Q_3-Q_1)$ or above $Q_3+1.5(Q_3-Q_1)$ depending on whether the variable decreases or increases with increasing stress. Q_1 and Q_3 are lower and upper quartile values and this 'normal' range is shown by the solid vertical lines (whiskers) in each box plot given in Appendix I.

However, simply because a given site has an abnormally high (or low) mean value for a given chemical stress variable does not necessarily mean that site is biologically impaired relative to the other sites in the same stream type. We therefore investigated each site identified in Appendix I as having abnormally high (or low) values for a particular chemical stress variable and examined their biotic index values to see if the abnormal chemical stress was accompanied by biological impairment. We set a threshold of potential biological impairment to where the 3 season combined observed ASPT for a site was in the lowest 10% of ASPTs in that site group (or Number of Taxa in the case of copper and zinc stress). Sites identified as having both potential chemical stress and potential biological impairment are highlighted in bold in Appendix I and are reproduced in Table 4.

We then further investigated the reliability of the chemical data that had been linked to each of the reference sites in Table 4. We found that for 16 of the sites the chemical data came from the original IFE VAX archive files and could therefore be regarded as both temporally and spatially reliable (Table 5). For the remaining 22 sites we identified the origin of the chemical data and investigated each source in more detail to assess the temporal relevancy of the chemical data to the RIVPACS sampling site and sampling date (Table 5). Twelve of the remaining 22 sites had chemical data that was collected within approximately 1 year of the RIVPACS sampling date. This left ten sites where the chemical data was collected at a period of greater than one year after the RIVPACS samples were collected. We investigated these sites further using chemical data that was available through the Environment Agency web pages to assess whether any appreciable changes in chemical quality had taken place between the oldest data we could obtain on the web and the data we had used to assess the RIVPACS sites. We could only find additional data for four of these ten sites, but in all four cases the

Table 4 - Sites where a lower 10%ile or upper 90%ile chemical determinand is exceeded and an appropriate 3 season combined biotic index value (ASPT for all except Cu & Zn where NTaxa was used) is in the lowest 10% within the TWINSPAN group

	TWINSPAN Group	TWINSPAN end group	RIVPACS site	River	Site	BOD ATU	Oxygen (%sat)	SRP	Nitrate	Nitrite	Ammonia	TON	Suspended Solids	Dissolved Cu	Diss^D/total^T Zn
Mainland GB RIVPACS	1	2	4885*	Unnamed	Westerdale		X								
	1	3	5001	Otter	Fairhouse Farm	X		X		X	X		X		
	1	3	TA07	Elliot Water	Elliot	X		X			X				
	2	5	5845	Unnamed	Dinmore Manor								X		
	2	5	6845	Unnamed	Alton Common	X				X	X				
	2	8	2001	Blithe	Cookshill						X				
	2	8	AN06	Rase	Bully Hills						X				
	2	8	TH06	Clayhill Brook	u/s Burghfield STW	X					X				
	3	14	3509	South Tyne	Bardon Mill								X		
	3	14	4909	Tweed	Peebles Gauge			X	X						
	4	17	2719	Ribble/Gayle Beck	Mitton Bridge			X	X	X	X	X			
	4	17	4107	Stinchar	Pinmore Bridge								X		
	5	19	5009	Otter	Newton Poppleford			X							
	5	20	8289	Clun	Jay									X	
	6	21	2211	Dove	Monk's Bridge									X	
	6	21	3309	Swale	Morton-on-Swale										X^D
	6	22	2507	Glen	Banthorpe Lodge				X			X			
	6	22	3515	Tyne/North Tyne	Wylam						X				X^D
	6	22	NW07	Waver	Waver Bridge		X								
	7	27	1407	Lee	Ware Weir			X					X		
	7	27	1907	Perry	Milford									X	
	7	27	2305	Colne	Earl's Colne	X		X	X						
	7	27	2307	Colne	Fordstreet Bridge			X	X						
	7	27	6103	Thet	East Harling						X				
	7	28	1909	Perry	Mytton									X	
	8	29	2103	Smite	Colston Bassett			X							
	8	29	6001	Blythe	Cheswick Green									X	
	8	30	2815	Weaver	Beam Bridge	X				X	X				
	8	30	SN01	Ditton Stream	Ditton										X^D
	9	34	2509	Glen	South of Twenty						X				
High-lands	1	1	SEPA E08	Tay/Dochart/Fillan/Cononish	Taymount Mains							X	X		
	1	2	4885*	Unnamed	Westerdale		X								
	2	5	SEPA W38	Carradale Water	B842 Bridge								X		
Islands	1	5	SEPA N09	Yell: Easter Burn of Bouster	Bouster		X								
Northern Ireland	1	3	20201101	Owenrigh River	Carnanbane										X^T
	2	6	NI 24	Crew Burn	Carrols Bridge	X		X			X				
	2	7	NI 32	Mullagh River	Mullagh Bridge				X	X		X			
	3	11	20303403	Blackwater	Moy								X		

*site part of the mainland GB RIVPACS model and the Scottish Highlands RIVPACS model

Table 5 - Sites where a lower 10%ile or upper 90%ile chemical determinand is exceeded and an appropriate 3 season combined biotic index value is in the lowest 10% within the TWINSPAN group together with details of the origin of the chemical data

	TWINSPAN Group	TWINSPAN end group	RIVPACS site	River	Site	Chemical data arising (at least in part) from IFE VAX files and therefore regarded as spatially and temporally reliable)	Origin of chemical data at sites where there were no data from IFE VAX files	Year of summer RIVPACS sampling	Year of chemical sampling for determinands exceeding 10/90 %ile	Temporal relevance (within 1 yr = 'Good', else 'Poor')
Mainland GB RIVPACS	1	2	4885*	Unnamed	Westerdale	Y	–	–	–	–
	1	3	5001	Otter	Fairhouse Farm	Y	–	–	–	–
	1	3	TA07	Elliot Water	Elliot	–	SEPA NCW database	1992	1992	Good
	2	5	5845	Unnamed	Dinmore Manor	–	GQA 2002 database	1991	2002	Poor
	2	5	6845	Unnamed	Alton Common	–	IFE data & GQA 2002	1991	1988-1990	Good
	2	8	2001	Blithe	Cookshill	Y	–	–	–	–
	2	8	AN06	Rase	Bully Hills	–	IFE data	1990	1988-1990	Good
	2	8	TH06	Clayhill Brook	u/s Burghfield	–	IFE data	1990	1988-1990	Good
	3	14	3509	South Tyne	Bardon Mill	–	GQA 2002	1978	2002	Poor
	3	14	4909	Tweed	Peebles Gauge	Y	–	–	–	–
	4	17	2719	Ribble/Gayle Beck	Mitton Bridge	Y	–	–	–	–
	4	17	4107	Stinchar	Pinmore Bridge	Y	–	–	–	–
	5	19	5009	Otter	Newton	Y	–	–	–	–
	5	20	8289	Clun	Jay	–	GQA 2002	1988	2002	Poor
	6	21	2211	Dove	Monk's Bridge	–	GQA 2002	1978	2002	Poor
	6	21	3309	Swale	Morton-on-Swale	–	GQA 2002	1978	2002	Poor
	6	22	2507	Glen	Banthorpe Lodge	Y	–	–	–	–
	6	22	3515	Tyne/North Tyne	Wylam	Y	–	–	–	–
	6	22	NW07	Waver	Waver Bridge	–	IFE data	1990	1988-1990	Good
	7	27	1407	Lee	Ware Weir	Y	–	–	–	–
	7	27	1907	Perry	Milford	–	GQA 2002	1978	2002	Poor
	7	27	2305	Colne	Earl's Colne	Y	–	–	–	–
	7	27	2307	Colne	Fordstreet Bridge	Y	–	–	–	–
	7	27	6103	Thet	East Harling	Y	–	–	–	–
	7	28	1909	Perry	Mytton	–	GQA 2002	1978	2002	Poor
	8	29	2103	Smite	Colston Bassett	–	GQA 1995	1979	1993-1995	Poor
	8	29	6001	Blythe	Cheswick Green	–	GQA 2002	1982	2002	Poor
	8	30	2815	Weaver	Beam Bridge	Y	–	–	–	–
	8	30	SN01	Ditton Stream	Ditton	–	GQA 2002	1990	2002	Poor
	9	34	2509	Glen	South of Twenty	Y	–	–	–	–
High-lands	1	1	SEPA E08	Tay/Dochart/Fillan/Cononish	Taymount Mains	–	SEPA NCW database	2001	2001-2002	Good
	1	2	4885*	Unnamed	Westerdale	Y	–	–	–	–
	2	5	SEPA W38	Carradale Water	B842 Bridge	–	SEPA NCW database	2001	2001-2003	Good
Island	1	5	SEPA N09	Yell: Easter Burn of Bouster	Bouster	–	SEPA NCW database	2001	2001-2004	Good
Northern Ireland	1	3	20201101	Owenrigh River	Carnanbane	–	EHS 1986-1995	1990	1986-1995	Good
	2	6	NI 24	Crew Burn	Carrols Bridge	–	EHS 1996-2005	2000	2001-2004	Good
	2	7	NI 32	Mullagh River	Mullagh Bridge	–	EHS 1996-2005	2000	2000-2004	Good
	3	11	20303403	Blackwater	Moy	–	EHS 1986-1995	1990	1986-1995	Good

*site part of the mainland GB RIVPACS model and the Scottish Highlands RIVPACS model additional data indicated that these sites had long running chemical pollution problems. We therefore conclude that all the sites identified in Table 4 and 5 were probably chemically impaired.

Using the data in Table 5 we can now identify the number of sites in each of the four RIVPACS models where sites have abnormal values for one or more chemical stress variables and there is some evidence of associated biological impairment (Table 6). The RIVPACS Great Britain model has the highest percentage of sites that are potentially stressed by chemical pollutants (4.8%), while the percentage of sites potentially stressed by chemical pollutants is lower in the other three models.

Table 6 - The number of RIVPACS sites with one or more outlying chemical pressures and an associated a typical biotic index value in each RIVPACS model

RIVPACS model	Number of sites	Number of sites with chemical pressure and an associated a-typical biotic index value	% of sites with chemical pressure and an associated a-typical biotic index value
Great Britain	614	30	4.8
Scot. Highlands	108	3	2.8
Scot. Islands	55	1	1.8
Northern Ireland	110	4	3.6
	Total	37*	

*site 4885 is used in both the Great Britain and Scottish Highlands models

The sites that have been identified as having probable chemical and biological impairment are fairly evenly distributed between the TWINSPAN end groups of all four RIVPACS models (Table 6) and there do not appear to be any end groups that are disproportionately populated by chemically stressed sites.

Summary statistics for the eleven commonly recorded chemical determinands have also been calculated for sites within each WFD system-A stream type (Appendix II). As part of this project we have also collated current levels of chemical pressures at the RIVPACS reference sites. While these data have not been included in this pressure analysis report, they may be of use to the UK agencies should they need to consider the collection of reference site samples for other biological quality elements such as macrophytes, diatoms or fish. These data are stored in the RIVPACS database in the tables prefixed ‘Chemistry current…’ and are set out in an identical structure to the data contemporary with the RIVPACS sample collection dates. In assessing the contemporary and current data it is important to realise that in some cases, because little data were available, the same data are used in both sets of tables.

3. FLOW

Our screening of the RIVPACS sites for flow related stress relies heavily on an existing investigation of quality of the RIVPACS sites in terms of flow (Clarke et al., 2003). Their study developed a new algorithm for the calculation of RIVPACS expected family level LIFE scores. The Lotic-invertebrate Index for Flow Evaluation (LIFE) is a biotic index developed to assess the biological impact of low flow (low discharge) on macroinvertebrate communities (Extence et al., 1999). Within England and Wales, the Environment Agency intend to use observed/RIVPACS expected LIFE scores as part of their Resource Assessment and Management (RAM) Framework for abstraction licensing and in their Catchment Abstraction Management Strategies (CAMS). O/E LIFE is therefore a well established measure of the biological impact of low flow.

Clarke et al. (2003) linked RIVPACS sites from the 614 site GB model to gauging stations using the CEH national river network GIS derived from the CEH-corrected Ordnance Survey 1:50000 blue line river layer. 443 RIVPACS sites had both summer flow data in the year of RIVPACS sampling and mean summer flow data from at least four other years. For each site, the mean summer flow across all available years was calculated together with the mean summer flow in the year of RIVPACS sampling. These data were then standardised as Percent Flow by expressing the flow in the RIVPACS sampling year as a percentage of the average flow in all years. Clarke et al. found that there were 31 sites whose mean summer flow in the year of biological sampling was less than 50% of the overall average summer flow across all years, of which eight sites had mean summer flows less that 40% of the overall average. Clarke et al. also assessed the relative flow in the summer of the RIVPACS sampling year as the Percent Rank Flow across all year's summer flows. Twenty of the 443 sites were found to have been sampled in years when the summer flows were amongst the lowest 10% of mean summer flow flows across all available years since 1970.

Clarke et al. (2003) then examined the relationship between O/E LIFE ratios and both Percent Flow and Percent Rank Flow finding that there was some suggestion that sites sampled in years of relatively low summer flow tended to have marginally lower values of LIFE O/E. While these correlations were statistically significant ($p<0.01$) they were very weak (r=0.15-0.17) indicating that there was no relationship of any practical concern amongst the reference sites between LIFE O/E and the relative flow in the year of RIVPACS sampling.

Correlations between LIFE O/E and relative flow in the RIVPACS sampling year were also investigated within different types of streams defined by the RIVPACS TWINSPAN end groups at the 9-group level (to ensure a large enough sample size within each stream type). Only one group had a significant relationship between LIFE O/E and the relative flow (Percent Rank Flow) in the RIVPACS sampling year. This was TWINSPAN group 29-32 comprising lowland sites mainly in south and southeast England and including many of the southern chalk streams. However, one of the sites in this end group had flow data obtained from 27km downstream and was therefore judged to be inappropriate and another site had a 30-year highest mean summer flow and a very high LIFE O/E. Overall it was concluded that amongst the RIVPACS reference sites there were no groups of sites (i.e. types of sites) that had several sites with both relatively low summer flow prior to sampling and low LIFE O/E and that there was therefore no major systematic problem in using RIVPACS to set expected LIFE scores for any type of river.

Although no major systematic problems were found in the RIVPACS dataset in terms of flow and its effects on the samples, there were three individual sites that were identified as having atypical flows and LIFE O/E (Table 7). These three sites are in group 33, an end group containing mostly lowland slow flowing rivers in the south, east and south east of England. Because this end group is quite large (31 sites) the effects of removing these sites would be quite small in terms of how the end group contributes to predictions of expected Number of Taxa and ASPT.

Table 7 - RIVPACS sites to be excluded on grounds of flow

Code	River	Site	LIFE O/E	Percent Flow	Percent Rank Flow
6259	Granta	Hildersham	0.867	17	14
6811	Stour	Longham	0.782	68	15
9113	Hull/West Beck	Corpslanding	0.798	41	19

4. HYDROMORPHOLOGY

Using River Habitat Survey datasets supplied by the Environment Agency, we were able to link 269 of the RIVPACS sites (32%) to River Habitat Surveys (based on proximity within 500m and a matching river name). These comprised sites in England (155), Scotland (52), Wales (21) and Northern Ireland (41) and enabled Habitat Modification Index (HMI) scores to be associated with these RIVPACS sites. Because only 32% of the RIVPACS sites could be linked to RHS surveys, and because hydromorphology is a relatively stable environmental stress (over time), we decided to accept RHS surveys from any RHS survey date relative to the RIVPACS sampling date.

In screening the RIVPACS sites for potential hydromorphological stress we first needed to establish whether the hydromorphological modifications described by HMI scores were related to the biological quality of the RIVPACS samples. This requirement is given in the REFCOND guidance notes where it is stated that that for a pressure to be used in reference site screening then a '…relationship between the pressure and ecological impact should be well established…' For hydromorphological pressure there is little or no existing information to suggest that such a relationship exists so we investigated this using the 269 RIVPACS sites with linked RHS surveys and HMI scores (section 4.1).

In addition to linking 269 RIVPACS sites to RHS surveys and HMI scores, we also re-examined RIVPACS field survey sheets that were filled in at the time the RIVPACS samples were collected (all drawn from the 614 site RIVPACS Great Britain model). This was done partly to increase the number of RIVPACS sites at which we could make a hydromorphological assessment and also to gather data where we were more confident about the spatial relevance of the hydromorphological features with respect to the RIVPACS sampling location than we had been for the RHS data. Field sheets were examined for 447 sites (53.5% of all UK RIVPACS sites) and details of hydromorphological modifications present at the RIVPACS sites were compiled (section 4.2).

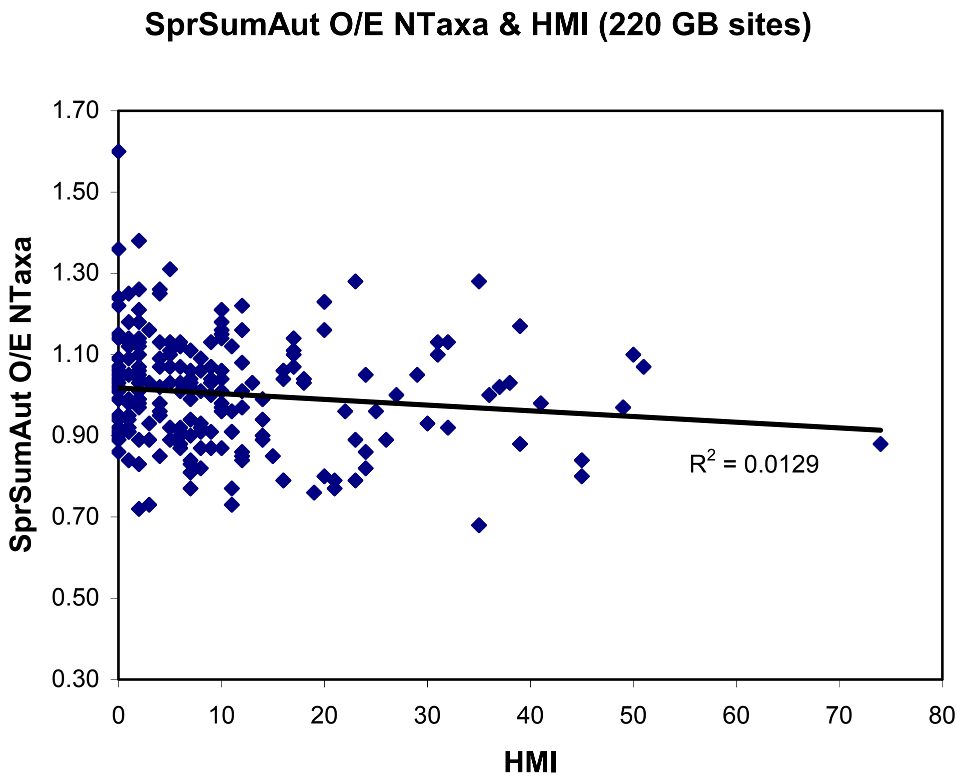
4.1 River Habitat Survey

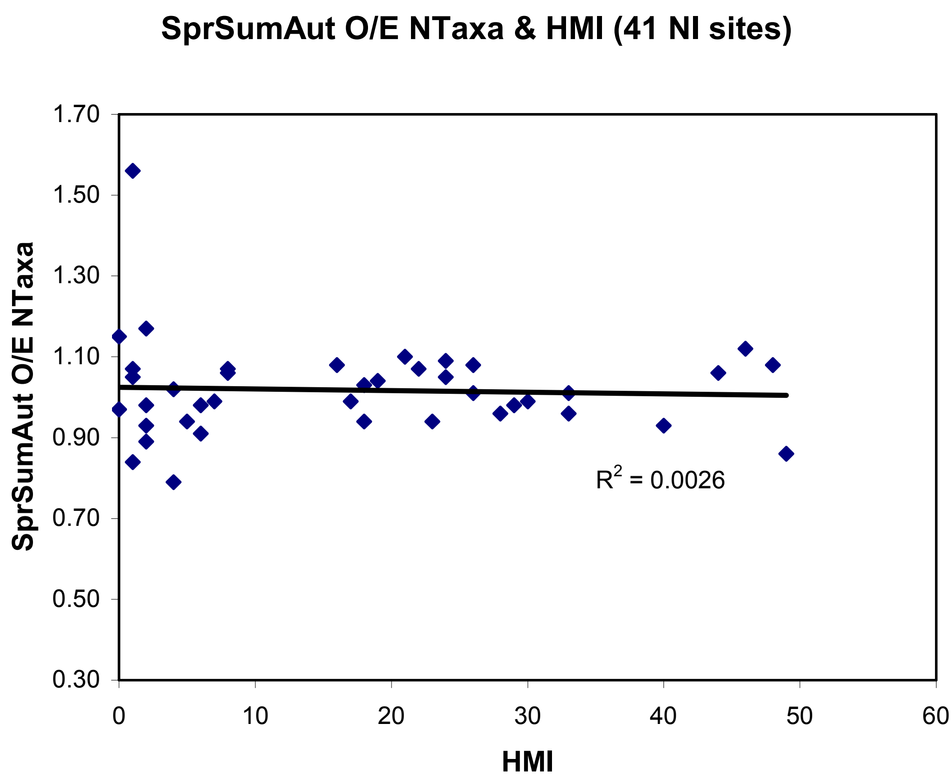
HMI scores of the 269 RIVPACS sites that have been linked to RHS surveys ranged from 0 to 74 (HMI classes 1 to 5) and therefore represented a wide range of hydromorphological modification. We investigated the relationship between the HMI scores and the biological quality of the RIVPACS reference sites (in terms of spring, summer and autumn combined O/E Number of Taxa) and found that for both the 220 RIVPACS sites in Great Britain and the 41 RIVPACS sites in Northern Ireland, the relationship between SprSumAut O/E NTaxa and HMI was very weak (Figure 1). High HMI scores were therefore not significantly associated with a lower than expected number of taxa within the 269 sites tested.

