EA - North East Box 7

A SUSTAINABLE FUTURE FOR THE HUMBER ESTUARY

[redacted]

ENVIRONMENT AGENCY

ENVIRONMENT AGENCY

ANGLIAN REGION

Kingfisher House, Goldhay Way,
Orton Goldhay,
Peterborough PE2 5ZR

HUMBER ESTUARY

A report from the
Humber Management Group
of the
Environment Agency

ENVIRONMENT QUALITY REPORT 1995

Comprising the Anglian, Midlands, and North East Regions of the Environment Agency

Anglian Region
Kingfisher House
Goldhay Way
Orton Goldhay
Peterborough
PE2 5ZR
Tel. 01733 371811
Fax. 01733 231840

Midlands Regions
Sapphire East
550 Streetsbrook Road
Solihull
B91 1QT
Tel. 0121-711 2324
Fax. 0121-711 5824

North East Region
Rivers House
21 Park Square South
Leeds
LS1 2QG
Tel. 0113-244 0191
Fax. 0113-246 1889

QUALITY OF THE HUMBER ESTUARY 1995

CONTENTS

LIST OF FIGURES

BIOLOGICAL QUALITY

CLASSIFICATION

MODELLING

LIST OF TABLES

APPENDICES

PREFACE

This report was produced on behalf of the Humber Management Group of the Environment Agency. The data utilised were collected during the lifetime of the Agency's predecessor, the National Rivers Authority, on behalf of the Humber Estuary Committee.

Marion Justice
Humber Technical Secretary
October 1997

SUMMARY

The Environment Agency's Humber Management Group (HMG), through its Environmental Quality Project Board (EQPB), co-ordinate Agency environmental quality monitoring of the Estuary. Non-statutory Environmental Quality Objectives (EQOs), designed to protect existing and potential uses of Estuary waters, are used as reference points for comparison of results. Routine monitoring programmes of the whole Estuary, aided by intensive special surveys of smaller areas, provide data on the quality of the Humber including its tidal tributaries and freshwater rivers, its industrial and sewage inputs, accumulation of substances in its sediments and organisms, and the nature and diversity of its invertebrate fauna and bacteria.

FRESHWATER FLOWS

The influence of the dry winter in 1994/95 was reflected in the rapid decline in flows during February. Flows remained low throughout the year and only showed a small increase in the last few weeks of the year.

CHEMICAL QUALITY

There was a deterioration in dissolved oxygen levels in the tidal waters probably related to low freshwater flows. Levels of all List I and List II metals complied with their respective Environmental Quality Standards (EQSs) except copper, which is an ongoing problem in the Estuary (see p. 17). Levels of synthetic organic compounds complied with the EQSs including Lindane on the River Aire at Snaith which failed in 1994.

Metal loads entering the Humber system via the non-tidal rivers, industrial and sewage discharges were below five-year means with the exception of the zinc load from industry.

Concentrations of metals in tidal river and intertidal estuarine sediments were generally lower than five-year means. All but two of the subtidal estuarine sites showed metal concentrations below the five-year means.

Concentrations of metals in the tissues of ragworms and seaweed showed no clear pattern, with some sites being below and others above the five-year mean. Similarly for brown shrimp no clear pattern emerged although all the results were within the normal range.

BIOLOGICAL QUALITY

The biological quality of the tidal rivers remained similar to previous years suggesting no significant improvements in water quality.

There was little significant change in the intertidal fauna of the Estuary, which remained of generally 'good quality'. Changes were attributed to natural population variations, sediment disturbances and sample site relocation. At one site, Grimsby, the continued faunal improvement is confidently attributed to the abatement of the nearby sewage discharge from Riby Street.

The subtidal biology of the Estuary suggests a slight decline in environmental conditions in the Upper and Middle Estuary but improved conditions in the Lower and Outer Estuary.

Intertidal sediment bacteria results suggest sewage contamination of mud-flats in the outermost part of the Estuary, particularly around sewage outfalls. Subtidal results showed peaks of bacterial contamination coinciding with the confluence of main tributaries and with the main sewage outfalls from Hull and Grimsby.

The abundance and species richness of the fish community in the Estuary were generally comparable with previous years.

SECTION 1
THE QUALITY OF THE HUMBER ESTUARY 1995

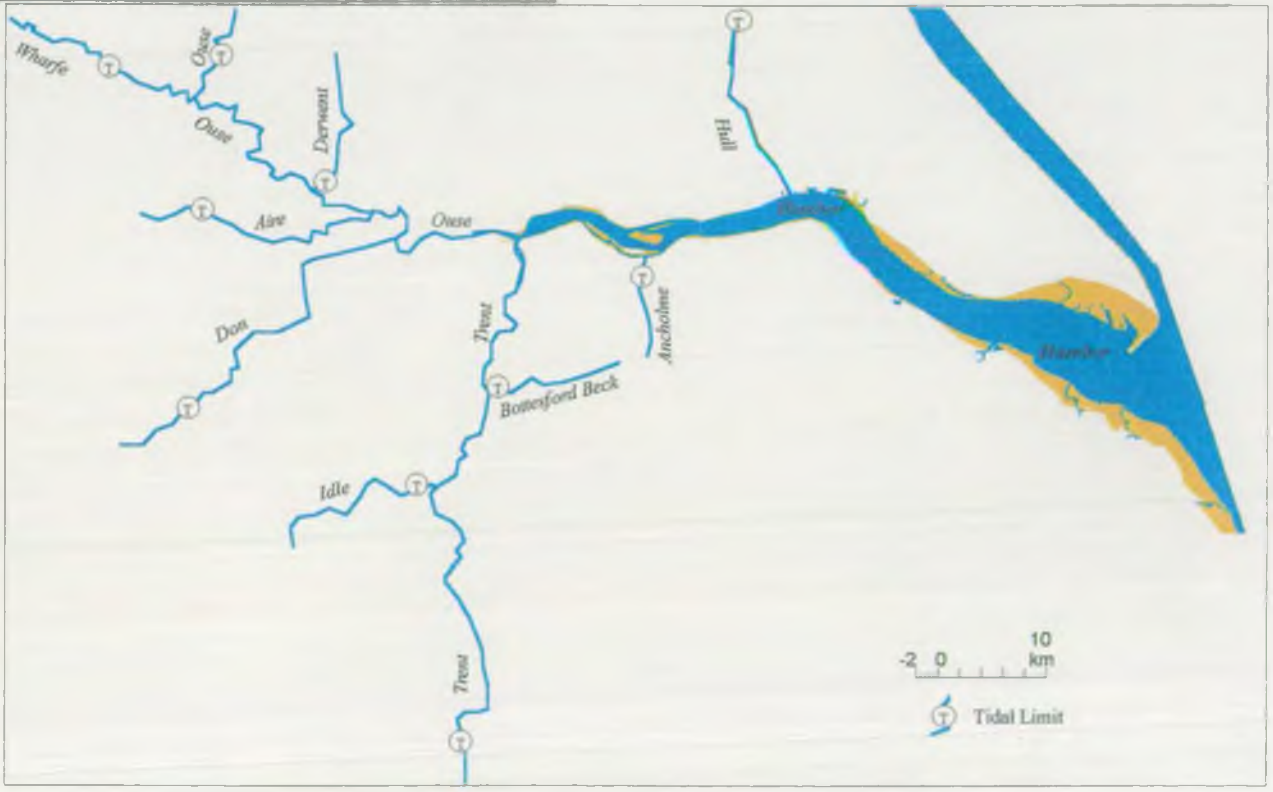
1.1 INTRODUCTION

The Humber Estuary is the largest estuary in the United Kingdom, with a catchment draining over 24 000 sq km, one fifth of the area of England (Figure 1.1). Much of the country's coal production, electricity generating capacity and manufacturing industry is located within the Humber catchment and 11 million people live in the area.

The Estuary is also one of the main freshwater inputs to the North Sea with the catchment generating an average of 250 cubic metres of freshwater per second. This freshwater is derived from two major river systems, the Trent and the Yorkshire Ouse. The Estuary has a tidal range of 6.5 metres at its mouth rising at Saltend to a maximum of 7.2 metres, which is the largest range on the East coast of Britain. A typical spring tide can move the water in the Estuary upstream by 5 km (depending on freshwater flow, location and wind), reversing the river flows. This energetic system results in large amounts of both riverine and marine sediments suspended in the water, giving the Estuary its characteristic brown colour. At the edge, this sediment settles out, forming the productive mud-flats which line the Estuary shores.

Historically, industries were allowed to discharge large quantities of substances directly into the Estuary without restriction. Many of these substances are now trapped within sediments and could be released in areas where the Estuary bed or banks are eroding. Current industrial discharges to the Estuary are regulated and the quantities of contaminants discharged have decreased substantially.

Figure 1.1 The Humber Estuary and its Catchment



Despite historical use, the Estuary is biologically very productive and supports internationally important numbers of over-wintering birds. Between Trent Falls and Donna Nook, for example, the Humber Flats and Marshes are recognised as internationally important with counts of approximately 14 000 wildfowl and 77 000 waders. Large areas of the shoreline are designated as Sites of Special Scientific Interest (SSSIs) and there are also several nature reserves managed by the RSPB and other conservation bodies.

The Estuary is an important nursery area for flatfish such as plaice, *Pleuronectes platessa*. It is also a spawning area for sole, *Solea solea*, and 25 fish species have recently been recorded in the annual fish survey (section 4.7.4).

Three regions of the Environment Agency (Anglian, Midlands and North East) border the Humber Estuary. Their activities are co-ordinated by the Humber Management Group (HMG) and, for environmental quality, the Environmental Quality Project Board (EQPB). The monitoring programme undertaken by the HMG each year enables the Agency to assess the amounts of substances discharged into the tidal rivers and Estuary, and the concentrations in the river and Estuary water. These are compared to Environmental Quality Standards (EQSs) to determine compliance for specific substances. These standards are given for toxic, persistent and bioaccumulative substances on List I of Directive 76/464/EEC on 'Pollution caused by Certain Dangerous Substances Discharged into the Aquatic Environment'. National standards are set for List II substances of the same Directive which are considered less dangerous than those of List I. Discharges of these substances are controlled by the Agency through the issuing of discharge consents and authorisations.

1.2 REPORT ON THE QUALITY OF THE HUMBER ESTUARY 1980 - 1990

In July 1993, the NRA produced a report on the 'Quality of the Humber Estuary 1980 - 1990', which reviewed the results of ten years of monitoring on the Humber including freshwater inputs, chemical and biological quality and fish populations.

The report showed that pollution loads to the tidal rivers and Estuary have decreased and that most substances were well within the EQSs. This was achieved by reductions in effluent inputs via efficient pollution control measures and the closure of Capper Pass smelting works near Brough. Within the ten year period, the estuarine faunal communities remained relatively stable and the Humber continues to be a very productive Estuary. In certain areas there was also a decrease in the accumulation of metals in sentinel species, such as ragworms, providing further evidence of general improvements in environmental quality.

Migratory salmon (*Salmo salar*) were sighted in the Wharfe, Ouse, Trent and Don catchments, but it is not known if salmon stocks were increasing in line with the water quality improvements noted during the decade.

Industries along the Estuary are now strictly regulated and more environmentally aware. They are installing more efficient treatment plants and employing manufacturing techniques which produce less waste. Sewage treatment works in the inland catchment are also improving and the implementation of the Urban Wastewater Treatment Directive (UWWTD) should require at least secondary treatment to be introduced for all major sewage discharges to the Humber. With this combined effort, the improvements in water quality between 1980 and 1990 are expected to continue through the present decade.

1.3 CATCHMENT MANAGEMENT PLANS

The majority of the Catchment Management Plans (CMPs) for the Humber and related rivers were published in 1995/96. The relevant CMPs include:

- Humber Estuary
- Hull and Coast
- Don, Rother and Dearne
- Derwent
- Swale, Ure and Ouse
- Nidd and Wharfe
- Grimsby
- Ancholme

With the formation of the Environment Agency in 1996, the scope of the NRA's CMPs was widened to take account of the integrated nature of the Agency. The CMPs will be replaced by Local Environment Action Plans (LEAPs) and will include issues relating to air quality and waste regulation. The Lower Trent LEAP is due for publication in 1998. So as to reduce the number of plans in the Humber area, the Environment Agency have agreed to incorporate its plans for the Humber in the Humber Estuary Management Strategy (HEMS) which was produced by a wide range of organisations working in partnership with one another.

SECTION 2 FRESHWATER FLOWS

2.1 INTRODUCTION

The major flows of freshwater into the Humber Estuary are from the Trent and Ouse Catchments. Minor components include the catchments of the Hull, Foulness, Mires Beck and the Ancholme.

The Ouse Catchment flows are derived mainly from the Rivers Don, Aire, Wharfe, Derwent and upper Ouse. The upper Ouse flows reflect the inputs from the Rivers Swale, Ure and Nidd which drain from North Yorkshire. Within the Ouse catchment the following flow measurement gauging stations are used:

River Don	Doncaster
River Aire	Beal
River Wharfe	Tadcaster
River Derwent	Buttercrambe
River Ouse	Skelton

There are also secondary flows to the Ouse catchment through the Don from the River Went at Walden Stubbs and through the Ouse from the River Foss in York.

The flows in the River Trent are measured at North Muskham where the gauging station has recently been improved.

Flows in the minor catchments are also measured. However, measurement of flow in the River Hull is problematic and, at present, flow data are not available.

There are a number of large abstractions on most principal rivers flowing to the Estuary. Water is abstracted, under licence from the Agency, for agricultural and industrial purposes as well as public water supply. The majority of abstracted water is returned to the river, although up to 40% may be lost by evaporative cooling at power stations such as Ferrybridge and Drax. Water is diverted from the River Aire at Beal and from the River Don at Long Sandall near Doncaster into the British Waterways Board's canal system. This diverted water re-enters the Estuary via Goole docks.

2.2 FRESHWATER FLOWS TO THE HUMBER IN 1995

The influence of the dry winter in 1994-95 can be seen in the rapid decline in flows during February (Figure 2.1). Flows remained low throughout the year and only showed a very small increase in the last few weeks of 1995.

Figure 2.1 Flows to the Humber in 1995

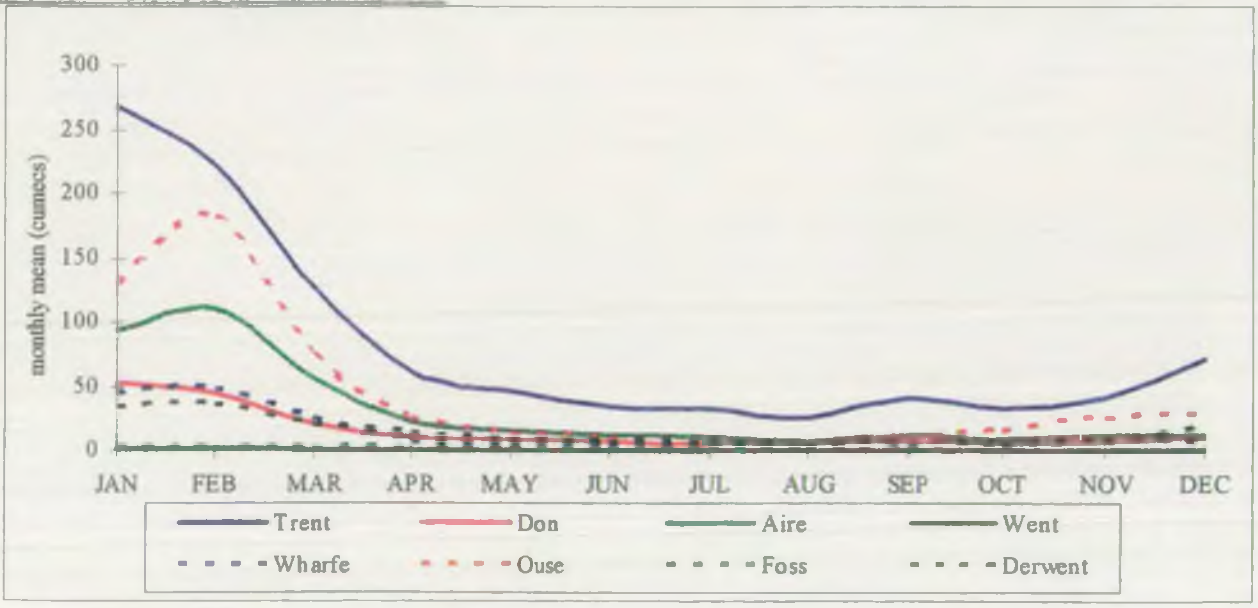


Figure 2.2 Contributions to the Flow of the Humber

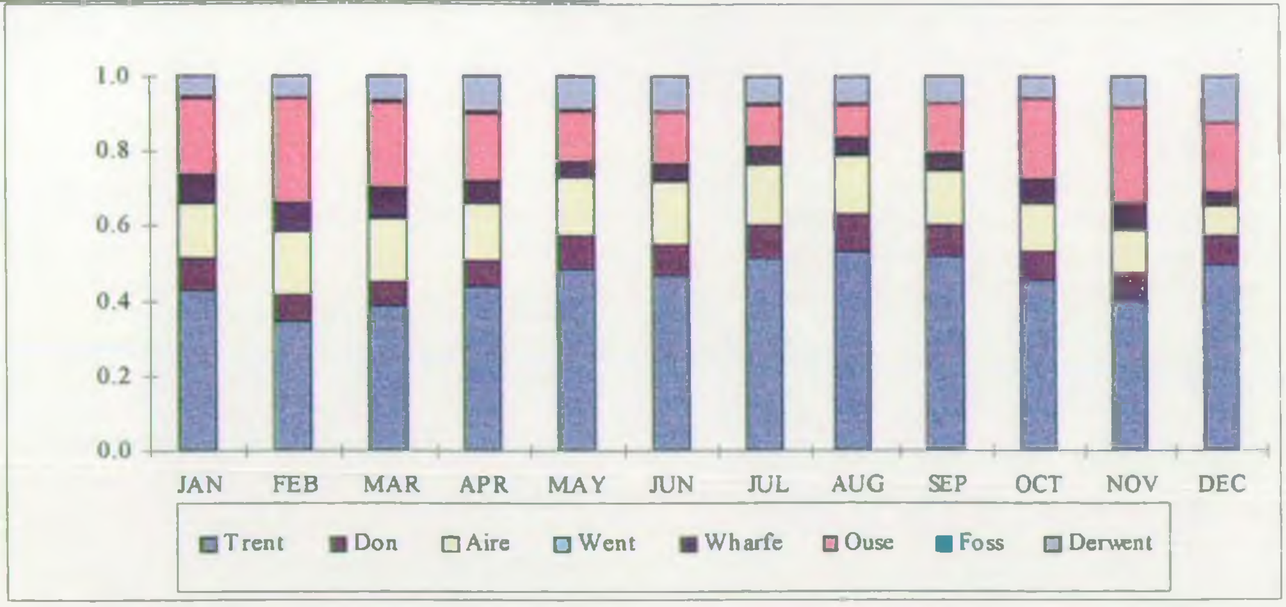


Figure 2.2 shows that the largest single contribution to freshwater flow comes from the River Trent. This is particularly so during summer months when the combined flow from other principal rivers (Don, Aire, Ouse) is of a similar magnitude. During winter months the contribution from the Ouse increases significantly and, in some storm events, can equal that of the Trent. (The data has been corrected for the two large public water supply abstractions on the Derwent).

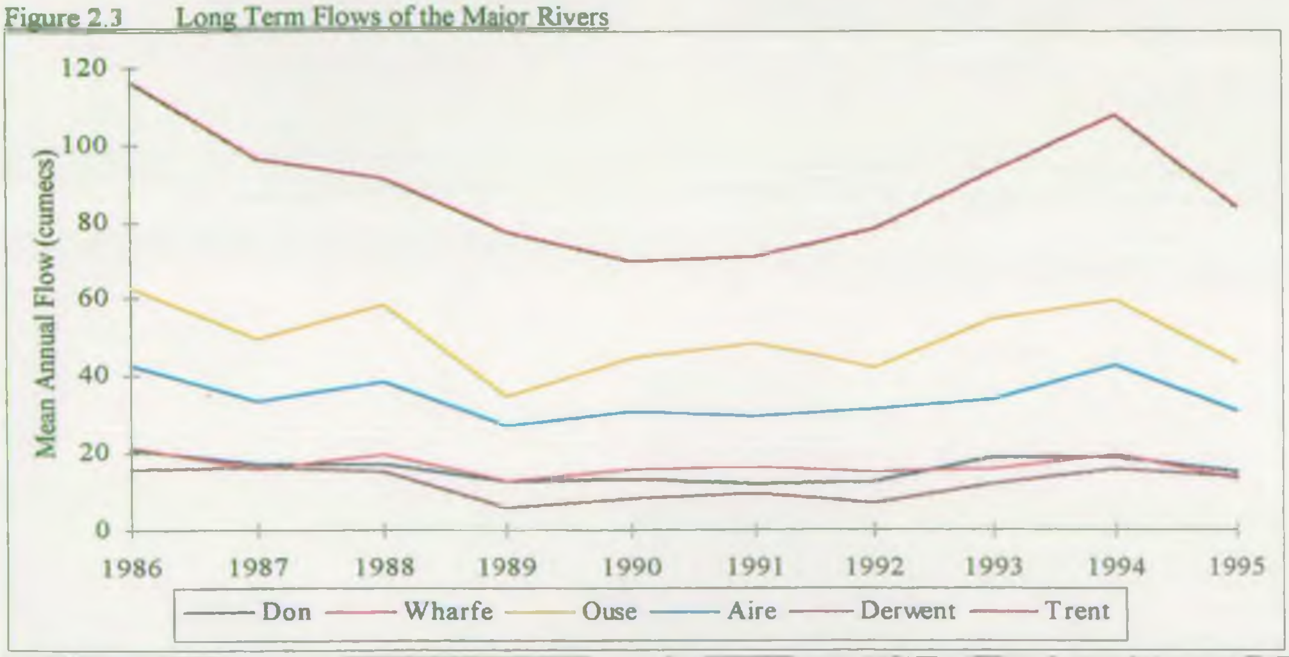
The Rivers Went and Foss are generally insignificant in their contribution to the Humber.

It is important to emphasise that these flows represent input to the Estuary and not the flow that might be measured within the Estuary. Tidal influences will tend to block freshwater flow at high tide and cause a flow surge at low tide. Within the Estuary, daily maximum flows following high spring tides may considerably exceed the freshwater inputs.

2.3 FRESHWATER INPUTS FROM THE TIDAL RIVERS 1986-1995

Historical records show that Yorkshire has been experiencing below average flows over the past decade with many areas having hosepipe bans during summer months. Flows were particularly low between 1989 and 1991 only beginning to increase again in 1992 and coming close to the long-term average in 1994 (see Figure 2.3). The relatively dry winter of 1994-95 reflected the beginning of another drought period and flows have fallen markedly during 1995.

Figure 2.3 Long Term Flows of the Major Rivers



SECTION 3 CHEMICAL QUALITY

3.1 INTRODUCTION

The chemical monitoring programme aims to measure the levels of metals, organic compounds, dissolved oxygen and other determinands in the tidal rivers and Estuary and those entering the system via effluent discharges. Water samples are collected from eleven sites along the five tidal rivers and six sites in the Estuary (Figure 3.1). The analytical results are compared to the relevant, Environmental Quality Standards (EQSs) (Appendix 1). These standards apply only to concentrations of substances in the water column since no EQSs have yet been set for sediments or biota.

Typical standards are:

- annual mean e.g. metals,
- percentiles e.g. dissolved oxygen, ammonia,
- ranges e.g. pH,
- maximum permitted levels e.g. endrin.

The annual mean is calculated using all the results obtained for the Humber Survey during the calendar year. In some cases, the chemical analysis may not detect a particular substance because its concentration in the sample is below the lowest limit that the current method of analysis can detect. This is called the 'limit of detection' (LOD). In such cases, a 'less than' (<) value is reported e.g. <0.05 μg /l where the LOD is 0.05 μg/l. In order to include these values in the calculation of the mean, the 'less than' figure is taken as half the face value. For instance, if the limit of detection for a particular substance is 1 μg/l, the true level of that substance in a sample which indicates 0 μg/l could be anywhere between 0 μg/l and 1 μg/l. Half the LOD in this case would be 0.5 μg/l, and this estimate would be used in the calculations. An alternative would be to calculate the mean taking the 'less than' figures as equal to zero and as equal to the LOD, thereby giving the lowest and highest means (see section 3.4.2).

Percentiles (%iles) are used where levels of substances compared to a particular value are of concern. The most commonly used are the 95 and 5 %iles. For example, the EQS for dissolved oxygen in tidal rivers is a 5 %ile of 40% saturation. This means that the dissolved oxygen level in the rivers should be at least 40% for 95% of the time (or not fall below 40% for more than 5% of the time).

Ranges are used for determinands such as pH, where both high and low levels can be harmful to aquatic life.

Maximum permitted levels, like some percentiles, are used where the concentration of a substance above a specific level is of concern.

Figure 3.1 The Humber Survey Chemical Monitoring Sites

3.2 CHEMICAL QUALITY OF TRIBUTARIES UPSTREAM OF THE TIDAL LIMITS

The 1995 results for biochemical oxygen demand (BOD), ammonia and unionised ammonia at the sites immediately upstream of the tidal limits of the Humber tributaries are compared to the 1994 results in Table 3.1. The apparent deterioration in water quality at some sites, especially in ammonia, may be a result of the reduced freshwater flows due to the drought.

Table 3.1 Freshwater Results 1995

STATION	BOD (ATU) mg/l				AMMONIA (mg/l - N)				UNIONISED AMMONIA (mg/l)			
	MEAN		95 %ile		MEAN		95 %ile		MEAN		95 %ile	
	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Ouse at Naburn	2.39	2.10	3.85	2.61	0.24	0.43	0.531	0.83	0.004	0.006	0.008	0.016
Wharfe at Tadcaster	1.60	2.07	1.96	3.00	0.08	0.10	0.136	0.16	0.002	0.001	0.004	0.001
Aire at Beal	5.77	4.67	10.88	6.61	0.97	1.41	1.685	2.18	0.040	0.007	0.125	0.012
Don at North Br	2.94	4.10	4.16	5.83	1.04	0.93	1.59	1.53	0.007	0.006	0.015	0.008
Trent at Dunham	2.29	2.50	3.35	3.70	0.00	0.23	0.0071	0.53	0.182	0.004	0.289	0.008
Derwent at Loftsome Br	1.41	1.66	2.09	2.04	0.07	0.09	0.125	0.16	0.001	0.001	0.003	0.002
Idle at Misterton	3.00	2.50	5.50	3.85	0.12	0.20	0.3265	0.64	0.002	0.003	0.004	0.008
Bottesford Beck at Snake Plantation	6.08	8.14	11.88	14.85	5.28	8.43	11.025	15.79	0.088	0.229	0.197	0.716
Three Rivers at Keadby	3.07	2.10	5.60	2.61	0.84	0.43	2.056	0.83	0.007	0.006	0.016	0.016
Hull at Drypool Br	1.87	2.16	2.54	3.38	0.37	0.38	0.65	1.18	0.007	0.003	0.0133	0.009

3.3 COMPLIANCE WITH EQSs IN TIDAL WATERS

Compliance with EQSs in the tidal reaches of the Humber Estuary are summarised in Table 3.2. More detail on compliance is shown in Appendix 2 (Tables A2.1 to A2.8).

Table 3.2 EQS Passes/Fails 1995

STATION	Temp	DO	pH	Amm	As	Hg	Cu	Cd	Cr	Ni	Pb	Zn	Fe	B	V	TCB	TCE	DCE	PER	PCP	CTC	HCH	Drins tot	End	DDT tot	DDT PP
TIDAL RIVERS																										
OUSE																										
Cawood	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Selby	Pass	FAIL	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	FAIL	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Drax	Pass	FAIL	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	FAIL	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Boothferry	Pass	FAIL	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Blacktoft	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	FAIL	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
AIRE																										
Snaith	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
DON																										
Kirk Bramwith	Pass	FAIL	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Rawcliffe	Pass	FAIL	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
TRENT																										
Gainsborough	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	*	Pass	Pass	Pass	Pass	Pass
Keadby	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	*	Pass	Pass	Pass	Pass	Pass
WHARFE																										
Ryther	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
ESTUARY																										
Brough	Pass	Pass	Pass	Pass	Pass	Pass	FAIL	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
New Holland	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	*	*	*	Pass	*	Pass	Pass	Pass	Pass	Pass
Albert Dock	Pass	Pass	Pass	Pass	Pass	Pass	FAIL	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Saltend	Pass	Pass	Pass	Pass	Pass	Pass	FAIL	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Killingholme	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	*	*	*	Pass	*	Pass	Pass	Pass	Pass	Pass
Spurn	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	*	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

* No data available

3.3.1 Temperature

The EQS for temperature was not exceeded at any site during 1995.