4.2 RIVPACS field sheets

While the use of RHS data to assess the hydromorphological condition of the RIVPACS sites had the advantage of being based on a well-established hydromorphological methodology, our re-examination of field survey sheets for 447 RIVPACS sites enabled the hydromorphological condition of these sites to be established with a higher degree of spatial and temporal relevance. From each RIVPACS field survey sheet we collated information from the sampler's sketch map and their notes on the presence of weirs, significant bank modifications to one or both banks (significant meaning hard engineering such as concrete, sheet piling, etc), channel straightening, and dredging (within the last year). Where any of the above features were recorded we regarded the

Figure 1 – Spring, summer and autumn combined O/E Number of Taxa verses HMI score at RIVPACS sites with linked RHS





site as being hydromorphologically modified. We then tested the relationship between our simple 'index' of hydromorphological modification ('modified' or 'unmodified') and the spring, summer and autumn combined sample O/E for Number of Taxa. We found that overall, across all end-groups, there was no significant difference between modified sites and unmodified sites in terms of their 3-season O/E NTaxa (t=-0.45, P=0.651, d.f.=76). We then examined the proportions of modified and unmodified sites in the TWINSPAN 9-level groups (Table 8) and found that TWINSPAN groups 6 and 9 had the highest proportions of modified sites (17.9% and 33.3% respectively).

Table 8 - Distribution of hydromorphologically modified and unmodified sites within TWINSPAN groups

TWINSPAN Group	Number of sites assessed	Number of modified sites	Number of unmodified sites	% modified
1	47	2	45	4.3
2	33	3	30	9.1
3	64	5	59	7.8
4	58	5	53	8.6
5	38	5	33	13.2
6	67	12	55	17.9
7	57	6	51	10.5
8	38	4	34	10.5
9	45	15	30	33.3

Because groups 6 and 9 had the most balanced proportions of modified and unmodified sites we tested each of these separately to see if there was a significant difference in 3-season O/E NTaxa between modified and unmodified sites, again finding no significant differences (group 6 t=0.72, *p*=0.482, df=16; group 9 t=0.16, *p*=0.873, df=36).

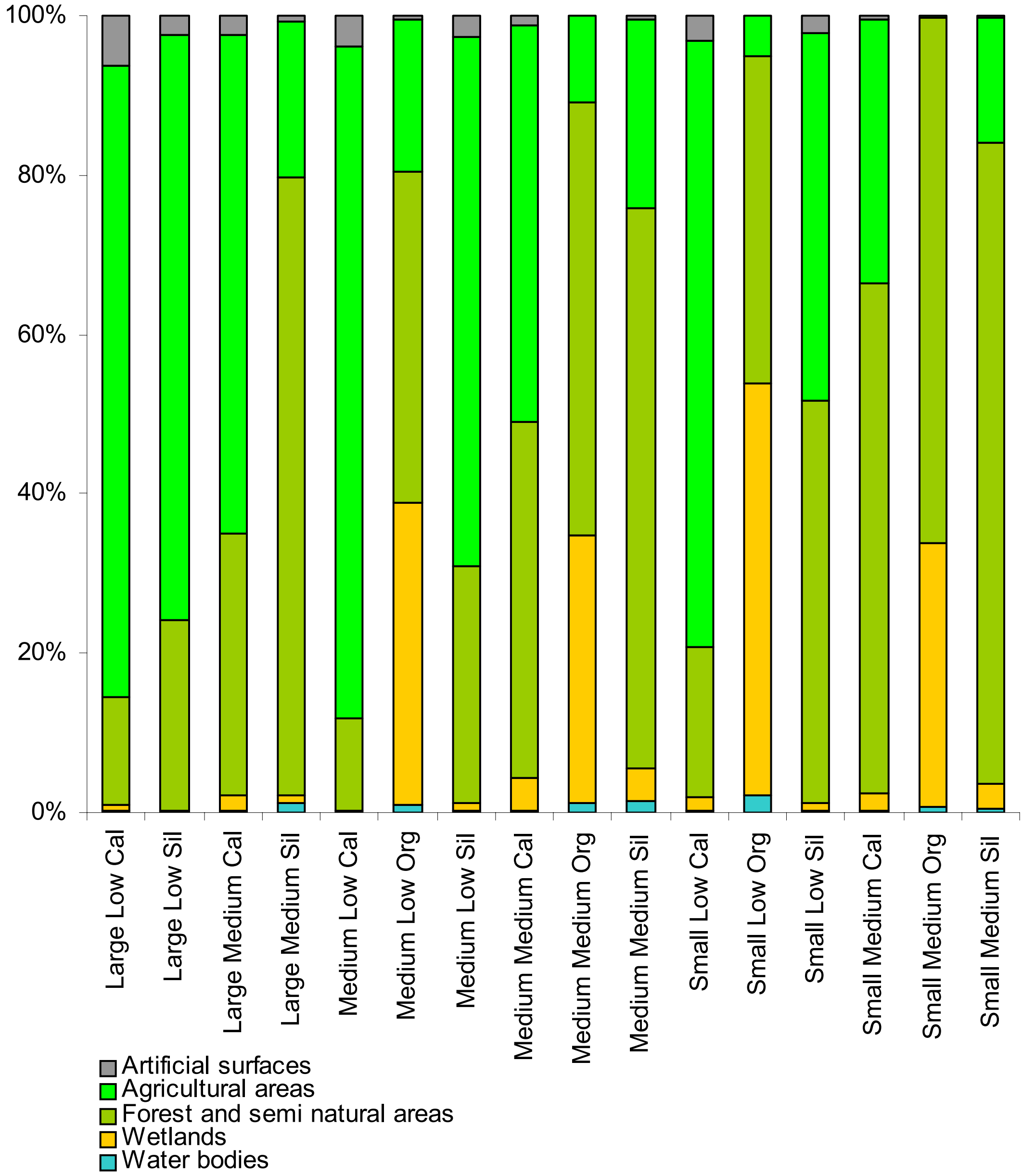
Finally we also used a 2-way unbalanced ANOVA to assess the relationship between 3 season combined observed NTaxa (rather that O/E) and site modification, simultaneously allowing for differences at the TWINSPAN 4-group level (thereby involving the maximum number of sites and increasing the power to detect differences). We found that while there was a highly significant difference between the 4 TWINSPAN groups in terms of the mean NTaxa (F=13.32, *p*=<0.001, df=3 and 439), there was no significant difference between the modified and unmodified sites across all end-groups (F=0, *p*=0.96, df=1 and 439) and that there was no significant interaction (F=0.43, *p*=0.732, df=3 and 439) indicating that differences in NTaxa between modified and unmodified sites do not change significantly between end-groups.

We therefore concluded that based on both the 269 linked RHS survey HMI scores and 447 RIVPACS field sheet based assessments of hydromorphological modification there was no clear relationship between hydromorphological modification and the three season combined number of macroinvertebrate taxa recorded at the RIVPACS sites. We conclude that there is no evidence that this degree of impairment has had a significant impact on the macroinvertebrate fauna.

5. CORINE 2000 LAND USE

CORINE (CoORdination of Information oN the Environment) land cover data (at CORINE label level 3 – see Appendix V) gathered in the year 2000 was summarised for the catchments draining into each of the RIVPACS reference sites. This as done using ArcMap9 GIS software and a Digital Terrain Model (DTM version IHDTM Sept 04). Firstly a flow accumulation grid was constructed using the DTM to visualise the courses of streams and rivers. Secondly, using the DTM, catchments were then generated for each RIVPACS reference site. This was done one-by-one to ensure that each catchment was sensible when judged against the flow accumulation grid. The coordinates of RIVPACS sites that failed to generate sensible catchments were adjusted accordingly. Thirdly, the RIVPACS catchments were then used to 'cookie-cut' CORINE land cover data at 50m x 50m resolution. These data were then summarised as the percentage land cover in the catchment draining into each RIVPACS site. Average CORINE 2000 land cover for the RIVPACS sites is summarised by WFD System-A streams at the CORINE level 1 (5 broad categories) in Figures 2 and 3, and at CORINE level 3 (44 detailed categories) in Appendix V.

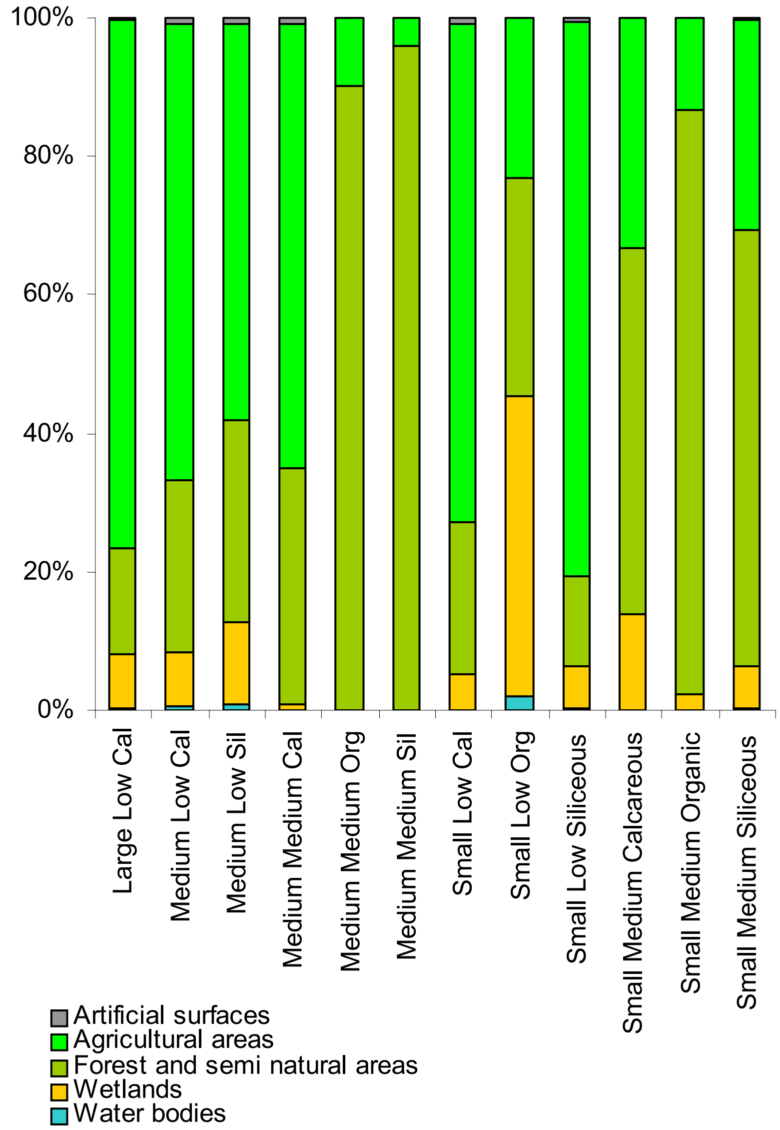
Figure 2 – CORINE 2000 level 1 land cover summarised by WFD System-A stream type for Great Britain



Our principle interest in the analysis of land cover was to determine the average percentage cover of artificial surfaces (urban, industrial ground etc). In both Great Britain and Northern Ireland the average percentage cover of CORINE label level 1 (defined in

Appendix V) artificial surfaces in catchments draining into the RIVPACS sites was low (1.983% and 0.593% respectively). The percentages of individual CORINE label level 3 artificial land use types in the RIVPACS catchments were also judged to be acceptable and not at levels that might suggest that individual sites were unacceptably stressed.

Figure 3 – CORINE 2000 level 1 land cover summarised by WFD System-A stream type for Northern Ireland



6. THERMAL POLLUTION

Information on possible thermal pollution was gathered from the survey notes on the RIVPACS field sheets that were filled in at the time the RIVPACS samples were collected. We examined 447 RIVPACS field sheets for evidence of thermal stress and found that no sites had any entries in the field survey notes to indicate that thermal pollution was present.

7. SEDIMENTATION STRESS

Although all RIVPACS sites have a standard assessments of substratum composition associated with all three separate season samples, sedimentation stress is difficult to distinguish from the very large natural variability in substratum composition that occurs naturally across the whole RIVPACS dataset. This difficulty of assessing sedimentation stress is further compounded by the fact that substratum composition is regarded as a predictor variable of macroinvertebrate community composition in all of the RIVPACS models. We therefore decided to assess sedimentation stress by again looking at the field survey sheets that had been collated for the RIVPACS sites. Each of these were filled in by experienced biologists at the time the RIVPACS samples were collected and we are confident that abnormally high levels of sedimentation would have been recorded on these sheets if it was present. We found that out of the 447 field survey sheets assessed only two made mention of possible sedimentation stress, site 0107 (the River Camel at Brockton) and site 4205 (the River Annan at Newton Bridge). We then examined the 3 season combined observed number of taxa at these sites in relation to the 3 season combined observed number of taxa in their respective end groups as a whole (at the 9-group TWINSPAN level). We found that for site 0107 the 3 season combined observed NTaxa ranked 30th highest out of 87 in the group and for site 4205 the 3 season combined observed NTaxa ranked 46th out of 83. Despite mention of possible sedimentation stress at both of these sites, the number of taxa was firmly within the natural range of variability for these types of rivers and we conclude that no sites should be regarded as having significant sedimentation stress.

8. NON-NATIVE SPECIES

Our assessment of the potential stress caused by non-native species is confined to the potential pressure exerted by non-native macroinvertebrate species. We made use of two lists of non-native freshwater macroinvertebrates in our assessment of pressure at the RIVPACS sites – a list produced by the UK Biodiversity Research Advisory Group (UK BRAG, 2004) reproduced in Appendix III, and a list produced by the UK Technical Advisory Group on the Water Framework Directive (UK TAG, 2003) reproduced in Appendix IV. We assessed the frequency of occurrence of all of the species described in Appendix III and IV across the RIVPACS dataset (Table 9).

Table 9 – Frequency of occurrence of non-native freshwater macroinvertebrate species across the 835 RIVPACS sites

Scientific name	English name	Freq. of occurrence
Achtheres percarum	Freshwater copepod	0
Anguillicola crassus	Swim bladder nematode	0
Asellus communis	Freshwater malacostracan	0
Astacus astacus	Noble crayfish	0
Astacus leptodactylus	Narrow-clawed (Turkish) crayfish	0
Branchiura sowerbyi	Freshwater oligochaete	5
Corbicula fluminea	Freshwater mollusc	0
Corophium curvispinum	Freshwater malacostracan	1
Crangonyx pseudogracilis	Freshwater amphipod	125
Craspedacusta sowerbyi	Freshwater coelenterate	0
Dikerogammarus villosus	Freshwater amphipod	0

Dreissena polymorpha	Zebra mussel	2
Dugesia tigrina	Freshwater triclad	35
Ergasilus briani	Freshwater copepod	0
Ergasilus sieboldi	Freshwater copepod	0
Eriocheir sinensis	Chinese mitten crab	0
Ferissia wautieri	Freshwater mollusc	0
Lernaea cyprinacea	Freshwater copepod	0
Limnodrilus cervix	Freshwater oligochaete	10
Lymnaea catascopium	Freshwater gastropod	0
Marstoniopsis scholtzi	Freshwater mollusc	0
Menetus dilatatus	Freshwater mollusc	0
Musculium transversum	Freshwater mollusc	0
Mytilopsis leucophaeata	Freshwater bivalve	0
Neoergasilus japonicus	Freshwater copepod	0
Orconectes limosus	Spiny-cheeked/striped crayfish	0
Pacifastacus leniusculus	North American signal crayfish	0
Phagocata woodworthi	Freshwater triclad	0
Physa acuta	Freshwater mollusc	13*
Physa gyrina	Freshwater mollusc	0
Physa heterostropha	Freshwater mollusc	1
Piscicola geometra	Fish leech	186
Planaria torva	Freshwater triclad	14
Potamopyrgus antipodarum	Jenkin's spire shell	529
Procambarus clarkii	Red swamp crayfish	0
Tracheliastes polycolpus	Freshwater copepod	0

**Physa acuta* group includes *Physa acuta* and *Physa heterostropha*

Of the 37 non-native species listed in Table 9, ten are definitely present within the RIVPACS dataset (*Branchiura sowerbyi*, *Corophium curvispinum*, *Crangonyx pseudogracilis*, *Dreissena polymorpha*, *Dugesia tigrina*, *Limnodrilus cervix*, *Physa heterostropha*, *Piscicola geometra*, *Planaria torva*, *Potamopyrgus antipodarum*). *Physa acuta* group includes the introduced species *Physa acuta* and *Physa heterostropha* so we are unable to assess whether *Physa acuta* is actually present at the 13 sites RIVPACS sites where *Physa acuta* group are recorded (without re-examination of archived specimens). Several of these species occur at many of the RIVPACS sites (*Crangonyx pseudogracilis*, *Piscicola geometra*, *Potamopyrgus antipodarum*, *Dugesia tigrina*, *Planaria torva*) and we regard these are completely naturalised taxa. Of the remaining species only the zebra mussel (*Dreissena polymorpha*) is cause for concern.

Dreissena polymorpha is one of three species highlighted by the UK TAG as being potentially damaging to aquatic ecosystems (together with the Chinese mitten crab (*Eriocheir sinensis*) and the North American signal crayfish (*Pacifastacus leniusculus*). Of these three species, only *Dreissena polymorpha* is found in the UK RIVPACS reference site data set (at site 6293 – The Wissey at Five Mile House, and site 6917 – the Thames at Reading). We compared the 3 season combined observed number of taxa at these two sites with the other sites in their TWINSPAN group (at the TWINSPAN 9-group level). Both sites are in TWINSPAN group 9 and we found that both sites were within to top 20th highest sites in terms of their 3 season combined observed number of taxa (site 6293 is 17th out of 58 sites in group 9 and site 6917 is 20th). It is therefore clear that while *Dreissena polymorpha* is recorded at these sites, both sites had fully intact reference macroinvertebrate communities and we do not therefore consider that these sites were stressed by *Dreissena polymorpha* at the time they were sampled.

We also examined the frequency of occurrence of *Gammarus pulex* in Northern Ireland (where it is non-native and thought to be displacing the native *Gammarus duebeni*). We found that while *Gammarus duebeni* was present in 96 of the 110 Northern Ireland reference sites, *Gammarus pulex* was present at only 22. We have not regarded the presence of *Gammarus pulex* in sites in Northern Ireland as a pressure with sufficient intensity for sites to be considered non-reference.

9. OVERALL PRESSURE ASSESSMENT

This study has enabled an overall assessment to be made of the degree to which the RIVPACS reference site dataset complies with the WFD and REFCOND concept of reference condition for macroinvertebrates. A summary of the RIVPACS sites identified as being potentially unsuitable is given in Table 10.

Table 10 – RIVPACS sites identified as potentially unsuitable

Model	Site code	River	Site	Unsuitability
GB	1407	Lee	Ware Weir	Organic/Nutrients
GB	1907	Perry	Milford	Metals
GB	1909	Perry	Mytton	Metals
GB	2001	Blithe	Cookshill	Organic
GB	2103	Smite	Colston Bassett	Nutrients
GB	2211	Dove	Monk's Bridge	Metals
GB	2305	Colne	Earl's Colne	Organic/Nutrients
GB	2307	Colne	Fordstreet Bridge	Nutrients
GB	2507	Glen	Banthorpe Lodge	Nutrients
GB	2509	Glen	South of Twenty	Organic
GB	2719	Ribble/Gayle Beck	Mitton Bridge	Organic/Nutrients
GB	2815	Weaver	Beam Bridge	Organic/Nutrients
GB	3309	Swale	Morton-on-Swale	Metals
GB	3509	South Tyne	Bardon Mill	Organic
GB	3515	Tyne/North Tyne	Wylam	Organic/Metals
GB	4107	Stinchar	Pinmore Bridge	Organic
GB	4909	Tweed	Peebles Gauge	Nutrients
GB	5001	Otter	Fairhouse Farm	Organic/Nutrients
GB	5009	Otter	Newton Poppleford	Nutrients
GB	5845	Unnamed	Dinmore Manor	Organic
GB	6001	Blythe	Cheswick Green	Metals
GB	6103	Thet	East Harling	Organic
GB	6259	Granta	Hildersham	Low flow
GB	6811	Stour	Longham	Low flow
GB	6845	Unnamed	Alton Common	Organic/Nutrients
GB	8289	Clun	Jay	Metals
GB	9113	Hull/West Beck	Corpslanding	Low flow
GB	AN06	Rase	Bully Hills	Organic
GB	NW07	Waver	Waver Bridge	Organic
GB	SN01	Ditton Stream	Ditton	Metals
GB	TA07	Elliot Water	Elliot	Organic/Nutrients
GB	TH06	Clayhill Brook	u/s Burghfield STW	Organic
GB, Highlands	4885	Unnamed	Westerdale	Organic
Highlands	SEPA_E08	Tay/Dochart/Fillan/Cononish	Taymount Mains	Organic/Nutrients
Highlands	SEPA_W38	Carradale Water	B842 Bridge	Organic
Islands	SEPA_N09	Yell: Easter Burn of Bouster	Bouster	Organic
N. Ireland	20201101	Owenrigh River	Carnanbane	Metals
N. Ireland	20303403	Blackwater	Moy	Organic
N. Ireland	NI_24	Crew Burn	Carrols Bridge	Organic/Nutrients
N. Ireland	NI_32	Mullagh River	Mullagh Bridge	Nutrients

Overall 40 (4.8%) of RIVPACS sites were identified as potentially unsuitable across the 835 sites in the four RIVPACS models (Great Britain 33 sites (5.4%), Northern Ireland 4 sites (3.6%), Scottish Highlands 3 sites (2.7%) and Scottish Islands 1 site (1.8%), one site being in both the Great Britain and Scottish Highlands models). Twenty-nine sites were identified as having either excessive organic or nutrient pollution (or both) relative to other sites in their group, 8 have excessive metals concentrations and 3 had unacceptably low flows. No sites were judged to have unacceptably low pH, or unacceptable levels of morphological degradation, thermal pollution, sedimentation or communities adversely affected by non-native species. While a thorough assessment of pressure arising from synthetic toxic pollutants and toxic metals was not possible due to insufficient data, the levels of these stressors at sites where data were available indicate that levels were low and often below the limits of detection of the analytical techniques available at the time the samples were analysed.

The presence of 40 potentially unsuitable sites within the UK RIVPACS models may mean that the targets set by these models could be too low for some test sites. There are several possible solutions:

(1) Remove these sites and develop new RIVPACS models

(2) Retain the current RIVPACS models but exclude these potentially impaired sites from estimates of expected faunas and biotic indices

(3) Retain the current RIVPACS models but statistically adjust/correct the expected biotic index values according to the estimated/perceived levels of stress acting at the reference sites at the time they were sampled.

Implementation any of the three options above will lead to slightly more stringent reference condition targets for test sites.