3.3.2 Dissolved Oxygen

Following improvements in 1993 and 1994, dissolved oxygen concentrations deteriorated in 1995 with five sites failing the EQS, probably as a result of the drought-induced low freshwater flows.

3.3.3 pH

All sites on both the tidal rivers and the Estuary complied with the pH EQS.

3.3.4 Unionised Ammonia

All sites complied with the ammonia EQS in 1995.

3.3.5 Metals

EQSs for metals are set as the annual average concentration of either the total or the dissolved fraction.

3.3.5.1 LIST I METALS

The List I metals, cadmium and mercury, are considered the most toxic due to their tendency to accumulate in living tissues and cause physiological harm. The EQSs for both are set for total metal in the tidal rivers and for dissolved metal in the Estuary.

All sites complied with the EQSs for both cadmium and mercury in 1995.

3.3.5.2 LIST II METALS

Arsenic levels during 1995 were generally similar to those of 1994 and all sites complied with the EQS.

Copper levels at all the tidal river sites complied with the EQS in 1995 with results generally similar to those of 1994. Only three Estuary sites failed in 1995, compared to all but one in the previous year. Work by the Water Research Centre (WRc 1990) has suggested that less than 1% of copper in saline water is in the non-complexed form and readily bio-available. Therefore the copper failures are not considered to be a serious concern.

Chromium levels on both the tidal rivers and the Estuary met the EQS in 1995 with some substantial decreases compared to 1994 at Blacktoft on the Ouse and at New Holland, Saltend and Killingholme on the Humber.

Nickel levels at most sites in 1995 were similar to those of 1994 and all sites complied with the EQS.

Lead levels at all sites complied with the EQS in 1995. Most sites had results similar to or lower than 1994 but there were significant increases at Blacktoft on the Ouse, Snaith on the Aire, and Albert Dock and Saltend on the Humber.

Zinc levels complied with the EQS at all sites in 1995. Most sites had results lower than in 1994, particularly at Snaith on the Aire and Keadby on the Trent, but results at Selby on the Ouse were significantly higher than in 1994.

Iron levels in 1995 were similar to those for 1994 at most sites but showed substantial decreases at all sites on the River Ouse. All sites complied with the EQS.

Boron levels in 1995 complied with the EQS at all but one site, Blacktoft on the Ouse. Results were similar to those of 1994.

Vanadium levels in 1995 were generally lower in the Estuary than and similar in the tidal rivers to 1994. Two sites on the Ouse failed the EQS: Selby and Drax.

3.3.6 Synthetic Organic Compounds

3.3.6.1 CHLORINATED SOLVENTS

The chlorinated solvents for which EQSs have been set in the Humber are:

trichlorobenzene (TCB)
trichloroethylene (TCE)
tetrachloroethylene (PER)
1,2,dichloroethane (DCE)
carbon tetrachloride (CTC).

Levels of all these chlorinated solvents were well below the relevant EQSs of 10 ug/l for TCB, TCE, DCE and PER and of 12 ug/l for CTC.

3.3.6.2 BIOCIDES

3.3.6.2 (a) HCH (Lindane & other isomers)

All sites, including the site of the previous year's failure (Snaith on the River Aire), showed decreases in the levels of hexachlorocyclohexane in 1995 and complied with the EQS.

3.3.6.2 (b) The 'drins

The 'drins include Isodrin, Dieldrin, Aldrin and Endrin. All sites in 1995 complied with the EQS for both total 'drins and Endrin (which has an individual EQS), and all the results were below the limit of detection.

3.3.6.2 (c) DDT (OP & PP)

EQSs are set for both total DDT (which includes the OP and PP isomers) and for the PP isomer alone. In both cases, all sites complied with the EQS and most of the results were below the limit of detection.

3.3.6.2 (d) PCP

All sites in 1995 were well below the EQS of 2ug/l for pentachlorophenol.

3.4 LOADS DISCHARGED TO THE HUMBER ESTUARY

3.4.1 Introduction

EQSs prescribe the maximum concentration of specific substances permitted in the water column, but information is also required on total quantities (i.e. 'loads') discharged to receiving waters. The advantage of a calculated load is that it estimates the amount of a substance entering a water body (and therefore available for deposition into sediment or release into the sea), rather than the concentration at any given point. This is particularly important for industrial effluents where effect may be related more to amount discharged rather than concentration. i.e. concentration may be high but have little impact because of low overall quantity.

Loads are calculated by multiplying the concentration of a given substance in an effluent or river by flow. Loads calculated for this report are those from major industrial and sewage discharges downstream of tidal limits and those entering the Humber via freshwater rivers. It must be noted that figures reported for rivers include loads from industrial and sewage discharges upstream of the tidal limits.

The Humber Estuary Report 1992 showed loads of metals such as mercury steadily decreasing over the last ten years, whereas the Contaminants Entering the Sea Report (1995) has shown them increasing. This discrepancy is a consequence of the way that results which are lower than the limit of detection (LOD) are used in the load calculations (see section 3.1).

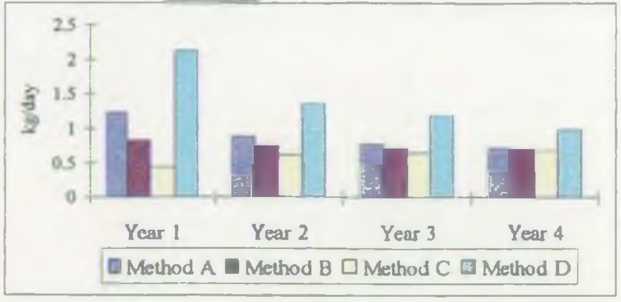
3.4.2 Effects of Different Methods of using LOD Data on Calculated Loads

LOD values can be treated in several ways when working out averages and percentiles:

A. ignore the 'less than' sign and assume the substance to be present at the LOD (often called a 'high load'),
B. divide the LOD by two and use this value in the calculation,
C. assume all 'less than' values to be zero (often called a low load),
D. ignore the 'less than' values and calculate the load using only real values (i.e. a smaller sample is used).

Figure 3.2 shows the results of load calculations on a four-year fictional data set using each of the four methods outlined above. Over the four years the loads almost halve with methods A and D, decrease slightly with method B , and nearly double with method C.

Figure 3.2 Loads Calculated using Four Different Methods



3.4.3 Interpreting Load Data

The example above shows the difficulties in interpreting loads where there are a significant number of 'less than' values in the data set. Loads of BOD, ammonia and TON are much less affected by this mathematical artefact since they are rarely present at levels lower than the LOD. On the test data set, method B (including 'less than' values at half the LOD) provides the most stable result. This is the method generally used when calculating means for EQS compliance and is the method used elsewhere in this report (see section 3.1). However, this does not solve the problem of assessing whether or not metal loads are decreasing. From the measurements of concentration in the water column they seem to be decreasing, but this is not the method used by the Paris Commission in assessing the levels discharged to the North Sea.

The only conclusion to draw from the load data is that, as the 'high' and 'low' load calculations converge with improvements in the LOD, we are closer to measuring the real situation. This should result in easier, and better, comparisons over the next ten years.

Since previous Humber Estuary Reports have used method B (including 'less than' values at half the LOD), this is the preferred method for reporting the 1995 data and comparison with the five-year mean (Figure 3.3a - 3.3l). The Parcom/A1A data are presented using methods A and C (thereby giving the 'high' and 'low loads') for completeness (Figure 3.4a -3.4h)[1] and to allow comparison with the North Sea reports. The differences which appear in the two sets of graphs are mainly due to the fact that the sites used in the Humber Routine Survey Programme are not identical to those used in the Parcom/A1A programme (see Appendix 3). Furthermore, sampling for Parcom/A1A is more frequent than the Humber Survey, and this may contribute to the differences.

[1] No graph is provided for 'high' and 'low' loads of iron since it is not included in the Parcom/A1A programme.

3.4.4 Cadmium and Mercury

The loads of these two List I metals from all three sources (section 3.4.1) in 1995 were well below the five-year mean (Figures 3.3a & 3.3b). The greatest differences in the cadmium loads were from the tidal rivers at one quarter and industry at less than one twenty-fifth of their respective five-year means (figure 3.3a). These changes continued the decreases reported for 1994 (Environment Agency, 1997). There was also a substantial difference in the mercury load from the tidal rivers, which was one fifth of the five-year mean (Figure 3.3b).

Figure 3.4a shows that the calculated 'high' and 'low' loads for cadmium are almost identical because very few 'less than' values were reported, whereas there is a significant difference between the 'high' and 'low' loads for mercury in tidal rivers and sewage effluents - where many of values were reported as 'less thans' (Figure 3.4b). For both these metals, a very large proportion of the total loads to the North Sea entered the Humber from the tidal rivers.

3.4.5 Other Metals

In 1995, the loads of other metals from all three sources were lower than the five-year mean, particularly those from the tidal rivers. The exception was the zinc load from industry (Figure 3.3h). Points of particular interest are discussed below.

Arsenic loads in 1995 were substantially lower than the five-year mean (Figure 3.3c), although the rivers load showed an increase on 1994. The decreases in effluent loads were particularly large: sewage loads were one-thirtieth and trade loads were 1/250th of the respective five-year means. The huge decrease in the trade effluent load is primarily due to the closure of Capper Pass.

Copper loads in 1995 from the tidal rivers, sewage and industry were one-third, one-half and one-sixth of the five-year means respectively (Figure 3.3d), although the industrial effluent load had increased from the 19 kg/day reported for 1994 to 37 kg/day in 1995.

Chromium loads from industrial effluents was much lower in 1995 at one-fifth of the five-year mean (Figure 3.3e), although it had increased slightly from the 1994 load of 96 kg/day (Environment Agency, 1997). No chromium data were available for 1995 for the two major sewage discharges to the Humber (Hull East and Hull West). Since sewage, and in particular the two Hull outfalls, is a major source of chromium in the Estuary, the lack of this data has a large impact on the total chromium load from sewage and makes it impossible to comment on the 1995 situation.

Nickel loads from tidal rivers continued to decrease in 1995 to less than a quarter of the five-year mean (Figure 3.3f).

Lead load from tidal rivers decreased in 1995 to one-third of the five-year mean (Figure 3.3g), continuing the decrease from the very high loads reported for 1993 (HEC, 1995).

Zinc load from tidal rivers in 1995 was one-third of the five-year mean (Figure 3.3h). The load from industrial effluents was the only example exceeding the five-year mean, although by only a small amount.

Iron loads were not reported prior to 1993, therefore calculation of the five-year mean is not possible. In 1995, however, the highest load by far was from industrial effluents with a negligable contribution from sewage discharges (Figure 3.3i).

It is notable that for most metals (cadmium, mercury, arsenic, copper, nickel and lead) the greatest loads entered the Humber system via the freshwater rivers. The highest loads of chromium would be expected to arise from sewage discharges, followed closely by industrial discharges - but this cannot be illustrated for 1995 because of missing data from the two largest sewage discharges to the Estuary. The highest zinc and iron loads arose from industry.

Figures 3.4c - 3.4h show the 'high' and 'low' loads of metals in the tidal rivers, sewage and industrial effluents calculated from Annex 1A and Parcom data, for comparison with the Contaminants Entering the Sea Report. In most cases, there was little or no difference between the 'high' and 'low' loads of metals since most of the results for 1995 were above the limit of detection. The exceptions were mercury and chromium loads from the tidal rivers (Figure 3.4b & e) where some of the results were below the limit of detection. The tidal rivers were by far the largest contributors to the total loads of arsenic, copper, nickel and lead entering the Humber. For chromium and zinc, industrial effluents provided about two-thirds of the total loads with the tidal rivers contributing another third, and the contribution from sewage effluent being negligible.

Figure 3.3a Cadmium Loads to the Humber

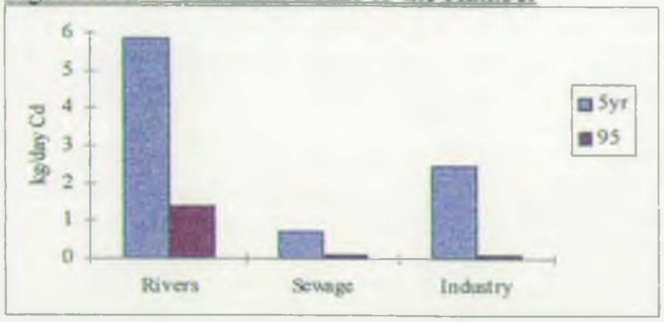


Figure 3.3b Mercury Loads to the Humber

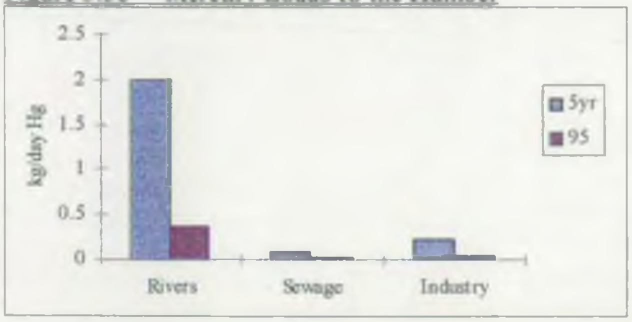


Figure 3.3c Arsenic Loads to the Humber

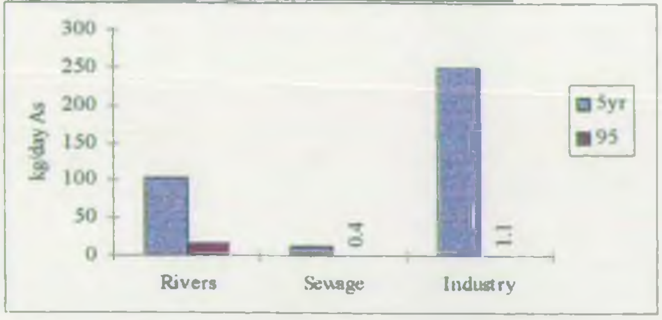


Figure 3.3d Copper Loads to the Humber

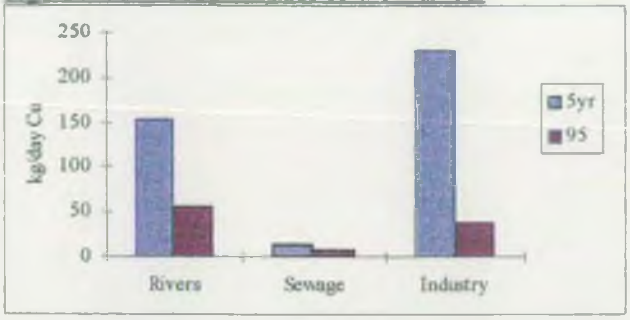


Figure 3.3e Chromium Loads to the Humber

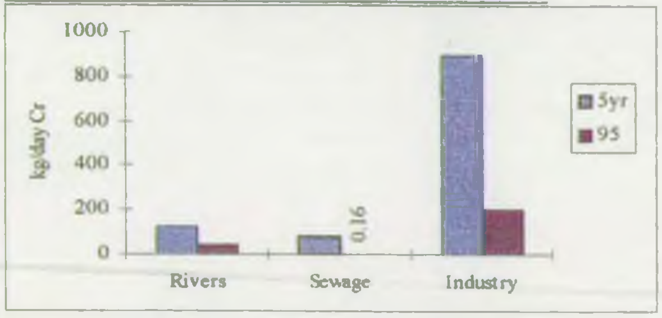


Figure 3.3f Nickel Loads to the Humber

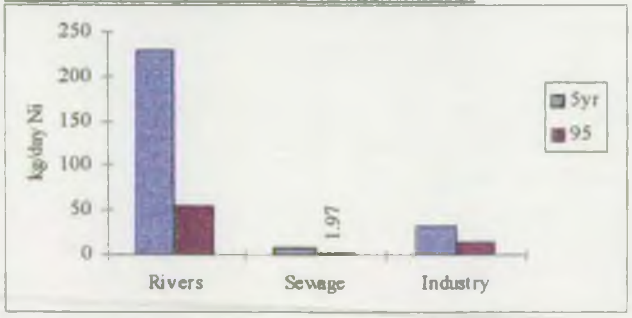


Figure 3.3g Lead Loads to the Humber

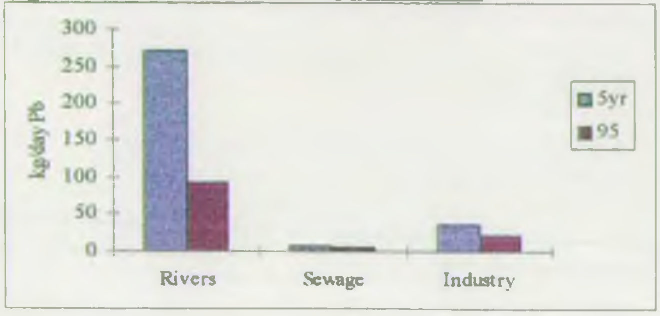


Figure 3.3h Zinc Loads to the Humber

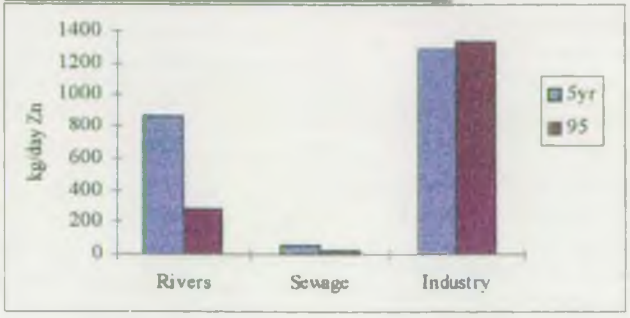


Figure 3.3i Iron Loads to the Humber

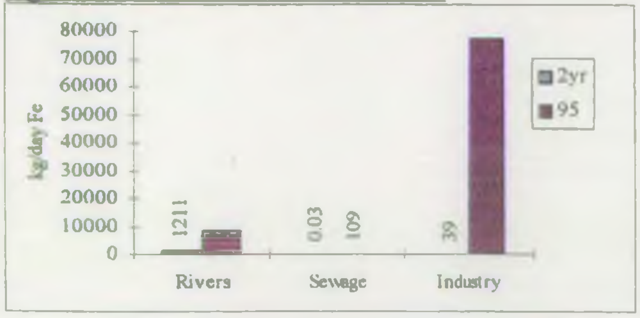


Figure 3.4a High and Low Loads of Cadmium

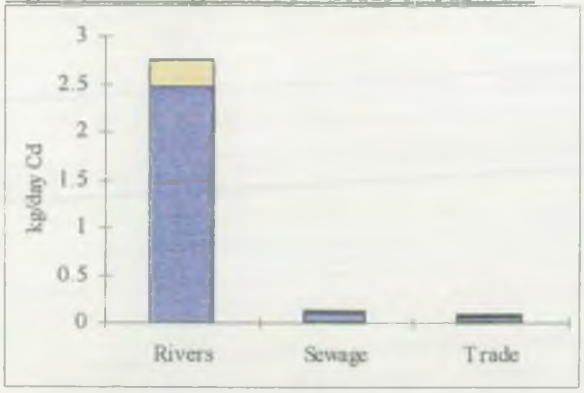


Figure 3.4b High and Low Loads of Mercury

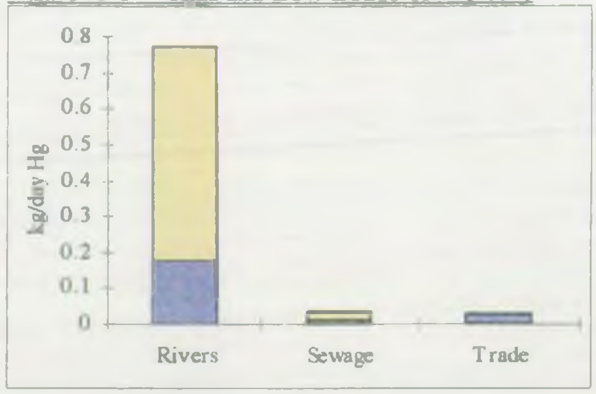


Figure 3.4c High and Low Loads of Arsenic

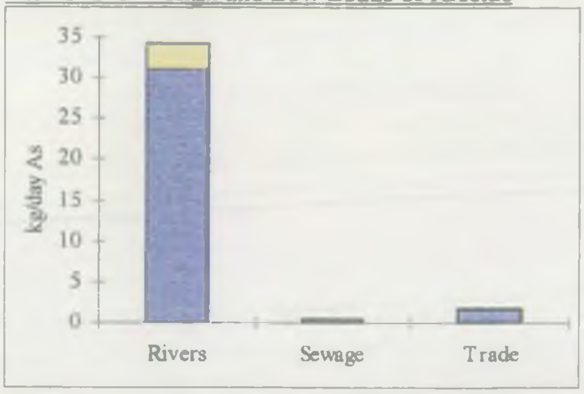


Figure 3.4d High and Low Loads of Copper

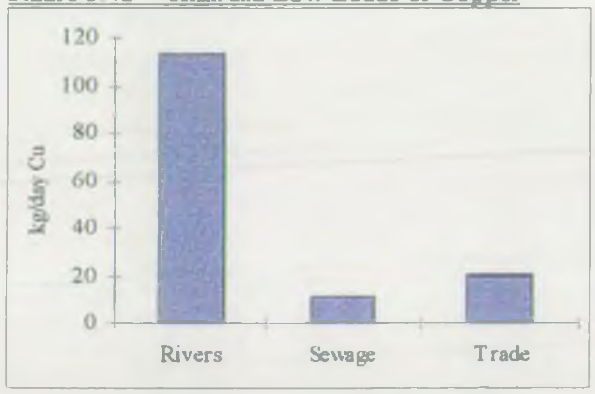


Figure 3.4e High and Low Loads of Chromium

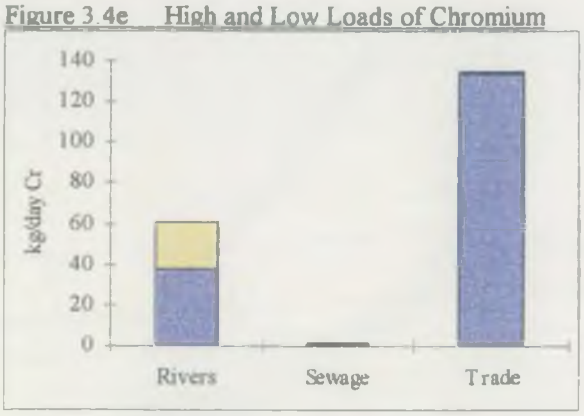


Figure 3.4f High and Low Loads of Nickel

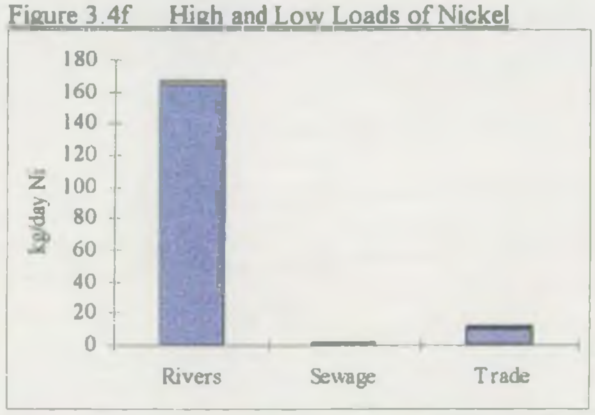


Figure 3.4g High and Low Loads of Lead

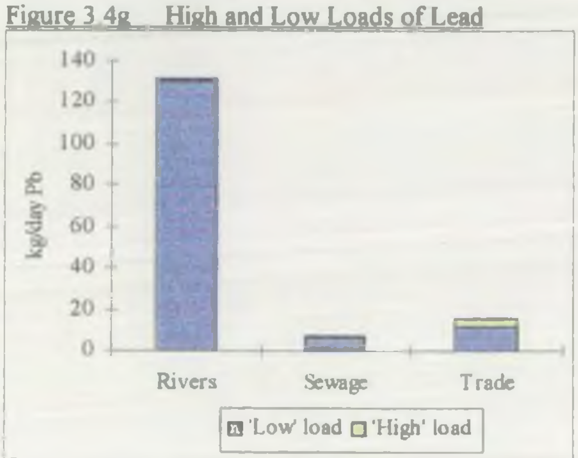
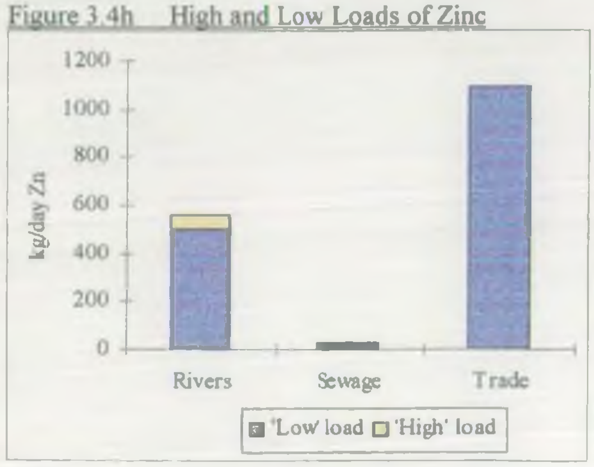


Figure 3.4h High and Low Loads of Zinc



3.5 METALS IN TIDAL RIVER SEDIMENTS

Sediments are collected bi-annually from seven sites on tidal rivers (Figure 3.5). In general, concentrations of metals in tidal river sediments in 1995 were lower than the five-year mean (1990 - 1994). The few sites where the 1995 results exceeded the five-year mean are consistent with the downstream migration of historically contaminated sediments (suggested as the cause of the elevated metal levels reported in 1993). Data were not available to allow the calculation of the five-year mean at site TR7.

Arsenic concentrations in 1995 were below the five-year mean except at TR5 as shown in Figure 3.6a

Mercury levels in 1995 were generally lower than the five-year mean except at TR3 and TR5 (Figure 3.6b). The 1995 results from sites TR1 and TR6 were substantially lower than the five-year mean, continuing the trend noted in the previous year when concentrations fell following peaks in 1993.

Copper concentrations in 1995 were lower than the five-year mean at all sites except TR2 (Figure 3.6c).

Cadmium concentrations were lower than the five-year mean at all sites in 1995 (Figure 3.6d) continuing the trend noted in 1994.

Chromium concentrations in 1995 were higher than the five-year mean at all but sites TR1 and TR3 (Figure 3.6e).

Nickel concentrations in 1995 were lower than the five-year mean at all except site TR5 where the 1995 level was fractionally higher than the five-year mean (Figure 3.6f).

Lead concentrations in 1995 were lower than the five-year mean except at sites TR2 and TR6 (Figure 3.6g). At site TR1, the trend noted in 1994 continued in 1995 with levels substantially lower than the five-year mean.

Zinc concentrations in 1995 were lower than the five-year mean except at site TR2 (Figure 3.6h).

Iron concentrations in 1995 slightly exceeded the five-year mean at site TR5 but were lower at the remaining sites (Figure 3.6i).

Figure 3.5 The Humber Survey Tidal River Sediment Sites

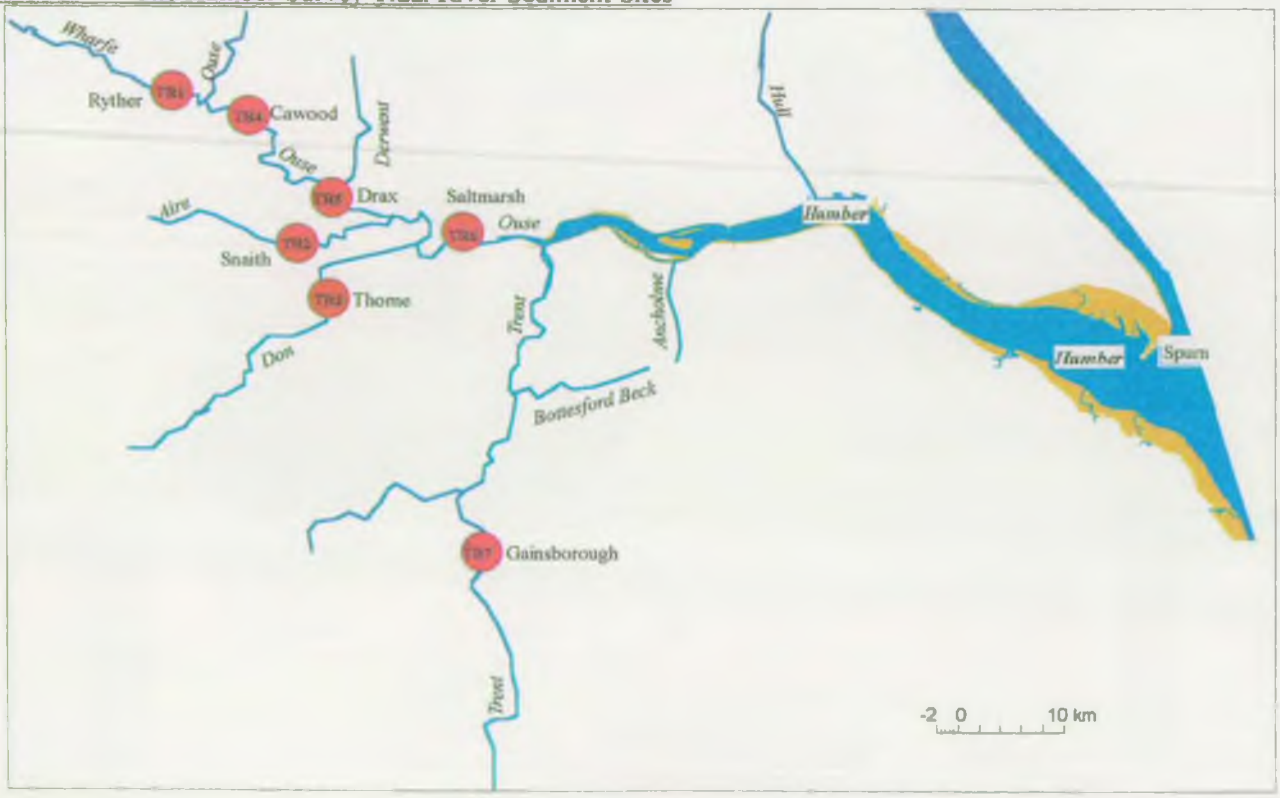


Figure 3.6a Arsenic in Tidal River Sediments

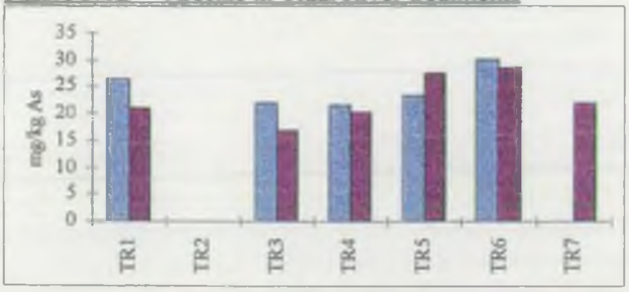


Figure 3.6b Mercury in Tidal River Sediments

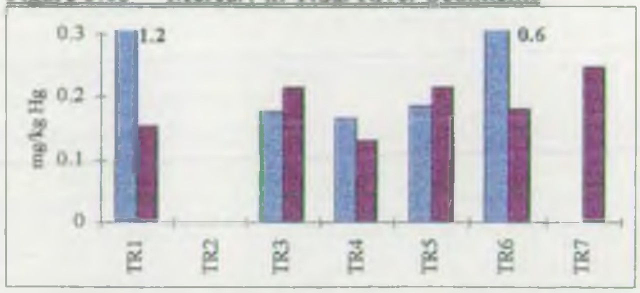


Figure 3.6c Copper in Tidal River Sediments

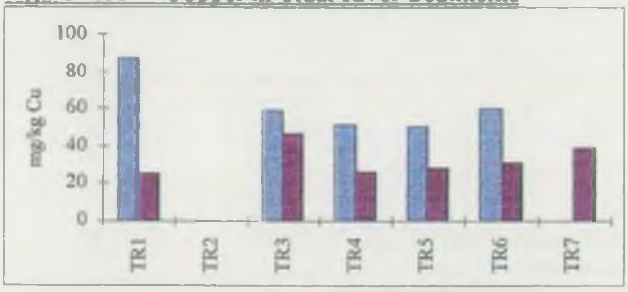


Figure 3.6d Cadmium in Tidal River Sediments

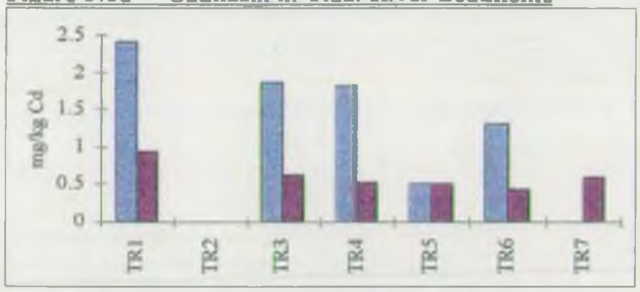


Figure 3.6e Chromium in Tidal River Sediments

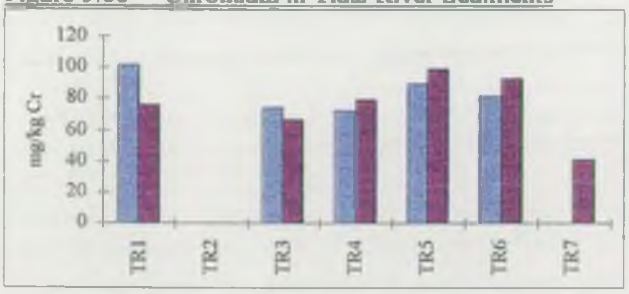


Figure 3.6f Nickel in Tidal River Sediments

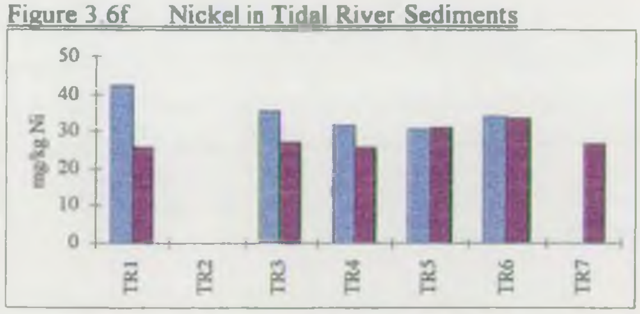


Figure 3.6g Lead in Tidal River Sediments

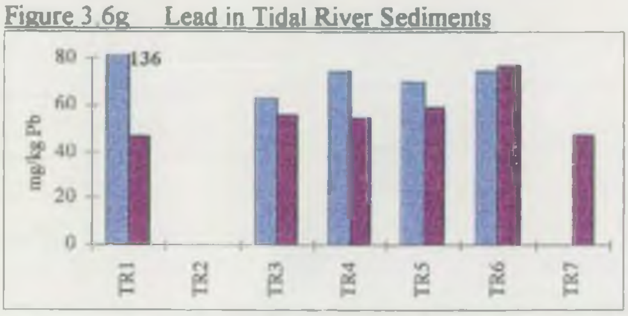


Figure 3.6h Zinc in Tidal River Sediments

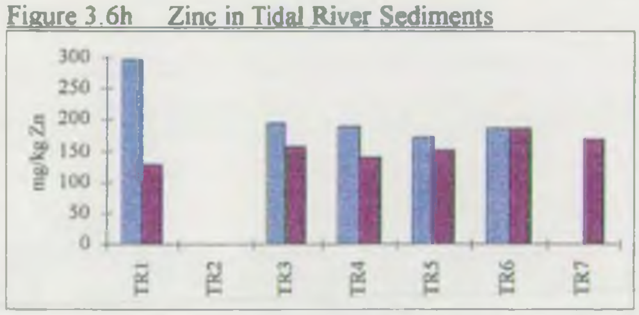
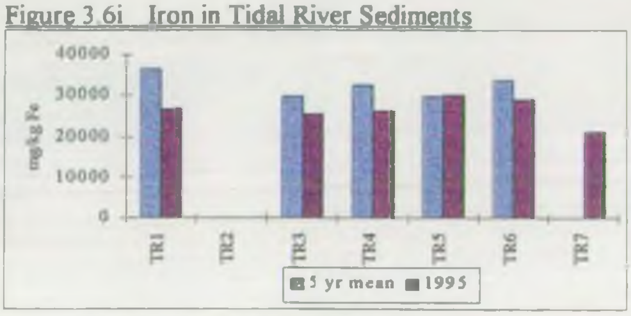


Figure 3.6i Iron in Tidal River Sediments



3.6 METALS IN INTERTIDAL ESTUARY SEDIMENTS

Sediments are collected bi-annually from twenty sites in the Estuary (Figure 3.7). No data were available in 1995 for three South Bank sites (S8, S9, and S10). At the remaining sites, the concentration of some metals in sediments decreased while others increased compared to the previous year but most sites still had metal concentrations lower than the five-year mean (1990 - 1994). On the North Bank, the results for chromium and and iron were higher than the South Bank and copper was slightly higher, while the South Bank returned slightly higher results for zinc.

Arsenic concentrations in 1995 were below the five-year mean except for a negligible increase at site N7 (Figure 3.8a).

Mercury concentrations in 1995 were generally lower than the five-year mean except for slight increases at sites N6 and N8, and a more substantial increase at site N7 (Figure 3.8b). Overall, concentrations on both banks of the Estuary were similar.

Copper concentrations in 1995 were lower than the five-year mean at all sites except for slight increases at sites N6 and N7 (Figure 3.8c). As in the previous year, results from the North Bank remained slightly higher than those from the South Bank.

Cadmium concentrations in 1995 were below the five-year mean except at sites N7 and N8, which were slightly higher (Figure 3.8d). The results for both banks of the Estuary were similar.

Chromium concentrations on the North Bank in 1995 were higher than the five-year mean except at sites N5 and N10, while on the South Bank all sites were below the five-year mean (Figure 3.8e). Consequently, the North Bank results were higher than the South Bank.

Nickel concentrations in 1995 were slightly higher than the five-year mean at most of the North Bank sites (with most sites showing a slight increase on the previous year) but lower at all the South Bank sites (Figure 3.8f). In general, the South Bank results were slightly lower than those from the North Bank.

Lead concentrations in 1995 were higher than the five-year mean at most North Bank sites but lower elsewhere (Figure 3.8g). Overall, the levels on both banks of the Estuary were similar.

Zinc concentrations in 1995 were generally lower than the five-year mean, particularly on the South Bank (Figure 3.8h). The highest levels were on the South Bank near the main inputs.

Iron concentrations in 1995 exceeded the five-year mean to some degree at all North Bank sites, especially in the upper part of the Estuary (Figure 3.8i). In contrast, there were no exceedences on the South Bank as a consequence of historically higher five-year means and generally lower levels on the South Bank.

Figure 3.7 The Humber Survey Intertidal Sediment Sites

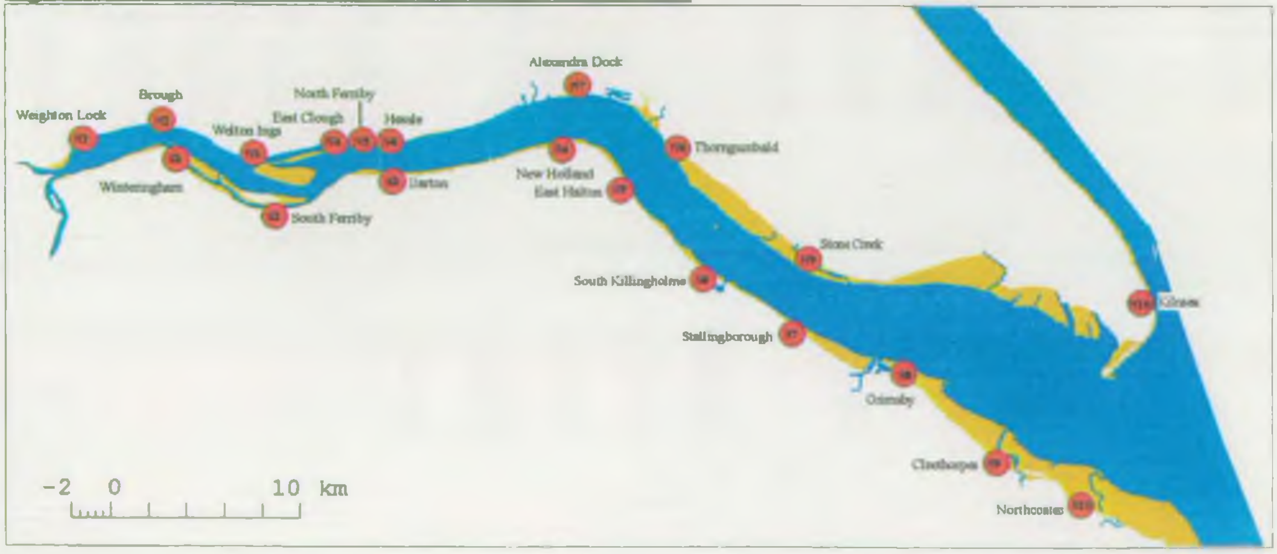


Figure 3.8a Arsenic in Intertidal Estuary Sediments

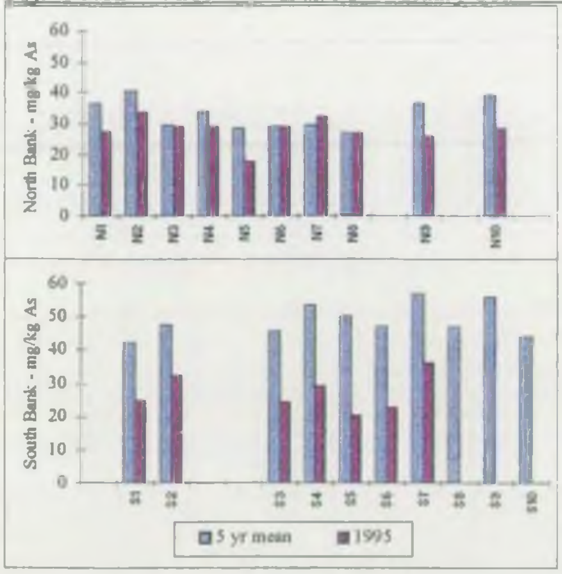


Figure 3.8b Mercury in Intertidal Estuary Sediments

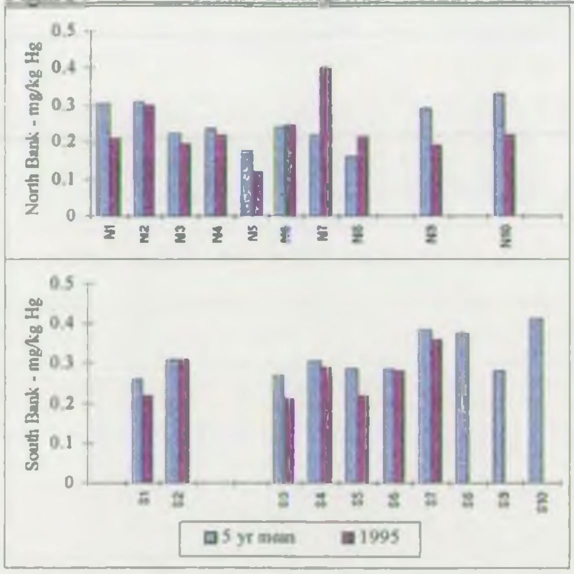


Figure 3.8c Copper in Intertidal Estuary Sediments

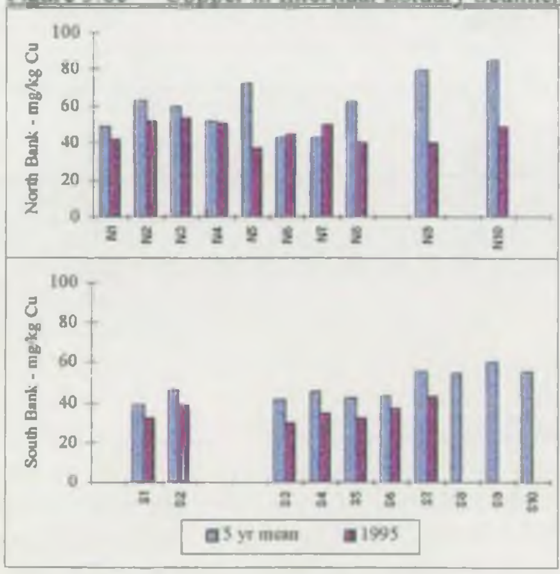


Figure 3.8d Cadmium in Intertidal Estuary Sediments

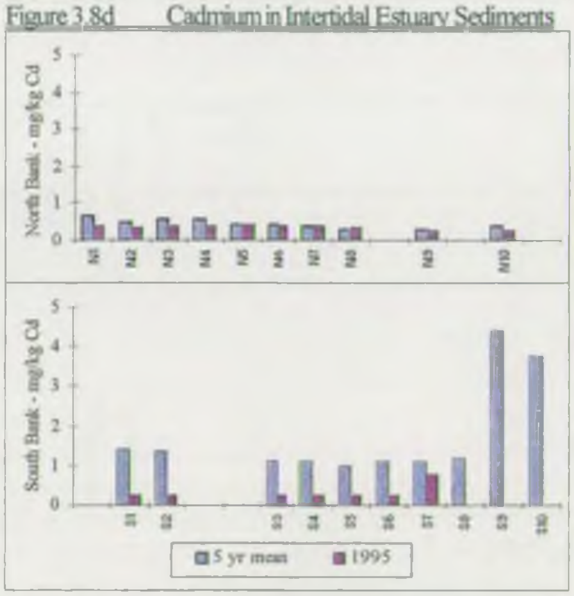


Figure 3.8e Chromium in Intertidal Estuary Sediments

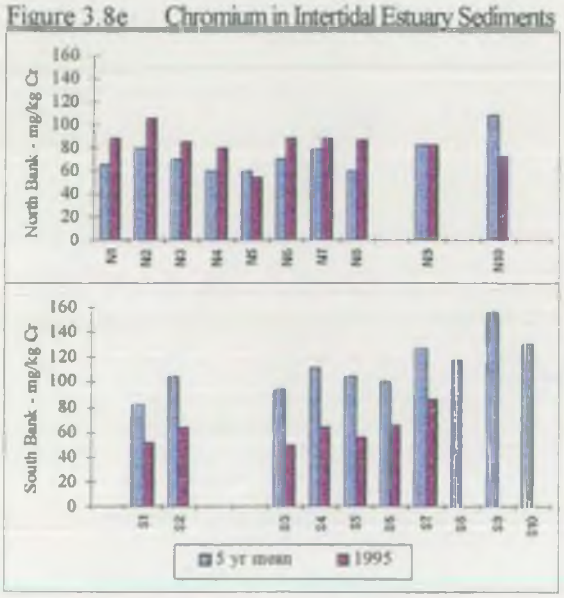


Figure 3.8f Nickel in Intertidal Estuary Sediments

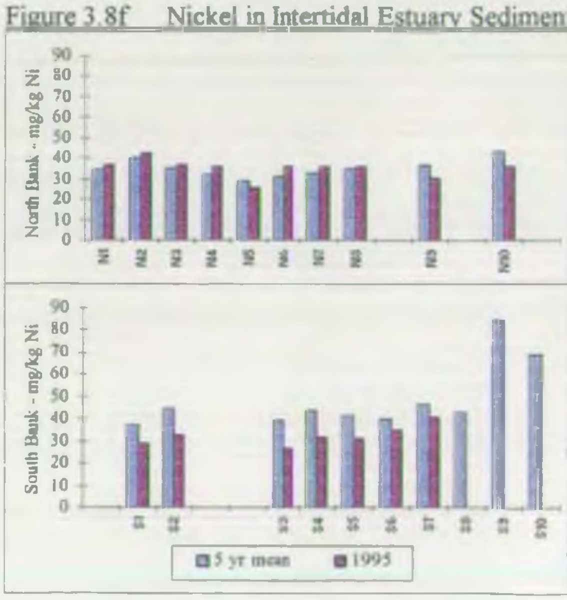


Figure 3.8g Lead in Intertidal Estuary Sediments

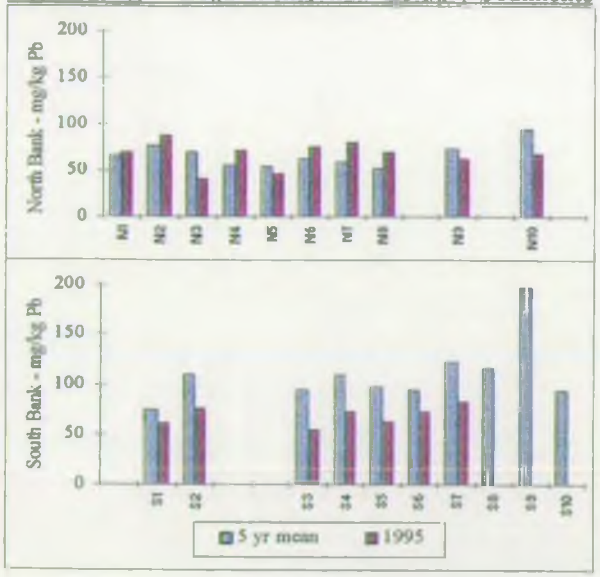


Figure 3.8h Zinc in Intertidal Estuary Sediments

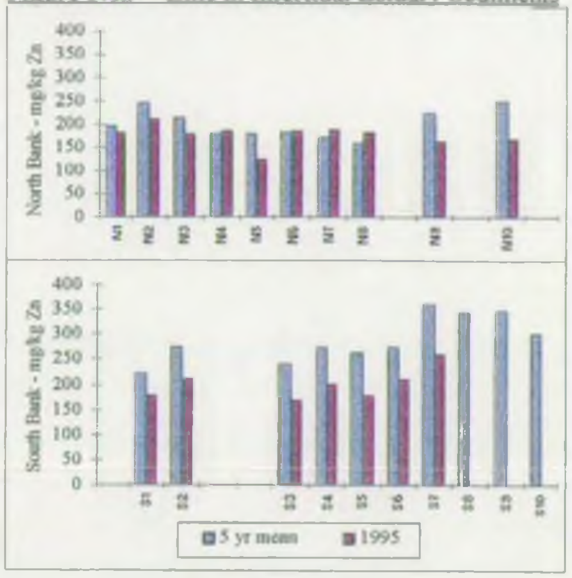


Figure 3.8i Iron in Intertidal Estuary Sediments

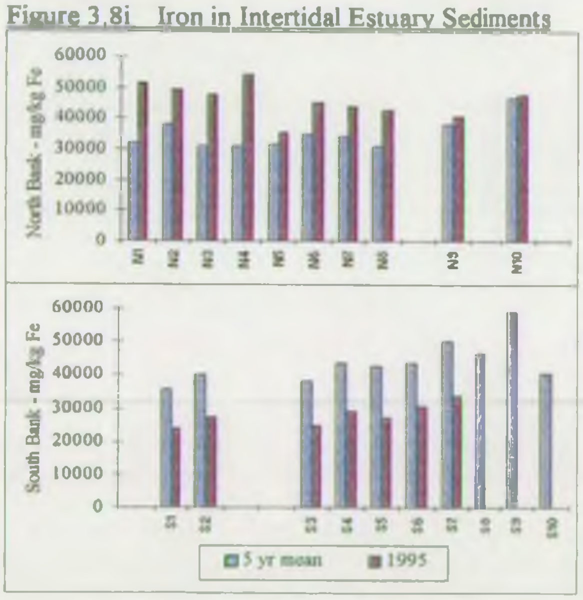
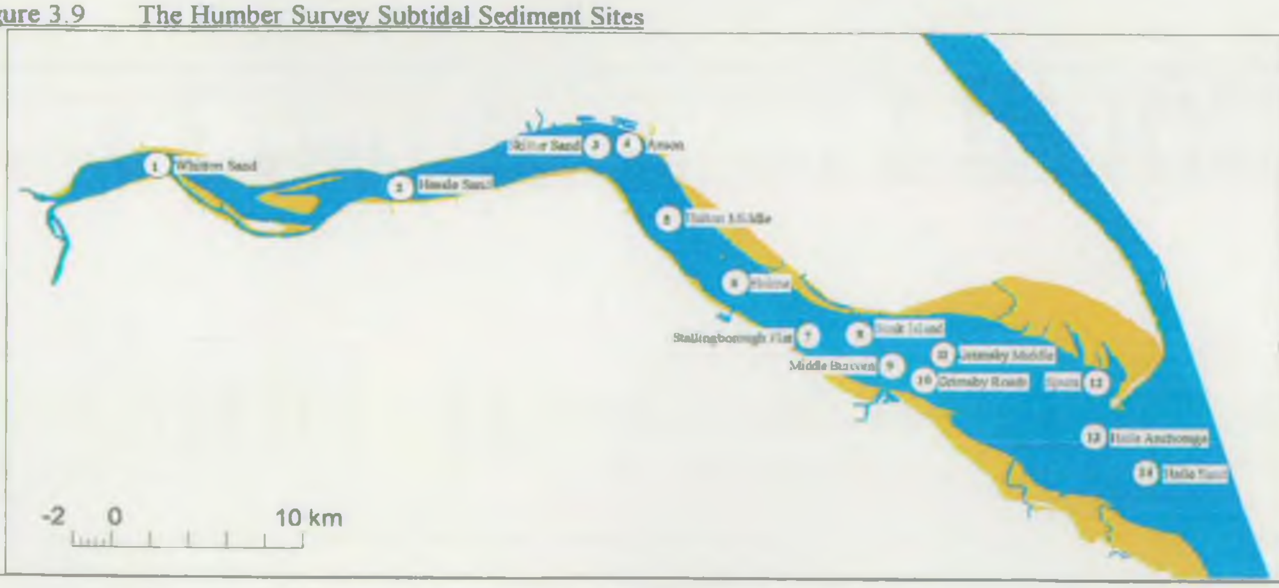


Figure 3.9 The Humber Survey Subtidal Sediment Sites



3.7 METALS IN SUBTIDAL SEDIMENTS

Fourteen subtidal sites on the Humber are sampled annually for metals and organics in the sediments (see Figure 3.9). The metals results for 1995 are shown in Figures 3.10a-h. Most cadmium results were less than the LOD in 1995 and are therefore not illustrated. All the 1995 results were below the five-year mean except at two sites: ST7 (arsenic, mercury and iron) and ST14 (arsenic and mercury). This appears to be an improvement on the previous year when these two sites plus another (ST6) yielded results higher than the five-year mean for most metals. The explanation for the 1994 results was that the continued accumulation of metals at these three sites could be the result of deposition of dredge-spoil in the area combined with the effect of sediment mobility and mudbank accretion.