10. GUIDELINES FOR FUTURE REFERENCE SITE SELECTION

This project has also enabled guidance to be formulated for future RIVPACS development projects where new sites need to be selected. Any potential new RIVPACS reference sites must now take account of the WFD definition of reference state and must involve a comprehensive assessment of all those forms of stress detailed above (organic pollution, nutrient pollution, acidification, synthetic toxic pollutants, toxic metals, hydrological stress, morphological degradation, thermal pollution, sedimentation stress, and non-native species). Any potential new RIVPACS reference sites must therefore be selected in consultation with the UK agencies and be based on a thorough appraisal of environmental stresses to ensure that none of these lie outside the appropriate range for that type of stream. This should include requests for comprehensive chemical data that is both temporally and spatially relevant. In addition, at all new sites field survey sheets (of the general type used in RIVPACS phases I, II and II) should be filled in so that site-specific pressures such as hydromorphological modifications and sedimentation can be properly assessed.

In the case of site selection for stream types that are not currently represented in great numbers in RIVPACS (e.g. small headwater streams) the data compiled in this project may not adequately represent that stream type but will still serve as a guide to the types of stress that should be considered.

11. WATER FRAMEWORK DIRECTIVE INTERCALIBRATION

The data collated for this project also assists the UK agencies in contributing to the European WFD intercalibration process that is currently underway within several Geographical Intercalibration Groups (GIGs). Appendix II contains summary statistics for a range of commonly measured chemical determinands in terms of WFD System-A stream types. Because the UK agencies now have access to comprehensive matched reference condition macroinvertebrate and chemical datasets these data also contribute towards a common EU-wide understanding of reference conditions for macroinvertebrates. It is clear from the summary statistics produce in this project that while it has long been recognised that biological targets should be site specific, it is also clear that chemical targets should be at least stream-type specific. These data clearly indicate that reference condition macroinvertebrate communities reside in streams and rivers with widely varying physico-chemical properties and a single standard threshold for a given stressor, for example nitrate, would not be appropriate for all types of streams. A further important finding from this project is that hydromorphological stress, although present at some sites, does not appear to significantly influence macroinvertebrate community richness in the UK RIVPACS reference site dataset. This does not mean to say that hydromorphological stress is unimportant at stream sites in general but it does show that the type and severity of hydromorphological degradation present at the RIVPACS reference sites is of little significance for macroinvertebrate communities.

12. RECOMMENDATIONS

- Of the 835 current RIVPACS reference sites across the United Kingdom, 40 were identified as potentially unsuitable due to organic pollution, nutrients, metals or low flow. Steps should be taken to either remove these sites (or their contribution to predictions) from future models or to statistically correct for their influence.

- The selection of potential new RIVPACS reference sites must now take account of the WFD definition of reference condition. Any potential new RIVPACS reference sites must be selected in consultation with the UK agencies and be based on a thorough appraisal of environmental stresses to ensure that none of these lie outside appropriate ranges for that stream type.

13. ACKNOWLEDGEMENTS

We would like to thank the Environment Agency, the Scottish Environment Protection Agency and the Environment and Heritage Service for their assistance in sending data on stresses. We would also like to acknowledge the assistance of the Centre for Ecology & Hydrology at Monk's Wood for supplying the 44-class CORINE 2000 national land cover map and the Centre for Ecology & Hydrology at Wallingford for the flow data extracted from the National Water Archive (NWA). We would also like to thank the various stakeholders in the RIVPACS dataset for their assistance and we also acknowledge the Ordnance Survey.

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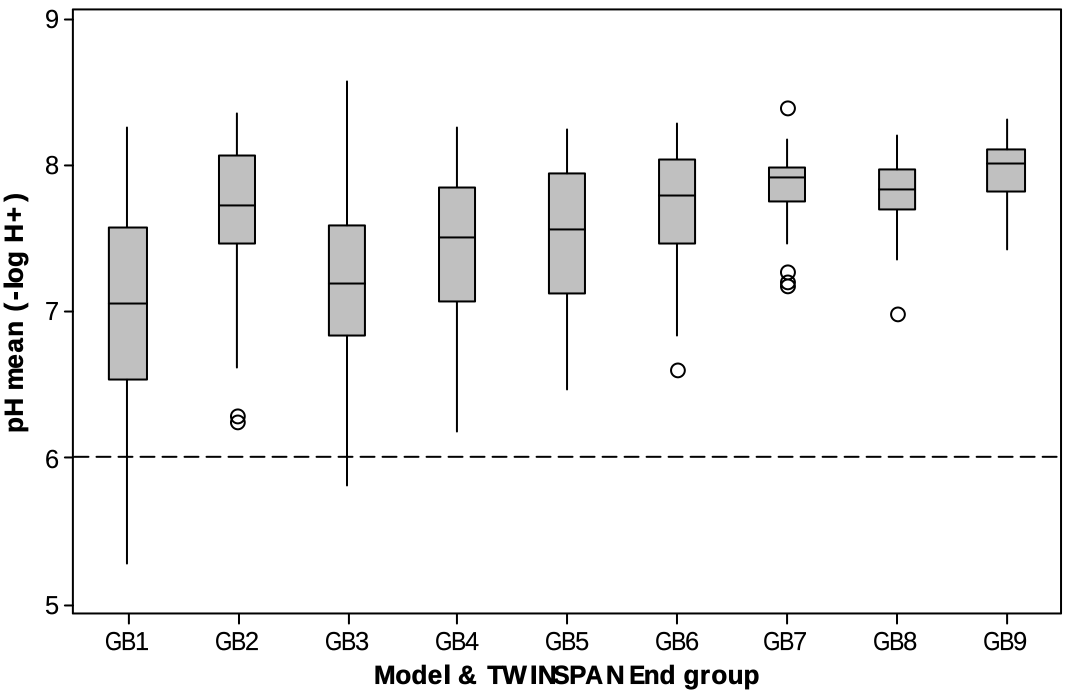
APPENDICES

Appendix I Chemical screening of RIVPACS sites

Contemporary mean pH (-log H^+) summarised by GB TWINSPAN end groups



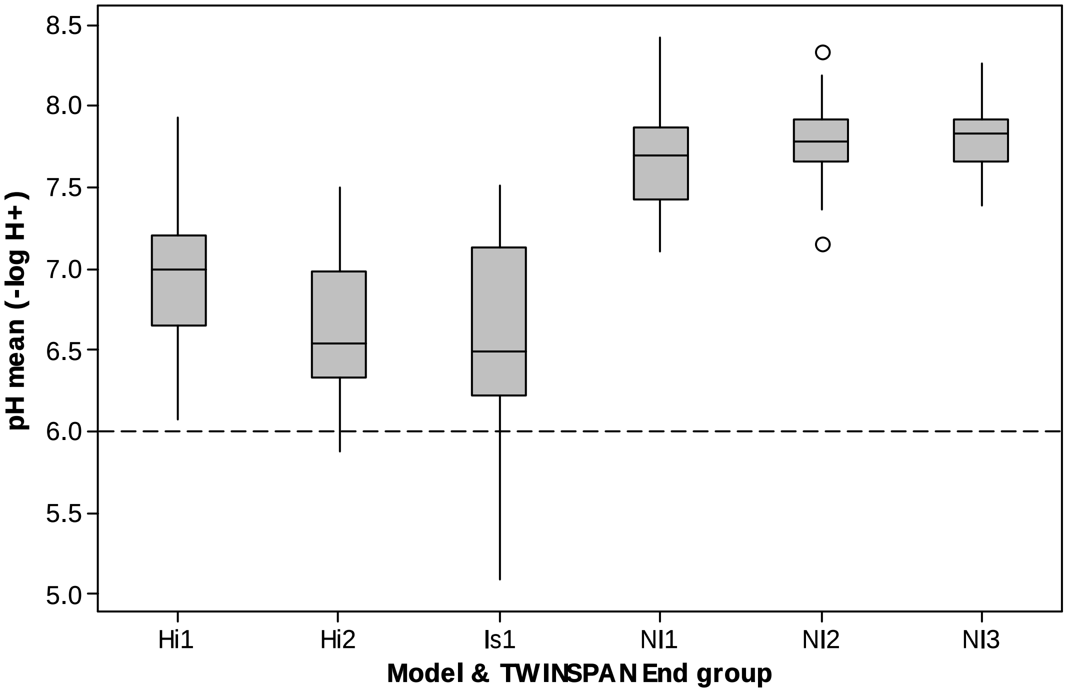
TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Maximum	8.26	8.36	8.57	8.26	8.24	8.28	8.39	8.21	8.32
90 percentile	7.96	8.22	7.72	7.98	8.05	8.17	8.11	8.08	8.21
75 percentile (Q3)	7.56	8.06	7.59	7.84	7.95	8.03	7.99	7.97	8.10
Median	7.05	7.73	7.19	7.50	7.56	7.80	7.92	7.83	8.01
25 percentile (Q1)	6.53	7.48	6.84	7.07	7.14	7.48	7.77	7.71	7.82
10 percentile	6.33	6.99	6.45	6.89	7.00	7.06	7.58	7.49	7.67
Minimum	5.28	6.25	5.81	6.18	6.46	6.60	7.18	6.99	7.42
Lower outlier limit*[2]	4.99	6.62	5.72	5.91	5.92	6.65	7.46	7.32	7.40
Sites with data	59	61	77	69	46	85	68	52	57
Sites in group	71	74	83	71	49	87	68	53	58
% with data	83.1	82.4	92.8	97.2	93.9	97.7	100.0	98.1	98.3
Mean	7.05	7.68	7.18	7.45	7.51	7.72	7.87	7.81	7.96

Outlier site codes

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

A threshold value of pH 6 has been assigned by expert judgement (dashed line). Only sites where the pH is less than the lower outlier limit for the group and <6 were considered to be unsuitable. No such sites were found.

Contemporary mean pH (-log H^+) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups

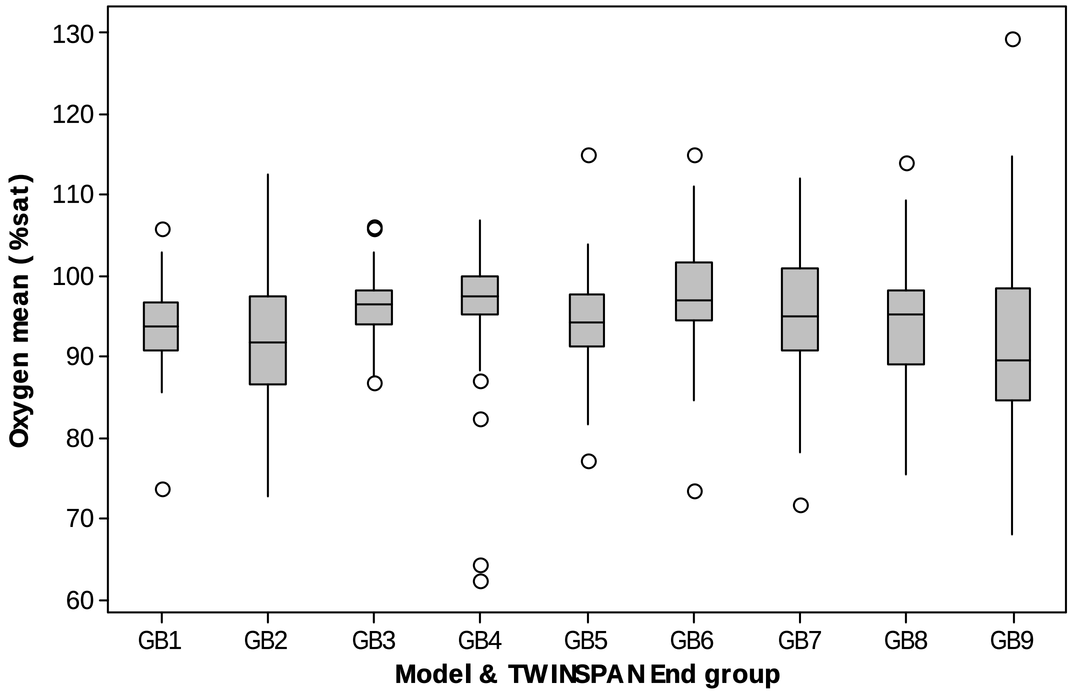


TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	N/A	N/A	N/A	N/A	N/A	N/A
Maximum	7.93	7.50	7.51	8.42	8.34	8.26
90 percentile	7.35	7.31	7.33	8.01	8.00	7.97
75 percentile (Q3)	7.18	6.98	7.12	7.85	7.92	7.91
Median	7.00	6.54	6.49	7.69	7.78	7.83
25 percentile (Q1)	6.69	6.33	6.28	7.45	7.67	7.67
10 percentile	6.48	6.13	5.71	7.31	7.49	7.54
Minimum	6.07	5.87	5.09	7.11	7.16	7.39
Lower outlier limit*[2]	5.94	5.36	5.03	6.85	7.29	7.29
Sites with data	28	49	25	34	43	33
Sites in group	39	69	55	34	43	33
% with data	71.8	71.0	45.5	100.0	100.0	100.0
Mean	6.94	6.64	6.59	7.67	7.78	7.79
Outlier site codes						

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

A threshold value of pH 6 has been assigned by expert judgement (dashed line). Only sites where the pH is less than the lower outlier limit for the group and <6 were considered to be unsuitable. No such sites were found.

Contemporary mean Oxygen (%sat) summarised by GB TWINSPAN end groups

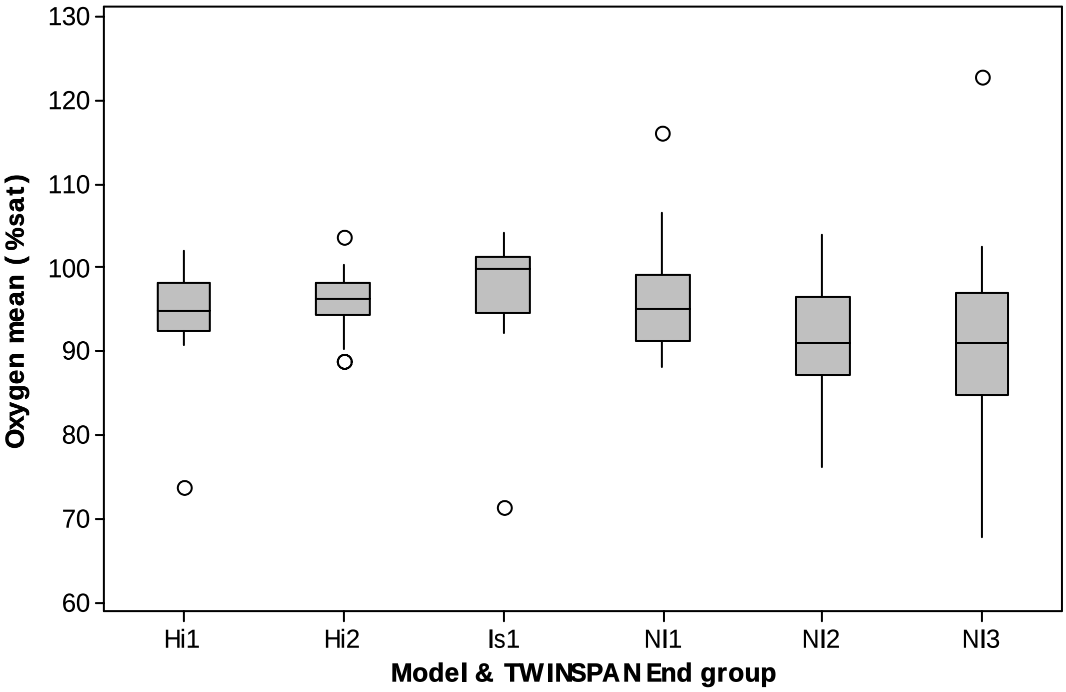


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Maximum	105.87	112.67	106.09	106.93	115.00	114.92	112.00	114.00	129.33
90 percentile	99.30	99.41	101.17	101.86	100.60	106.90	105.35	100.62	105.40
75 percentile (Q3)	96.50	97.35	98.25	99.94	97.59	101.16	100.15	98.20	98.10
Median	93.75	91.77	96.40	97.37	94.32	96.97	94.95	95.10	89.50
25 percentile (Q1)	90.76	86.87	94.10	95.32	91.36	94.42	90.73	89.11	84.93
10 percentile	88.74	81.88	92.06	90.69	88.08	91.58	87.14	82.77	80.14
Minimum	73.70	72.57	86.86	62.33	77.14	73.32	71.70	75.52	68.08
Lower outlier limit*[2]	82.15	71.15	87.88	88.39	82.01	84.30	76.61	75.46	65.18
Sites with data	57	70	75	69	48	85	68	52	57
Sites in group	71	74	83	71	49	87	68	53	58
% with data	80.3	94.6	90.4	97.2	98.0	97.7	100.0	98.1	98.3
Mean	93.61	91.52	96.50	96.31	94.31	97.96	95.27	93.56	91.77
Outlier site codes	**4885**		HI10	0505	0703	**NW07**	0711		
				0503					
				0303					
				5601					

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in six groups have been identified as lying outside the lower outlier limit for Oxygen % saturation. Two of these (4885 and NW07) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean Oxygen (%sat) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups

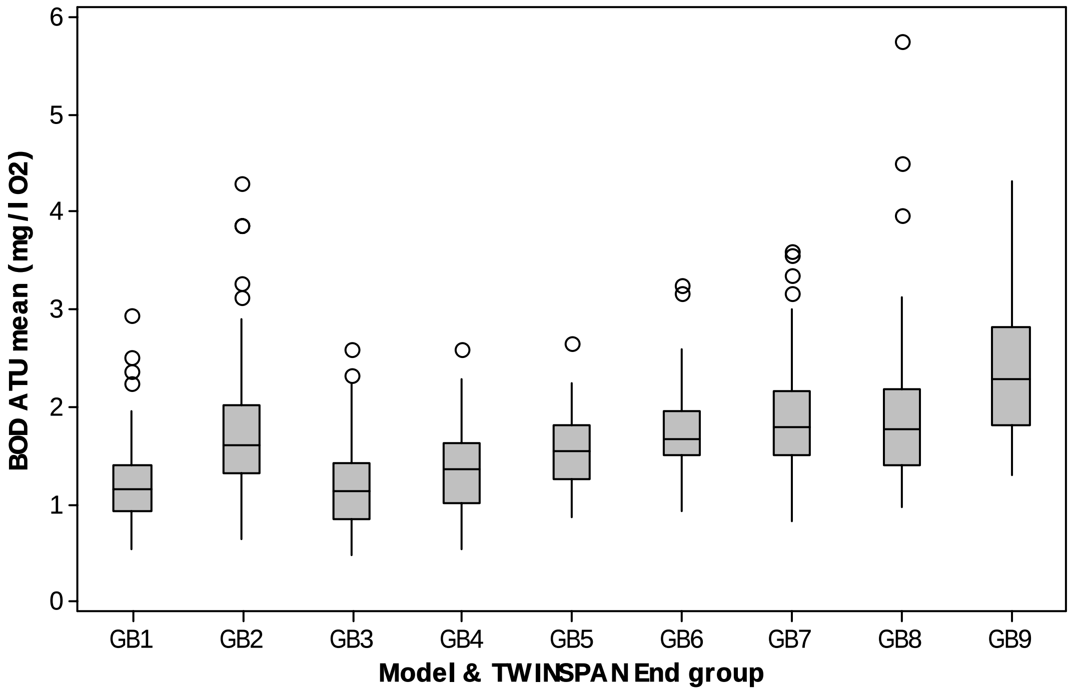


TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	N/A	N/A	N/A	N/A	N/A	N/A
Maximum	102	103.67	103.98	116.1	103.74	122.79
90 percentile	99.81	99.08	102.32	102.15	99.98	99.98
75 percentile (Q3)	97.75	97.87	101.16	99.06	95.98	96.37
Median	94.87	96.28	99.78	94.89	90.95	91
25 percentile (Q1)	92.52	94.6	95.23	91.66	87.24	84.94
10 percentile	91.23	91.45	92.23	89.24	82.98	75.95
Minimum	73.7	88.75	71.32	88	76.13	67.76
Lower outlier limit*[2]	84.69	89.71	86.33	80.56	74.13	67.79
Sites with data	26	30	18	34	43	33
Sites in group	39	69	55	34	43	33
% with data	66.7	43.5	32.7	100	100	100
Mean	94.48	95.8	97.14	95.92	91.14	90.23
Outlier site codes	**4885**	7505 7511	**SEPA_N09**			

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Three sites in the Scottish Highlands model and one in the Scottish Islands model have been identified as lying outside the lower outlier limit for Oxygen % saturation. While the Northern Ireland TWINSPAN group 3 has sites with low Oxygen % saturation, these are within the normal range for that group. Two of these sites (4885 in the Scottish Highlands and SEPA_N09 in the Scottish Islands) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean BOD ATU (mg/l O_2) summarised by GB TWINSPAN end groups

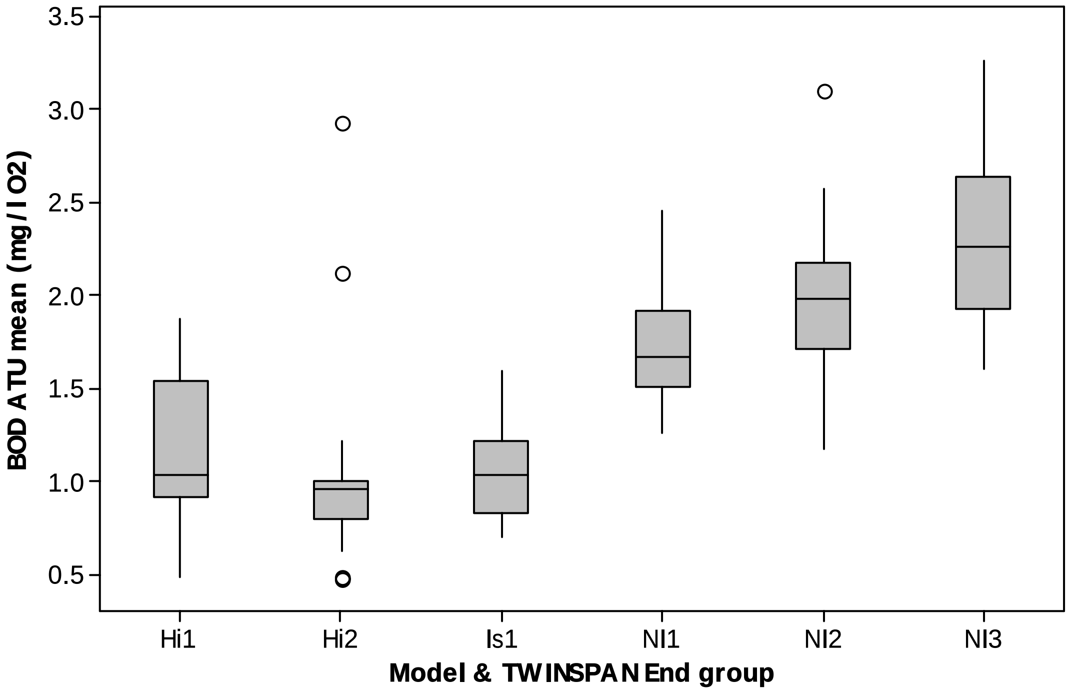


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	2.07	3.05	2.23	2.53	2.60	2.59	3.09	3.23	4.21
Maximum	2.93	4.30	2.59	2.59	2.66	3.25	3.60	5.75	4.31
90 percentile	1.69	2.40	1.82	1.94	2.11	2.29	2.70	2.63	3.27
75 percentile (Q3)	1.38	2.01	1.40	1.62	1.79	1.94	2.14	2.16	2.78
Median	1.15	1.61	1.12	1.35	1.54	1.66	1.80	1.77	2.29
25 percentile (Q1)	0.93	1.32	0.85	1.02	1.26	1.51	1.51	1.44	1.83
10 percentile	0.70	1.03	0.69	0.85	1.09	1.30	1.33	1.32	1.55
Minimum	0.54	0.63	0.48	0.53	0.87	0.92	0.83	0.96	1.29
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	54	70	68	66	48	85	68	52	57
Sites in group	71	74	83	71	49	87	68	53	58
% with data	76.1	94.6	81.9	93.0	98.0	97.7	100.0	98.1	98.3
Mean	1.22	1.74	1.18	1.34	1.56	1.74	1.91	1.96	2.34
Outlier site codes	CL05	**6845**	9703	TA03	1003	2721	2109	**2815**	
	NH06	6848	SO01			0203	0709	6001	
	TA07	6849					**2305**		
	5001	0201					0711		
		TH06							

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in seven groups have been identified as lying outside the upper outlier limit for BOD ATU (mg/l O_2). Six of these sites (TA07, 5001, 6845, TH06, 2305 and 2815) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean BOD ATU (mg/l O_2) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups

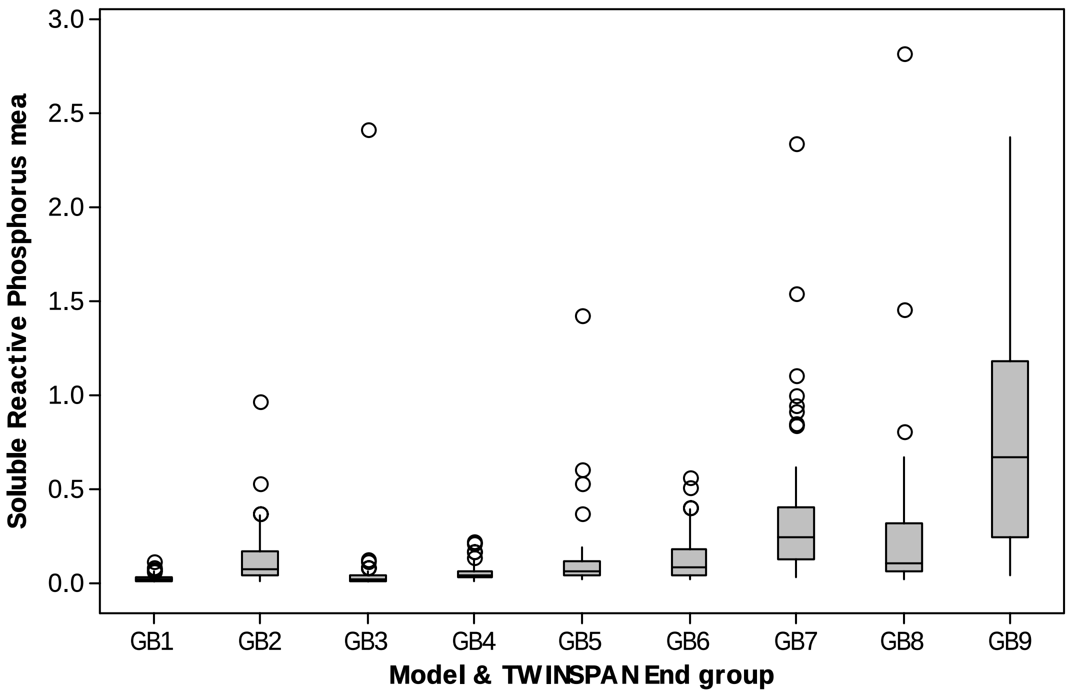


TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	2.32	1.27	1.59	2.51	2.88	3.64
Maximum	1.88	2.93	1.59	2.46	3.1	3.27
90 percentile	1.64	1.22	1.43	2.12	2.32	2.89
75 percentile (Q3)	1.49	0.99	1.16	1.91	2.18	2.64
Median	1.03	0.95	1.04	1.67	1.98	2.26
25 percentile (Q1)	0.94	0.8	0.86	1.51	1.71	1.97
10 percentile	0.56	0.66	0.8	1.42	1.59	1.79
Minimum	0.49	0.47	0.7	1.26	1.18	1.61
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	22	26	18	34	43	33
Sites in group	39	69	55	34	43	33
% with data	56.4	37.7	32.7	100	100	100
Mean	1.14	1.01	1.06	1.73	1.96	2.29
Outlier site codes		CL05 TA05			**NI_24**	

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Two sites in the Scottish Highlands group 1 and one site in the Northern Ireland group 2 have been identified as lying outside the upper outlier limit for BOD ATU (mg/l O_2). One of these sites (NI_24) has a 3 season combined observed ASPT value within the lowest 10% of its group.

Contemporary mean Soluble Reactive Phosphorus (mg/l P) summarised by GB TWINSPAN end groups

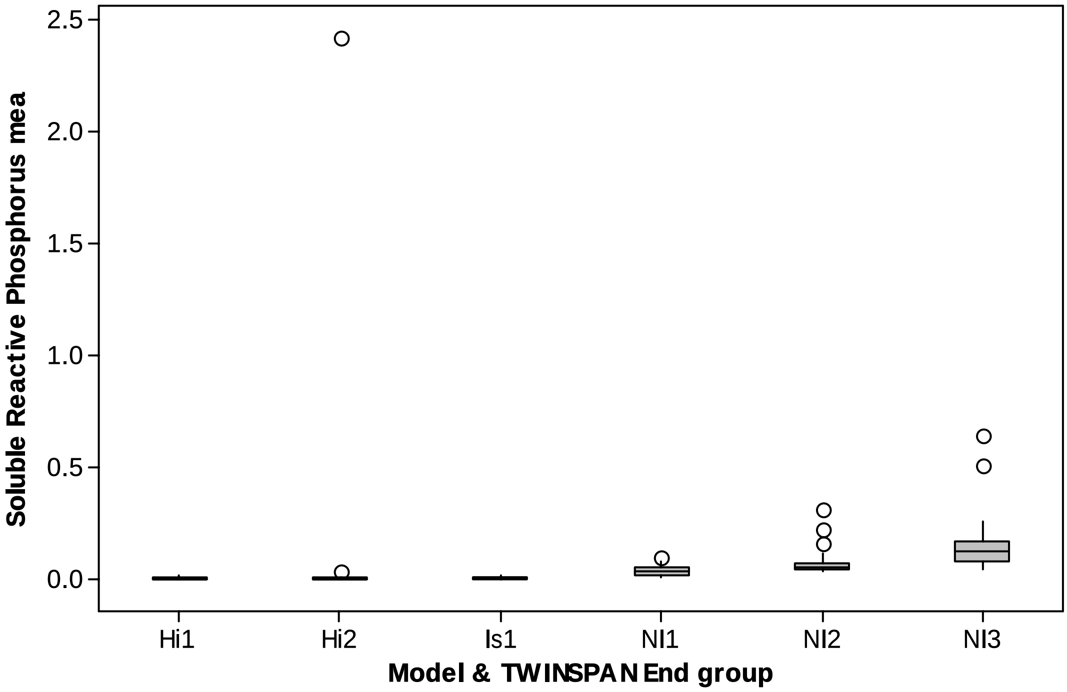


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	0.05	0.35	0.07	0.12	0.23	0.37	0.79	0.68	2.53
Maximum	0.11	0.96	2.42	0.22	1.42	0.56	2.34	2.82	2.37
90 percentile	0.04	0.25	0.05	0.09	0.16	0.30	0.84	0.63	1.71
75 percentile (Q3)	0.02	0.16	0.03	0.06	0.11	0.17	0.39	0.31	1.16
Median	0.01	0.07	0.01	0.03	0.06	0.08	0.24	0.10	0.66
25 percentile (Q1)	0.00	0.03	0.00	0.02	0.03	0.03	0.12	0.06	0.24
10 percentile	0.00	0.01	0.00	0.01	0.03	0.02	0.08	0.04	0.14
Minimum	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.03
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	57	61	77	69	46	84	68	53	56
Sites in group	71	74	83	71	49	87	68	53	58
% with data	80.3	82.4	92.8	97.2	93.9	96.6	100.0	100.0	96.6
Mean	0.02	0.12	0.05	0.05	0.12	0.12	0.34	0.26	0.76
Outlier site codes	**5001**	1105	HI07	0505	0703	1309	1305	**2103**	
	TA07	5101	NH07	**2719**	0803	2211	1411	1307	
	3395	8805	3305	2201	1003	2007	**2305**	6001	
	NH05	8809	4901	0503	**5009**		**2307**		
			4903	3605			5507		
			4905				1311		
			4909				0711		
							1407		

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in eight groups have been identified as lying outside the upper outlier limit for Soluble Reactive Phosphorus (mg/l P). Nine of these sites (5001, TA07, 4909, 2719, 5009, 2305, 2307, 1407 and 2103) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean Soluble Reactive Phosphorus (mg/l P) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups

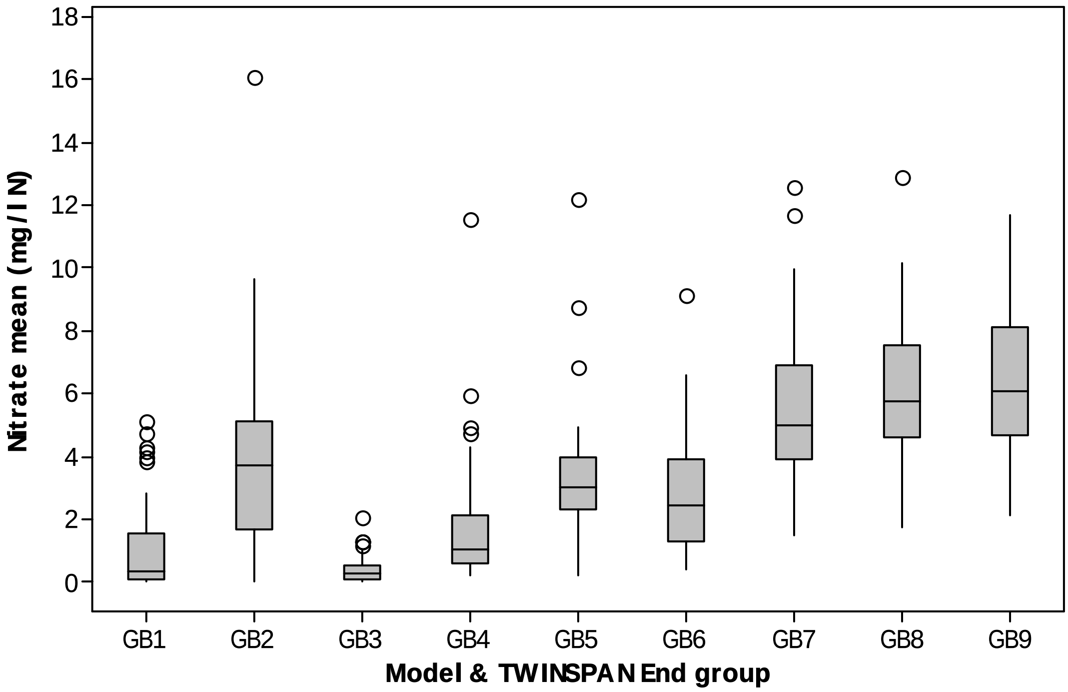


TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	0.02	0.01	0.02	0.08	0.12	0.29
Maximum	0.02	2.42	0.02	0.1	0.31	0.64
90 percentile	0.01	0.01	0.02	0.05	0.09	0.21
75 percentile (Q3)	0.01	0.01	0.01	0.04	0.07	0.16
Median	0	0	0.01	0.03	0.05	0.12
25 percentile (Q1)	0	0	0	0.02	0.04	0.08
10 percentile	0	0	0	0.01	0.03	0.04
Minimum	0	0	0	0.01	0.03	0.04
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	27	34	18	34	43	33
Sites in group	39	69	55	34	43	33
% with data	69.2	49.3	32.7	100	100	100
Mean	0	0.08	0.01	0.03	0.07	0.14
Outlier site codes		HI07 TA05		NI_26	20303801 **NI_24** 20400201	20302201 20501301

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in one Scottish Highlands group and all three Northern Ireland groups have been identified as lying outside the upper outlier limit for Soluble Reactive Phosphorus (mg/l P). One of these sites (NI_24) had a 3 season combined observed ASPT value within the lowest 10% of its group.

Contemporary mean Nitrate (mg/l N) summarised by GB TWINSPAN end groups

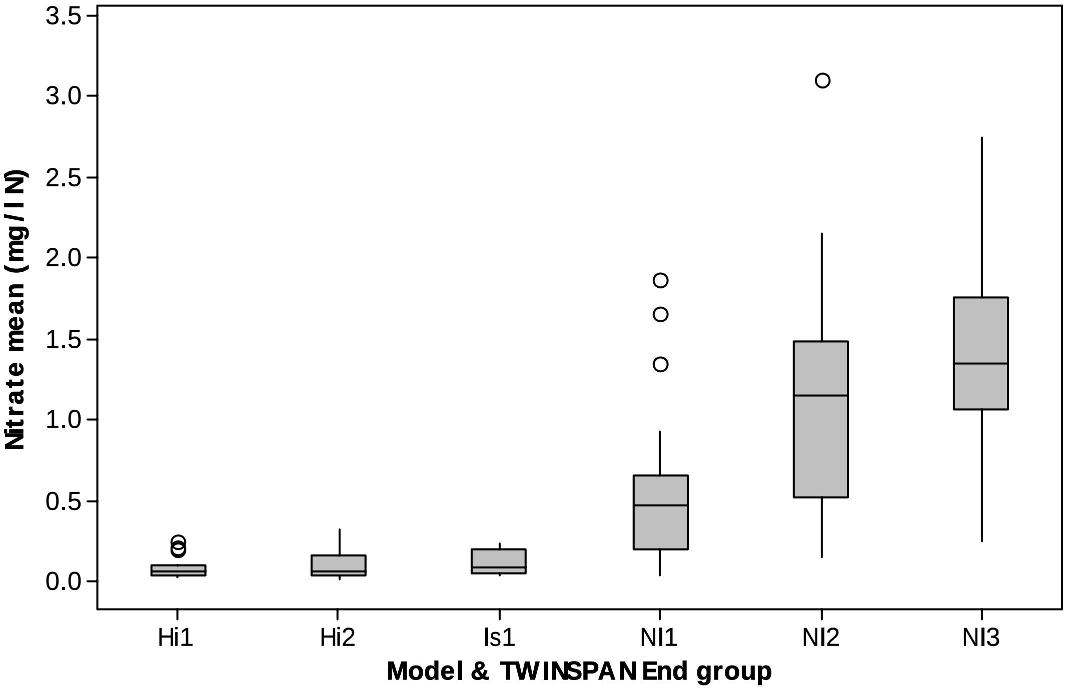


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	3.15	10.04	1.12	4.31	6.53	7.63	10.77	11.67	13.30
Maximum	5.09	16.10	2.05	11.53	12.19	9.12	12.58	12.89	11.66
90 percentile	3.83	7.33	1.00	3.81	4.88	4.72	7.96	9.28	9.70
75 percentile (Q3)	1.31	5.08	0.51	2.08	3.98	3.85	6.73	7.55	8.13
Median	0.32	3.72	0.24	1.03	3.00	2.41	4.98	5.74	6.08
25 percentile (Q1)	0.09	1.78	0.10	0.59	2.28	1.33	4.03	4.80	4.68
10 percentile	0.03	0.43	0.04	0.26	1.07	0.87	3.19	2.40	3.42
Minimum	0.01	0.01	0.02	0.19	0.19	0.38	1.45	1.74	2.14
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	51	47	70	66	43	82	60	41	41
Sites in group	71	74	83	71	49	87	68	53	58
% with data	71.8	63.5	84.3	93.0	87.8	94.3	88.2	77.4	70.7
Mean	1.07	3.91	0.38	1.64	3.33	2.76	5.51	6.05	6.52
Outlier site codes	SW01	6381	NH09	**2719**	0703	**2507**	**2305**	2505	
	5850		**4909**	NE03	5855		**2307**		
	8605		TA01	8281	0773				
	3160		3307	5861					
	SW02								
	3801								

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in eight groups have been identified as lying outside the upper outlier limit for Nitrate (mg/l N). Five of these sites (4909, 2719, 2507, 2305 and 2307) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean Nitrate (mg/l N) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups

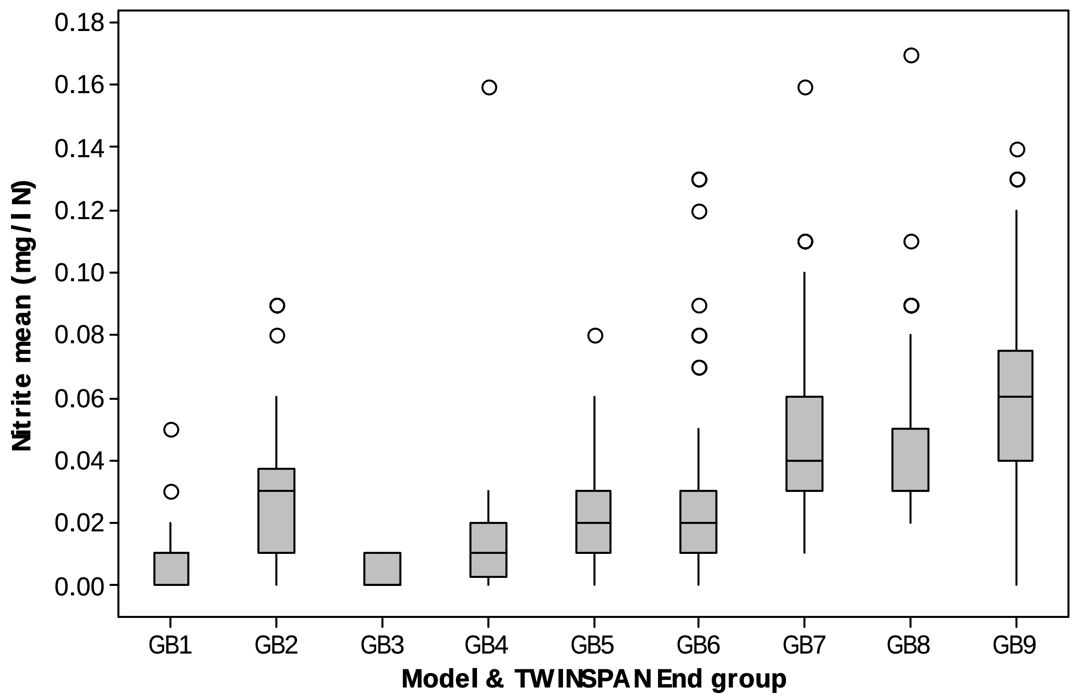


TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	0.18	0.3	0.36	1.26	2.78	2.79
Maximum	0.24	0.32	0.23	1.87	3.1	2.75
90 percentile	0.2	0.28	0.2	0.92	1.78	1.95
75 percentile (Q3)	0.1	0.14	0.18	0.64	1.46	1.75
Median	0.05	0.06	0.08	0.47	1.15	1.35
25 percentile (Q1)	0.04	0.04	0.05	0.22	0.58	1.06
10 percentile	0.03	0.02	0.04	0.16	0.33	0.75
Minimum	0.02	0.01	0.03	0.04	0.15	0.25
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	20	33	15	34	43	33
Sites in group	39	69	55	34	43	33
% with data	51.3	47.8	27.3	100	100	100
Mean	0.08	0.11	0.11	0.54	1.1	1.35
Outlier site codes	7417			20500101 20303001 NI_26	**NI_32**	

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

One Scottish Highlands group and two Northern Ireland groups have sites identified as lying outside the upper outlier limit for Nitrate (mg/l N). One of these sites (NI_32) has a 3 season combined observed ASPT value within the lowest 10% of its group.