Figure 3.10a Arsenic in Subtidal Sediments

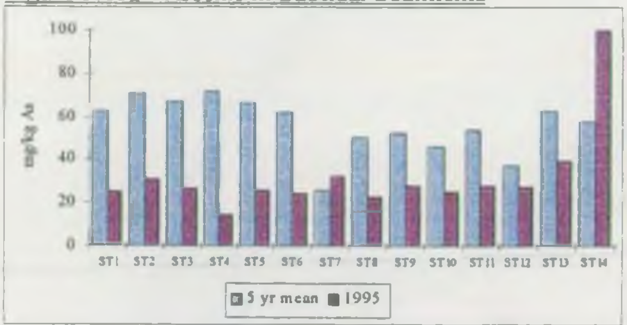


Figure 3.10b Mercury in Subtidal Sediments

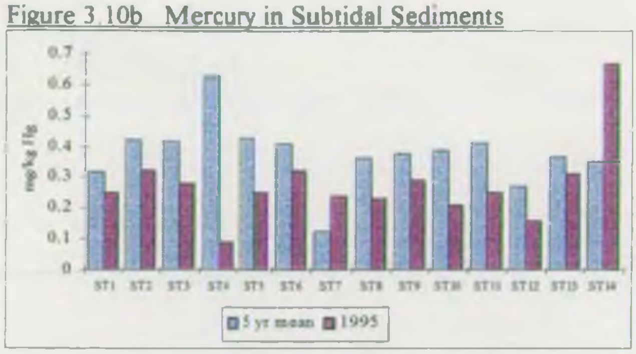


Figure 3.10c Copper in Subtidal Sediments

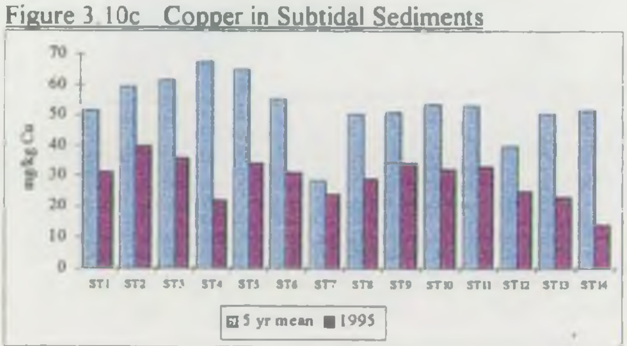


Figure 3.10d Chromium in Subtidal Sediments

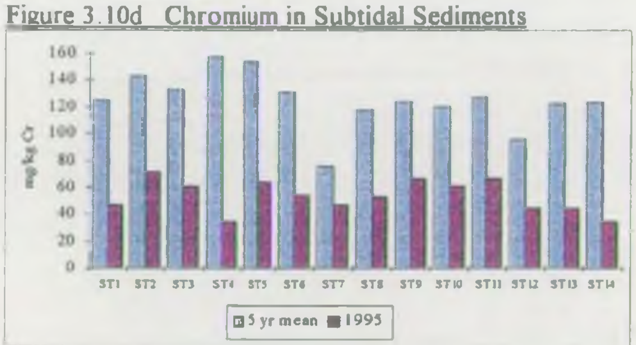


Figure 3.10e Nickel in Subtidal Sediments

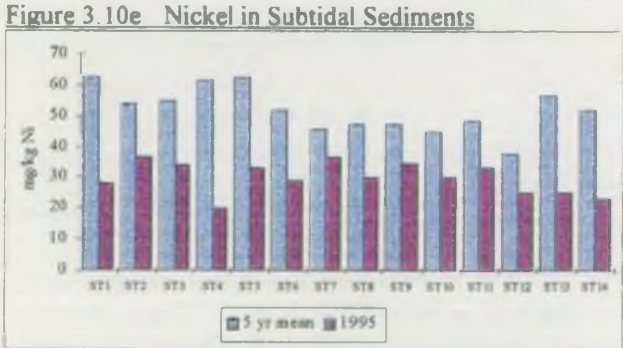


Figure 3.10f Lead in Subtidal Sediments

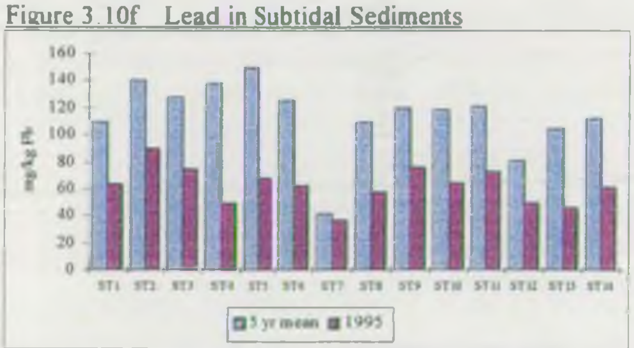


Figure 3.10g Zinc in Subtidal Sediments

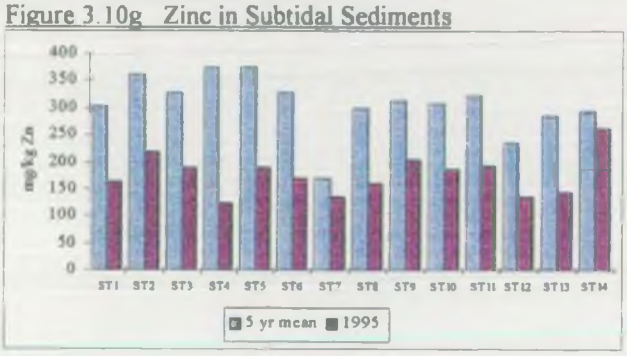
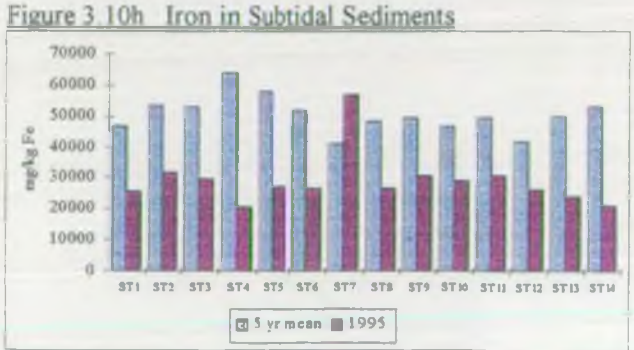


Figure 3.10h Iron in Subtidal Sediments



3.8 BIOACCUMULATION IN ESTUARY ORGANISMS

The concentration of certain substances accumulated by some aquatic organisms provides a longer-term view of the chemical quality of the Estuary. Many invertebrates and flora are exposed to potential contaminants either continuously or for a large proportion of their lives, and tend to accumulate certain substances within their tissues. Analysis of these tissues can help to assess the quality of the water column over a longer-time period. There are twenty-one shore-based and three subtidal sites in the Estuary where organisms are collected for tissue bioaccumulation sampling (Figure 3.11).

Figure 3.11 The Humber Survey Bioaccumulation Sites

3.8.1 Bioaccumulation in Ragworms

Samples of *Nereis diversicolor* are collected annually and analysed for metals and organic substances[2]. Results for organic compounds in 1995 were all below the LOD and are, therefore, not included in this discussion. A number of metals results were also reported as 'less than' values especially for chromium and lead which are, therefore, not illustrated. Results for the remaining metals are illustrated in Figures 3.12a-g including those for nickel on the North Bank which were all below the limit of detection. Some differences between the North and South Bank results appear to be caused by different analytical methods employed.

Arsenic concentrations in 1995 were higher than the five-year mean at the North Bank sites but lower on the South Bank (Figure 3.12a).

Mercury concentrations in 1995 were lower than the five-year mean at about half the sites on each bank (Figure 3.12b).

Copper concentrations in 1995 were lower than the five-year mean at just over half the sites on each bank (Figure 3.12c).

Cadmium concentrations in 1995 were lower than the five-year mean at most North Bank sites but higher at most South Bank sites (Figure 3.12d) - a pattern similar to that of the previous year.

Nickel concentrations in 1995 were higher than the five-year mean at most South Bank sites (Figure 3.12e). All North Bank results were below the limit of detection.

Zinc concentrations in 1995 were lower than the five-year mean at half the North Bank sites but higher at most of the South Bank sites (Figure 3.12f).

Iron concentrations in 1995 were lower than the five-year mean at half the sites on both banks, especially site N6, but slightly higher at the others (Figure 3.12 g). No iron results were available for site S11 in 1995.

[2] Dieldrin, HCH gamma and DDT (PP).

Figure 3.12a Arsenic in *Nereis*

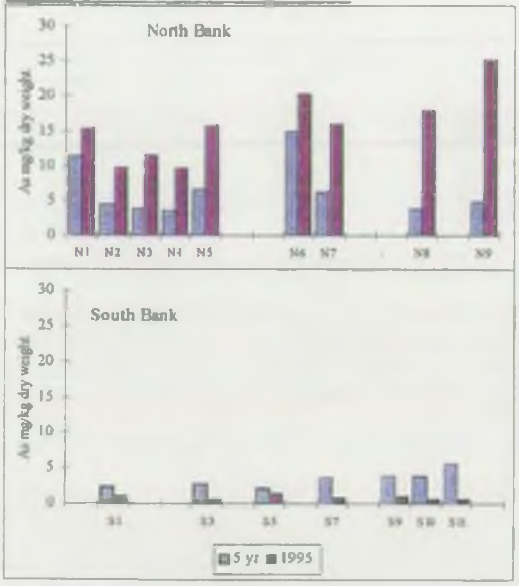


Figure 3.12b Mercury in *Nereis*

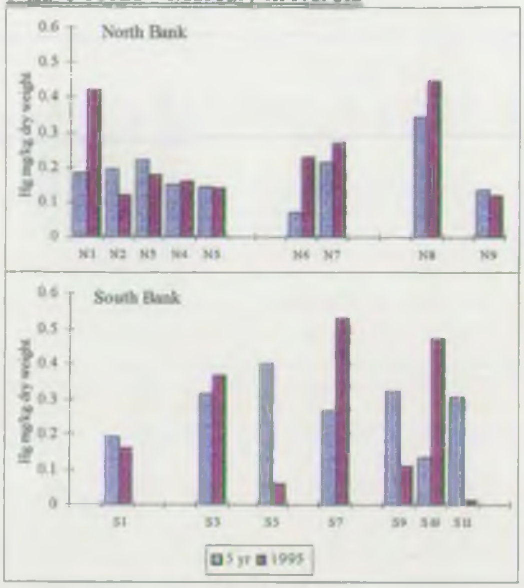


Figure 3.12c Copper in *Nereis*

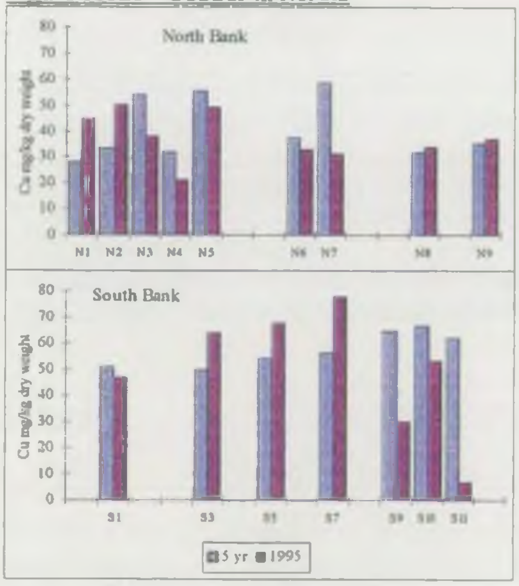


Figure 3.12d Cadmium in *Nereis*

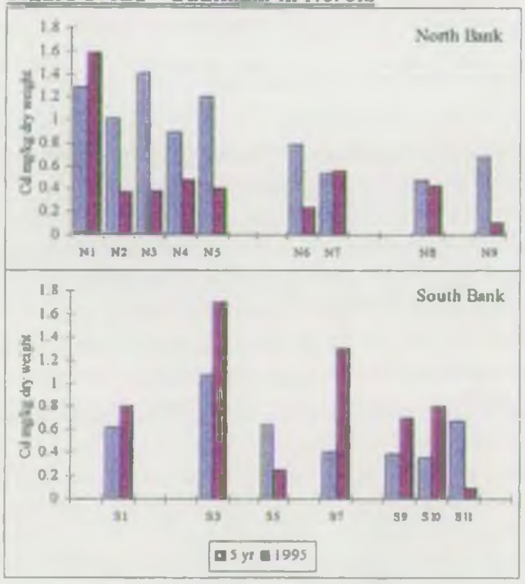


Figure 3.12e Nickel in *Nereis*

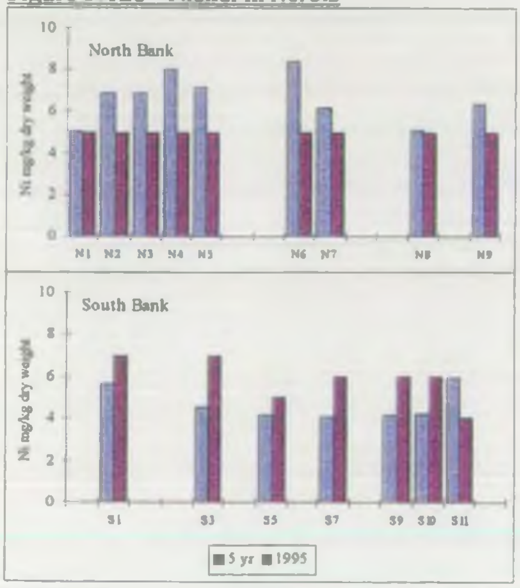


Figure 3.12f Zinc in *Nereis*

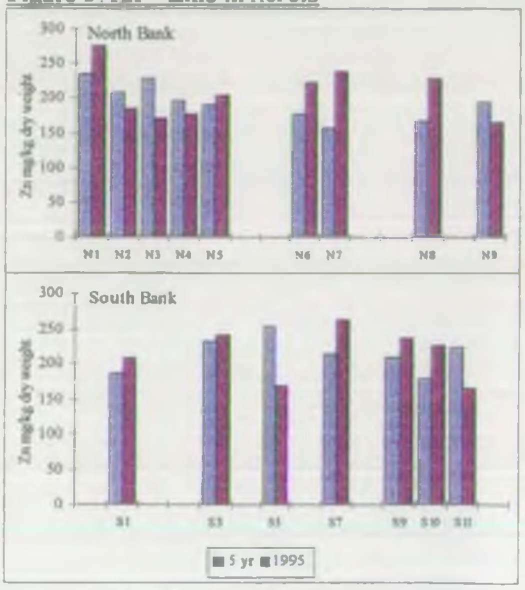
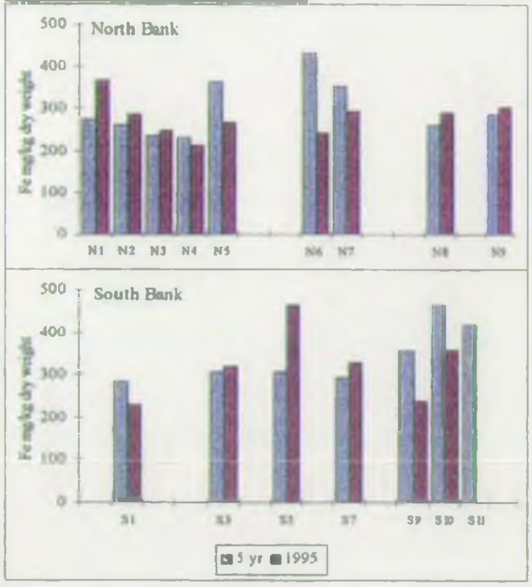


Figure 3.12g Iron in *Nereis*



3.8.2 Bioaccumulation in Seaweed

Fucus vesiculosus samples are collected bi-annually from five North Bank and ten South Bank sites (see Figure 3.11). *Fucus* can take up substances from the environment only passively, i.e. by absorption of metals in solution and, therefore, does not reliably accumulate mercury, chromium or lead. The results for other metals are shown in Figures 3.13a-f. No 1995 results were available for site S3. In most cases, particularly cadmium, there is generally a decrease in metal levels moving seawards, with peaks of copper and zinc in the lower Estuary around the main discharges.

Arsenic concentrations in 1995 were all higher than the five-year mean on the North Bank (Figure 3.13a). Data were not available to calculate the five-year mean for the South Bank but the 1995 results were substantially lower than those from the North Bank.

Copper concentrations in 1995 were higher than the five-year mean at all the North Bank and half the South Bank sites (Figure 3.13b). There is a peak in copper concentrations around the Killingholme area which may be due to the proximity of industrial discharges.

Cadmium concentrations in 1995 were higher than the five-year mean - particularly at site N9 - at all but one site (Figure 3.13c).

Nickel concentrations in 1995 were higher than the five-year mean at all sites and the South Bank results were higher than those of the North Bank (Figure 3.13d).

Zinc concentrations in 1995 were higher than the five-year mean at most sites (Figure 3.13e) and higher on the South Bank than on the North Bank.

Iron concentrations in 1995 were slightly higher than the five-year mean at most North Bank and half the South Bank sites (Figure 3.13f). The South Bank results were substantially lower than the those of the North Bank.

Figure 3.13a Arsenic in *Fucus*

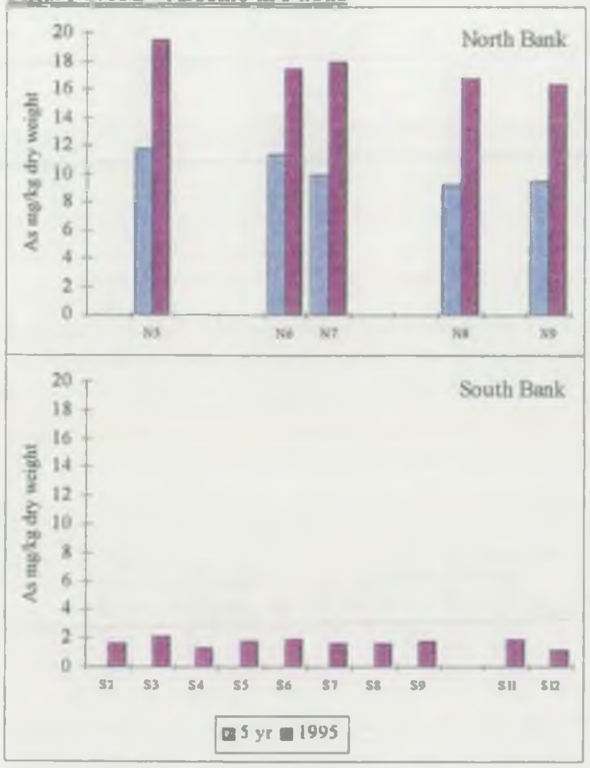


Figure 3.13b Copper in *Fucus*

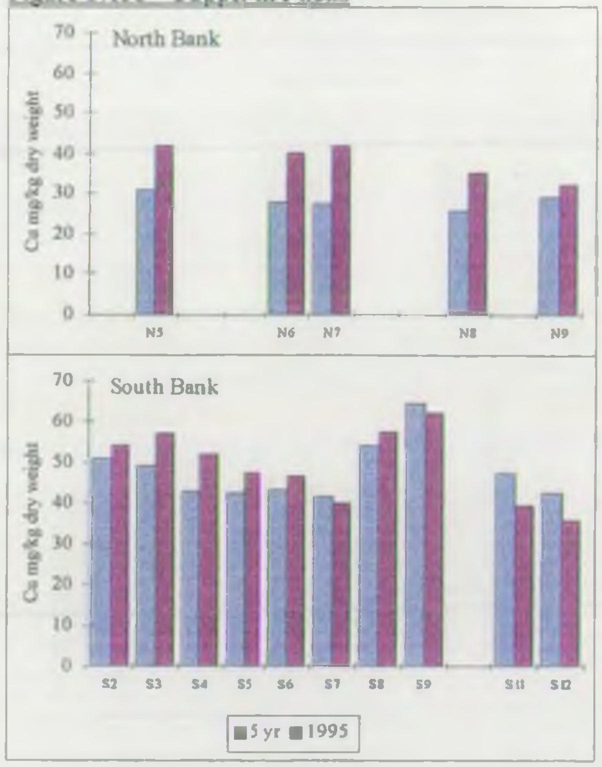


Figure 3.13c Cadmium in *Fucus*

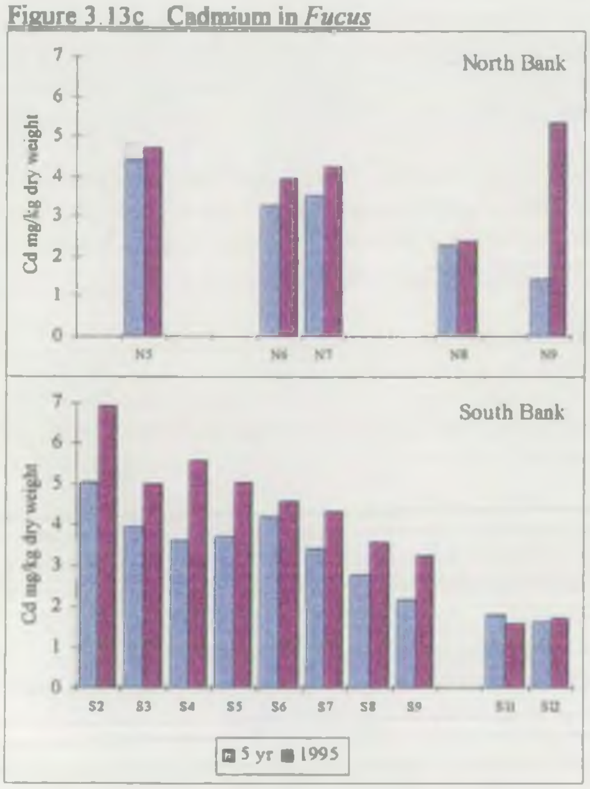


Figure 3.13d Nickel in *Fucus*

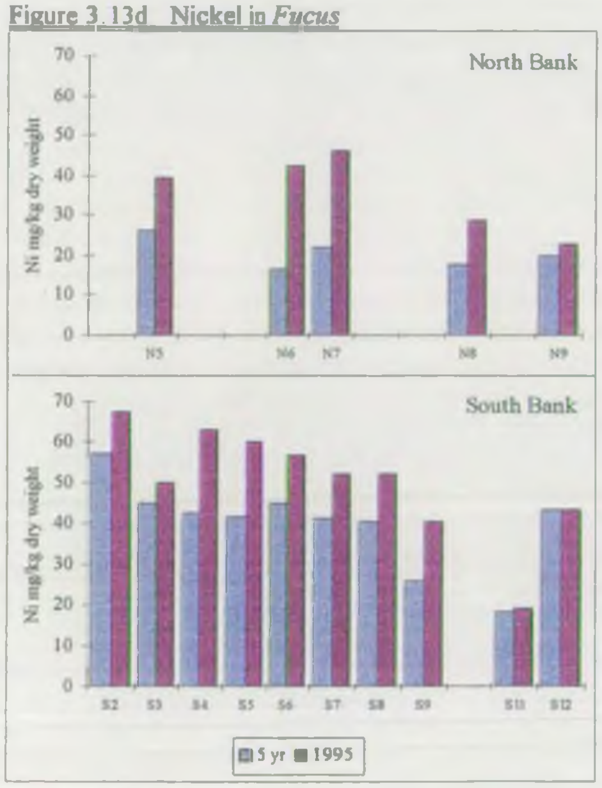


Figure 3.13e Zinc in *Fucus*

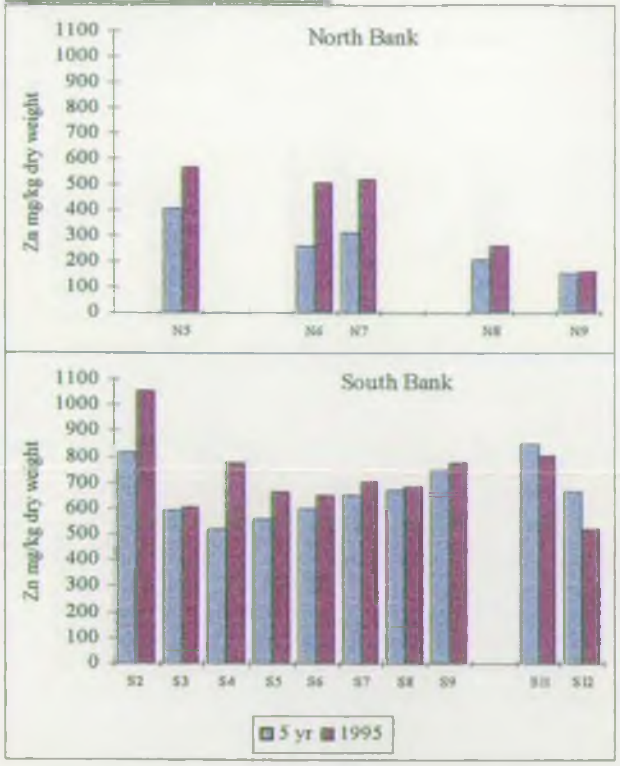
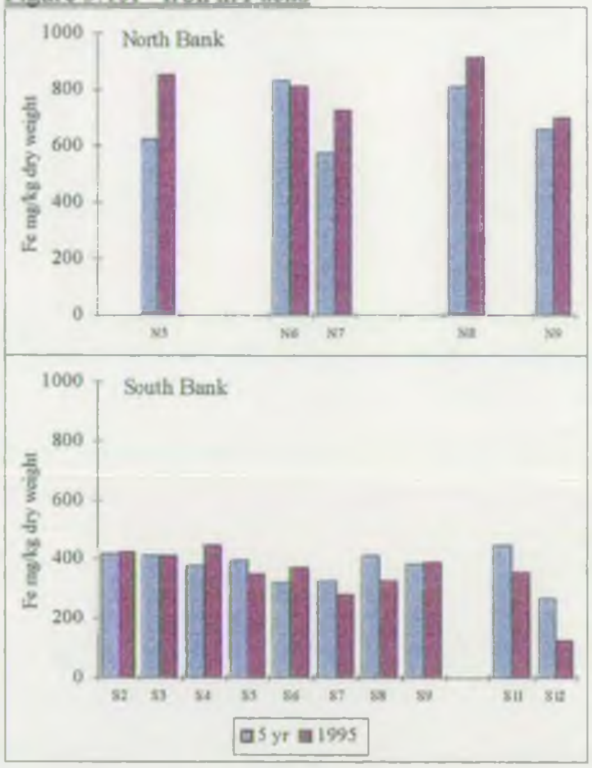


Figure 3.13f Iron in *Fucus*



3.8.3 Bioaccumulation in Brown Shrimps

Samples of *Crangon crangon* are collected once per year from three subtidal sites in the Estuary and are analysed for metals and organics (see Figure 3.11). The 1995 results for chromium, lead and vanadium were all below the limit of detection, as were most of the nickel results, and are not illustrated here. Results for organics were not available for 1995. The remaining metal results are shown in Figures 3.14 a-f. In general, lower levels were recorded in the shrimps collected from the upper estuary where the 1995 results were generally similar to or lower than the five-year mean. In the middle and lower estuary, the 1995 results tended to be higher than the five-year mean with the exceptions of arsenic and iron.

Arsenic concentrations in 1995 were appreciable lower than the five-year mean (Figure 3.14a) continuing the decrease evident in 1994. The results from site C1 were all below the limit of detection.

Mercury concentrations in 1995 varied about the five-year mean but by such small amounts as to be negligible (Figure 3.14b).

Copper concentrations in 1995 were similar to the five-year mean in the upper estuary but higher in the middle and lower estuary (Figure 3.14c) following the spatial pattern seen in the previous year.

Cadmium levels in 1995 were similar to the five-year mean in the upper estuary but higher in the middle and lower estuary (Figure 3.14d), although the results were within the normal range following low levels recorded in 1993.

Zinc concentrations in 1995 were similar to the five-year mean in the upper estuary but higher in the middle and lower estuary (Figure 3.14e).

Iron concentrations in 1995 were lower than the five-year mean at all three sites (Figure 3.14f), following the pattern observed in the previous year.