Contemporary mean Nitrite (mg/l N) summarised by GB TWINSPAN end groups

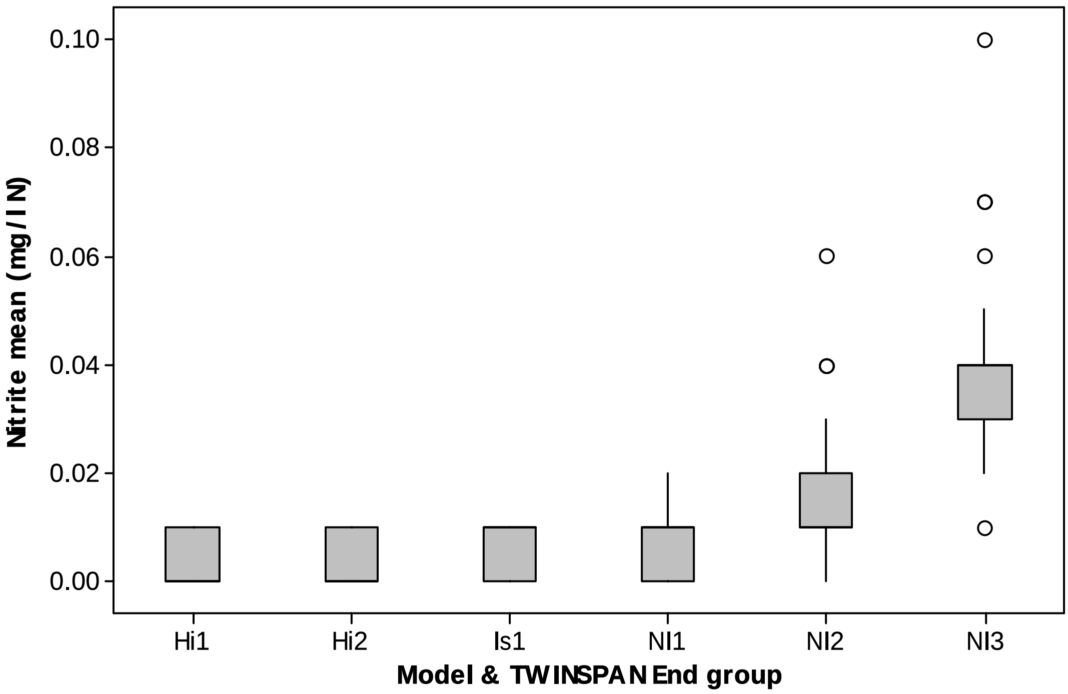


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	0.02	0.07	0.01	0.03	0.05	0.07	0.10	0.08	0.12
Maximum	0.05	0.09	0.01	0.16	0.08	0.13	0.16	0.17	0.14
90 percentile	0.01	0.05	0.01	0.02	0.03	0.05	0.08	0.08	0.12
75 percentile (Q3)	0.01	0.03	0.01	0.02	0.03	0.03	0.06	0.05	0.07
Median	0.01	0.03	0.00	0.01	0.02	0.02	0.04	0.03	0.06
25 percentile (Q1)	0.00	0.01	0.00	0.00	0.01	0.01	0.03	0.03	0.04
10 percentile	0.00	0.01	0.00	0.00	0.01	0.01	0.02	0.02	0.03
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	52	56	74	68	43	84	63	46	46
Sites in group	71	74	83	71	49	87	68	53	58
% with data	73.2	75.7	89.2	95.8	87.8	96.6	92.6	86.8	79.3
Mean	0.01	0.03	0.00	0.01	0.02	0.03	0.05	0.04	0.06
Outlier site codes	3801	2401		**2719**	0703	3803	1305	**2815**	0713
	5001	2403				3809	0709	9109	6213
		6845				2721		2405	6215
						TA06			
						0707			

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in eight groups have been identified as lying outside the upper outlier limit for Nitrite (mg/l N). Four of these sites (5001, 6845, 2719 and 2815) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean Nitrite (mg/l N) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups

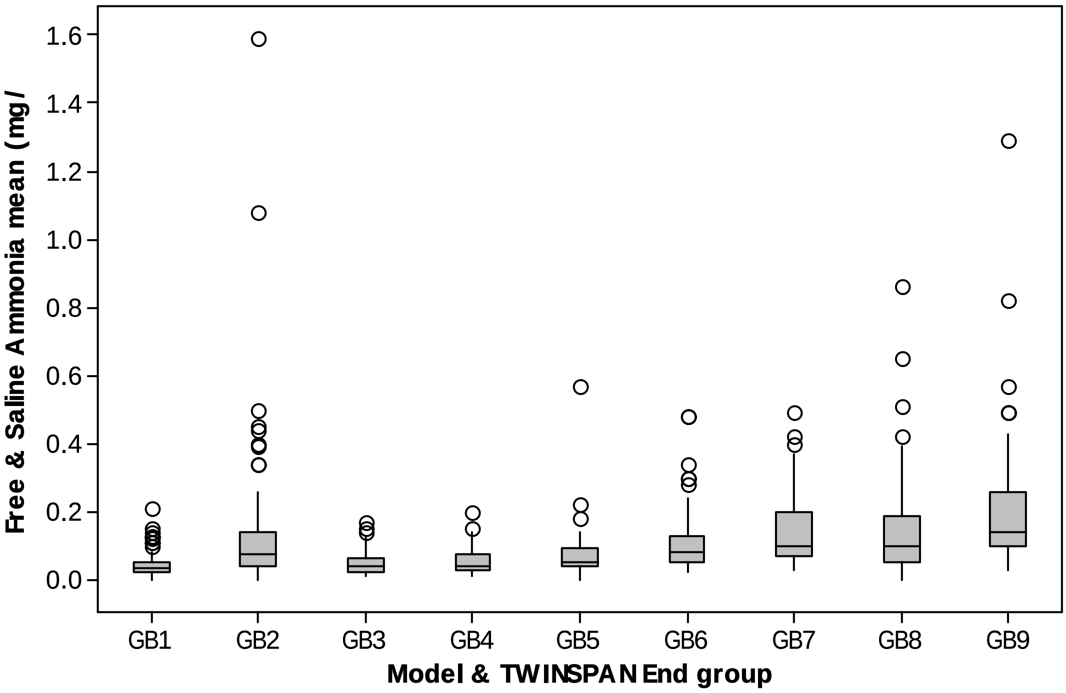


TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	0.01	0.01	0.01	0.03	0.04	0.05
Maximum	0.01	0.01	0.01	0.02	0.06	0.1
90 percentile	0.01	0.01	0.01	0.02	0.03	0.06
75 percentile (Q3)	0.01	0.01	0.01	0.01	0.02	0.04
Median	0	0	0.01	0.01	0.01	0.04
25 percentile (Q1)	0	0	0	0	0.01	0.03
10 percentile	0	0	0	0	0.01	0.02
Minimum	0	0	0	0	0	0.01
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	25	32	18	34	43	33
Sites in group	39	69	55	34	43	33
% with data	64.1	46.4	32.7	100	100	100
Mean	0	0	0.01	0.01	0.02	0.04
Outlier site codes					**NI_32**	20302201
					20303801	20302905
						20304501
						20302901

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in two Northern Ireland groups have been identified as lying outside the upper outlier limit for Nitrite (mg/l N). However, only one of these sites (NI_32) has a 3 season combined observed ASPT value within the lowest 10% of its group.

Contemporary mean Free & Saline Ammonia (mg/l N) summarised by GB TWINSPAN end groups

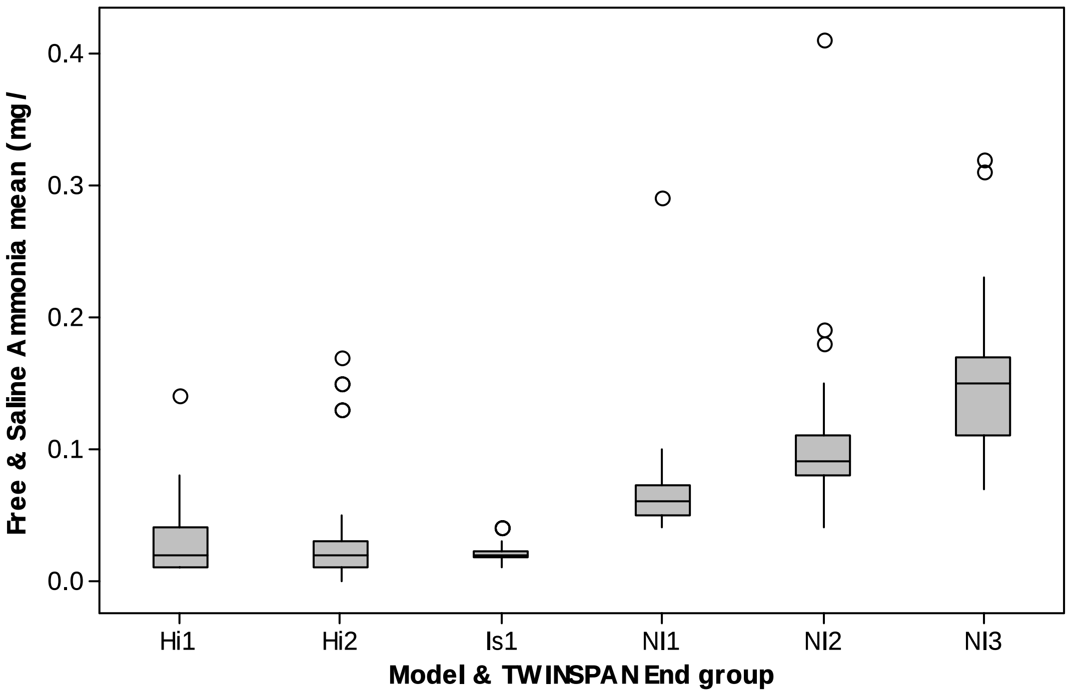


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	0.10	0.29	0.13	0.14	0.17	0.25	0.40	0.37	0.43
Maximum	0.21	1.59	0.17	0.20	0.57	0.48	0.49	0.86	1.29
90 percentile	0.11	0.39	0.11	0.10	0.13	0.20	0.31	0.37	0.45
75 percentile (Q3)	0.05	0.14	0.06	0.07	0.09	0.13	0.20	0.18	0.23
Median	0.04	0.08	0.04	0.04	0.05	0.08	0.10	0.10	0.14
25 percentile (Q1)	0.02	0.04	0.02	0.03	0.04	0.05	0.07	0.06	0.10
10 percentile	0.01	0.02	0.01	0.02	0.03	0.03	0.05	0.02	0.05
Minimum	0.00	0.00	0.01	0.01	0.00	0.02	0.03	0.00	0.03
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	64	70	77	69	48	85	68	52	57
Sites in group	71	74	83	71	49	87	68	53	58
% with data	90.1	94.6	92.8	97.2	98.0	97.7	100.0	98.1	98.3
Mean	0.05	0.15	0.05	0.05	0.08	0.10	0.15	0.15	0.21
Outlier site codes	9205	**TH06**	4705	**2719**	1003	2721	1305	**2815**	**2509**
	4701	**6845**	4703	2703	0703	TA06	**6103**	1307	6259
	5001	**2001**	4805		3205	**3515**		6101	6009
	4801	7192				0203		6001	6258
	NH06	3145				2003		2513	AN03
	3781	6848				3413			6857
	SW01	6849							
	TA07	0201							
		2401							
		2403							
		AN06							

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in nine groups have been identified as lying outside the upper outlier limit for Free & Saline Ammonia (mg/l N). Eleven of these sites (5001, TA07, TH06, 6845, 2001, AN06, 2719, 3515, 6103, 2815 and 2509) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean Free & Saline Ammonia (mg/l N) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups

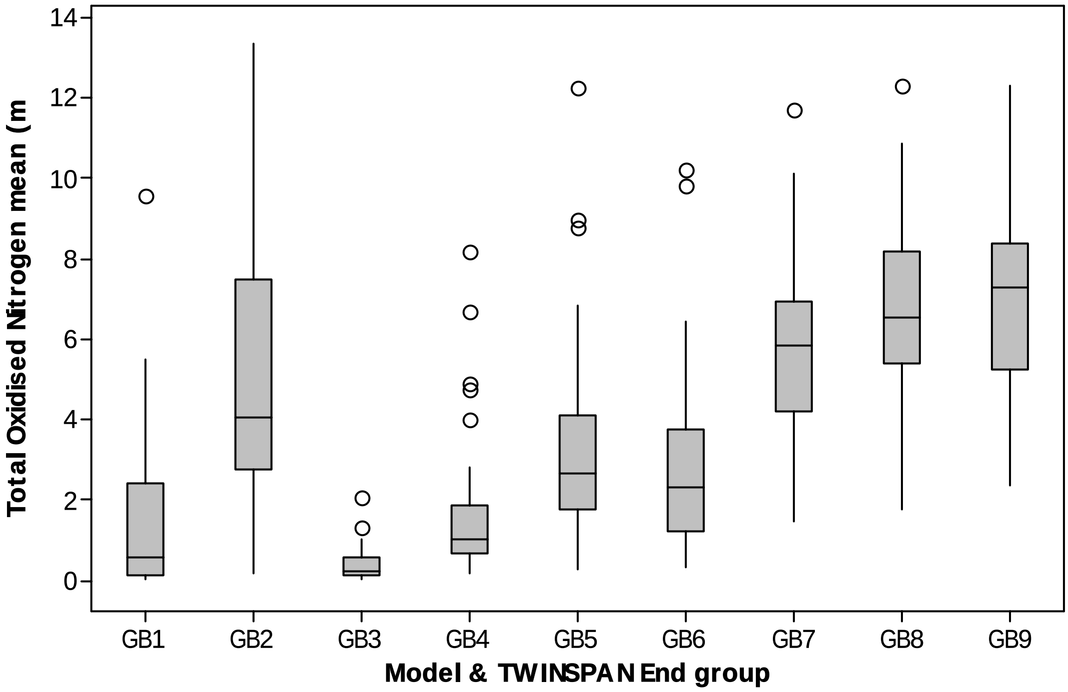


TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	0.07	0.06	0.03	0.1	0.14	0.26
Maximum	0.14	0.17	0.04	0.29	0.41	0.32
90 percentile	0.05	0.13	0.04	0.09	0.14	0.22
75 percentile (Q3)	0.04	0.03	0.02	0.07	0.1	0.17
Median	0.02	0.02	0.02	0.06	0.09	0.15
25 percentile (Q1)	0.01	0.01	0.02	0.05	0.08	0.11
10 percentile	0.01	0.01	0.01	0.05	0.06	0.09
Minimum	0.01	0	0.01	0.04	0.04	0.07
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	27	35	18	34	43	33
Sites in group	39	69	55	34	43	33
% with data	69.2	50.7	32.7	100	100	100
Mean	0.03	0.04	0.02	0.07	0.1	0.15
Outlier site codes	4805	4705	SEPA_W02	NI_26	**NI_24**	20302905
		4701	SEPA_W03		NI_3	20101203
		4703	SEPA_W01		20303801	
		4801			20304101	
		4803				

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in both Scottish Highlands groups, the Scottish Islands model and all three Northern Ireland groups have been identified as lying outside the upper outlier limit for Free & Saline Ammonia (mg/l N). However, only one of these sites (NI_24) has a 3 season combined observed ASPT value within the lowest 10% of its group.

Contemporary mean Total Oxidised Nitrogen (mg/l N) summarised by GB TWINSPAN end groups

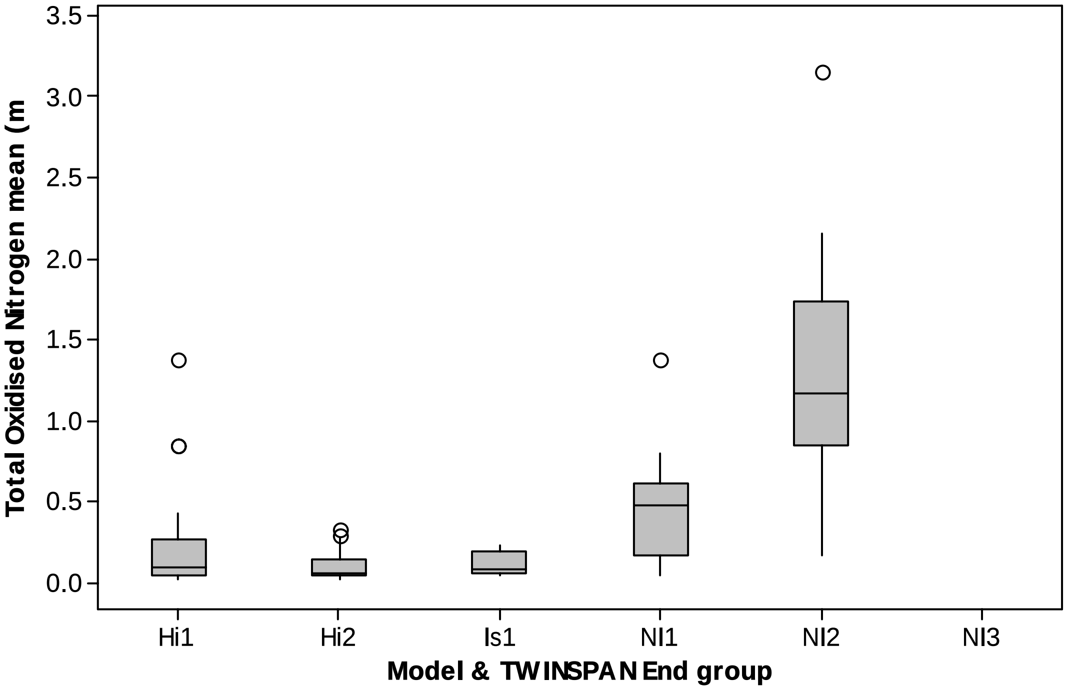


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	5.82	13.13	1.14	3.64	7.27	7.40	10.86	12.14	13.00
Maximum	9.58	13.37	2.06	8.17	12.27	10.22	11.75	12.34	12.34
90 percentile	4.35	9.73	0.69	2.66	5.52	4.67	7.80	9.64	9.35
75 percentile (Q3)	2.42	6.94	0.53	1.85	4.00	3.70	6.87	8.10	8.36
Median	0.54	4.03	0.22	0.99	2.66	2.30	5.87	6.54	7.27
25 percentile (Q1)	0.15	2.82	0.12	0.66	1.82	1.23	4.21	5.41	5.27
10 percentile	0.08	0.91	0.04	0.32	0.92	0.68	3.36	4.83	4.00
Minimum	0.02	0.19	0.02	0.17	0.26	0.33	1.47	1.74	2.37
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	48	60	71	69	46	85	68	52	57
Sites in group	71	74	83	71	49	87	68	53	58
% with data	67.6	81.1	85.5	97.2	93.9	97.7	100.0	98.1	98.3
Mean	1.43	4.96	0.35	1.47	3.28	2.66	5.64	6.76	6.94
Outlier site codes	TA07		NH09	**2719**	0703	**2507**	AN02	2505	
			TA01	NE03	TH05	TA06			
				8281	5855				
				5861					
				8213					

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in seven groups have been identified as lying outside the upper outlier limit for Total Oxidised Nitrogen (mg/l N). Two of these sites (2719 and 2507) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean Total Oxidised Nitrogen (mg/l N) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups

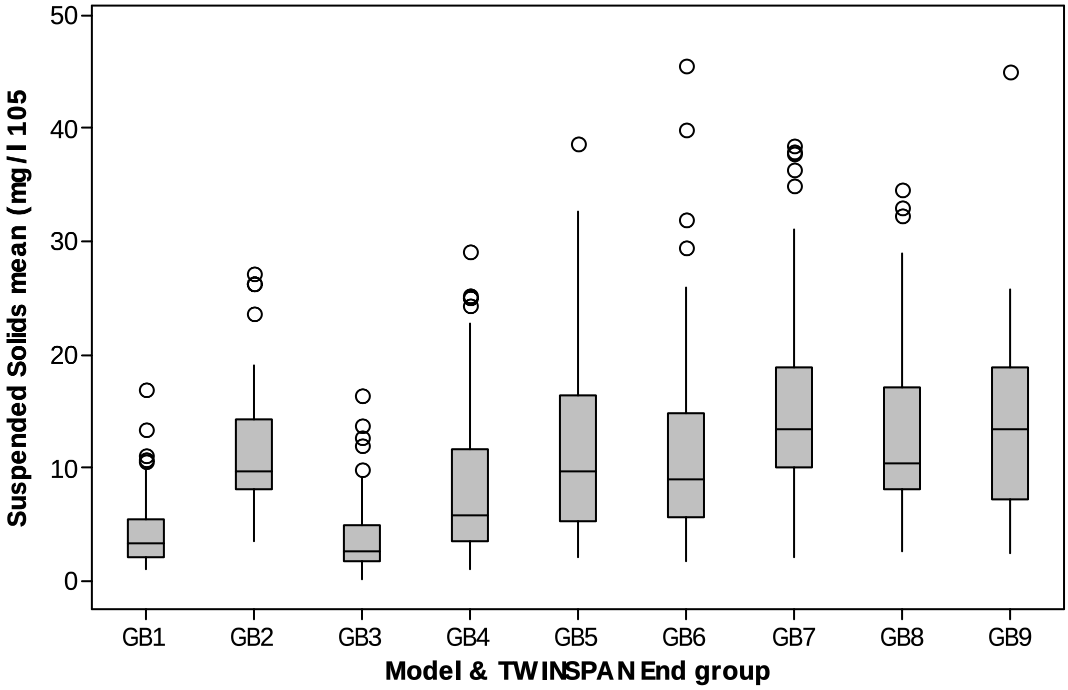


TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	0.6	0.28	0.36	1.21	3.05	No Data
Maximum	1.37	0.32	0.23	1.37	3.16	No Data
90 percentile	0.8	0.28	0.2	0.74	1.98	No Data
75 percentile (Q3)	0.27	0.13	0.18	0.59	1.74	No Data
Median	0.09	0.06	0.08	0.48	1.16	No Data
25 percentile (Q1)	0.05	0.04	0.06	0.17	0.87	No Data
10 percentile	0.04	0.03	0.04	0.14	0.31	No Data
Minimum	0.02	0.02	0.04	0.04	0.16	No Data
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	22	28	15	17	23	No Data
Sites in group	39	69	55	34	43	No Data
% with data	56.4	40.6	27.3	50	53.5	No Data
Mean	0.25	0.1	0.11	0.46	1.23	No Data
Outlier site codes	SEPA_E10 SEPA_E03 **SEPA_E08**	TA05 SEPA_E01		NI_26	**NI_32**	

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in both Scottish Highlands groups, and two Northern Ireland groups have been identified as lying outside the upper outlier limit for Total Oxidised Nitrogen (mg/l N). Two of these sites (SEPA_E08 and NI_32) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean Suspended Solids (mg/l 105°C) summarised by GB TWINSPAN end groups

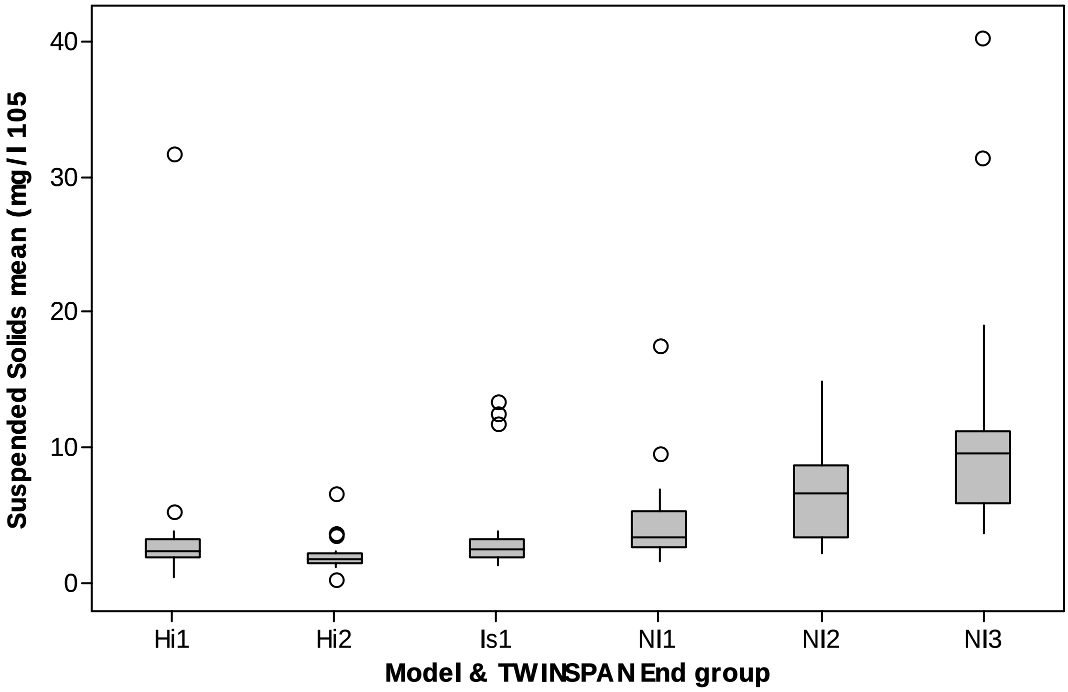


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	10.02	23.61	9.64	23.41	32.13	28.15	29.47	30.74	34.11
Maximum	17.00	27.15	16.42	29.21	38.75	45.58	38.56	34.67	45.00
90 percentile	9.89	18.99	7.24	21.37	18.07	22.41	28.41	28.99	22.63
75 percentile (Q3)	5.27	14.35	4.92	11.44	16.10	14.70	17.79	17.20	18.27
Median	3.39	9.73	2.69	5.73	9.60	8.97	13.40	10.42	13.34
25 percentile (Q1)	2.10	8.17	1.77	3.46	5.42	5.74	10.00	8.17	7.71
10 percentile	1.55	5.25	1.34	1.87	4.18	3.96	6.98	6.30	6.38
Minimum	1.00	3.58	0.20	1.00	2.04	1.67	2.04	2.65	2.47
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	50	52	75	67	39	84	60	42	43
Sites in group	71	74	83	71	49	87	68	53	58
% with data	70.4	70.3	90.4	94.4	79.6	96.6	88.2	79.2	74.1
Mean	4.62	11.74	3.71	8.72	11.36	11.34	15.47	13.55	14.19
Outlier site codes	**5001**	2601	**3509**	3605	5697	5717	5007	2107	6215
	5703	**5845**	5613	9485	0703	0205	2009	0805	
	5305	6848	5615	0505		5619	**1407**	1307	
	NH05	6849	3507	0503		5005	5621		
	3801	5101	5705	**4107**			2109		
							5607		

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in all nine groups have been identified as lying outside the upper outlier limit for Suspended Solids (mg/l 105°C). Five of these sites (5001, 5845, 3509, 4107 and 1407) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean Suspended Solids (mg/l 105°C) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups

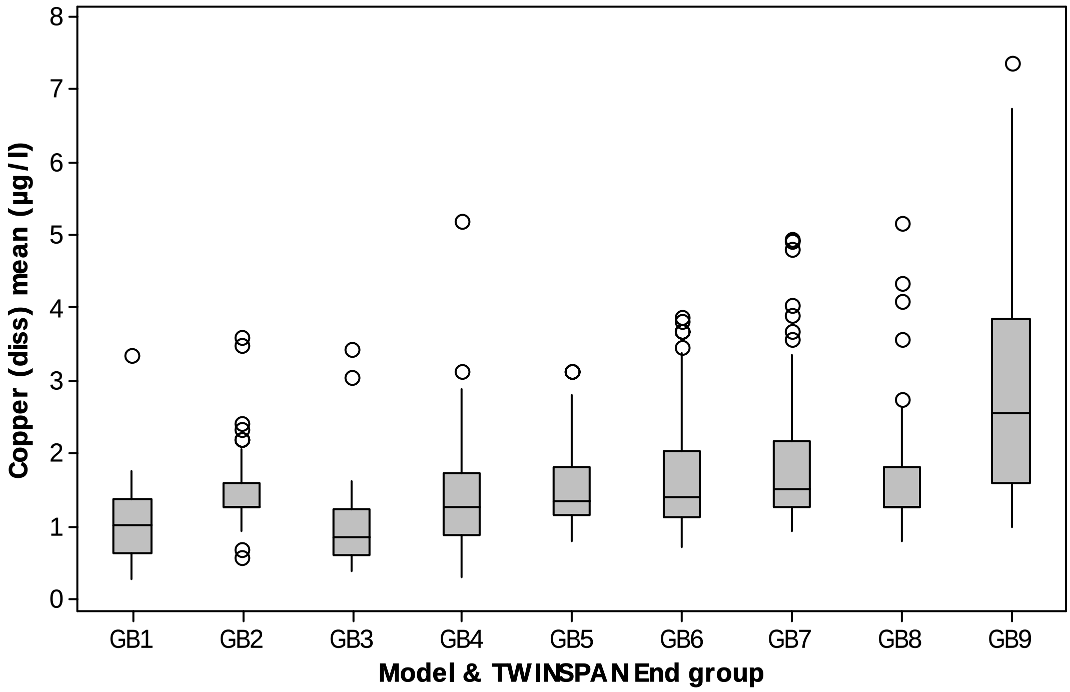


TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	18.61	3.11	4.7	7.92	16.58	18.61
Maximum	40.3	6.53	13.33	17.5	14.91	40.3
90 percentile	13.02	3.39	11.92	6.67	10.42	13.02
75 percentile (Q3)	10.96	2.1	2.98	4.72	8.58	10.96
Median	9.53	1.67	2.36	3.25	6.49	9.53
25 percentile (Q1)	5.86	1.43	1.83	2.59	3.25	5.86
10 percentile	5.13	1.33	1.29	1.87	2.8	5.13
Minimum	3.53	0.2	1.19	1.46	2.1	3.53
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	26	30	18	22	33	33
Sites in group	39	69	55	34	43	33
% with data	66.7	43.5	32.7	64.7	76.7	100
Mean	3.5	1.96	3.9	4.31	6.41	10.29
Outlier site codes	**SEPA_E08**	TA05	SEPA_W04	20400901		20303401
		SEPA_W37	SEPA_W03	23600801		**20303403**
		SEPA_W38	SEPA_W02			20303405
		CL05				

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in both Scottish Highlands groups, the Scottish Islands model and two Northern Ireland groups have been identified as lying outside the upper outlier limit for Suspended Solids (mg/l 105°C). Three of these sites (SEPA_E08, SEPA_W38 and 20303403) have 3 season combined observed ASPT values within the lowest 10% of their respective groups.

Contemporary mean dissolved Copper (µg/l) summarised by GB TWINSPAN end groups

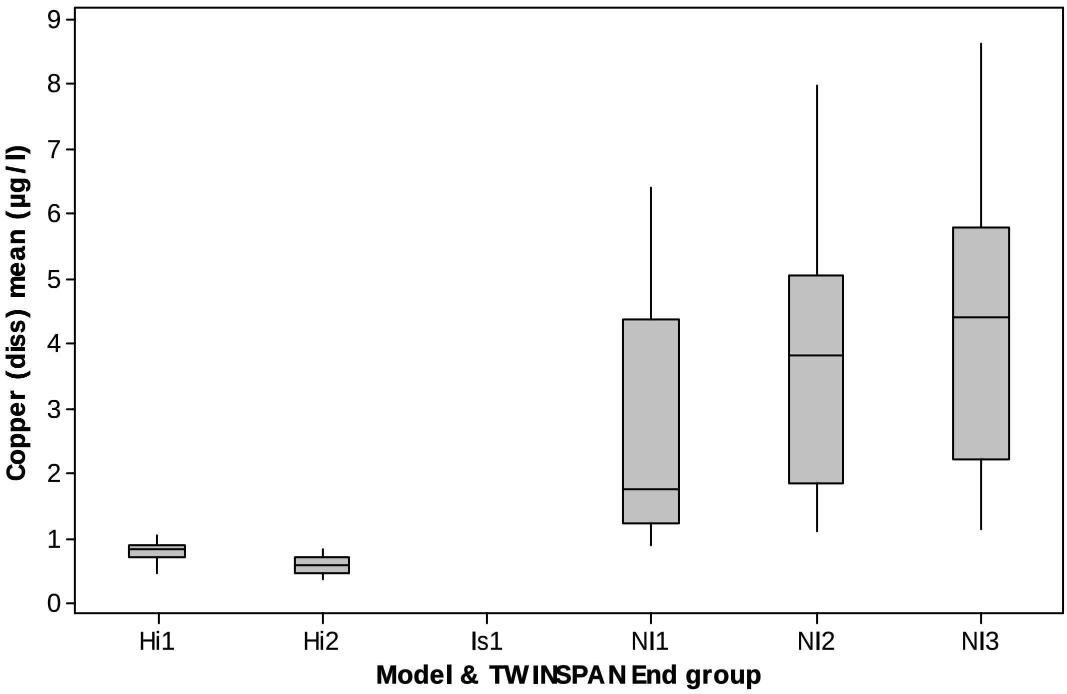


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	2.48	2.04	2.11	2.95	2.62	3.37	3.51	2.57	7.08
Maximum	3.35	3.59	3.43	5.19	3.14	3.86	4.96	5.17	7.37
90 percentile	1.61	2.14	1.47	2.29	2.42	2.77	3.58	2.68	4.69
75 percentile (Q3)	1.37	1.57	1.21	1.70	1.74	2.02	2.15	1.78	3.81
Median	1.02	1.25	0.83	1.25	1.35	1.40	1.49	1.25	2.56
25 percentile (Q1)	0.62	1.25	0.60	0.87	1.15	1.12	1.25	1.25	1.63
10 percentile	0.54	1.25	0.49	0.64	0.92	0.91	1.25	1.25	1.37
Minimum	0.25	0.56	0.36	0.29	0.79	0.70	0.92	0.79	0.98
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	32	54	48	58	41	72	60	47	50
Sites in group	71	74	83	71	49	87	68	53	58
% with data	45.1	73.0	57.8	81.7	83.7	82.8	88.2	88.7	86.2
Mean	1.06	1.48	1.00	1.37	1.55	1.67	1.99	1.71	2.90
Outlier site codes	SW01	2001	ST01	NE02	8285	**2211**	TH08	**6001**	6921
		SW06	TA01	8281	**8289**	2209	6005	2815	
		1105			8217	4983	1411	2103	
		6845				2007	**1909**	1901	
		6844				2003	**1907**	1807	
						2721	2005	6409	
						ST02	1903		

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in all nine groups have been identified as lying outside the upper outlier limit for dissolved Copper (µg/l). Five of these sites (8289, 2211, 1909, 1907 and 6001) have 3 season combined observed Number of Taxa values within the lowest 10% of their respective groups.

Contemporary mean dissolved Copper (µg/l) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups



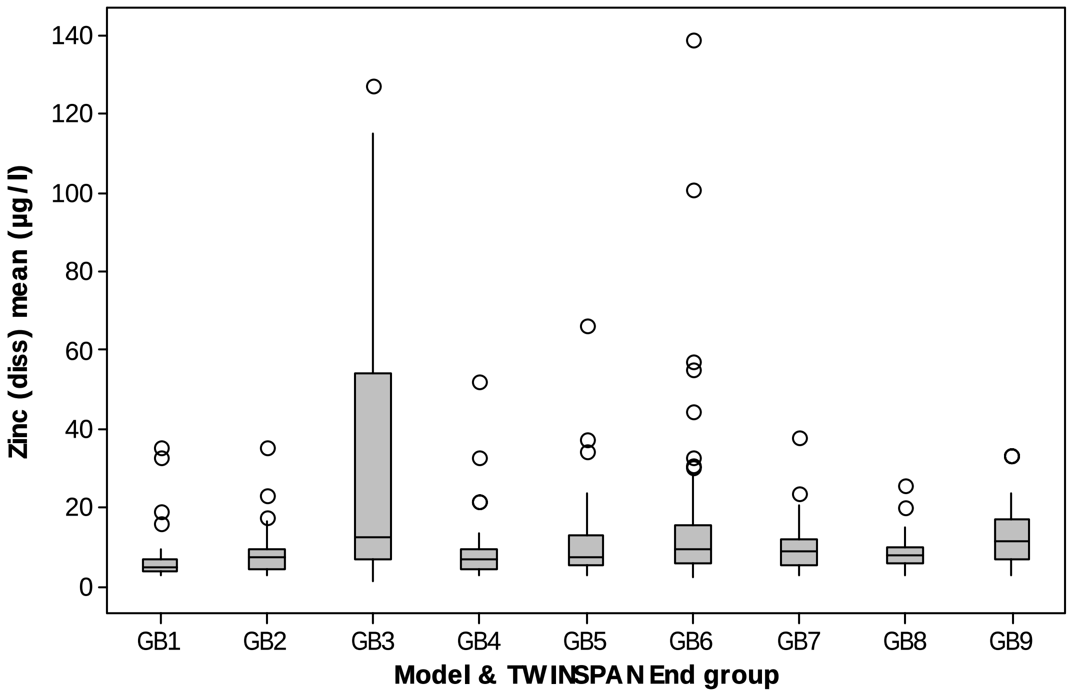
TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	1.05	1	No Data	8.92	9.61	10.98
Maximum	1.04	0.82	No Data	6.41	8	8.63
90 percentile	0.91	0.82	No Data	4.57	6.4	6.1
75 percentile (Q3)	0.88	0.67	No Data	4.33	5	5.74
Median	0.81	0.57	No Data	1.74	3.83	4.42
25 percentile (Q1)	0.77	0.45	No Data	1.27	1.93	2.24
10 percentile	0.62	0.44	No Data	1.09	1.43	1.77
Minimum	0.46	0.36	No Data	0.88	1.1	1.13
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	12	14	No Data	22	33	32
Sites in group	39	69	No Data	34	43	33
% with data	30.8	20.3	No Data	64.7	76.7	97
Mean	0.79	0.59	No Data	2.53	3.68	4.2

Outlier site codes

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

No sites in the Scottish Highlands, the Scottish Islands or Northern Ireland have been identified as lying outside the upper outlier limit for dissolved Copper (µg/l)

Contemporary mean dissolved Zinc (µg/l) summarised by GB TWINSPAN end groups

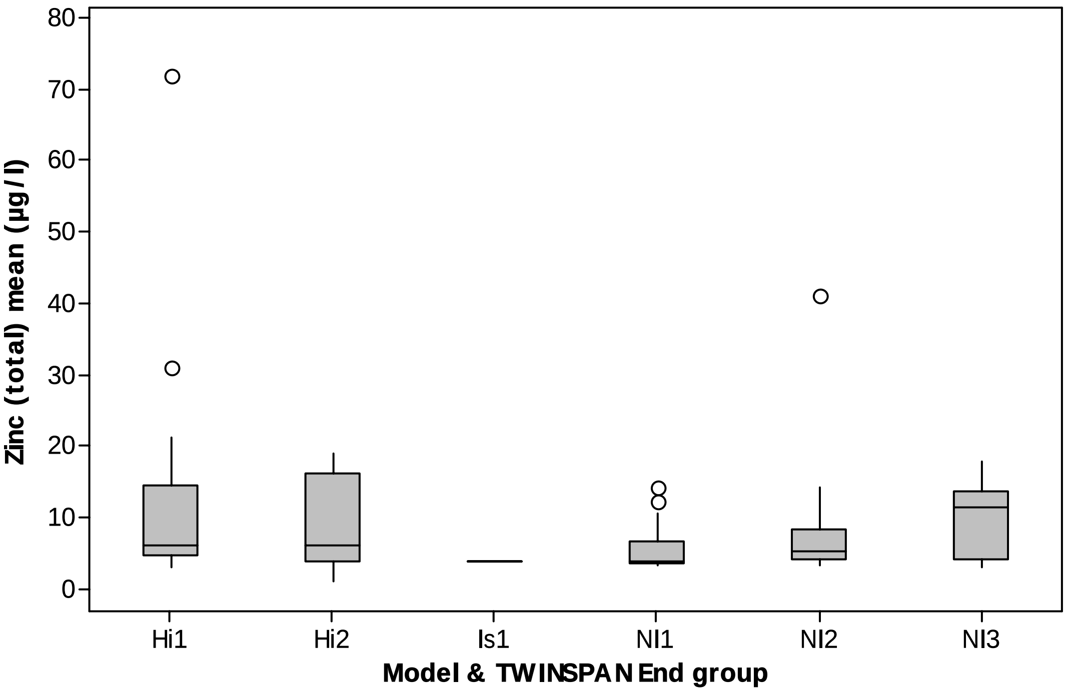


TWINSPAN group	GB1	GB 2	GB 3	GB 4	GB 5	GB 6	GB 7	GB 8	GB 9
Upper outlier limit*[1]	10.75	16.74	122.74	17.28	22.93	27.86	21.34	15.65	31.78
Maximum	35.22	35.22	127.37	52.20	66.34	138.91	37.50	25.48	33.17
90 percentile	17.33	14.95	108.87	12.21	18.74	30.22	13.65	14.12	22.17
75 percentile (Q3)	6.57	9.38	53.20	9.36	12.55	14.66	11.86	9.58	16.75
Median	4.71	7.11	12.07	6.57	7.45	9.36	8.57	7.55	11.07
25 percentile (Q1)	3.78	4.48	6.83	4.08	5.63	5.85	5.55	5.54	6.73
10 percentile	3.32	3.39	2.84	3.28	3.76	4.17	4.26	3.01	5.86
Minimum	2.50	2.50	1.21	2.50	2.50	2.16	2.50	2.50	2.84
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	26	52	30	51	38	67	54	46	49
Sites in group	71	74	83	71	49	87	68	53	58
% with data	36.6	70.3	36.1	71.8	77.6	77.0	79.4	86.8	84.5
Mean	7.95	8.15	31.34	8.53	11.25	15.63	9.53	8.42	13.02
Outlier site codes	3395	3391	3505	3513	ST06	9585	0701	**SN01**	5403
	1701	WE05		1703	8613	5717	8517	0781	5405
	WE01	2001		0505	9581	**3309**			5407
	SW01			0503	1603	**3515**			5401
						1705			
						2903			
						ST05			
						3311			
						ST07			

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in all nine groups have been identified as lying outside the upper outlier limit for dissolved Zinc (µg/l). Three of these sites (3309, 3515 and SN01) have 3 season combined observed Number of Taxa values within the lowest 10% of their respective groups.

Contemporary mean total Zinc (µg/l) summarised by N. Ireland, Scottish Highlands and Scottish Island TWINSPAN end groups



TWINSPAN group	Hi 1	Hi 2	Is 1	NI1	NI 2	NI 3
Upper outlier limit*[1]	12.5	34.47	No Data	10.63	10.88	27.66
Maximum	72	19	No Data	14.14	41.15	17.73
90 percentile	21	18.04	No Data	10.34	13.08	16.62
75 percentile (Q3)	8	16	No Data	6.34	6.75	13.57
Median	5.96	5.87	No Data	3.84	5.14	11.33
25 percentile (Q1)	5	3.69	No Data	3.48	4	4.19
10 percentile	4.13	2	No Data	3.22	3.64	3.42
Minimum	3	1	No Data	3.16	3.09	3
Lower outlier limit*[2]	N/A	N/A	N/A	N/A	N/A	N/A
Sites with data	21	20	No Data	22	33	32
Sites in group	39	69	No Data	34	43	33
% with data	53.8	29	No Data	64.7	76.7	97
Mean	12	9.32	No Data	5.47	7.4	9.63
Outlier site codes	4407 4805 4707 4807 7311			**20201101** 20100701	20303801	

*[1] Upper outlier limit = Q3+1.5(Q3-Q1), *[2] Lower outlier limit = Q1-1.5(Q3-Q1)

Sites in one Scottish Highlands group and two Northern Ireland groups have been identified as lying outside the upper outlier limit for total Zinc (µg/l). One of these sites (20201101) has a 3 season combined observed Number of Taxa value within the lowest 10% of its group.