Figure 3.14a Arsenic in *Crangon*

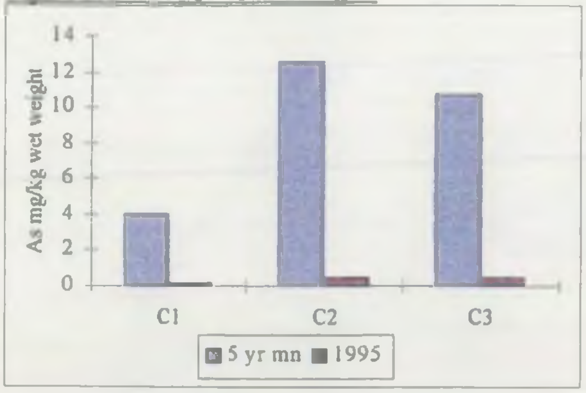


Figure 3.14b Mercury in *Crangon*

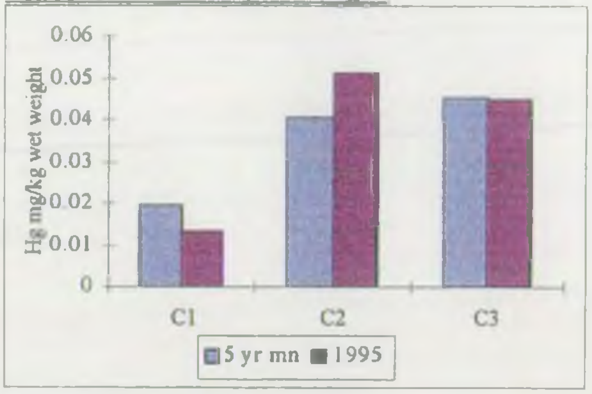


Figure 3.14c Copper in *Crangon*

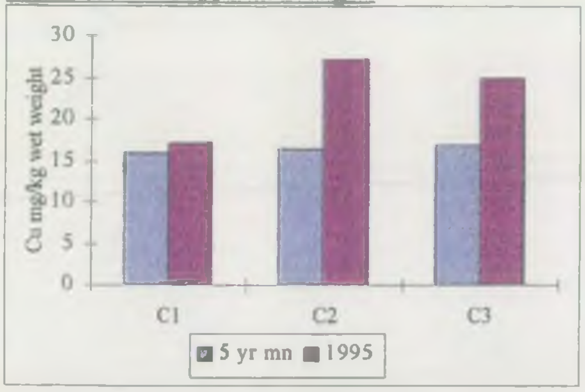


Figure 3.14d Cadmium in *Crangon*

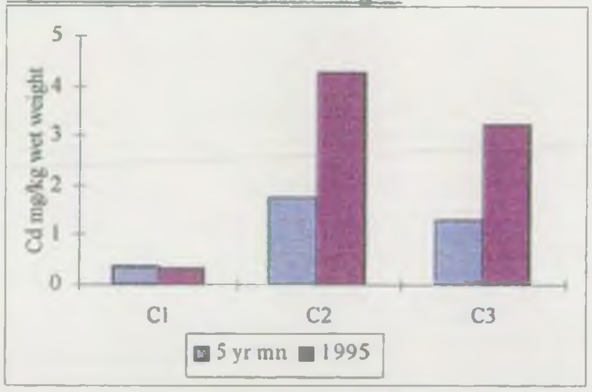


Figure 3.14e Zinc in *Crangon*

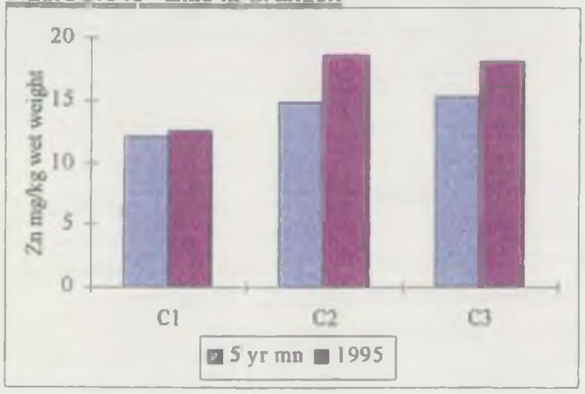


Figure 3.14f Iron in *Crangon*

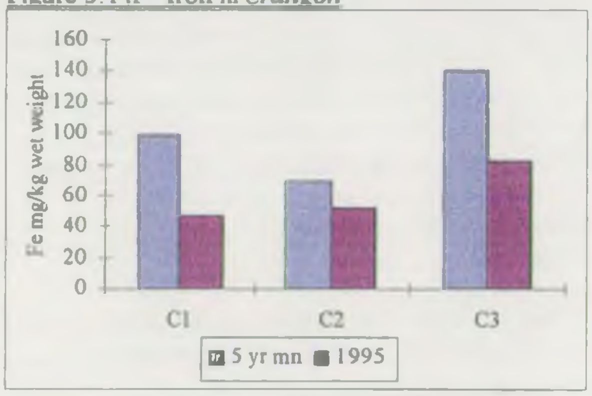


Figure 3.15 Continuous Monitors in the Humber

3.9 CONTINUOUS MONITORS/DISSOLVED OXYGEN

Dissolved oxygen (DO) is a long-standing problem in the Estuary and is therefore continuously monitored at several sites in the Humber and its tidal rivers (Figure 3.15). Equipment is permanently in place which monitors (at 15 minute intervals) DO and temperature together with pH[3] and salinity and, on some tidal rivers, turbidity and ammonia. This data supplements the spot sampling and gives a more detailed picture of the changing conditions in the Estuary throughout the day, particularly for dissolved oxygen which varies with both the tidal cycle and temperature and is critical in sustaining fish-life.

Some examples of the data recorded by the monitors located at Cawood Bridge, Boothferry Bridge and Blacktoft Jetty on the River Ouse and at Corporation Pier on the Humber are described below.

3.9.1 Downstream Patterns

Figures 3.16a-c show the continuous data readings (at 30 minute intervals) for temperature, dissolved oxygen and salinity during the period 18 November and 10 December 1995. Comparison of the three sites clearly shows the increase in tidal influence downstream. The Cawood site is freshwater[4] with no visible tidal influence on salinity, Boothferry Bridge has low salinity levels with stronger tidal influence around the time of spring tides (24 November 1995), whereas Corporation Pier shows relatively high salinity and strong tidal influences throughout the tidal cycle.

3.9.2 The Ouse at Blacktoft Jetty

Figure 3.17 shows the daily mean readings 1995 at Blacktoft Jetty where oxygen levels are often critical. Dissolved oxygen levels are most likely to fall below the EQS (40% saturation) when suspended sediment levels and/or temperatures are high. The effects of temperature can be seen throughout the summer months. During this period, low dissolved oxygen levels coincided with increased temperatures. Dissolved oxygen levels might have been further depressed if not for the intrusion of saline water up the Estuary which, during the summer months tends to be cooler and better oxygenated.

3.9.3 The Humber at Corporation Pier

Figure 3.18 shows the continuous readings for a five-day period between 24th and 29th June 1995 at Corporation Pier. There is little freshwater influence at this site and the strong positive relationship between salinity and dissolved oxygen is clearly illustrated, reflecting the intrusion of well-oxygenated seawater on the flood tide. The dissolved oxygen peaks coinciding with last stages of the ebb tide reflect the downstream movement of freshwater flow from the Estuary's tributary rivers.

[3] The equipment at Killingholme does not monitor pH.

[4] The salinity of seawater is about 35‰ and of freshwater is always less than 0.5‰. Therefore, estuarine water has a salinity of between 0.5‰ and 35‰.

Figure 3.16a Continuous Readings at Cawood 18 November - 10 December 1995

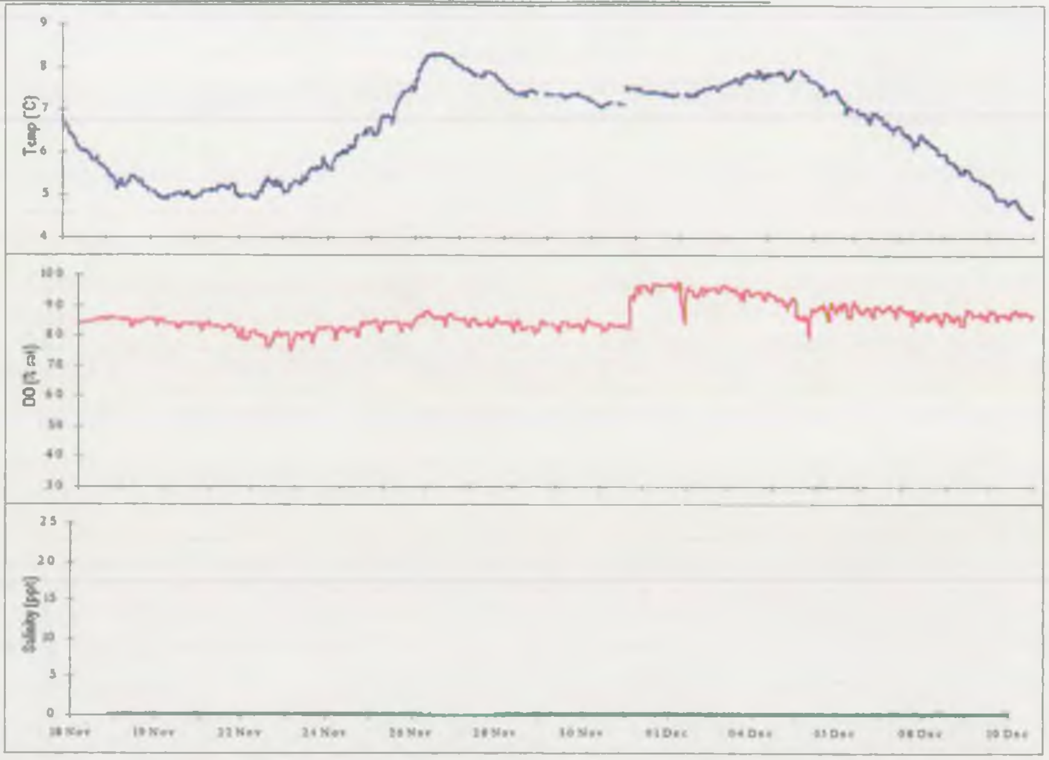


Figure 3.16b Continuous Readings at Boothferry Bridge 18 November - 10 December 1995

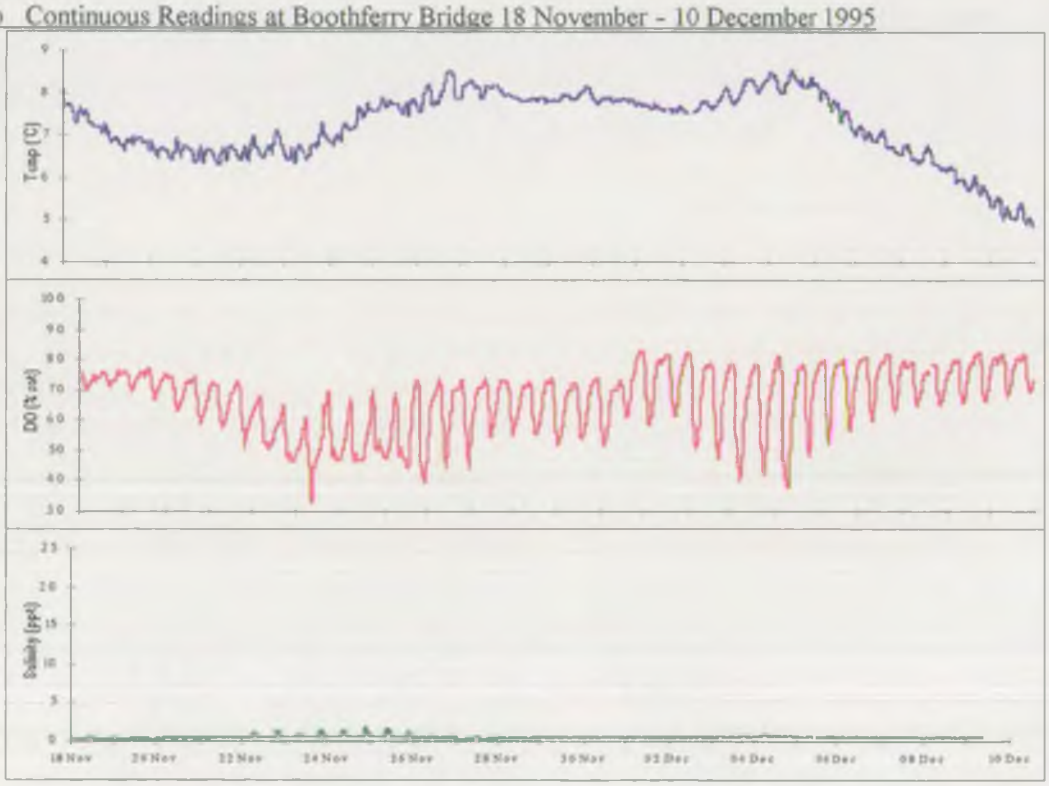


Figure 3.16c Continuous Readings at Corporation Pier 18 November - 10 December 1995

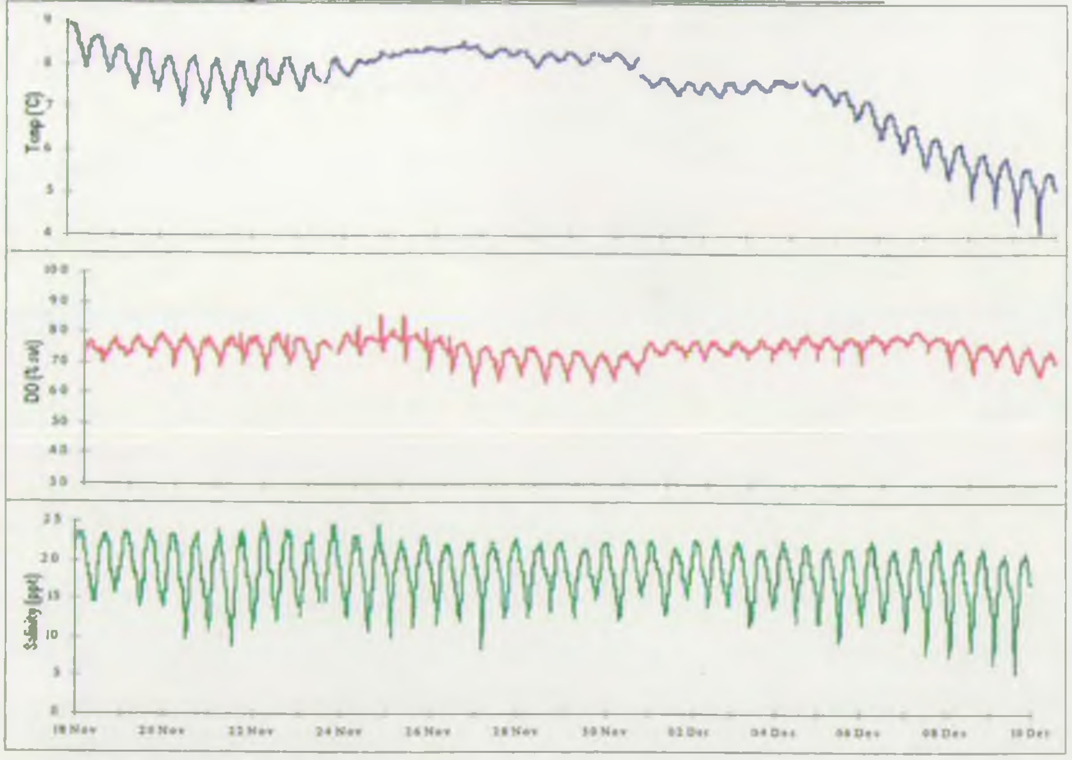


Figure 3.17 Continuous Readings at Blacktoft Jetty 1995

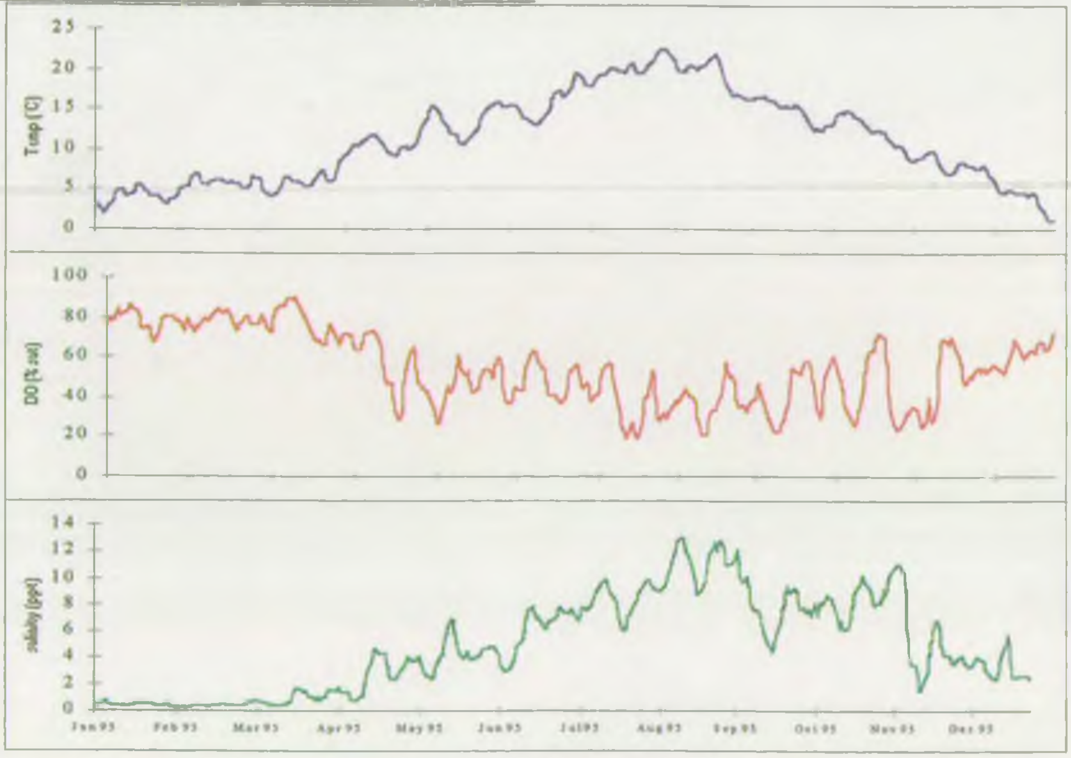
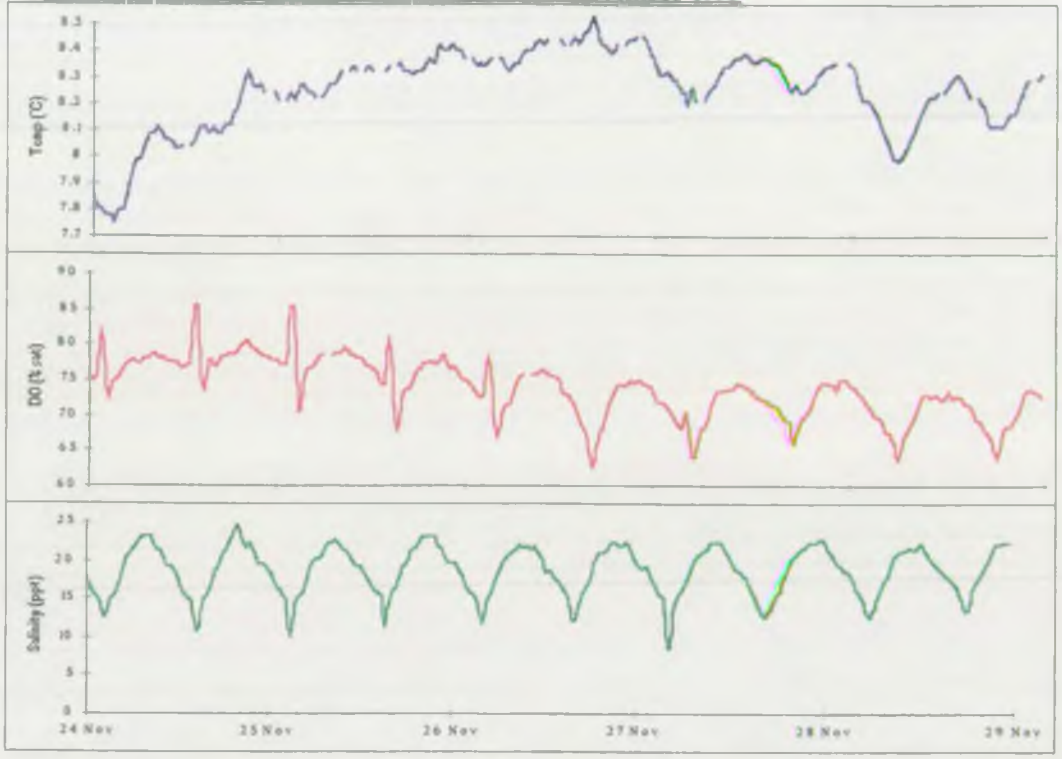


Figure 3.18 Continuous Readings at Corporation Pier 24 - 29 November 1995



SECTION 4
BIOLOGICAL QUALITY

4.1 INTRODUCTION

Monitoring invertebrate animals and fish living in tidal rivers and the Humber is an important part of assessing health of the Estuary. Many invertebrates live on or in the mud and are exposed to contaminants in the sediment and/or water column. The variety and abundance of these organisms give an indication of the health of the estuarine system. Tidal rivers and estuaries can be harsh environments presenting organisms with soft, shifting sediments, variations in salinity and daily desiccation in the intertidal zones. Human influences such as pollution and reclamation schemes exacerbate these effects. Analysis of biological data attempts to separate the effects of natural and anthropogenic stresses and to assess the health and productivity of the Estuary.

Faunal abundance is more prone to biological fluctuation than species variety since certain species undergo wide natural population changes. It is also less responsive to pollution effects, although toxic pollution can depress abundance and organic enrichment can cause tolerant species to flourish.

4.2 DATA ANALYSIS

The interpretation of biological data has always been problematic because of the inherent variability of populations and mobility of certain species such as fish and shrimps.

The analysis used here consists mainly of comparing species variety and abundance with five-year means. The presence or absence of particular species and changes in a population can indicate improvement or deterioration in water quality.

4.3 TIDAL RIVERS INVERTEBRATE BIOLOGY

4.3.1 Introduction

In 1995, faunal sampling of tidal rivers was carried out at eleven sites (Figure 4.1), including the Trent at Gainsborough which had not been sampled the previous year.

Figure 4.1 The Humber Survey Tidal River Macrofauna Sites

4.3.2 Methods

Standard EA sampling methods were used appropriate to each site (sweep, airlift or kick sample). The River Aire at Snaith has previously been sampled by airlift from a bridge: the bridge is now considered to be unsafe and a sweep sample at low water was obtained in 1995. Where possible, organisms were identified to species level, abundances noted and standard biological indices (BMWP & ASPT - see Appendix 4) calculated[5].

4.3.3 Results and Discussion

The results of the 1995 survey are listed in Appendix 5: summary statistics are shown in Table 4.1 below. As in previous years, the dominant fauna in most rivers were various species of oligochaete worms and/or the brackish-water shrimp, *Gammarus zaddachi*, although the Keadby, Ouse and Saltmarsh sites contained no worms and the Snaith and Thorne Bridge sites contained no shrimps.

Table 4.1 Summary Statistics of Tidal Rivers Fauna

Site	90	91	92	93	94	95
Trent at Dunham						
BMWP Taxa	3		7	4		8
BMWP Score	10		26	15		24
ASPT	3.33		3.71	3.75		3.00
Trent at Gainsborough						
BMWP Taxa	1			3		2
BMWP Score	6			13		7
ASPT	6.00			4.33		3.50
Trent at Keadby						
BMWP Taxa						1
BMWP Score						6
ASPT						6.00
Aire at Snaith						
BMWP Taxa	3	7	3	3	2	1
BMWP Score	10	24	6	10	3	1
ASPT	3.30	3.43	2.00	3.30	1.5	1.00
Don at Thorne Bridge						
BMWP Taxa	3	4	4	4	4	1
BMWP Score	10	17	13	13	13	1
ASPT	3.30	4.25	3.25	3.25	3.25	1.00
Wharfe at Ryther						
BMWP Taxa	13	12	12	14	18	15
BMWP Score	63	51	52	61	83	63
ASPT	5.20	3.64	4.33	4.36	4.61	4.20
Hull at Beverley						
BMWP Taxa	8	14	6	11	9	12
BMWP Score	26	51	18	41	31	48
ASPT	3.30	3.64	3.00	3.73	3.44	4.00
Hull at Sutton Rd Bridge						
BMWP Taxa	3	5	3	4	5	2
BMWP Score	9	18	9	12	15	7
ASPT	3.00	3.60	3.00	3.00	3.00	3.50
Ouse at Cawood						
BMWP Taxa	1	3	4	4	3	2
BMWP Score	1	12	14	12	13	7
ASPT	1.00	4.00	3.50	3.00	4.33	3.50
Ouse at Drax						
BMWP Taxa		2	1		2	1
BMWP Score		7	1		7	6
ASPT		3.50	1.00		3.5	6.00
Ouse at Saltmarsh						
BMWP Taxa	2	4	2	1	3	1
BMWP Score	7	15	7	6	14	6
ASPT	3.50	3.75	3.50	6.00	4.66	6.00

Ryther is the most upstream site of the survey and exhibited the greatest diversity, dominated by freshwater species. The 1995 survey showed appreciable differences in the faunal composition between some sites. *Gammarus zaddachi* was dominant at Beverley and the only species observed at Keadby and Drax. Other sites (including Ryther and Beverley) contained oligochaete worms, often in large numbers. The Aire at Snaith is the most 'stressed' site and could be expected to yield a large proportion of oligochaete worms. However, in 1995, no worms (or any other species) were recorded.

The biotic indices and species composition of the tidal rivers remained broadly similar to previous surveys between 1989 and 1994, although some short-term perturbations were noted. The 1995 results from the Wharfe showed a slight decline on the previous year although the Hull at Beverley maintained the improvement seen in the previous year. The results from Dunham were very variable over the period 1990 to 1995 suggesting variations in water quality possibly linked to salinity since this site is very near to the saline limit of the Trent.

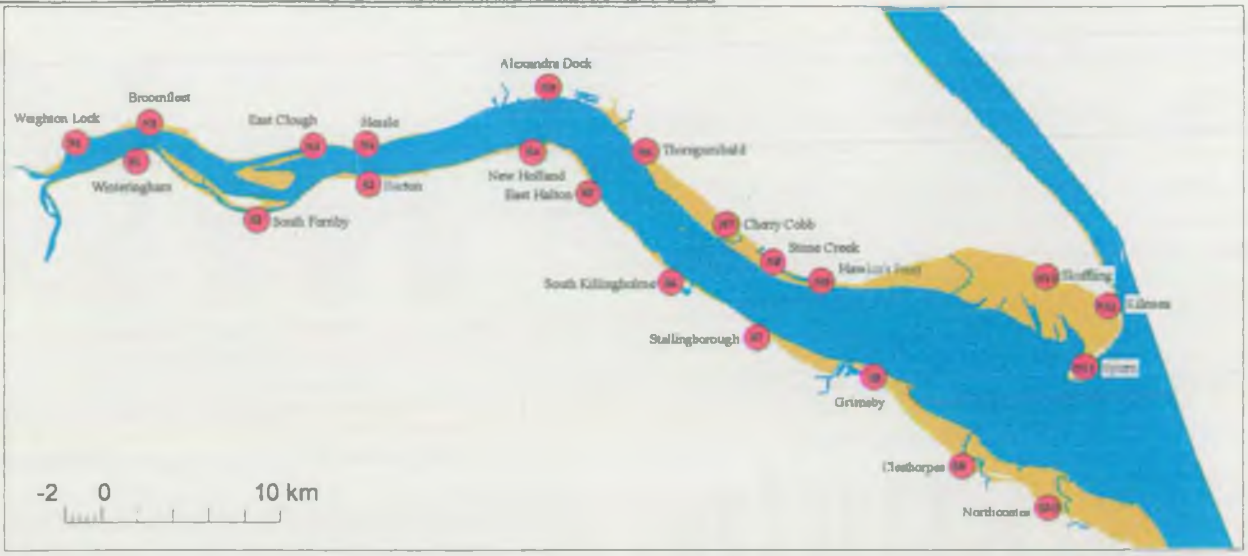
The potential causes of the generally poor species diversity in the tidal rivers have been identified in previous reports, and include habitat paucity, tidal scour, salinity fluctuations and pollution from industrial and sewage outfalls as well as the inherent difficulties in sampling such challenging environments. In addition, 1995 also exhibited the effects of drought. It is often difficult to distinguish the effects of natural events from pollution-induced changes in such stressed environments but the sites exhibiting particularly low diversity in 1995 coincided with elevated BODs and low dissolved oxygen (a trend especially marked on the Trent and at Beverley). This indicates a potential adverse effect from sewage or other organic inputs.

4.3.4 Conclusions

Biological assessment undertaken as part of the 1995 survey indicated poor quality in tidal rivers, except at the least saline site, Ryther on the Wharfe. Since all sites are subject to natural salinity variations, overall biotic paucity may be due to cumulative effects of upstream input and a naturally stressed environment, exacerbated by low freshwater flows. Future data may give a better insight into the impact of the 1995 drought.

[5] Although the BMWP Score was designed for use in freshwater, there is currently no similar system for application in estuarine waters. Its use in brackish waters results in very low scores compared to freshwater systems.

Figure 4.2 The Humber Survey Intertidal Macroinvertebrate Sites



4.4 INTERTIDAL INVERTEBRATE BIOLOGY

4.4.1 Introduction

Surveys of the North and South Bank intertidal fauna were carried out in August 1995 at 22 sites (Figure 4.2). The results of these surveys are provided in Appendix 6 for the North Bank and Appendix 7 for the South Bank and are discussed below.

4.4.2 Methods

Standard EA method for this type of sampling is to take five replicate 10cm diameter cores from each shore level at each site. Following the recommendations of a national working party which recognised that this sampling regime, although adequate for estuarine mud-flats, resulted in undersampling of sandy sediments, enhanced sampling was introduced at sandy sites on the South Bank in 1994 and on the North Bank in 1995. Ten replicate cores are therefore taken at each of the sandy sites while five cores continue to be taken at the muddy sites and, although it disrupts the continuity of the data for the (few) sandy stations in the Outer Estuary, this will provide a more realistic assessment of species variety for future interpretation. The samples were washed through a 0.5mm sieve and preserved in formalin for later analysis. Sediment analyses included particle size analysis, organic carbon content and loss on ignition at 400°C and 480°C.