Appendix II Chemical summary statistics by WFD system-A stream type

Contemporary mean pH (-log H^+) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	7.92	7.99	7.83	7.97	7.11	7.60	8.42	7.75	7.92	8.18	7.89	7.68
90 percentile	7.92	7.97	7.79	7.96	7.11	7.60	8.18	7.68	7.88	8.03	7.84	7.61
75 percentile	7.92	7.88	7.77	7.94	7.11	7.60	8.01	7.58	7.82	7.96	7.73	7.53
Mean	7.92	7.78	7.59	7.91	7.11	7.60	7.92	7.54	7.68	7.83	7.59	7.46
Median	7.92	7.78	7.71	7.91	7.11	7.60	7.91	7.48	7.66	7.83	7.60	7.49
25 percentile	7.92	7.66	7.38	7.88	7.11	7.60	7.80	7.44	7.56	7.71	7.38	7.34
10 percentile	7.92	7.58	7.30	7.86	7.11	7.60	7.68	7.44	7.50	7.64	7.36	7.29
Minimum	7.92	7.49	7.16	7.85	7.11	7.60	7.55	7.44	7.41	7.48	7.35	7.28
Sites with data	1	22	8	3	1	1	32	4	8	13	8	8
Sites in type	1	22	8	3	1	1	32	4	8	13	8	8
% with data	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	8.24	8.25	8.39	8.18	8.23	8.14	8.15	8.27	7.53	8.28	8.36	7.51	8.21	8.57	8.32	7.88
90 percentile	8.14	8.15	8.14	7.79	8.11	7.63	7.99	8.14	7.52	7.89	8.16	7.39	7.90	8.26	8.00	7.55
75 percentile	8.08	8.00	8.06	7.38	8.02	7.26	7.64	7.95	7.51	7.52	8.02	7.35	7.73	8.01	7.73	7.18
Mean	7.94	7.86	7.93	7.29	7.80	7.07	7.40	7.67	7.48	7.16	7.81	6.78	7.15	7.69	7.49	6.84
Median	7.99	7.76	7.95	7.19	7.90	6.90	7.44	7.83	7.48	7.14	7.85	6.51	7.17	7.74	7.64	6.90
25 percentile	7.90	7.66	7.80	7.07	7.67	6.75	7.10	7.48	7.46	6.83	7.68	6.45	6.78	7.55	6.98	6.51
10 percentile	7.58	7.60	7.69	6.92	7.38	6.66	6.95	7.05	7.44	6.32	7.43	6.28	6.19	7.06	6.93	6.24
Minimum	7.51	7.56	7.43	6.84	6.60	6.56	6.46	6.46	7.43	6.00	6.31	5.45	5.28	6.43	6.80	5.09
Sites with data	27	3	10	17	115	8	23	54	2	78	108	11	65	41	8	74
Sites in type	27	3	10	18	116	9	23	57	3	89	127	22	79	49	8	89
% with data	100.0	100.0	100.0	94.4	99.1	88.9	100.0	94.7	66.7	87.6	85.0	50.0	82.3	83.7	100.0	83.1

WFD System A stream types with <10 RIVPACS reference sites are given in italics

Contemporary mean Oxygen (%sat) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	88.32	100.22	122.79	99.08	89.00	88.95	103.74	97.52	96.52	106.55	99.10	116.10
90 percentile	88.32	98.05	110.37	98.08	89.00	88.95	100.19	94.66	95.19	102.08	99.07	106.35
75 percentile	88.32	94.87	100.90	96.58	89.00	88.95	97.13	90.38	93.36	100.34	98.18	100.11
Mean	88.32	89.71	95.55	94.14	89.00	88.95	91.78	84.60	90.70	94.93	95.89	96.31
Median	88.32	92.00	93.85	94.08	89.00	88.95	91.21	82.38	91.09	96.00	95.78	91.87
25 percentile	88.32	85.33	86.01	91.67	89.00	88.95	89.12	76.60	88.68	92.30	93.33	90.01
10 percentile	88.32	80.33	83.30	90.22	89.00	88.95	83.85	76.31	85.93	82.70	93.14	89.61
Minimum	88.32	67.76	77.46	89.25	89.00	88.95	69.02	76.13	82.92	80.68	92.90	89.18
Sites with data	1	22	8	3	1	1	32	4	8	13	8	8
Sites in type	1	22	8	3	1	1	32	4	8	13	8	8
% with data	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	108.19	102.00	102.54	105.70	129.33	98.30	103.83	114.92	94.30	108.96	115.00	98.31	107.41	106.09	101.00	105.00
90 percentile	100.40	101.19	102.05	102.37	105.14	97.04	100.95	106.98	93.97	102.04	105.94	97.89	100.79	101.92	101.00	101.44
75 percentile	96.45	99.97	100.50	98.40	99.38	95.00	97.56	100.81	93.48	100.28	97.99	95.28	98.20	99.26	98.75	98.09
Mean	93.85	99.10	97.84	96.21	93.52	93.11	93.41	97.69	92.65	97.54	93.16	92.14	93.87	95.10	97.78	96.15
Median	93.29	97.94	97.80	95.25	94.21	93.57	93.60	97.83	92.65	97.50	92.30	94.00	95.18	96.77	97.57	96.20
25 percentile	91.18	97.65	94.93	93.47	87.16	92.33	88.91	94.32	91.83	95.47	88.54	92.21	89.84	89.61	96.20	94.09
10 percentile	89.22	97.48	94.75	92.43	81.59	88.91	87.04	90.34	91.33	91.79	82.50	90.76	88.01	87.09	95.29	91.88
Minimum	76.24	97.36	93.42	88.20	71.70	84.93	81.38	77.50	91.00	86.86	68.08	71.32	62.33	84.24	95.29	82.28
Sites with data	27	3	10	17	114	8	23	56	2	74	110	11	66	42	8	58
Sites in type	27	3	10	18	116	9	23	57	3	89	127	22	79	49	8	89
% with data	100.0	100.0	100.0	94.4	98.3	88.9	100.0	98.2	66.7	83.1	86.6	50.0	83.5	85.7	100.0	65.2

Contemporary mean BOD ATU (mg/l O_2) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	2.64	3.27	2.85	2.48	1.88	2.18	3.10	2.03	2.67	2.32	1.97	2.94
90 percentile	2.64	2.43	2.73	2.30	1.88	2.18	2.45	2.00	2.66	2.15	1.87	2.16
75 percentile	2.64	2.29	2.37	2.02	1.88	2.18	2.26	1.95	2.59	1.97	1.82	1.67
Mean	2.64	2.08	2.19	1.82	1.88	2.18	2.06	1.83	2.29	1.79	1.68	1.68
Median	2.64	2.02	2.06	1.57	1.88	2.18	2.01	1.88	2.39	1.80	1.64	1.47
25 percentile	2.64	1.78	1.94	1.48	1.88	2.18	1.78	1.75	2.02	1.52	1.59	1.43
10 percentile	2.64	1.67	1.87	1.43	1.88	2.18	1.64	1.61	1.87	1.45	1.50	1.37
Minimum	2.64	1.61	1.71	1.40	1.88	2.18	1.35	1.52	1.60	1.18	1.35	1.26
Sites with data	1	22	8	3	1	1	32	4	8	13	8	8
Sites in type	1	22	8	3	1	1	32	4	8	13	8	8
% with data	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	3.38	1.79	3.25	1.71	5.75	3.15	2.88	2.29	1.57	2.59	4.50	1.06	3.97	2.50	1.38	2.93
90 percentile	3.09	1.74	2.65	1.68	2.87	2.19	2.26	1.95	1.54	2.00	2.63	1.04	2.00	1.94	1.25	1.60
75 percentile	2.69	1.67	2.20	1.64	2.19	1.19	2.01	1.69	1.49	1.63	2.14	0.94	1.73	1.50	1.20	1.34
Mean	2.23	1.55	1.97	1.27	1.98	1.40	1.74	1.48	1.40	1.31	1.90	0.87	1.53	1.31	1.10	1.18
Median	1.98	1.54	2.02	1.47	1.82	1.02	1.67	1.46	1.40	1.34	1.80	0.84	1.39	1.27	1.20	1.06
25 percentile	1.81	1.43	1.45	0.89	1.51	0.98	1.53	1.20	1.32	0.90	1.48	0.81	1.27	1.01	0.94	0.93
10 percentile	1.60	1.36	1.25	0.72	1.33	0.98	1.41	1.00	1.26	0.61	1.15	0.74	1.08	0.92	0.81	0.68
Minimum	1.50	1.32	1.24	0.53	0.83	0.98	0.87	0.87	1.23	0.48	0.63	0.70	0.58	0.54	0.81	0.47
Sites with data	27	3	10	16	114	6	22	55	2	71	110	9	67	42	8	53
Sites in type	27	3	10	18	116	9	23	57	3	89	127	22	79	49	8	89
% with data	100.0	100.0	100.0	88.9	98.3	66.7	95.7	96.5	66.7	79.8	86.6	40.9	84.8	85.7	100.0	59.6

Contemporary mean Soluble Reactive Phosphorus (mg/l P) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	0.10	0.20	0.51	0.21	0.02	0.03	0.64	0.05	0.31	0.12	0.05	0.11
90 percentile	0.10	0.14	0.34	0.18	0.02	0.03	0.10	0.05	0.23	0.10	0.05	0.07
75 percentile	0.10	0.13	0.20	0.14	0.02	0.03	0.08	0.05	0.18	0.06	0.05	0.05
Mean	0.10	0.09	0.15	0.10	0.02	0.03	0.09	0.04	0.12	0.05	0.04	0.04
Median	0.10	0.09	0.05	0.06	0.02	0.03	0.06	0.04	0.07	0.04	0.03	0.02
25 percentile	0.10	0.04	0.04	0.04	0.02	0.03	0.05	0.03	0.05	0.03	0.03	0.01
10 percentile	0.10	0.04	0.04	0.03	0.02	0.03	0.04	0.03	0.04	0.02	0.02	0.01
Minimum	0.10	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.04	0.02	0.01	0.01
Sites with data	1	22	8	3	1	1	32	4	8	13	8	8
Sites in type	1	22	8	3	1	1	32	4	8	13	8	8
% with data	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	1.93	0.26	0.50	0.10	2.37	0.24	2.34	0.29	0.04	0.13	2.82	0.01	0.75	0.19	0.03	2.42
90 percentile	1.62	0.24	0.40	0.09	0.95	0.08	0.84	0.12	0.04	0.08	0.61	0.01	0.21	0.11	0.03	0.08
75 percentile	0.99	0.22	0.30	0.03	0.38	0.01	0.18	0.08	0.04	0.03	0.25	0.01	0.08	0.04	0.02	0.03
Mean	0.68	0.17	0.19	0.03	0.37	0.03	0.29	0.07	0.03	0.03	0.25	0.00	0.09	0.04	0.01	0.06
Median	0.35	0.17	0.11	0.02	0.23	0.01	0.07	0.05	0.03	0.02	0.11	0.00	0.04	0.02	0.02	0.01
25 percentile	0.18	0.13	0.07	0.01	0.11	0.00	0.03	0.03	0.02	0.01	0.05	0.00	0.01	0.02	0.00	0.00
10 percentile	0.12	0.10	0.04	0.01	0.05	0.00	0.02	0.02	0.02	0.00	0.03	0.00	0.01	0.01	0.00	0.00
Minimum	0.09	0.08	0.03	0.00	0.01	0.00	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sites with data	27	3	10	17	115	8	23	54	2	74	104	11	64	37	8	62
Sites in type	27	3	10	18	116	9	23	57	3	89	127	22	79	49	8	89
% with data	100.0	100.0	100.0	94.4	99.1	88.9	100.0	94.7	66.7	83.1	81.9	50.0	81.0	75.5	100.0	69.7

Contemporary mean Nitrate (mg/l) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	1.06	2.12	2.22	1.85	0.19	0.16	2.75	0.52	3.10	2.15	1.59	1.62
90 percentile	1.06	1.73	1.96	1.66	0.19	0.16	1.81	0.45	2.26	1.33	0.92	1.13
75 percentile	1.06	1.44	1.78	1.36	0.19	0.16	1.55	0.36	1.77	0.90	0.59	0.81
Mean	1.06	1.12	1.17	1.12	0.19	0.16	1.20	0.29	1.63	0.71	0.55	0.61
Median	1.06	1.10	0.83	0.87	0.19	0.16	1.28	0.24	1.60	0.70	0.47	0.44
25 percentile	1.06	0.84	0.68	0.75	0.19	0.16	0.70	0.17	1.36	0.20	0.34	0.32
10 percentile	1.06	0.31	0.61	0.69	0.19	0.16	0.41	0.17	1.02	0.16	0.16	0.21
Minimum	1.06	0.25	0.53	0.64	0.19	0.16	0.32	0.17	0.43	0.15	0.10	0.04
Sites with data	1	22	8	3	1	1	32	4	8	13	8	8
Sites in type	1	22	8	3	1	1	32	4	8	13	8	8
% with data	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	11.30	4.37	6.55	1.86	12.89	0.24	6.43	11.53	1.00	4.26	16.10	0.22	10.17	4.89	0.55	4.26
90 percentile	9.10	4.27	5.60	1.53	9.22	0.21	4.40	4.10	0.96	2.09	7.96	0.22	6.14	3.67	0.30	1.84
75 percentile	7.69	4.12	4.31	1.10	7.12	0.17	3.82	3.03	0.90	1.31	6.38	0.17	4.19	2.76	0.20	0.79
Mean	6.17	3.46	3.11	0.89	5.81	0.13	2.63	2.04	0.81	0.90	4.75	0.10	2.73	1.96	0.20	0.63
Median	6.15	3.86	2.77	1.04	5.36	0.10	2.57	1.34	0.81	0.64	4.42	0.05	2.40	2.10	0.19	0.27
25 percentile	4.09	3.01	1.71	0.25	4.16	0.10	1.62	0.81	0.71	0.11	3.04	0.03	0.28	0.68	0.11	0.06
10 percentile	3.51	2.49	0.92	0.22	3.36	0.07	0.37	0.31	0.65	0.05	0.91	0.03	0.09	0.45	0.10	0.02
Minimum	3.36	2.15	0.57	0.19	0.99	0.05	0.26	0.22	0.61	0.03	0.02	0.03	0.01	0.05	0.09	0.01
Sites with data	25	3	10	9	95	7	20	52	2	65	75	8	58	38	8	61
Sites in type	27	3	10	18	116	9	23	57	3	89	127	22	79	49	8	89
% with data	92.6	100.0	100.0	50.0	81.9	77.8	87.0	91.2	66.7	73.0	59.1	36.4	73.4	77.6	100.0	68.5

Contemporary mean Nitrite (mg/l) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	0.03	0.07	0.07	0.05	0.00	0.00	0.10	0.02	0.06	0.04	0.02	0.04
90 percentile	0.03	0.04	0.05	0.05	0.00	0.00	0.03	0.02	0.06	0.02	0.02	0.02
75 percentile	0.03	0.04	0.04	0.03	0.00	0.00	0.02	0.02	0.05	0.01	0.01	0.01
Mean	0.03	0.03	0.03	0.02	0.00	0.00	0.02	0.01	0.03	0.01	0.01	0.01
Median	0.03	0.03	0.02	0.01	0.00	0.00	0.02	0.01	0.03	0.01	0.01	0.01
25 percentile	0.03	0.02	0.02	0.01	0.00	0.00	0.01	0.01	0.02	0.00	0.00	0.00
10 percentile	0.03	0.01	0.02	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
Minimum	0.03	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
Sites with data	1	22	8	3	1	1	32	4	8	13	8	8
Sites in type	1	22	8	3	1	1	32	4	8	13	8	8
% with data	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	0.14	0.04	0.12	0.01	0.17	0.01	0.16	0.16	0.00	0.03	0.13	0.01	0.12	0.05	0.01	0.03
90 percentile	0.12	0.04	0.08	0.01	0.09	0.01	0.04	0.02	0.00	0.02	0.08	0.01	0.03	0.02	0.01	0.01
75 percentile	0.07	0.04	0.04	0.01	0.06	0.01	0.02	0.02	0.00	0.01	0.05	0.01	0.03	0.01	0.01	0.01
Mean	0.06	0.03	0.04	0.01	0.05	0.01	0.03	0.02	0.00	0.01	0.04	0.00	0.02	0.01	0.01	0.01
Median	0.04	0.03	0.03	0.01	0.04	0.01	0.02	0.01	0.00	0.01	0.03	0.00	0.02	0.01	0.01	0.00
25 percentile	0.04	0.02	0.02	0.00	0.03	0.00	0.02	0.01	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00
10 percentile	0.03	0.02	0.01	0.00	0.02	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
Minimum	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Sites with data	26	3	9	17	103	6	22	52	1	74	92	9	60	35	8	61
Sites in type	27	3	10	18	116	9	23	57	3	89	127	22	79	49	8	89
% with data	96.3	100.0	90.0	94.4	88.8	66.7	95.7	91.2	33.3	83.1	72.4	40.9	75.9	71.4	100.0	68.5

Contemporary mean Free & Saline Ammonia (mg/l) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	0.17	0.32	0.23	0.19	0.06	0.06	0.41	0.19	0.23	0.11	0.08	0.16
90 percentile	0.17	0.17	0.17	0.17	0.06	0.06	0.15	0.17	0.20	0.11	0.07	0.10
75 percentile	0.17	0.16	0.12	0.13	0.06	0.06	0.12	0.12	0.18	0.08	0.07	0.06
Mean	0.17	0.14	0.12	0.10	0.06	0.06	0.11	0.10	0.14	0.07	0.06	0.07
Median	0.17	0.13	0.11	0.07	0.06	0.06	0.09	0.08	0.12	0.07	0.06	0.06
25 percentile	0.17	0.09	0.09	0.06	0.06	0.06	0.08	0.06	0.09	0.06	0.05	0.05
10 percentile	0.17	0.07	0.08	0.05	0.06	0.06	0.07	0.05	0.08	0.05	0.05	0.04
Minimum	0.17	0.04	0.07	0.04	0.06	0.06	0.04	0.05	0.08	0.05	0.05	0.04
Sites with data	1	22	8	3	1	1	32	4	8	13	8	8
Sites in type	1	22	8	3	1	1	32	4	8	13	8	8
% with data	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	0.43	0.10	0.48	0.11	1.29	0.20	0.65	0.20	0.06	0.13	1.59	0.13	0.57	0.21	0.15	0.15
90 percentile	0.29	0.10	0.30	0.07	0.34	0.18	0.24	0.13	0.05	0.07	0.37	0.13	0.13	0.14	0.12	0.07
75 percentile	0.17	0.10	0.17	0.07	0.17	0.15	0.13	0.09	0.05	0.06	0.20	0.02	0.08	0.06	0.11	0.04
Mean	0.14	0.09	0.12	0.05	0.16	0.11	0.12	0.07	0.05	0.04	0.17	0.04	0.07	0.06	0.06	0.03
Median	0.11	0.09	0.04	0.06	0.10	0.11	0.08	0.05	0.05	0.03	0.11	0.02	0.04	0.04	0.03	0.02
25 percentile	0.09	0.09	0.03	0.03	0.05	0.05	0.05	0.04	0.04	0.02	0.07	0.01	0.03	0.03	0.03	0.02
10 percentile	0.07	0.08	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.01	0.04	0.01	0.01	0.02	0.01	0.01
Minimum	0.05	0.08	0.03	0.02	0.01	0.02	0.02	0.02	0.03	0.01	0.01	0.01	0.00	0.01	0.01	0.00
Sites with data	27	3	10	17	114	8	23	56	2	74	111	11	69	42	8	63
Sites in type	27	3	10	18	116	9	23	57	3	89	127	22	79	49	8	89
% with data	100.0	100.0	100.0	94.4	98.3	88.9	100.0	98.2	66.7	83.1	87.4	50.0	87.3	85.7	100.0	70.8

Contemporary mean Total Oxidised Nitrogen (mg/l) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	No Data	1.04	No Data	0.88	0.20	0.16	2.01	0.54	3.16	2.16	0.59	0.79
90 percentile	No Data	1.03	No Data	0.86	0.20	0.16	1.81	0.50	2.74	1.53	0.57	0.71
75 percentile	No Data	1.01	No Data	0.82	0.20	0.16	1.47	0.44	2.10	0.86	0.53	0.59
Mean	No Data	0.77	No Data	0.76	0.20	0.16	1.27	0.35	1.77	0.71	0.39	0.41
Median	No Data	0.98	No Data	0.76	0.20	0.16	1.31	0.35	1.74	0.44	0.48	0.40
25 percentile	No Data	0.63	No Data	0.70	0.20	0.16	1.05	0.26	1.41	0.17	0.29	0.22
10 percentile	No Data	0.42	No Data	0.67	0.20	0.16	0.62	0.21	0.83	0.16	0.18	0.11
Minimum	No Data	0.28	No Data	0.64	0.20	0.16	0.55	0.17	0.43	0.16	0.10	0.04
Sites with data	No Data	3	No Data	2	1	1	13	2	4	6	3	4
Sites in type	No Data	22	No Data	3	1	1	32	4	8	13	8	8
% with data	No Data	13.6	No Data	66.7	100.0	100.0	40.6	50.0	50.0	46.2	37.5	50.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	9.43	4.37	5.61	1.35	12.34	8.36	7.38	8.17	0.44	2.90	13.37	0.22	10.17	4.91	0.56	3.02
90 percentile	9.22	4.27	4.43	1.25	8.95	4.28	5.13	3.96	0.44	2.01	9.93	0.22	8.53	4.04	0.29	1.90
75 percentile	7.96	4.11	3.62	0.89	7.13	0.19	3.83	2.77	0.44	1.32	7.43	0.16	5.83	2.67	0.15	0.71
Mean	6.33	3.51	2.71	0.60	5.97	1.50	2.59	1.90	0.44	0.83	5.67	0.11	3.41	1.97	0.16	0.61
Median	6.38	3.85	2.53	0.48	6.02	0.13	2.16	1.33	0.44	0.67	5.41	0.08	2.66	2.15	0.13	0.36
25 percentile	4.48	3.08	1.73	0.27	4.31	0.10	1.62	0.57	0.44	0.19	3.73	0.05	0.36	0.73	0.08	0.10
10 percentile	3.73	2.62	0.93	0.17	3.25	0.10	0.39	0.30	0.44	0.06	1.91	0.04	0.15	0.48	0.04	0.04
Minimum	3.29	2.31	0.57	0.12	0.46	0.10	0.19	0.18	0.44	0.03	0.20	0.04	0.02	0.05	0.04	0.02
Sites with data	27	3	10	18	114	6	23	54	1	71	100	7	63	38	8	59
Sites in type	27	3	10	18	116	9	23	57	3	89	127	22	79	49	8	89
% with data	100.0	100.0	100.0	100.0	98.3	66.7	100.0	94.7	33.3	79.8	78.7	31.8	79.7	77.6	100.0	66.3

Contemporary mean Suspended Solids (mg/l 105°C) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	40.30	31.37	11.93	9.36	3.80	No Data	13.28	3.21	11.17	17.50	6.79	11.56
90 percentile	40.30	15.31	10.78	9.36	3.80	No Data	11.08	3.17	11.06	9.26	4.96	9.75
75 percentile	40.30	10.45	7.44	9.36	3.80	No Data	8.58	3.11	10.87	6.78	3.25	7.04
Mean	40.30	9.68	6.70	9.36	3.80	No Data	6.67	3.06	9.75	5.62	3.10	5.40
Median	40.30	8.79	5.68	9.36	3.80	No Data	6.84	3.00	10.17	3.83	2.45	4.11
25 percentile	40.30	5.48	4.99	9.36	3.80	No Data	3.53	2.98	8.90	2.77	2.24	2.47
10 percentile	40.30	4.97	4.53	9.36	3.80	No Data	3.07	2.96	8.01	2.57	1.88	2.07
Minimum	40.30	2.99	3.55	9.36	3.80	No Data	2.10	2.95	7.39	1.83	1.46	1.81
Sites with data	1	20	8	1	1	No Data	25	3	6	12	7	4
Sites in type	1	22	8	3	1	No Data	32	4	8	13	8	8
% with data	100.0	90.9	100.0	33.3	100.0	No Data	78.1	75.0	75.0	92.3	87.5	50.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	45.00	17.23	45.58	31.81	39.89	5.16	32.33	22.80	6.00	24.33	35.00	3.77	25.06	29.44	4.92	25.23
90 percentile	27.17	16.82	38.20	5.08	25.20	4.19	14.92	18.40	5.90	7.75	24.60	3.67	17.20	16.25	4.92	7.34
75 percentile	22.36	16.21	31.98	3.09	17.21	3.38	13.45	14.92	5.75	5.73	14.34	2.64	12.69	9.19	4.01	4.37
Mean	19.00	14.14	23.90	4.64	13.93	2.89	11.20	10.17	5.50	4.46	12.13	2.41	9.27	7.52	2.90	4.07
Median	17.37	15.19	22.66	3.00	11.45	2.69	11.00	8.00	5.50	3.49	9.99	2.31	8.17	5.21	2.61	2.46
25 percentile	13.37	12.60	15.77	2.27	8.64	2.05	5.29	5.27	5.25	1.74	7.50	2.15	5.24	3.38	1.81	1.76
10 percentile	10.95	11.04	12.48	1.91	6.22	1.65	4.25	4.25	5.10	1.50	4.33	1.31	2.69	1.83	1.40	1.15
Minimum	7.03	10.00	6.92	1.10	2.47	1.57	2.75	2.75	5.00	0.20	1.35	1.19	1.83	1.46	1.00	0.72
Sites with data	26	3	9	17	96	7	23	53	2	73	88	11	54	35	8	55
Sites in type	27	3	10	18	116	9	23	57	3	89	127	22	79	49	8	89
% with data	96.3	100.0	90.0	94.4	82.8	77.8	100.0	93.0	66.7	82.0	69.3	50.0	68.4	71.4	100.0	61.8