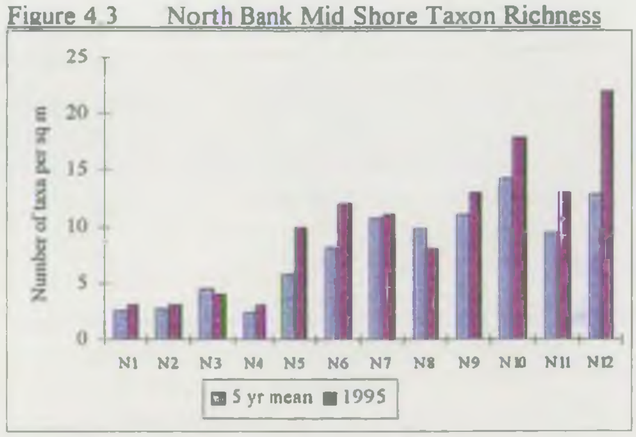
4.4.3 North Bank

4.4.3.1 MID SHORE FAUNAL PATTERNS

4.4.3.1 (a) Taxon Richness

In 1995, taxon richness was highest at site N12 and lowest at sites N1, N2 and N4. At ten sites, taxon richness was higher than the five-year mean but slightly lower at sites N3 and N8 (Figure 4.3). This general pattern was reflected at other shore levels. Since this increase was not associated with a concomitant decrease in faunal abundance (see section 4.4.3.1 (b)), the changes cannot be directly linked to any change in water quality.

Figure 4.3 North Bank Mid Shore Taxon Richness



The large increase, by ten taxa, at site N12 was caused by the increased sampling effort at this sandy site in 1995.

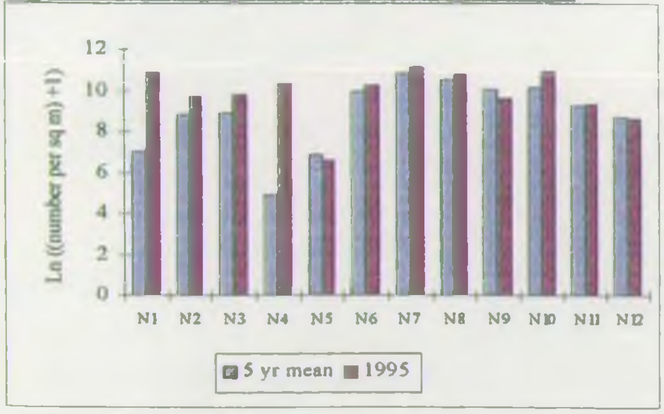
The dominant taxa remained similar to previous years with some slight differences caused by the oligochaetes (with the exception of *Tubificoides benedii*) not being identified to species level in 1995.

The dominant taxa at sites N4 and N6 changed in 1995 from the amphipod crustacean *Corophium volutator* to oligochaete species, although *Corophium* was still present at both sites. This change in community structure was not reflected at low shore and was unlikely to be related to any reduction in water quality.

4.4.3.1 (b) Abundance

Faunal abundance in 1995 was highest at site N7 (68,000 per sq m) and lowest at site N5 (700 per sq m). Compared to the five-year mean, there was very little change at most sites, although sites N1 and N4 showed a higher result due to an increase in oligochaetes (Figure 4.4). At site N1 there was a fifty-fold increase in the numbers of *Paranais* and a fifteen-fold increase in the number of Oligochaeta spp. At site N4 nearly 30 000 oligochaetes were recorded per square metre in 1995 where none had been present in the previous year.

Figure 4.4 North Bank Mid Shore Abundance



The increase in oligochaetes occurred, to a lesser extent, at all the other sites. This may reflect a change in water quality but could equally be attributed to natural population fluctuations. The changes observed in 1995 would be expected to continue in future years if the cause was changing water quality.

At site N10, as well as the increase in oligochaetes, there was a ten-fold reduction in the ragworm *Nereis* and a decrease in organic carbon levels from 2.8% to 0.17%. These changes indicate an improvement in water quality at this site following a previously reported period of increased loading of untreated sewage (EA 1997).

The abundance of *Corophium volutator* and *Macoma balthica* remained generally consistent with previous years, the peaks and troughs of both species occurring at the same sites as previously.

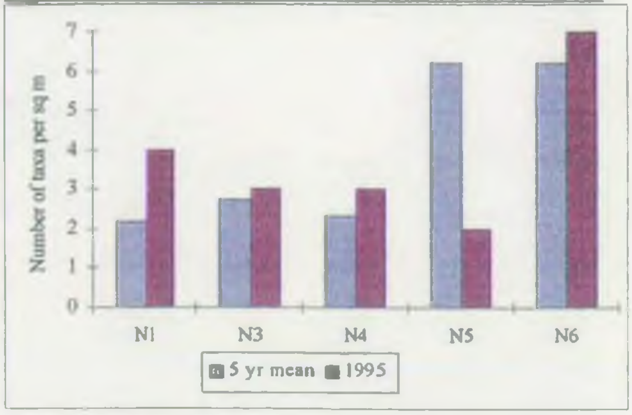
4.4.3.2 LOW SHORE FAUNAL PATTERNS

Only sites N1, N3, N4, N5 and N6 are sampled at the low shore level since the other sites are considered too dangerous to sample at low tide.

4.4.3.2 (a) Taxon Richness

In 1995, taxon richness was highest at site N6 and lowest at site N5, and was slightly higher than the five-year mean at four sites but slightly lower at site N5 (Figure 4.5).

Figure 4.5 North Bank Low Shore Taxon Richness



At site N5, the previous years result was also lower than the five-year mean (EA 1997) which had been elevated by artificially high numbers in 1990 and 1993. Other shore levels show an increase in taxon richness at this site and the site notes indicate a loss of sediment from the low shore level. This suggests that the population changes are due to the unstable sediment regime rather than any change in water quality.

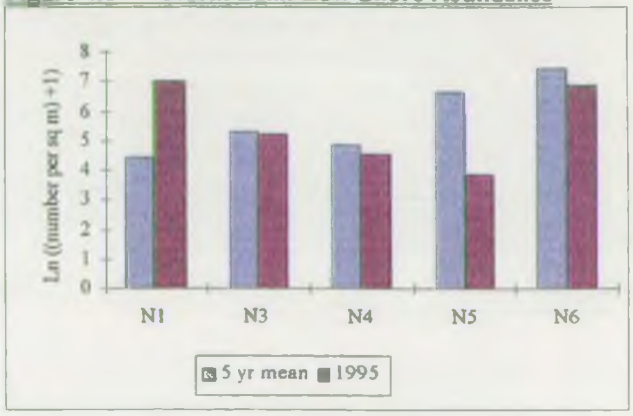
The increase in taxon richness at site N1 was due to the presence of *Corophium volutator* and *Tubificoides benedii*. This appears to be a natural phenomenon as these taxa have been present at this site intermittently over the past five years.

4.4.3.2 (b) Abundance

Faunal abundance was highest at site N1 (1100) and lowest at site N5 (50).

In 1995, three sites had slightly lower faunal abundance than the five-year mean (Figure 4.6).

Figure 4.6 North Bank Low Shore Abundance



The lower result at site N5 followed the pattern observed in the previous three years, which has been attributed to the sediment regime.

The higher result at site N1 was accounted for by an increase in the number of *Paranais* from less than 50 in 1994 to more than 900 in 1995. This reflects the situation at mid shore and is likely to be a natural population fluctuation.

4.4.3.3 CONCLUSIONS

The overall pattern of intertidal invertebrate macrofauna remained similar to previous years. Throughout the Estuary in 1995, an increase in oligochaetes was evident particularly at the mid shore level at sites N1 and N4. This may reflect a change in water quality but is equally likely to be a result of natural population fluctuations. A total of 43 species[6] was recorded in 1995 compared to 37 in 1994, at least part of the increase being due to the additional sampling undertaken at site N12. No new species were added to the taxa list. Faunal population and organic carbon changes at site N10 may indicate recovery after a period of degraded water quality associated with the input of untreated sewage from a recent residential development.

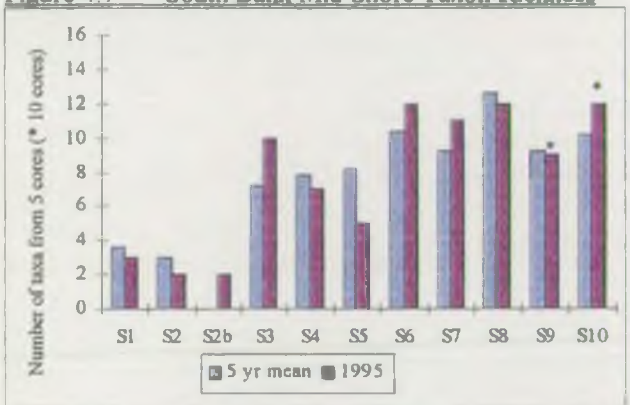
4.4.4 South Bank

4.4.4.1 MID SHORE FAUNAL PATTERNS

4.4.4.1 (a) Taxon Richness

Overall, taxon richness in 1995 was similar to, or higher than, the five-year mean at most sites (Figure 4.7). Of the sites with lower results than the five-year mean, only site S5 showed an appreciable decline.

Figure 4.7 South Bank Mid Shore Taxon Richness



The increases in taxon richness at sites S3 and S6 in 1995 continued the pattern noted in recent years mainly because the five-year mean is suppressed by lower species variety in the early 1990s. This long-term change is ascribed to a combination of possible salinity influences and greater sediment stability.

[6] Including some species not included in the data analysis.

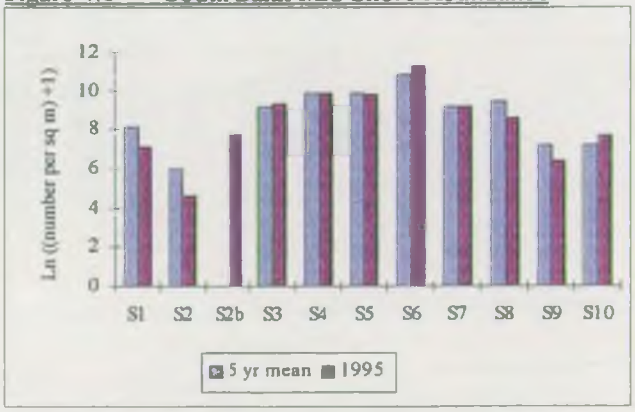
The increases at sites S7 and S10 were within the range of historical variation and probably reflect natural variability. However, the concomitant increase in species variety at the low shore of site S7 suggests that the changes may be a result of slight relocation of the site (see section 4.4.4.2 (a)).

The only site which showed an appreciable decline in taxon richness was site S5, although sites S1 and S2 tended towards the lower end of the 'natural range'. The 1995 result for site S5 was similar to that for 1994 and the contrast with the five-year mean was exaggerated by unusually high values in 1992 and 1993, which were due to the presence of only a few transient individuals of other species (EA 1997).

4.4.4.1 (b) Abundance

For most sites in 1995 faunal abundance was similar to the five-year mean and well within the expected range of variation. The exceptions were site S9, which exhibited levels marginally below the five-year minimum, and sites S1 and S2, which were discernibly below the mean value (Figure 4.8).

Figure 4.8 South Bank Mid Shore Abundance



The low abundance at site S9 would not normally merit comment, especially at a sandy site where sparse populations are not unusual. However, the result contrasts with that for 1994 when a large population of the spionid polycheate *Pygospio* caused the site to considerably exceed the five-year mean[7] (EA 1997). Since this spionid characteristically undergoes considerable fluctuations in density, their low abundance in 1995 should not be regarded as significant.

The distinctly lower than average abundance at site S2 reflects the physical instability of the steeply shelving shore at this site. This has been a long-standing problem in this part of the Upper Estuary and a replacement site with a more gently sloping shore is currently being phased in[8].

[7] Site 10 is also a sandy site but showed no concomitant increase in faunal abundance in 1994.

[8] The 1995 data for this site are incuded in Figures 4.9 and 4.10 as site 2b.

The low abundance at site S1 compared to the five-year mean reflected a continuation of the decline (first reported in 1993) in tubificid oligochaetes (HEC 1995). Since the previously substantial populations of the potentially pollution-tolerant worms could not be clearly linked to organic enrichment, the recent decline cannot be confidently ascribed to a reduction in such pollution. However, the changes at this site are likely to indicate environmental improvement rather than deterioration.

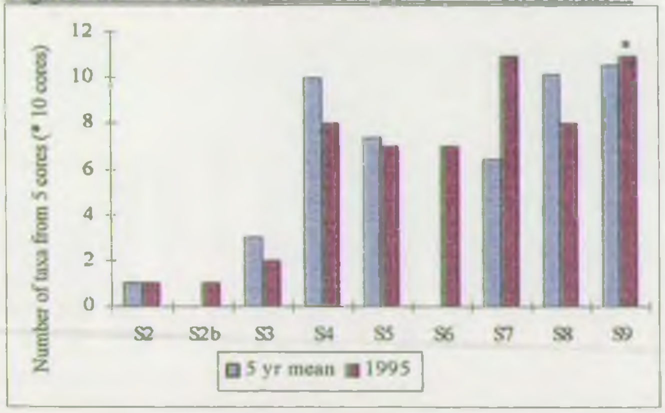
4.4.4.2 LOW SHORE FAUNAL PATTERNS

Sites S1 and S10 are not sampled at low shore for practical reasons. Site S6 was sampled at low shore for the first time in 1995 and, therefore, no five-year mean is available

4.4.4.2 (a) Taxon Richness

In 1995, four sites showed taxon richness lower than the five-year mean, two sites were higher and one site the same (Figure 4.9).

Figure 4.9 South Bank Low Shore Taxon Richness



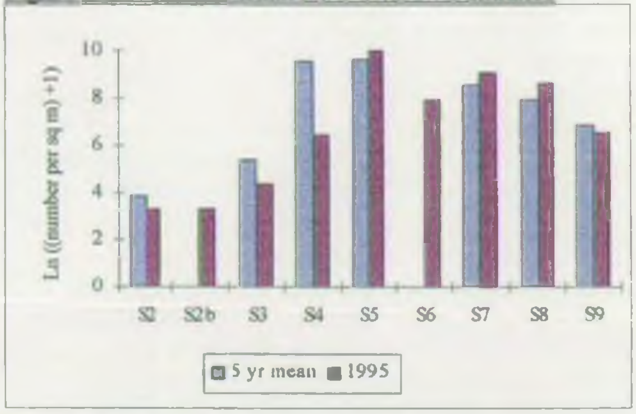
At site S7, the exceptional increase in species variety coincided with the relocation of the sampling point. A similar increase was also seen at mid shore (see section 4.4.4.1 (a)). The new sampling position was enforced by construction of a new coffer-dam on the exact location of the original site. Although the relatively low species variety in previous years had been attributed to sediment instability associated with flood-defence works (EA 1997), it was not anticipated that such a small shift in sampling position (less than 100m downstream) would significantly influence the number of taxa. Clearly, it is inappropriate to interpret the change at this site as an improvement in biological or quality terms.

The lower than average species variety recorded at sites S4 and S8 in 1995 reflect the absence of taxa which were previously present in only very low numbers. The decrease at site S4 was first noted in the previous year (EA 1997) while at site S8 the change is specific to 1995 and coincides with an increase in abundance (see section 4.4.4.2 (b)).

4.4.4.2 (b) Abundance

In 1995, three sites showed total abundance higher than the five-year mean and four sites were lower (Figure 4.10).

Figure 4.10 South Bank Low Shore Abundance



The faunal abundance at site S8 exceeds the five-year mean, and is higher than the previous year although the contrast with the average value is exaggerated by low abundances in the early 1990s. Since the recent increases have involved polychaetes such as *Tharyx* spp. rather than pollution-tolerant oligochaetes (or polychaetes such as *Capitella*), it is likely that the change reflects a long-term trend of stabilisation following abatement of the nearby Grimsby (Riby Street) sewage outfall.

The apparent increase in abundance at site S7 is probably associated with the relocation of the site (see section 4.4.4.2 (a)).

At sites S4 and S9, the abundances in 1995 fell below the five-year minimum. At site S9 the 1995 value was only slightly below the average and, since species variety remained comparable with the five-year mean (section 4.4.4.2 (a)), the cahnge is unlikely to be environmentally significant.

At site S4 the apparent decline in abundance mainly reflects the virtual absence of *Corophium* which disappeared in 1994 and has not successfully recolonised the site. The further decline below the five-year minimum is attributed to lower numbers of spionid polychaetes. Since both *Corophium* and spionids can have naturally variable population densities, the decline is not considered to be related to any deterioration in water quality.

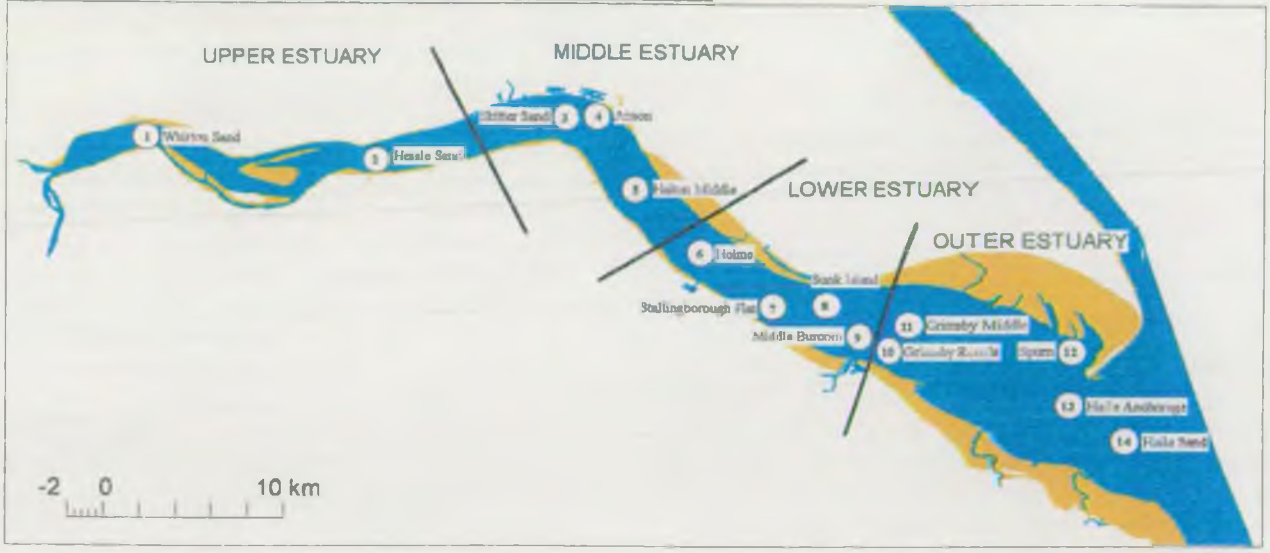
4.4.4.3 CONCLUSIONS

In 1995, species variety was generally comparable with the five-year mean with 37 taxa recorded, compared to 42 in both 1993 and 1994. Where species variety fell below the five-year mean, the losses consisted mainly of transient species or reflected the continued absence of transient species lost the previous year. The exceptional increases in species variety at site S7 were an unforeseen consequence of relocation of the sample site.

The total number of specimens in 1995 was 7250 (compared to 5600 in 1994 and 9500 in 1993). The higher abundance in 1995 compared to the previous two years is largely a result of increased densities of *Corophium* (accounting for nearly 60% of the increase). The failure of this species to recolonise the low shore at site S4 also explains much of the shortfall in total abundance compared to previous years.

The overall pattern of species variety and abundance along the Estuary is broadly consistent with that observed historically. It is apparent that the mud- and sand-flats on the South Bank continue to support a reasonable variety of invertebrate fauna in moderately high abundance. While it is inappropriate to assume causality between ecological changes and improvements in water quality, there is little clear evidence on any deterioration and at least one site has shown a strong biological indication of sustained improvement following abatement of the nearby sewage discharge at Riby Street, Grimsby.

Figure 4.11 The Humber Survey Subtidal Macroinvertebrate Sites



4.5 SUBTIDAL INVERTEBRATE BIOLOGY

4.5.1 Methods

Standard Agency methods were followed in the collection, processing and analysis of biological samples. Particle size analysis and determination of organic carbon content of the sediments were carried out by the Institute of Estuarine and Coastal Studies at the University of Hull.

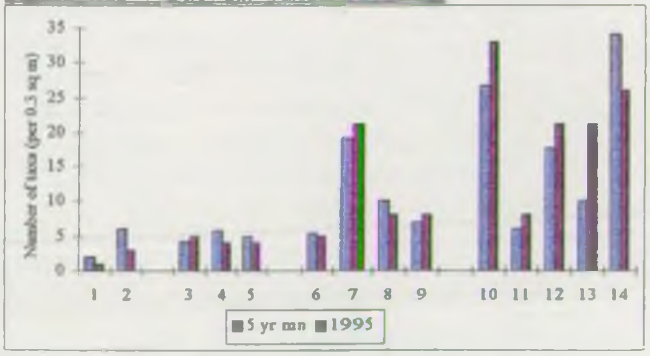
4.5.2 Results

For convenience of discussion, the fourteen subtidal sites are divided into four Estuary sections: Upper, Middle, Lower and Outer, as shown in Figure 4.11.

4.5.2.1 UPPER ESTUARY

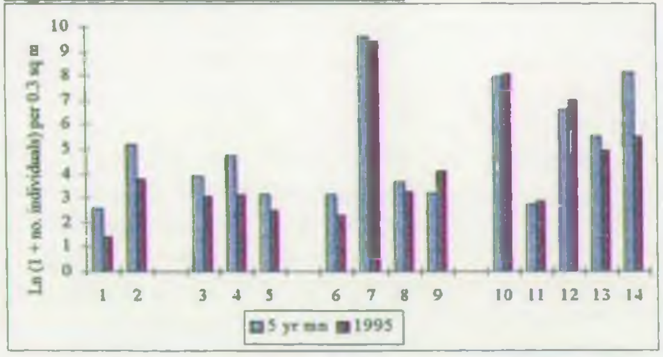
The species richness at the Upper Estuary sites in 1995 was appreciably lower than the five-year mean (Figure 4.12). Only three species were recorded at site 2 in 1995 in comparison with between four and eight species during the five preceding years. However, the results can be considered to be within the expected range when taking into account that previous years results included several records of a single specimen per species.

Figure 4.12 Subtidal Taxon Richness



The total abundance at both sites was appreciably lower than recorded over the previous five years (Figure 4.13). The results from the 1995 (and 1994 - Environment Agency, 1997) grab samples indicate that *Neomysis integer* has become much less abundant at site 1 despite previously having been a dominant species. This was probably due to changes in the bed sediment in this area which has recently become muddier. *Neomysis* numbers were not excessively low in the Macer sledge samples taken at the site, which represent all sediment types encountered over a distance of 500 - 1000m (cancelling out most patchiness).

Figure 4.13 Subtidal Abundance



The low total abundance at site 2 was a result of much reduced densities of the polycheate worm *Capitella capitata*, which peaked in 1991 and 1992.

The 1995 results indicate a deterioration in environmental conditions in the Upper Estuary, although examination of additional data from previous periods and Macer sledge samples suggest the results are within the expected ranges and probably related to changes in the sediment regime rather then water quality.

4.5.2.2 MIDDLE ESTUARY

The species richness in the Middle Estuary was similar in 1995 to the five-year mean, whereas the total abundance was below average at all three sites. The relatively low abundance reflects the reduced population density of the dominant species, *Capitella capitata* (see section 4.5.2.1). This area is impoverished in terms of species richness and species other than *Capitella* make up only a small proportion of the total number of individuals found at each site.

In 1995 the benthos in the Middle Estuary remained dominated by *Capitella* which is considered to be indicative of organic enrichment. The fluctuations in density are possibly a result of annual variations in salinity. *Capitella* is rarely found at salinities below 10 ‰ (Wolff 1973) and peak densities in the Middle Estuary (1991 - 1992) follow years of low freshwater flow into the Humber (HEC 1993). The paucity of other taxa in the Middle Estuary and the continued dominance by *Capitella* indicates generally poor environmental conditions and an ongoing state of organic enrichment.

4.5.2.3 LOWER ESTUARY

Species richness and total abundance in the Lower Estuary in 1995 were generally comparable with the five-year means. The benthic fauna at sites 6, 8 and 9 has been relatively impoverished since 1990. The severity of the physical conditions in these areas, which are in or near the main estuary channels, is the most likely cause of the impoverished fauna. Although sites 6 and 8 show little change in 1995, there was a marginal increase in both species richness and total abundance at site 9 in 1994 and 1995.

Site 7 is situated inshore near the South Bank and away from the main channels. The benthic fauna consists of a large number of species and high total abundance compared with the other Lower Estuary sites, and both were comparable in 1995 to the five-year mean.

The 1995 results suggest little change in environmental conditions in the Lower Estuary, although there is an indication of some improvement in conditions in the vicinity of the main channels where the fauna has recently been impoverished.

4.5.2.4 OUTER ESTUARY

Species richness and total abundance were comparable with, if somewhat higher than, the five-year mean at four of the five Outer Estuary stations. At site 14, both the number of taxa and total abundance were lower than had been recorded over the previous five years (Figures 4.12 & 4.13), continuing the situation reported for 1994 (Environment Agency 1997). There had been a reduction in the number of individuals of all species and several species which were previously found in low numbers had disappeared. The very low numbers of the tube-building polycheate worms, *Spiophanes bombyx* and *Lanice conchilega*, suggests that a physical disturbance may have caused the impoverishment.

The 1995 results indicate improved environmental conditions in the Outer Estuary except at the outermost site where the recent decline in benthic fauna indicates a physical disturbance.

4.5.3 Conclusions

The 1995 results indicate a slight decline in environmental conditions in the Upper and Middle Estuary with species richness and abundance lower than the long-term averages but still within previously observed ranges. The Lower and Outer Estuary show evidence of improved environmental conditions with the exception of the outermost site where sediment disturbance and natural fluctuations in the benthic community resulted in the lowest species richness and abundance recorded over the previous twelve year period.

4.6 MICROBIOLOGICAL SEDIMENT ANALYSES

Microbiological tests on intertidal sediment samples were carried out for the first time in 1994. The concentrations of faecal bacteria (*Escherichia coli*, faecal *Streptococcus* spp. and *Clostridium* spp.) were determined by the Royal Infirmary in Hull and the Public Health Laboratory in Lincoln. In 1995, samples were taken from the mid shore level at the 22 intertidal biology sites, from the low shore level at thirteen intertidal biology sites (coinciding with the low shore macroinvertebrate sample sites - see section 4.4.3.2), and from fourteen subtidal sites.

4.6.1 Intertidal

4.6.1.1 MID SHORE BACTERIAL PATTERNS

The results from both the North and South Banks showed marked fluctuations, especially towards the Outer Estuary (Figures 4.14 & 4.15).

Figure 4.14 North Bank Mid Shore Microbiology

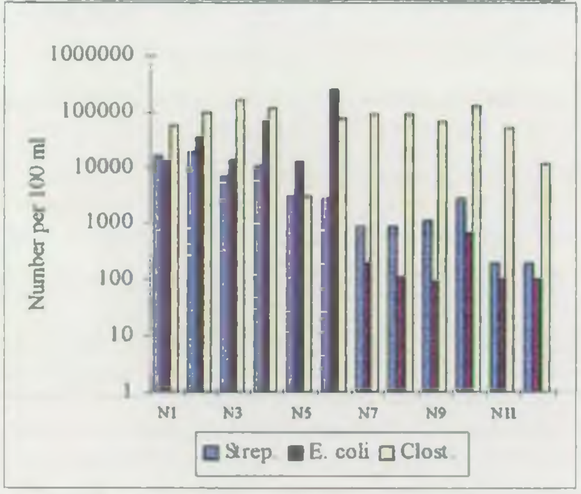
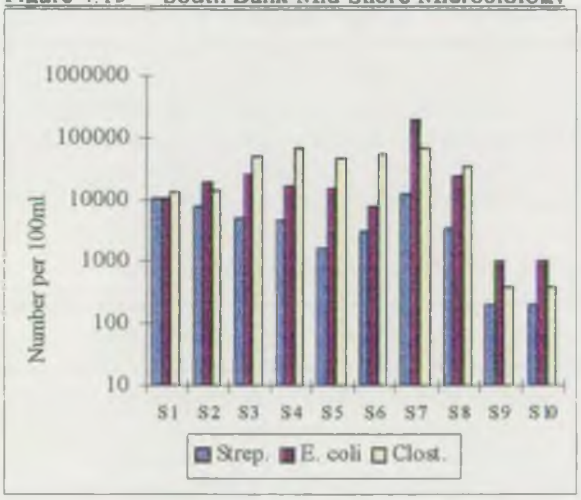


Figure 4.15 South Bank Mid Shore Microbiology



Clostridium perfringens is often used as a long-term indicator of sewage contamination because it produces endospores which have a much longer survival time than vegetative bacterial cells. The presence of this species in the Outer Estuary, particularly on the North Bank (Figure 4.14), indicates that sewage is contaminating mud-flats further down the Estuary than would otherwise have been expected. The high proportion of *C. perfringens*, relative to the other two species, towards the Outer Estuary may be due to the survival of bacterial spores, which subsequently germinate within the laboratory culture, within the sediment on the North Bank.