Contemporary mean dissolved Copper (µg/l) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	5.71	7.60	8.63	5.37	4.50	No Data	7.00	8.00	6.43	6.42	6.41	4.36
90 percentile	5.71	6.25	6.68	5.37	4.50	No Data	5.08	6.79	6.03	5.18	5.31	4.23
75 percentile	5.71	5.90	5.48	5.37	4.50	No Data	4.37	4.96	5.53	4.27	4.51	4.05
Mean	5.71	4.12	3.62	5.37	4.50	No Data	3.11	3.67	4.75	3.25	2.98	2.85
Median	5.71	4.67	2.27	5.37	4.50	No Data	2.36	1.93	4.92	3.67	1.75	2.84
25 percentile	5.71	1.91	1.81	5.37	4.50	No Data	1.75	1.51	3.97	1.75	1.27	1.65
10 percentile	5.71	1.43	1.36	5.37	4.50	No Data	1.44	1.26	3.30	0.97	1.20	1.49
Minimum	5.71	1.13	1.18	5.37	4.50	No Data	1.10	1.09	2.86	0.88	1.13	1.38
Sites with data	1	19	8	1	1	No Data	25	3	6	12	7	4
Sites in type	1	22	8	3	1	No Data	32	4	8	13	8	8
% with data	100.0	86.4	100.0	33.3	100.0	No Data	78.1	75.0	75.0	92.3	87.5	50.0

Ecoregion 18: Great Britain

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	7.37	3.38	3.86	1.46	4.93	0.82	2.34	3.82	0.84	5.19	5.17	No Data	3.49	3.14	1.41	2.47
90 percentile	5.46	3.17	3.53	1.46	3.44	0.82	2.10	2.30	0.84	2.21	3.57	No Data	1.53	1.74	1.41	1.75
75 percentile	4.04	2.85	2.67	1.04	2.59	0.82	1.71	1.74	0.84	1.25	2.15	No Data	1.25	1.31	1.24	1.39
Mean	2.94	2.48	1.88	0.87	2.04	0.82	1.54	1.50	0.84	1.20	1.86	No Data	1.36	1.05	0.98	1.15
Median	2.08	2.32	1.37	0.81	1.64	0.82	1.58	1.29	0.84	0.92	1.48	No Data	1.25	0.86	0.94	1.25
25 percentile	1.50	2.03	0.94	0.63	1.25	0.82	1.25	1.15	0.84	0.71	1.25	No Data	1.25	0.63	0.76	0.83
10 percentile	1.27	1.85	0.89	0.50	1.25	0.82	0.95	0.79	0.84	0.50	1.25	No Data	1.17	0.56	0.57	0.46
Minimum	1.21	1.74	0.77	0.29	0.79	0.82	0.95	0.58	0.84	0.33	0.61	No Data	0.84	0.41	0.57	0.25
Sites with data	26	3	9	10	100	3	17	47	1	56	84	No Data	49	30	8	34
Sites in type	27	3	10	18	116	9	23	57	3	89	127	No Data	79	49	8	89
% with data	96.3	100.0	90.0	55.6	86.2	33.3	73.9	82.5	33.3	62.9	66.1	No Data	62.0	61.2	100.0	38.2

Contemporary mean dissolved/total Zinc (µg/l) summarised by WFD System A stream type

Ecoregion 17: Northern Ireland (total Zinc)

Catchment size	Large	Medium					Small					
Altitude category	Low	Low		Medium			Low			Medium		
Geology category	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	14.03	17.39	17.73	14.09	8.20	No Data	14.25	4.43	41.15	13.26	12.26	14.14
90 percentile	14.03	14.65	15.30	14.09	8.20	No Data	10.49	4.23	29.05	11.81	11.25	12.52
75 percentile	14.03	13.52	12.62	14.09	8.20	No Data	6.75	3.92	14.22	6.07	8.54	10.09
Mean	14.03	9.74	8.56	14.09	8.20	No Data	5.89	3.71	12.90	5.66	6.60	8.29
Median	14.03	12.63	5.90	14.09	8.20	No Data	4.38	3.41	5.51	4.00	5.50	7.80
25 percentile	14.03	4.33	4.63	14.09	8.20	No Data	3.74	3.34	4.46	3.43	3.84	5.99
10 percentile	14.03	3.35	4.02	14.09	8.20	No Data	3.31	3.30	4.14	3.17	3.76	4.45
Minimum	14.03	3.11	3.71	14.09	8.20	No Data	3.09	3.28	4.00	3.00	3.68	3.43
Sites with data	1	19	8	1	1	No Data	25	3	6	12	7	4
Sites in type	1	22	8	3	1	No Data	32	4	8	13	8	8
% with data	100.0	86.4	100.0	33.3	100.0	No Data	78.1	75.0	75.0	92.3	87.5	50.0

Ecoregion 18: Great Britain (dissolved Zinc)

Catchment size	Large				Medium						Small					
Altitude category	Low		Medium		Low			Medium			Low			Medium		
Geology category	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
Maximum	146.00	No Data	50.00	6.11	90.00	31.00	No Data	40.00	33.00	72.00	60.00	18.00	40.00	24.00	16.00	64.00
90 percentile	34.40	No Data	42.00	5.98	37.50	25.00	No Data	35.20	32.40	14.50	42.00	18.00	19.30	21.60	13.77	32.20
75 percentile	28.00	No Data	30.00	5.92	20.25	21.00	No Data	18.00	31.50	6.87	20.00	18.00	17.00	18.00	10.43	17.82
Mean	29.38	No Data	24.00	4.37	21.10	16.64	No Data	15.03	30.00	8.02	18.55	9.98	13.63	13.33	8.58	15.54
Median	18.00	No Data	17.00	4.57	14.50	19.00	No Data	9.00	30.00	5.00	10.00	6.30	11.13	12.00	4.87	11.17
25 percentile	15.00	No Data	12.00	2.99	10.00	10.15	No Data	6.00	28.50	3.16	7.55	3.80	7.09	8.00	4.87	3.69
10 percentile	10.60	No Data	11.40	2.72	8.92	4.26	No Data	6.00	27.60	1.71	4.96	3.80	4.82	5.60	4.87	3.08
Minimum	10.00	No Data	11.00	1.67	5.91	4.20	No Data	6.00	27.00	0.82	4.74	3.80	3.24	4.00	4.87	3.00
Sites with data	13	No Data	5	10	20	7	No Data	9	2	38	7	5	10	3	3	14
Sites in type	27	No Data	10	18	116	9	No Data	57	3	89	127	22	79	49	8	89
% with data	48.1	No Data	50.0	55.6	17.2	77.8	No Data	15.8	66.7	42.7	5.5	22.7	12.7	6.1	37.5	15.7

Appendix III UK Biodiversity Research Advisory Group list of non-native freshwater macroinvertebrate species in the United Kingdom

UK Biodiversity Research Advisory Group list of non-native freshwater macroinvertebrate species in the United Kingdom

Scientific name	English name
Achtheres percarum	Freshwater copepod
Asellus communis	Freshwater isopod
Astacus astacus	Noble crayfish
Astacus leptodactylus	Narrow-clawed crayfish
Branchiura sowerbyi	Freshwater oligochaete
Corbicula fluminea	Asian Clam
Corophium curvispinum	Freshwater amphipod
Crangonyx pseudogracilis	Freshwater amphipod
Craspedacusta sowerbyi	Freshwater coelenterate
Dikerogammarus villosus	Dikerogammarus
Dreissena polymorpha	Zebra mussel
Dugesia tigrina	Freshwater triclad
Ergasilus briani	Freshwater copepod
Ergasilus sieboldi	Freshwater copepod
Eriocheir sinensis	Chinese Mitten Crab
Ferrissia wautieri	Freshwater limpet
Lernaea cyprinacea	Freshwater copepod
Limnodrilus cervix	Freshwater oligochaete
Lymnaea catascopium	Freshwater gastropod
Marstoniopsis scholtzi	Freshwater gastropod
Menetus dilatatus	Freshwater gastropod
Musculium transversum	Freshwater bivalve
Mytilopsis leucophaeata	Freshwater bivalve
Neoergasilus japonicus	Parasitic copepod
Orconectes limosus	Spiny-cheeked/striped crayfish
Pacifastacus leniusculus	Signal crayfish
Phagocata woodworthi	Freshwater triclad
Physella acuta	Freshwater gastropod
Physella gyrina	Freshwater gastropod
Physa heterostropha	Freshwater gastropod
Piscicola geometra	Fish leech
Planaria torva	Freshwater triclad
Potamopyrgus antipodarum	Jenkin's spire-snail
Procambarus clarkii	Red swamp crayfish
Tracheliastes polycolpus	Parasitic copepod

Appendix IV UK Technical Advisory Group on the Water Framework Directive list of non-native freshwater macroinvertebrate species in rivers in the United Kingdom

UK Technical Advisory Group on the Water Framework Directive list of non-native freshwater macroinvertebrate species occurring in rivers in the United Kingdom (species in bold are regarded as having a high impact)

Scientific name	English name
Pacifastacus leniusculus	**North American signal crayfish**
Procambarus clarkii	Red swamp crayfish
Lernaea cyprinacea	Freshwater copepod
Crangonyx pseudogracilis	Freshwater amphipod
Eriocheir sinensis	**Chinese mitten crab**
Dreissena polymorpha	**Zebra mussel**
Anguillicola crassus	Swim bladder nematode
Potamopyrgus antipodarum	Jenkin's spire shell
Astacus leptodactylus	Narrow-clawed (Turkish) crayfish
Astacus astacus	Noble crayfish
Craspedacusta sowerbyi	Freshwater coelenterate
Dugesia tigrina	Freshwater triclad
Phagocata woodworthi	Freshwater triclad
Planaria torva	Freshwater triclad
Corbicula fluminea	Freshwater mollusc
Ferissia wautieri	Freshwater mollusc
Marstoniopsis scholtzi	Freshwater mollusc
Menetus dilatatus	Freshwater mollusc
Musculium transversum	Freshwater mollusc
Physa acuta	Freshwater mollusc
Physa gyrina	Freshwater mollusc
Physa heterostropha	Freshwater mollusc
Branchiura sowerbyi	Freshwater oligochaete
Limnodrilus cervix	Freshwater oligochaete
Achtheres percarum	Freshwater copepod
Ergasilus briani	Freshwater copepod
Ergasilus sieboldi	Freshwater copepod
Neoergasilus japonicus	Freshwater copepod
Tracheliastes polycolpus	Freshwater copepod
Asellus communis	Freshwater malacostracan
Corophium curvispinum	Freshwater malacostracan

Appendix V Average CORINE level 3 land cover percentages within WFD System A stream types and CORINE label level key

Average CORINE level 3 land cover percentages within WFD System A stream types (Ecoregion 18: Great Britain)

	Catchment size	Large				Medium						Small					
	Altitude cat.	Low		Medium		Low			Medium			Low			Medium		
CORINE code & Level 3 name	Geology cat.	Cal	Sil	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
111 Continuous urban fabric																	
112 Discontinuous urban fabric		3.8	1.4	1.5	0.3	2.2	0.3	1.8	0.5		0.3	1.8		1.3	0.1		0.1
121 Industrial or commercial units		0.4	0.2	0.2		0.2						0.1					
122 Road and rail networks and associated land											0.1						
123 Port areas																	
124 Airports		0.4	0.1			0.2		0.2				0.2					0.1
131 Mineral extraction sites		0.2	0.1	0.2		0.1	0.1	0.2	0.4		0.1				0.1		0.1
132 Dump sites																	
133 Construction sites						0.1								0.4			
141 Green urban areas		0.1	0.1			0.1											
142 Sport and leisure facilities		1.2	0.6	0.5	0.3	1.1	0.2	0.6	0.3		0.1	0.8		0.3	0.1		
211 Non-irrigated arable land		54.6	14.4	11.8	3.8	51.4	10.4	11.9	7.9		1.7	37.4		15.0	1.0		
212 Permanently irrigated land																	
213 Rice fields																	
221 Vineyards																	
222 Fruit trees and berry plantations				0.1		0.2								0.3			
223 Olive groves																	
231 Pastures		18.3	50.1	45.9	12.4	23.9	7.8	47.4	39.0	10.8	20.1	30.0	5.1	27.0	29.7	0.1	14.5
241 Annual crops associated with permanent crops																	
242 Complex cultivation patterns		4.5	5.0	3.2	1.5	5.4	0.4	4.0	1.5		0.8	5.7		2.0	0.4		0.3
243 Agriculture, with significant natural vegetation		1.8	3.9	1.7	2.0	3.6	0.5	3.0	1.5		1.0	3.0		1.9	2.1		0.9
244 Agro-forestry areas																	
311 Broad-leaved forest		3.0	3.8	1.1	0.8	4.6	0.1	8.5	1.2	0.2	1.4	3.4	0.1	9.7	0.3		1.0
312 Coniferous forest		1.9	4.1	3.5	10.7	2.9	15.7	9.1	3.9	1.5	9.8	4.4	3.3	8.3	5.4	1.4	9.1
313 Mixed forest		0.3	0.1	0.4		0.2		0.2	0.2		0.1	0.7		0.7	0.1		
321 Natural grasslands		4.7	12.0	22.3	14.5	1.8	4.9	6.1	27.3	23.9	20.5	2.4	5.1	11.3	35.2	41.4	24.7
322 Moors and heathland		3.4	3.4	4.7	33.9	1.7	18.3	4.7	11.3	28.2	29.4	7.1	31.0	19.7	20.6	20.9	36.6
323 Sclerophyllous vegetation																	
324 Transitional woodland-shrub		0.2	0.5	0.7	1.4	0.3	2.6	1.2	0.5	0.2	1.2	0.8	1.6	0.3	0.9	1.1	1.9
331 Beaches, dunes, sands																	
332 Bare rocks					1.0					0.1	1.0			0.1	1.0		2.0
333 Sparsely vegetated areas				0.1	15.1				0.3	0.3	6.8			0.2	0.3	1.2	4.9
334 Burnt areas																	
335 Glaciers and perpetual snow																	
411 Inland marshes					0.1									0.1			
412 Peat bogs		0.7		1.7	1.0	0.1	37.7	1.0	4.1	33.6	4.0	1.8	51.6	0.9	2.3	33.2	3.3
421 Salt marshes																	
422 Salines																	
423 Intertidal flats																	
511 Water courses																	
512 Water bodies		0.2	0.2	0.4	1.2	0.1	1.1	0.2	0.2	1.3	1.6	0.2	2.2	0.3	0.2	0.6	0.5
521 Coastal lagoons																	
522 Estuaries																	
523 Sea and ocean																	

Average CORINE 2000 level 3 land cover percentages within WFD System A stream types (Ecoregion 17: Northern Ireland)

	Catchment size	Large	Medium					Small					
	Altitude cat.	Low	Low		Medium			Low			Medium		
CORINE code & Level 3 name	Geology cat.	Cal	Cal	Sil	Cal	Org	Sil	Cal	Org	Sil	Cal	Org	Sil
111	Continuous urban fabric				0.1								
112	Discontinuous urban fabric	0.3	0.4	0.6	0.8			0.2		0.4			
121	Industrial or commercial units				0.1			0.1					
122	Road and rail networks and associated land												
123	Port areas												
124	Airports												
131	Mineral extraction sites		0.2		0.1			0.6		0.1	0.1		
132	Dump sites												
133	Construction sites												
141	Green urban areas												
142	Sport and leisure facilities		0.1		0.1			0.1					0.2
211	Non-irrigated arable land	0.1	0.1		0.1					0.1	0.2		0.2
212	Permanently irrigated land												
213	Rice fields												
221	Vineyards												
222	Fruit trees and berry plantations												
223	Olive groves												
231	Pastures	70.8	61.9	53.9	60.9	2.9	4.1	65.6	16.4	73.8	30.3	10.6	29.1
241	Annual crops associated with permanent crops												
242	Complex cultivation patterns		0.3	0.7	0.2			0.1			0.4		0.6
243	Agriculture, with significant natural vegetation	5.5	3.7	2.7	2.8	7.0		6.1	6.6	6.3	2.3	2.5	0.7
244	Agro-forestry areas												
311	Broad-leaved forest	0.5	0.1	0.1				0.3		0.1	0.3		0.3
312	Coniferous forest	4.9	6.9	11.4	1.0	27.5		6.2	10.6	5.0	19.3	6.7	6.7
313	Mixed forest	0.8											
321	Natural grasslands	7.0	12.1	10.3	28.2	42.3		9.9	17.7	5.3	22.4	31.0	37.3
322	Moors and heathland	0.6	4.4	5.5	4.9	16.2	95.9	4.5	2.4	1.9	7.9	44.5	15.6
323	Sclerophyllous vegetation												
324	Transitional woodland-shrub	1.5	1.3	1.7		4.1		1.0	1.0	0.7	2.8	2.5	3.1
331	Beaches, dunes, sands												
332	Bare rocks												
333	Sparsely vegetated areas												
334	Burnt areas												
335	Glaciers and perpetual snow												
411	Inland marshes												
412	Peat bogs	7.9	7.8	11.9	0.9			5.2	43.2	6.1	13.8	2.2	6.2
421	Salt marshes												
422	Salines												
423	Intertidal flats												
511	Water courses												
512	Water bodies	0.2	0.4	0.9					2.1	0.2	0.1		0.2
521	Coastal lagoons												
522	Estuaries												
533	Sea and ocean												

CORINE Land Cover 2000 label level key

Code Level 3	Label Level1	Label Level2	Label Level3	RGB Color
111	Artificial surfaces	Urban fabric	Continuous urban fabric	230-000-077
112	Artificial surfaces	Urban fabric	Discontinuous urban fabric	255-000-000
121	Artificial surfaces	Industrial, commercial and transport units	Industrial or commercial units	204-077-242
122	Artificial surfaces	Industrial, commercial and transport units	Road and rail networks and associated land	204-000-000
123	Artificial surfaces	Industrial, commercial and transport units	Port areas	230-204-204
124	Artificial surfaces	Industrial, commercial and transport units	Airports	230-204-230
131	Artificial surfaces	Mine, dump and construction sites	Mineral extraction sites	166-000-204
132	Artificial surfaces	Mine, dump and construction sites	Dump sites	166-077-000
133	Artificial surfaces	Mine, dump and construction sites	Construction sites	255-077-255
141	Artificial surfaces	Artificial, non-agricultural vegetated areas	Green urban areas	255-166-255
142	Artificial surfaces	Artificial, non-agricultural vegetated areas	Sport and leisure facilities	255-230-255
211	Agricultural areas	Arable land	Non-irrigated arable land	255-255-168
212	Agricultural areas	Arable land	Permanently irrigated land	255-255-000
213	Agricultural areas	Arable land	Rice fields	230-230-000
221	Agricultural areas	Permanent crops	Vineyards	230-128-000
222	Agricultural areas	Permanent crops	Fruit trees and berry plantations	242-166-077
223	Agricultural areas	Permanent crops	Olive groves	230-166-000
231	Agricultural areas	Pastures	Pastures	230-230-077
241	Agricultural areas	Heterogeneous agricultural areas	Annual crops associated with permanent crops	255-230-166
242	Agricultural areas	Heterogeneous agricultural areas	Complex cultivation patterns	255-230-077
243	Agricultural areas	Heterogeneous agricultural areas	Land principally occupied by agriculture, with significant areas of natural veg.	230-204-077
244	Agricultural areas	Heterogeneous agricultural areas	Agro-forestry areas	242-204-166
311	Forest and semi natural areas	Forests	Broad-leaved forest	128-255-000
312	Forest and semi natural areas	Forests	Coniferous forest	000-166-000
313	Forest and semi natural areas	Forests	Mixed forest	077-255-000
321	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Natural grasslands	204-242-077
322	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Moors and heathland	166-255-128
323	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Sclerophyllous vegetation	166-230-077
324	Forest and semi natural areas	Scrub and/or herbaceous vegetation associations	Transitional woodland-shrub	166-242-000
331	Forest and semi natural areas	Open spaces with little or no vegetation	Beaches, dunes, sands	230-230-230
332	Forest and semi natural areas	Open spaces with little or no vegetation	Bare rocks	204-204-204
333	Forest and semi natural areas	Open spaces with little or no vegetation	Sparsely vegetated areas	204-255-204
334	Forest and semi natural areas	Open spaces with little or no vegetation	Burnt areas	000-000-000
335	Forest and semi natural areas	Open spaces with little or no vegetation	Glaciers and perpetual snow	166-230-204
411	Wetlands	Inland wetlands	Inland marshes	166-166-255
412	Wetlands	Inland wetlands	Peat bogs	077-077-255
421	Wetlands	Maritime wetlands	Salt marshes	204-204-255
422	Wetlands	Maritime wetlands	Salines	230-230-255
423	Wetlands	Maritime wetlands	Intertidal flats	166-166-230
511	Water bodies	Inland waters	Water courses	000-204-242
512	Water bodies	Inland waters	Water bodies	128-242-230
521	Water bodies	Marine waters	Coastal lagoons	000-255-166
522	Water bodies	Marine waters	Estuaries	166-255-230
523	Water bodies	Marine waters	Sea and ocean	230-242-255