The concentration of the other two species, *E. coli* and *Streptococcus* spp., became generally lower towards the Outer Estuary suggesting either dilution by the increased volume of clean water entering the Estuary on the surge tide or a disinfecting effect of saline water. Localised peaks remained around sites N6, S6, S7 and S8 on the South Bank, which probably reflect nearby sewage outfalls. Concentrations of these two species may be boosted during each tide by the accretion of microbiologically enriched fine matter from suspension in the water column.

4.6.1.2 LOW SHORE BACTERIAL PATTERNS

The results from the low shore levels on both the North and South Banks show fluctuations similar to those seen at the mid shore level (Figures 4.16 & 4.17). The high proportion of *C. perfringens*, relative to the other two species, towards the Outer Estuary may be due to the survival of bacterial spores within the sediment on the South Bank (see section 4.6.1.1).

Figure 4.16 North Bank Low Shore Microbiology

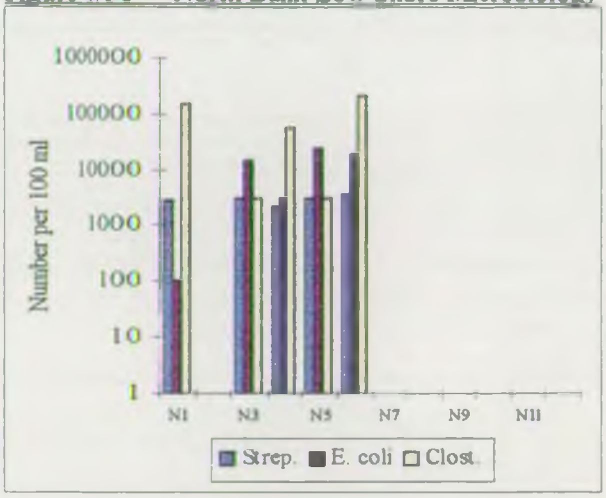
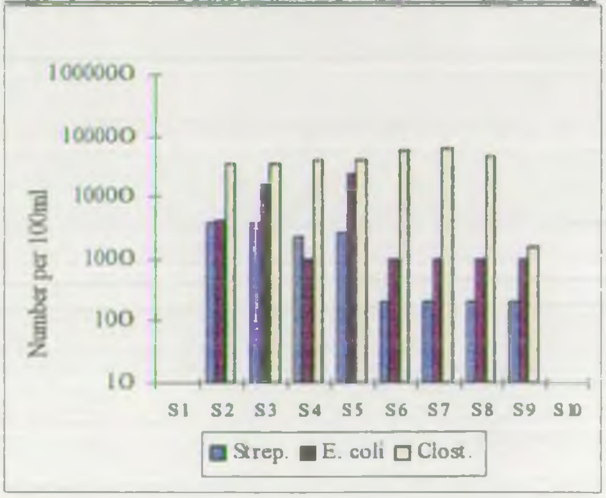


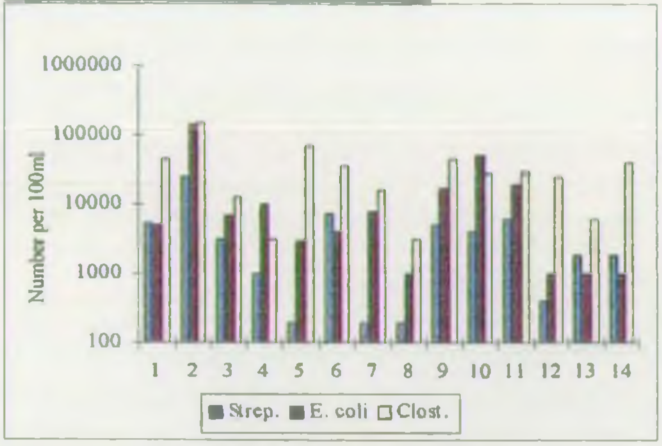
Figure 4.17 South Bank Low Shore Microbiology



4.6.2 Subtidal

Figure 4.18 shows the patterns of the three types of bacteria monitored in the subtidal sediments. There was a general decrease in the concentrations of *Streptococcus* spp and *E. coli* seaward with three fairly consistent peaks. The Upper Estuary peak coincides with the confluence of the main tributaries of the Humber while the other two peaks correspond to the main sewage discharges from Hull and from Grimsby.

Figure 4.18 Subtidal Microbiology



The downstream pattern of *Clostridium* spp., reflects the ability of these organisms, as endospores, to survive longer in the sediments than *Streptococcus* and *E. coli*. High concentrations were recorded in the areas of the Hull and Grimsby sewage outfall but also at site 2 which is upstream of the major sewage outfalls, and moderately high concentrations were recorded seaward to the outermost sites.

4.7 FISH DISTRIBUTION SURVEY

4.7.1 Introduction

A survey of the fish communities of the Humber was carried out in September 1995 in conjunction with MAFF.

4.7.2 Methods

Standard methods employed by MAFF were used throughout the survey. Fourteen sites, shown in Figure 4.19, were sampled by towing a two-metre beam trawl rigged for catching young and small fish. However, a valid sample was not obtained at Whitton and the Read's Island site had to be relocated from a drying bank to within the channel near the North Bank. Replicate samples were taken at five sites and additional push-net samples were taken at Cleethorpes and Spurn.

4.7.3 Results

The survey results are shown in Tables A8.1 and A8.2 in Appendix 8 and illustrated in Figures 4.19 and 4.20. Results for sites where replicate samples were taken are presented as averages.

Catches in 1995 were generally comparable with previous years (for both species richness and abundance) showing an impoverished fish community in the Upper Estuary[9], and a moderately rich community in the Lower and Outer Estuary. The Upper Estuary sites provided one to five fish per 1000 sq m in contrast with the 60 fish per 1000 sq m caught at the seaward extreme of the survey (Haile Sand).

4.7.3.1 OCCURRENCE OF SPECIES OF PARTICULAR INTEREST

Sand goby was caught at eleven sites. It has been the most abundant and widespread species in the Humber according to previous surveys and the 1995 catches were comparable with historical data.

Whiting (juveniles) was caught at eight sites, but not upstream of Halton Flat. In the previous year it had been found at only two sites although in some previous surveys it had occurred throughout the Estuary. Annual variations in the timing of the migrations of juvenile whiting up the Estuary are probably the main cause of the observed fluctuations, although annual variation in recruitment from North Sea stock also influence the numbers caught.

Dover sole was found at most sites downstream of Halton Flat and was most abundant at Burcom Shoal. This distribution pattern and the catch sizes are comparable with previous surveys.

Plaice (juveniles) was caught at only two sites. In previous surveys juvenile plaice has been found at most of the Lower and Outer Estuary sites. The largest numbers are usually recorded at Haile Sand where catches in 1995 were substantially smaller than previous results. As with whiting, this could be due to variations in the timing of migration (see section 4.7.3.2) or to fluctuations in recruitment from the North Sea stock.

Flounder occurred at three sites, which is consistent with previous surveys. It has been caught in moderate numbers throughout the Estuary at other times of the year, particularly during spring and summer (Marshall & Elliott 1993; NRA fish sampling 1992 - 1995, unpublished records). Most of the fish are of the 12 - 25 cm size range and the catches are probably under-estimates since the large fish are able to avoid the trawl.

Dab occurred at three sites, which is comparable with previous surveys.

4.7.3.2 PUSH-NET RESULTS

The push-net results are shown in Table A8.2 (Appendix 8). Catch size and species richness were comparable

[9] This is consistent with the harsh salinity conditions experienced in this part of the Estuary.

with previous surveys. Sand goby and juvenile plaice were the most abundant species and the number of juvenile plaice were similar to previous years, in contrast to the trawl results (section 4.7.3.1). The push-net survey was carried out ten days after the trawl survey, supporting the assertion above that the timing of migrations influenced the results.

4.7.4 Community Structure

The ability of the Estuary to support fish communities is indicated by the variety of fish species recorded in the surveys, their abundance and distribution. The results of the 1989 to 1995 surveys are summarised in Figure 4.20, showing the number of sites at which each species has been found. Of the 25 species recorded only Dover sole (although not in 1995), whiting and sand goby had been found at more than half the sampling sites. The remainder were either restricted to the marine conditions in the Lower and Outer Estuary or were relatively scarce in the Estuary.

The species recorded were of a range of ecological types (see classification by Pomfret *et al* 1991). Of the species recorded in 1995, there were five estuarine residents (ER), three marine adventurous migrants (MA), four marine juveniles (MJ), two marine seasonal migrants (MS), one freshwater ER (FW/ER), and one ER/MJ (Figure 4.20).

4.7.5 Conclusions

The results of the fish survey of September 1995 were generally comparable with previous year and did not indicate any environmental problems affecting the fish community. The trawl results showed low numbers of juvenile plaice present in the Outer Estuary compared to historical data but this is more likely to reflect variations in migration patterns and the spawning activity of the North Sea stock rather than the environmental quality of the Estuary.

Figure 4.19 Fish Distribution Survey (September 1995)

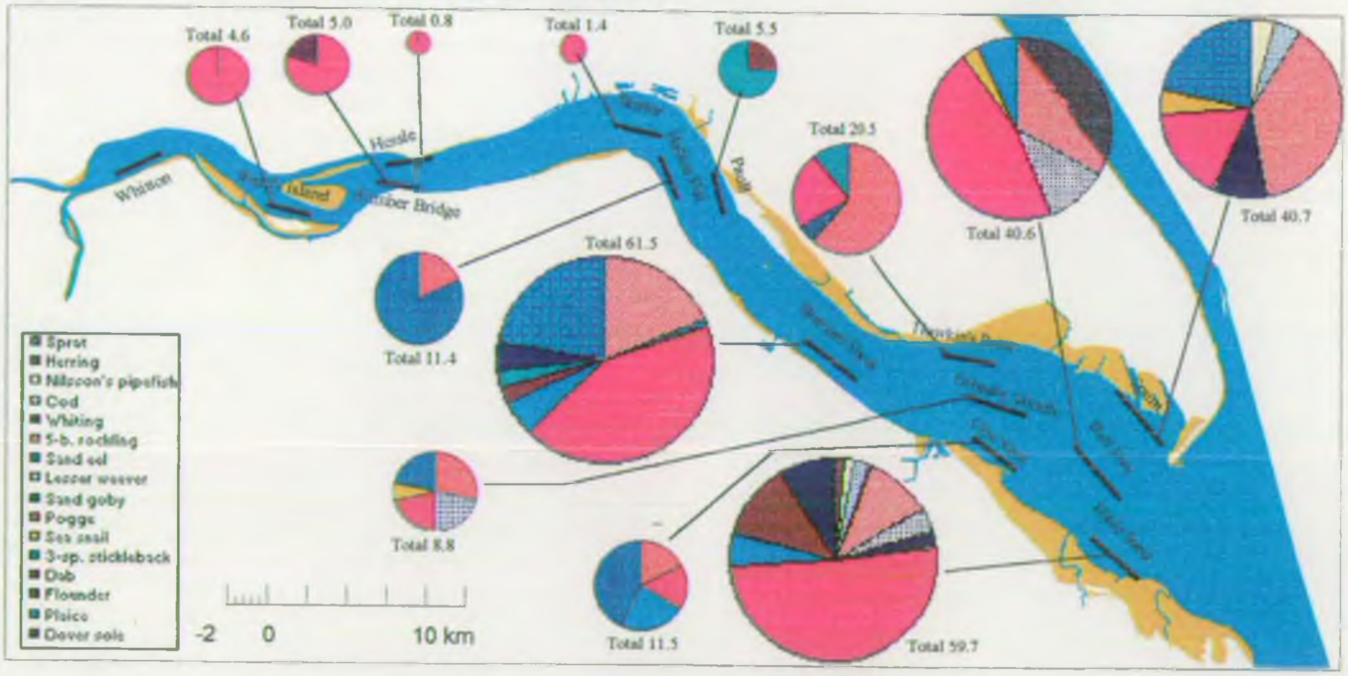
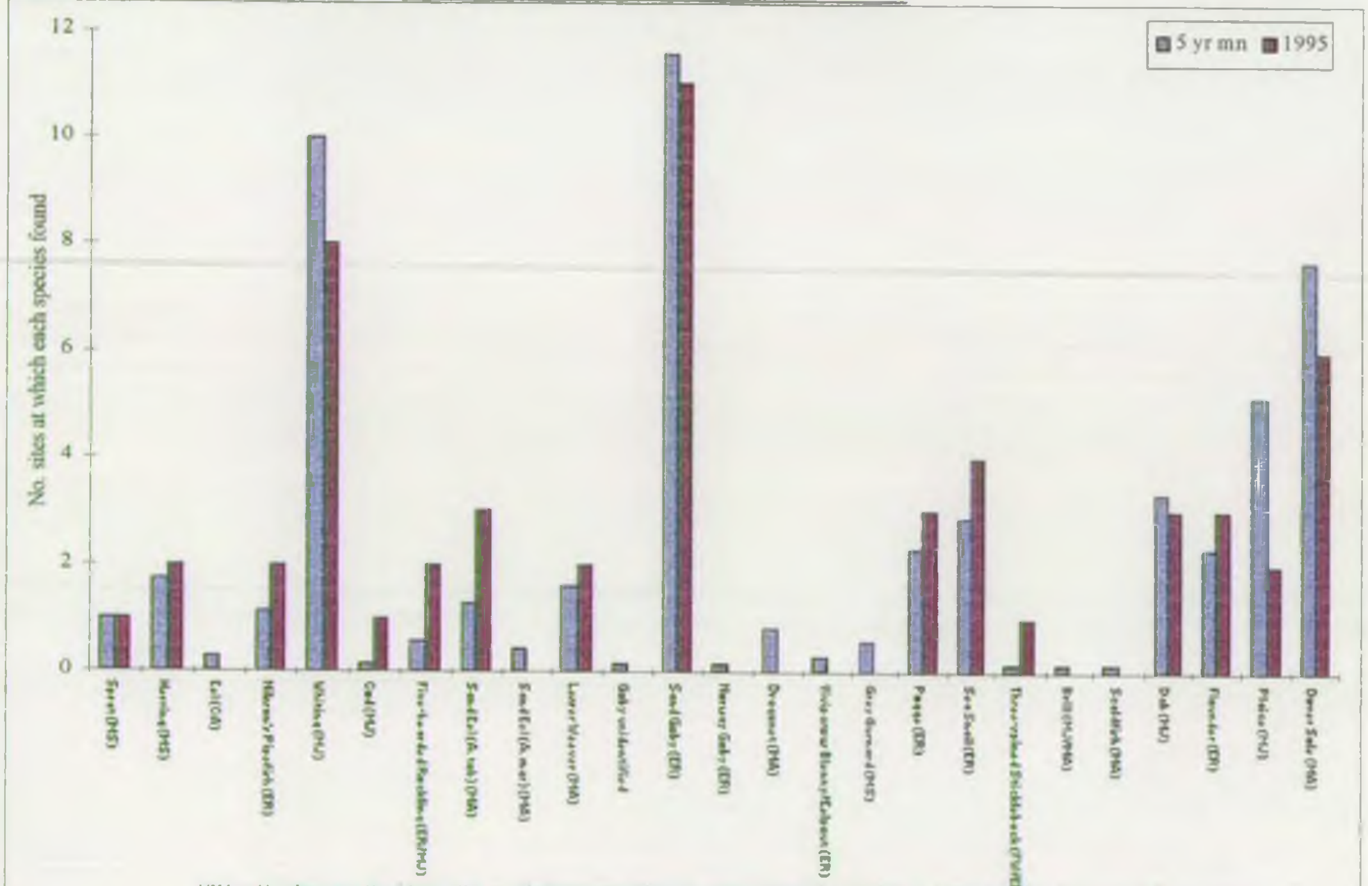


Figure 4.20 Occurrence of Fish Species in September Surveys of the Humber



FW = Freshwater Resident, CA = Diadromous Migrant, ER = Estuarine Resident, MS = Marine Seasonal Migrant, MJ = Marine Juvenile Migrant, MA = Marine Adventurous Migrant (After Pomfret *et al* 1991)

SECTION 5
CLASSIFICATION OF TIDAL RIVERS AND ESTUARIES

5.1 ESTUARY

The Humber Estuary is classified in accordance with the CEWP Classification Scheme (Appendix 9). This scheme assesses the Estuary in terms of biological, aesthetic and water quality with points awarded for each of the criteria met. In broad terms the Humber Estuary is classified as Class B (fair quality) on the South Bank and west of the Humber Bridge, and as Class A (good quality) along the North Bank (Figure 5.1).

This grading is an average of conditions along the banks of the Estuary and localised areas on either bank may be above or below these grades. For instance, although the North Bank is categorised as Class A, there are localised areas with aesthetic problems, particularly close to the Hull East and West crude sewage outfalls.

The Environment Agency is currently funding investigations and research into a more objective method of classifying estuaries, which could be used in conjunction with the General Quality Assessment (GQA) classification for freshwaters (see section 5.2). Until this is completed and the scheme adopted, estuaries will continue to be classified according to the CEWP scheme.

5.2 FRESHWATER INPUTS

Freshwaters are classified according to the GQA Scheme. The basic chemical grade for a river reach is calculated from the BOD, ammonia and dissolved oxygen levels over a three year period. These parameters were selected for use in the scheme because they are indicators of the influence of wastewater discharges and rural land-use runoff including organic, degradable material. It does not take into account contamination by substances included in the EC Dangerous Substances Directive.

Table 5.1 shows details of the GQA classification scheme. Figure 5.1 shows the GQA classification for 1995 and Figure 5.2 indicates the locations of the major industrial and sewage discharges to the Estuary.

Figure 5.1 CEWP Classification Results 1995

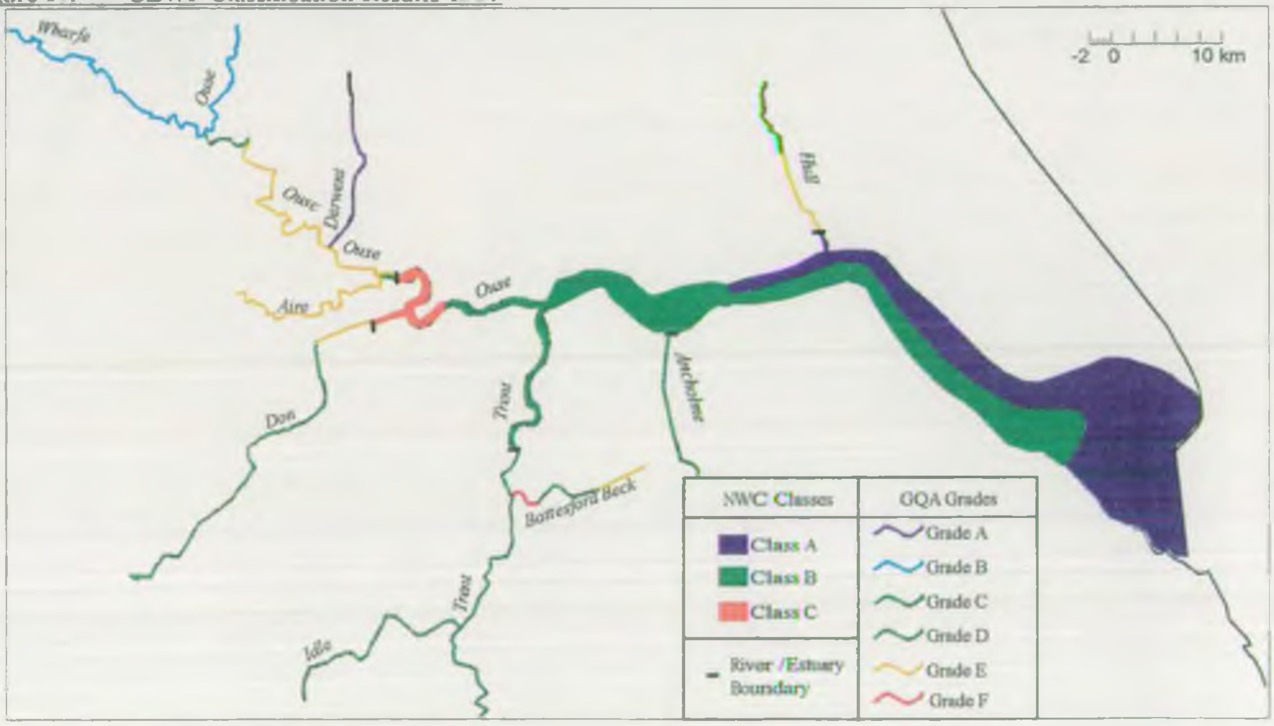


Table 5.1 GOA Chemical Grading for Freshwater Rivers and Canals

Water Quality	Grade	DO (% sat) (10 %ile)	BOD (mg/l) (90 %ile)	Ammonia (mg/l) (90 %ile)
Good	A	80	2.5	0.25
	B	70	4	0.6
Fair	C	60	6	1.3
	D	50	8	2.5
Poor	E	20	15	9
Bad	F	< 20	> 15	> 9
The overall grade assigned to a river or canal reach is determined by the worst grade for each of the three parameters.				

Figure 5.2 Industrial and Sewage Outfalls to the Humber

SECTION 6
MATHEMATICAL MODELLING OF THE HUMBER ESTUARY

6.1 INTRODUCTION

The QUESTS (Quality of Estuaries) suite of water quality models of the Humber system was implemented and verified (calibrated and checked for accuracy against actual data) in 1994. In 1995, QUESTS was used for all water quality modelling work of the Humber and further research and development work was begun to improve the model predictions. Some of the work carried out is summarised below.

6.2 WATER ABSTRACTION FROM INLAND WATERS

Under the current scheme of charges for abstraction licensing, there is a higher charge for abstractions where the water has a chloride concentration of less than 8000 mg/l. The model was used to estimate more accurately the points on the tidal rivers where this value is exceeded. Figures 6.1(a) - (d) show the salinity curves for the tidal river and Ouse-Humber systems.

Figure 6.1a Tidal Aire chloride profile

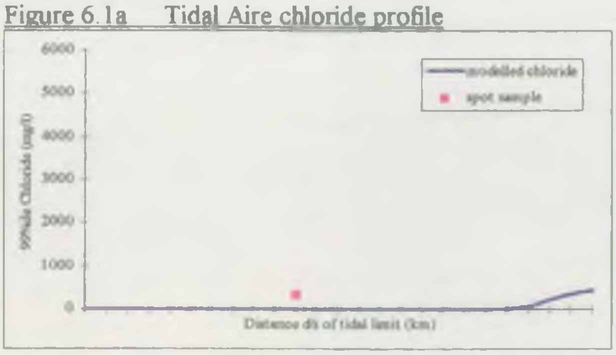


Figure 6.1b Tidal Trent chloride profile

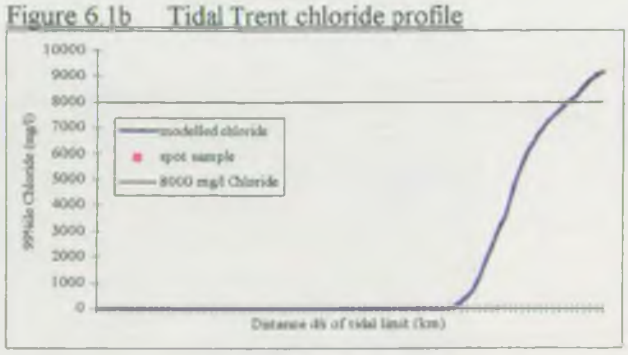


Figure 6.1c Tidal Don chloride profile

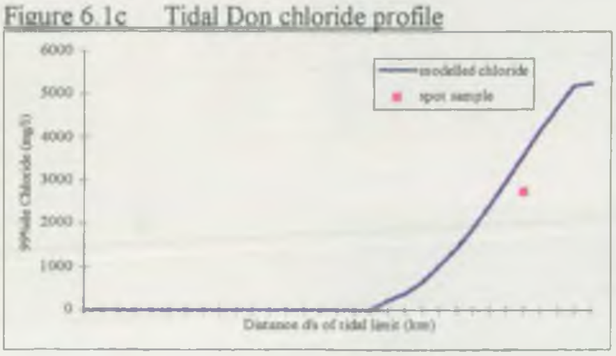
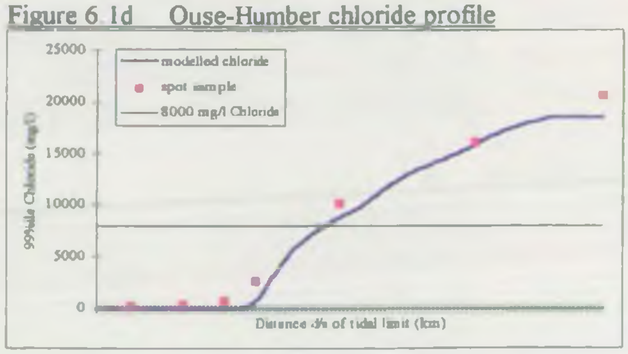


Figure 6.1d Ouse-Humber chloride profile



6.3 MODELLING THE SYSTEM USING 1978 AND 1995 ORGANIC LOAD DATA

Since 1978, there have been some major reductions in the BOD loads in the Rivers Wharfe, Ouse and Don. This has been partly reflected by results from routine chemical samples and continuous monitor data but, since these are at fixed sites, it is difficult to use the results to look for changes such as the extent of the zone of deoxygenation in the Estuary. To look for this type of change, the model was used. Organic load data from 1978 and from 1995, after some of the major reductions had taken effect, was used in the simulations.

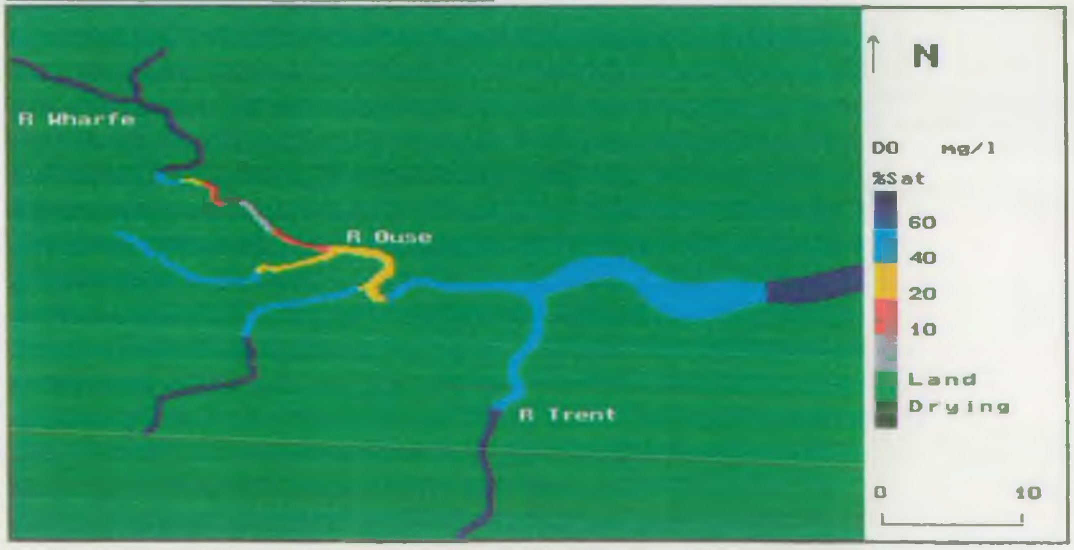
Figure 6.2 shows the modelled changes in dissolved oxygen levels due to reductions in BOD between 1978 and 1995. The 10%ile dissolved oxygen levels are shown, which indicate the conditions in the Estuary during the worst 10% of the year. In 1975, the low oxygen zone in the Ouse extended from above Selby to below the Don confluence. The Wharfe was deoxygenated below Tadcaster almost to the Ouse confluence. The Don and Aire close to the Ouse confluence were also deoxygenated, due to low oxygen water being pushed up the rivers at high tide, as well as local inputs from the rivers themselves.

In 1995, the low oxygen area in the Wharfe had disappeared, and the deoxygenated zone in the Ouse was reduced in size, with the area of very low oxygen levels reduced by two thirds in length. There is now very little deoxygenation in the lower Don, although the lower Aire still has an area of deoxygenation, since the Aire confluence is within the most deoxygenated area of the Ouse.

The results of this modelling work are to be followed up by more detailed data analysis during 1996, to look for statistically significant changes in the actual data.

Figure 6.2a Modelled DO levels - 1978

Figure 6.2b Modelled DO levels - effluent loads 1995



6.4 SEDIMENT OXYGEN DEMAND STUDY

Despite the encouraging results of the modelling work showing improved DO levels due to reduced BOD loads, the oxygen depletion of the lower Ouse remains one of the most significant water quality problems in the tidal Ouse. Work with the QUESTS model suggests that the oxygen demand of suspended sediments forms a significant contribution to the oxygen depletion in the tidal Ouse, tidal Trent and Upper Humber. The model includes a sediment oxygen demand process but the accuracy of the predictions using this process have not been fully tested by comparison with observed data.

Since the assessment of the impact of river discharges carried out with the model are used to help set effluent consents, it is essential that the model predictions are as accurate as possible to ensure the required river standards.

To improve the understanding of the sediment oxygen demand processes, and to quantify the size of the effect on water quality, the Sediment Oxygen Demand Study was initiated in partnership with Sheffield University.

The work began in September 1995, with a review of the existing information on sediment oxygen demand in estuaries. This will be followed by a review of all the available monitoring data from the Humber to establish relationships between tidal range, freshwater flows, suspended solids, temperature and dissolved oxygen conditions.

In addition to the review and theoretical work, field measurements of the oxygen uptake of high turbidity water samples and the organic carbon content and particle size of surface sediments will be carried out during 1996. Oxygen uptake measurements will be carried out on both filtered and total samples and will be based on a stirred BOD test.

Finally, the results from the data collection and analysis will be used to assess the size of the sediment oxygen demand process. The model will then be run to test its ability to accurately represent the sediment oxygen demand process and any modifications or calibration carried out as required.

SECTION 7
1995 QUALITY - CONCLUSIONS

River flows remained low throughout most of 1995 following the previous dry winter.

Dissolved oxygen levels in the tidal rivers deteriorated after improvements in the previous two years, probably as a result of low freshwater flows.

Ammonia levels continued to improve with all sites complying with the EQS.

Concentrations of List I and List II metals generally complied with their respective EQSs.

Copper concentrations improved in the Estuary.

Metal loads generally continued to decrease from tidal rivers, industrial and sewage discharges.

Concentrations of most metals in sediments were below the five-year mean.

Metals at some sites showed increased concentrations in sediments, probably due to mobile sediments releasing historic deposits.

Macroinvertebrate fauna generally remained consistent with previous years.

Macroinvertebrate populations were influenced by natural changes and mobile sediments rather than by pollution or water quality.

Faecal bacteria concentrations showed the influence of localised sewage contamination.

Fish communities generally remained consistent with previous years.

REFERENCES

Barnett, B.E. (1996) *HEC Routine Intertidal Benthic Survey (South Bank): 1995*, Environment Agency (Anglian Region - Northern Area)

Dunn, N (1997) *Humber Estuary Intertidal Report 1995 - North Bank*, Environment Agency (North East Region - Ridings Area)

Environment Agency (1997) *Humber Estuary Quality Report 1994*, Environment Agency: Leeds.

Gudmundsson, H. (1996) *Routine Subtidal Survey 1995. Summary Report*, Environment Agency (Anglian Region) Ref: H.G./Sc.N./96.12.1.

Gudmundsson, H. (1997) *Humber Estuary. Fish Communities - September 1995*, Environment Agency (Anglian Region) Ref.: H.G./Sc.N./97.1.1.

Gudmundsson, H. (1997) *Humber Fish Survey - June 1995*, Environment Agency (Anglian Region) Ref: H.G./M.Sc./97.1.2.

Humber Estuary Committee (1995) *The Quality of the Humber Estuary 1993, Edition 2*, NRA: Leeds.

Jennings, R. (1997) *Report on the Biological Quality of the Tidal Rivers (1995)*, Environment Agency (North East Region, Ridings Area)

Marshall, S. (1995) *The Structure and Functioning of the Fish Assemblage of the Humber Estuary, UK*, Ph.D. Thesis: Univ. Hull.

Marshall, S. & Elliott, M. (1993) *Fishes of the Humber*, unpublished Ph.D. Progress Report.

National Rivers Authority (1993) *The Quality of the Humber Estuary 1980 - 1990. Water Quality Series No.12*, NRA: Bristol.

National Rivers Authority (1995) *Contaminants Entering the Sea. A report on contaminant loads entering the seas around England and Wales for the years 1990 - 1993. Water Quality Series No. 24*, HMSO: London.

Pomfret, J.R., Elliott, M., O'Reilly, M.G. & Philips, S. (1991) 'Spatial and temporal patterns in the fish communities in two UK North Sea estuaries', pp. 277-284 in: ESCA 19th Symposium, Estuaries and Coasts.

Water Research Centre (1990) *Examination of the Range of Copper Complexing Ligands in Natural Waters using a Combination of Cathodic Stripping Voltammetry and Computer Simulation, PRS 2395-M*, WRc: Stevenage.

Wolff (1973) *The Estuary as a Habitat: an analysis of data on the soft-bottom macrofauna on the estuarine area of the Rivers Rhine, Meuse and Scheldt.* Communication No. 16 of the Delta Institute for Hydrobiological Research, Yeserke, The Netherlands.

ACRONYMS

%ile	percentile
A1A	Annex 1A
amm-N	ammoniacal nitrogen
AMP2	Asset Management Plan 2
As	Arsenic
ASPT	Average Score Per Taxon
B	Boron
BATNEEC	Best Available Technique Not Entailing Excessive Costs
BMWP	Biological Monitoring Working Party
BOD	biochemical oxygen demand
BPEO	Best Practicable Environmental Option
Cd	Cadmium
CEWP	Classification of Estuaries Working Party
CMP	Catchment Management Plan
Cr	Chromium
CTC	carbon tetrachloride
Cu	Copper
DCE	1,2,dichloroethane
DDT	dichlorodiphenyltrichloroethane
DO	dissolved oxygen
EQO	Environmental Quality Objective
EQPB	Environmental Quality Project Board
EQS	Environmental Quality Standard
Fe	Iron
GQA	General Quality Assessment
HCH	hexachlorocyclohexane
HEC	Humber Estuary Committee
HESAC	Humber Estuary Scientific Advisory Committee
Hg	Mercury
HMG	Humber Management Group
HMIP	Her Majesty's Inspectorate of Pollution
IPC	Integrated Pollution Control
LEAP	Local Environment Action Plan
LOD	limit of detection
Ni	Nickel
NRA	National Rivers Authority
NWC	National Water Council
Parcom	Paris Commission
Pb	Lead
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PER	tetrachloroethylene
QUESTS	Quality of Estuaries
RSPB	Royal Society for the Protection of Birds
SS	suspended solids
SSA	suspended solids, ashed
SSSI	Site of Special Scientific Interest
TCB	trichlorobenzene
TCE	trichloroethylene
TON	total oxidised nitrogen
un-amm	unionised ammonia
UWWTD	Urban Wastewater Treatment Directive
V	Vanadium
WRA	Waste Regulatory Authority
WRc	Water Research centre
Zn	Zinc

GLOSSARY

N.B. Cross-references are indicated by italic script.

A

Abstraction	Removal of water from surface or groundwater, usually by pumping.
Abundance	The total number of individual organisms recorded in a sample or at a site. [see also *Faunal Abundance*, *Total Abundance*]
Ammonia	A chemical found in water, often as the result of the discharge of sewage effluents. High levels of ammonia affect fisheries and abstractions for potable water supply.
Amphipod	A small, shrimp-like crustacean.
Anaerobic	Containing no oxygen.
Annex 1A	Following the Second North Sea Conference in 1987, the UK Government issued a list of dangerous substances for control to the North Sea (Red List). The Third North Sea Conference of 1990 modified this list (Annex 1A).
Asset Management Plan	A strategic business plan produced by the water companies for the Office of Water Services (OFWAT) setting out the industry's investment programme for the period 1995 to 2000.
Average Score Per Taxon	A statistical refinement of the BMWP Score.

B

Benthic	Referring to life in or on the sea floor.
Bio-accumulation	A mechanism whereby organisms accumulate, in their body tissues, substances which are present in dilute concentration in sea or freshwater.
Biochemical Oxygen Demand	A standard test for measuring the uptake of dissolved oxygen in water by the microbial decomposition of organic matter.
Bio-concentration	A mechanism whereby organisms concentrate, in their body tissues, substances which are present in dilute concentration in sea or freshwater.
Biological Monitoring Working Party Score	A biological index for indicating the health of a river.
Brackish Water	Water which is saltier than freshwater but less salty than seawater.

C

Catchment	The area of land that drains into a particular river system.
Catchment Management Plan	An NRA plan providing a comprehensive framework for addressing all their functions, including flood defence, within the catchment of a main river. [see also *Local Environment Action Plan*]
Confluence	The point at which two rivers meet.
Consent	A statutory document issued by the NRA under Schedule 10 of the Water Resources Act 1991 to indicate any limits and conditions on the discharge of an effluent to a controlled water.
Cumecs	Cubic metres per second (1 cumec = 1000 litres per second).

D

Dangerous Substances .... Substances defined by the European Commission as in need of special control because of their toxicity, bio-accumulation and persistence. The substances are classified as List I or List II according to the Dangerous Substances Directive.

Dissolved Oxygen .... The amount of oxygen dissolved in water, which is an indication of the 'health' of the water and its ability to support aquatic life. It is part of the system used to classify water quality.

'Drins .... A collective term for the insecticides Dieldrin, Endrin, Aldrin and Isodrin, previously used in the textile industry. Total 'drins are controlled under List I of the Dangerous Substances Directive.

E

Environment Agency....................................... A Government body responsible for environmental protection, incorporating the *National Rivers Authority*, *Her Majesty's Inspectorate of Pollution* and the *Waste Regulatory Authorities*.

Environmental Quality Standard....................... A specific limit for the concentration of a particular substance in water.

Eutrophication .... An increase in nutrients in a body of water, which may lead to extensive algal and weed growth, with undesirable consequences.

F

Faecal Coliforms .... Bacteria found in faeces (e.g. human waste).

Faunal Abundance... The total number of individual organisms recorded in a sample or at a site. [see also *Abundance*, *Total Abundance*]

G

General Quality Assessment .... A national method of evaluating water quality whereby the rivers in England and Wales have been divided into reaches each with an allocated chemistry sample point. These points are monitored for BOD, dissolved oxygen and total ammonia with GQA grades assigned accordingly. This scheme is replacing the previous *NWC Classification* scheme.

H

High Shore .... Shoreline nearest to land, covered only at high tide.

Her Majesty's Inspectorate of Pollution .... A Government body responsible for pollution control of inland industries. Now incorporated into the *Environment Agency*.

Hydrocarbons .... Compounds of carbon and hydrogen found in petroleum products (e.g. oil).

I

Integrated Pollution Control............................ An approach to pollution control in the UK which recognises the need to look at the environment as a while, so that solutions to particular pollution problems take account of potential effects upon all environmental media. IPC deals with releases to air, land and water and uses the principles of BATNEEC (Best Available Technique Not Entailing Excessive Costs) and BPEO (Best Practicable Environmental Option).

Intertidal .... The region of shore that lies between the highest and lowest tides.

Invertebrate .... Animal without a backbone.

L

Local Environment Action Plan........................ An Environment Agency plan which provides a comprehensive framework for addressing all its functions within the local environment. These plans replace the NRA's *Catchment Management Plans*.

Lindane.. Gamma HCH: a form of the chemical hexachlorocyclohexane used as a wood preservative and previously used in sheep dip. HCH is controlled under List I of the Dangerous Substances Directive.

Low Shore.. Shoreline uncovered only at very low tides.

M

MAFF....................Ministry of Agriculture, Fisheries and Food.
mg/l....................milligrams per litre (1/1000 of a gram per litre). [see also *ppt*]
Mid Shore....................Shoreline uncovered for approximately half the tidal cycle.

N

ng/l....................nanograms per litre (1/100,000,000 of a gram per litre).
NWC Classification....................A national method of evaluating water quality whereby the rivers in England and Wales have been divided into reaches each with an allocated chemistry sample point. These points are monitored for BOD, dissolved oxygen with total ammonia and NWC classes assigned accordingly. This scheme is being replaced by the new *GQA Classification* scheme.
National Rivers Authority....................A Government body responsible for water quality, resources and pollution control. Now incorporated into the *Environment Agency*.

O

Oligochaetes....................Segmented worms related to the common earthworm.
Organic Complex....................A compound formed between, for example, a metal ion and an organic substance such as a protein.

P

Percentile....................A set of data is arranged in descending order and the n %ile is the greatest value of n % of the sorted data set.
Polychaetes....................Segmented bristle worms.
ppt....................Parts per thousand (equivalent to *mg/l*).

R

Recruitment....................The influx of new members into the population by reproduction or immigration.

S

Site of Special Scientific Interest....................A site given statutory designation by English Nature or the Countryside Council for Wales because of its conservation value.
Species Richness....................The number of different species recorded in a sample or at a site. [see also *Species Variety*]
Species Variety....................The number of different species recorded in a sample or at a site. [see also *Species Richness*]
Subtidal....................The area which lies below the low water mark and which is continuously covered by water.
Suspended Solids....................Solid matter in a water sample which is retained by filtration under specified conditions.
Suspended Solids, Ashed....................Solid matter remaining once the material filtered out of a water sample (under specified conditions) has been incinerated at a specified temperature for a specified period of time.

T

Taxon (pl. taxa)....................A grouping of organisms without defining the taxonomic level.
Taxonomic Level....................The precision with which an organism is identified, i.e. species, genus or family.
Taxon Richness....................The number of different taxa recorded in a sample or at a site.
Tidal Range....................The difference in height between the high and low water levels.
Tidal River....................The stretch of a river between the tidal limit and the estuary proper: subject to tides but not saline.
Total Abundance....................The total number of individual organisms recorded in a sample or at a site. [see also *Abundance*, *Faunal Abundance*]

U

ug/l....................Microgrammes per litre (1/1,000,000 of a gram per litre).

W

Waste Regulatory Authority....................A Local Government body responsible for waste regulation. Now incorporated into the *Environment Agency*.

APPENDIX 1
Environmental Quality Standards for the Humber

For the purpose of defining EQOs, the Humber is divided into a tidal rivers section (from the tidal limits to Trent Falls) and an estuary section (from Trent Falls to the seaward limit - a line drawn between Spurn Point and Donna Nook).

DETERMINAND	TIDAL RIVERS	ESTUARY	COMMENT
Temperature	25°C	25°C	95 %ile
Dissolved oxygen	40% saturation	55% saturation	5 %ile
pH	5.5-9.0	6.0-8.5	95 %ile
Unionised ammonia	0.021 mg/l	0.021 mg/l	95 %ile
Mercury	1.0 ug/l T	0.3 ug/l D	annual mean (1)
Cadmium	5.0 ug/l T	2.5 ug/l D	annual mean (1)
Arsenic	50 ug/l D	25 ug/l D	annual mean (3)
Chromium (III + VI)	250 ug/l D	15 ug/l D	annual mean (3)
Copper (II)	28 ug/l D	5.0 ug/l D	annual mean (2,3)
Lead	250 ug/l D	25 ug/l D	annual mean (3)
Nickel	200 ug/l D	30 ug/l D	annual mean (3)
Zinc	500 ug/l T	40 ug/l D	annual mean (3)
Iron	1000 ug/l D	1000 ug/l D	annual mean (3)
Boron	1000 ug/l T	7000 ug/l T	annual mean (1)
Vanadium	60 ug/l T	100 ug/l T	annual mean (1)
HCH	0.1 ug/l	0.02 ug/l	annual mean (1)
DDT (all isomers)	0.025 ug/l	0.025 ug/l	annual mean (1)
DDT (pp isomer)	0.01 ug/l	0.01 ug/l	annual mean (1)
CTC	12 ug/l	12 ug/l	annual mean (1)
PCP	2 ug/l	2 ug/l	annual mean (1)
Total 'drins	0.03 ug/l	0.3 ug/l	annual mean (1)
Endrin	0.005 ug/l	0.005 ug/l	maximum (1)
TCB	0.4 ug/l	0.4 ug/l	annual mean (1)
TCE	10 ug/l	10 ug/l	annual mean (1)
DCE	10 ug/l	10 ug/l	annual mean (1)
PER	10 ug/l	10 ug/l	annual mean (1)

(1) Mandatory: EC Dangerous Substances Directive Environmental Quality Standards for List I Substances.
(2) Higher values acceptable where acclimation expected or copper present in organic complexes.
(3) National List II Environmental Quality Standard.

APPENDIX 2
Results of Humber Routine Survey: Shore-based Water Quality Sampling

Table A2.1 1995 Results vs. EOS: temp. DO. pH

STATION	Temperature (° C)						Dissolved oxygen (mg/l)						pH					
	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	95 %ile with < at half LOD	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	5 %ile with < at half LOD	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	95 %ile with < at half LOD
TIDAL RIVERS																		
OUSE																		
Cawood	13	0	23.2	2.2	*	22.8	13	0	98.8	45.0	*	51.8	14	0	7.82	7.35	*	7.82
Selby	13	0	25.9	2.2	*	23.9	13	0	104.0	6.8	*	10.3	14	0	7.76	7.22	*	7.75
Drax	14	0	23.2	2.4	*	22.9	14	0	92.5	6.0	*	21.0	14	0	7.73	7.20	*	7.70
Boothferry	13	0	25.0	3.5	*	23.8	11	0	124.0	22.0	*	23.6	14	0	7.71	7.23	*	7.65
Blacktoft	11	0	24.0	3.0	*	23.0	10	0	95.5	43.3	*	45.1	14	0	7.91	7.55	*	7.84
AIRE																		
Snaith	14	0	23.2	3.0	*	22.9	14	0	182.0	37.0	*	46.1	14	0	7.64	7.33	*	7.60
DON																		
Kirk Bramwith	12	0	23.0	3.9	*	22.3	12	0	99.0	34.0	*	36.8	10	0	7.91	7.42	*	7.85
Rawcliffe	14	0	22.7	3.2	*	22.4	14	0	104.0	26.0	*	27.3	12	0	7.92	7.41	*	7.78
TRENT																		
Gainsborough	13	0	23.0	3.0	*	22.4	13	0	122.0	55.0	*	67.6	14	0	8.80	7.80	*	8.61
Keadby	14	0	23.0	3.0	*	22.4	14	0	110.0	46.0	*	49.9	14	0	8.30	7.70	*	8.11
WHARFE																		
Ryther	10	0	25.7	2.1	*	24.3	8	0	107.0	72.8	*	76.6	11	0	8.08	7.58	*	8.06
EQS						25 (95 %ile)						40 (5 %ile)						5.5 - 9.0
ESTUARY																		
Brough	7	0	22.0	3	*	19.60	7	0	88.4	66.5	*	67.7	7	0	7.91	7.65	*	7.89
New Holland	14	0	22.5	3	*	21.53	12	0	93.0	72.4	*	74.6	14	0	8.00	6.60	*	8.00
Albert Dock	14	0	22.0	4	*	22.00	11	0	86.2	69.0	*	70.4	14	0	7.98	7.62	*	7.98
Saltend	12	0	22.1	3.7	*	22.05	12	0	102.0	61.0	*	64.4	14	0	8.04	7.33	*	7.97
Killingholme	14	0	21.5	3	*	20.53	12	0	104.0	81.5	*	81.9	14	0	8.00	7.30	*	8.00
Spurn	14	0	22.0	4	*	20.70	13	0	114.0	78.2	*	78.6	14	0	8.34	7.79	*	8.33
EQS						25 (95 %ile)						55 (5 %ile)						6.0 - 8.5

* No data available
Range of mean is calculated by taking the 'less than' values as equal to zero for the lower value and as equal to the LOD for the higher value (see section 3.4.2).

Table A2.2 1995 Results vs. EOS: un-amm. As. Hg

STATION	Unionised ammonia (mg/l)						Arsenic (ug/l)						Mercury (ug/l)					
	No of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	95 %ile with < at half LOD	No of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS																		
OUSE																		
Cawood	13	0	0.0063	0.0002	*	0.0045	7	3	9.4	< 1.0	2.6 - 3.0	2.8	7	2	0.30	< 0.03	0.08 - 0.11	0.10
Selby	14	0	0.0043	0.0001	*	0.0031	7	1	10.4	< 1.0	4.1 - 4.2	4.1	6	2	0.44	< 0.06	0.11 - 0.15	0.13
Drax	14	0	0.0049	0.0002	*	0.0043	7	0	11.0	1.2	*	5.3	7	2	0.81	< 0.10	0.25 - 0.28	0.27
Boothferry	13	0	0.0051	0.0003	*	0.0037	7	0	13.1	1.8	*	6.7	7	2	0.25	< 0.06	0.10 - 0.13	0.12
Blacktoft	11	0	0.0034	0.0002	*	0.0030	7	0	4.8	1.1	*	3.0	7	0	0.32	0.11	*	0.21
AIRE																		
Snaith	14	0	0.0144	0.0018	*	0.0117	7	0	16.8	2.1	*	8.8	7	3	0.26	< 0.02	0.08 - 0.11	0.10
DON																		
Kirk Bramwith	10	0	0.0200	0.0028	*	0.0169	*	*	*	*	*	*	1	1	< 0.10	< 0.10	0.00 - 0.10	0.05
Rawcliffe	12	0	0.0130	0.0002	*	0.0120	7	0	9.6	1.4	*	5.2	5	1	0.23	< 0.09	0.11 - 0.13	0.12
TRENT																		
Gainsborough	13	1	0.0070	< 0.0010	0.0035 - 0.0035	0.0064	7	0	19.7	1.4	*	6.8	7	2	0.28	< 0.02	0.10 - 0.11	0.10
Keadby	14	3	0.0070	< 0.0010	0.0026 - 0.0028	0.0070	7	0	12.8	2.2	*	7.3	7	0	0.23	0.02	*	0.11
WHARFE																		
Ryther	10	0	0.0073	0.0002	*	0.0060	5	3	4.0	< 1.0	1.1 - 1.7	1.4	5	3	0.05	< 0.02	0.01 - 0.06	0.03
EQS						0.021 (95 %ile)						50 D						1 T
ESTUARY																		
Brough	7	0	0.0021	0.0002	*	0.0018	7	0	4.0	2.3	*	3.0	7	4	0.05	< 0.02	0.01 - 0.04	0.03
New Holland	*	*	*	*	*	*	7	0	4.0	2.0	*	2.7	7	0	0.16	0.02	*	0.10
Albert Dock	14	0	0.0036	0.0002	*	0.0035	7	0	3.3	1.5	*	2.1	7	5	0.05	< 0.02	0.01 - 0.04	0.03
Saltend	12	0	0.0026	0.0002	*	0.0022	7	1	1.9	< 1.0	1.3 - 1.4	1.3	7	4	0.06	< 0.02	0.02 - 0.05	0.03
Killingholme	*	*	*	*	*	*	7	0	2.0	2.0	*	2.0	7	1	0.09	< 0.01	0.05 - 0.05	0.05
Spurn	14	0	0.0038	0.0002	*	0.0037	7	5	1.2	< 1.0	0.3 - 1.0	0.7	6	3	0.05	< 0.02	0.02 - 0.06	0.04
EQS						0.021 (95 %ile)						25 D						0.3 D

T = Total D = Dissolved
* No data available
Range of mean is calculated by taking the 'less than' values as equal to zero for the lower value and as equal to the LOD for the higher value (see section 3.4.2).

Table A2.3 1995 Results vs. EQS: Cu, Cd, Cr

Copper (ug/l)

STATION	No of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	1	5.70	< 1.00	2.78 - 2.92	2.85
Selby	7	0	10.70	1.51	*	5.19
Drax	7	0	12.30	3.43	*	8.01
Boothferry	7	0	14.40	3.05	*	8.08
Blacktoft	6	0	8.02	3.56	*	6.13
AIRE						
Snaith	7	0	20.50	5.76	*	12.77
DON						
Kirk Bramwith	1	0	4.09	4.09	*	4.09
Rawcliffe	6	0	12.60	3.99	*	7.24
TRENT						
Gainsborough	7	0	11.30	5.14	*	8.80
Keadby	7	0	13.10	7.53	*	10.34
WHARFE						
Ryther	4	0	2.72	1.70	*	2.03
EQS						28 D
ESTUARY						
Brough	5	0	17.80	4.78	*	8.17
New Holland	7	0	5.11	1.14	*	2.57
Albert Dock	5	0	8.04	1.27	*	5.53
Saltend	6	0	8.37	4.82	*	6.53
Killingholme	7	0	6.11	1.40	*	3.14
Spurn	6	0	3.81	1.50	*	2.82
EQS						5 D

Cadmium (ug/l)

STATION	No of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	1	0.27	< 0.10	0.15 - 0.17	0.16
Selby	7	0	2.50	0.11	*	0.75
Drax	7	0	2.55	0.21	*	0.86
Boothferry	7	0	0.91	0.12	*	0.35
Blacktoft	7	2	2.10	< 0.10	0.25 - 0.88	0.57
AIRE						
Snaith	7	0	0.70	0.16	*	0.32
DON						
Kirk Bramwith	1	0	0.30	0.30	*	0.30
Rawcliffe	7	0	0.47	0.17	*	0.27
TRENT						
Gainsborough	7	0	2.07	0.15	*	0.66
Keadby	7	2	0.70	< 0.10	0.32 - 0.34	0.33
WHARFE						
Ryther	5	3	0.16	< 0.10	0.05 - 0.11	0.08
EQS						5 T
ESTUARY						
Brough	7	3	2.10	< 0.10	0.10 - 0.77	0.43
New Holland	7	6	0.27	< 0.25	0.04 - 0.25	0.15
Albert Dock	5	3	2.10	< 0.12	0.08 - 1.02	0.55
Saltend	6	2	2.10	< 0.15	0.23 - 0.97	0.60
Killingholme	7	7	< 0.25	< 0.25	0.00 - 0.25	0.13
Spurn	6	3	2.10	< 0.05	0.10 - 0.85	0.47
EQS						2.5 D

Chromium (ug/l)

STATION	No. of Samples	No of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	6	4	2.0	< 1.0	0.5 - 1.2	0.9
Selby	7	5	1.5	< 1.0	0.4 - 1.2	0.8
Drax	7	2	3.4	< 1.0	1.5 - 1.8	1.7
Boothferry	7	1	3.0	< 1.0	1.6 - 1.8	1.7
Blacktoft	7	4	4.4	< 1.0	1.2 - 1.8	1.5
AIRE						
Snaith	7	0	6.1	1.8	*	3.6
DON						
Kirk Bramwith	7	0	2.5	1.1	*	1.6
Rawcliffe	7	1	20.2	< 1.0	4.2 - 4.3	4.3
TRENT						
Gainsborough	7	2	2.6	< 1.0	1.5 - 1.8	1.7
Keadby	7	3	5.1	< 1.0	1.8 - 2.2	2.0
WHARFE						
Ryther	5	4	1.2	< 1.0	0.2 - 1.0	0.6
EQS						250 D
ESTUARY						
Brough	7	2	5.1	< 1.0	2.6 - 2.9	2.7
New Holland	7	6	2.7	< 1.5	0.4 - 1.7	1.0
Albert Dock	7	3	5.9	< 1.0	2.4 - 2.8	2.6
Saltend	7	2	7.1	< 1.0	3.0 - 3.2	3.1
Killingholme	7	5	3.9	< 1.5	1.0 - 2.1	1.5
Spurn	7	2	18.4	< 1.0	5.0 - 5.3	5.2
EQS						15 D

T = Total D = Dissolved

* No data available

Range of mean is calculated by taking the 'less than' values as equal to zero for the lower value and as equal to the LOD for the higher value (see section 3.4.2).

Table A2.4 1995 Results vs. EQS: Ni, Pb, Zn

Nickel (ug/l)

STATION	No of Samples	No of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	2	3.6	< 1.0	1.8 - 2.1	1.9
Selby	7	1	9.0	< 1.0	3.9 - 4.0	4.0
Drax	7	0	12.1	1.3	*	6.2
Boothferry	7	0	9.9	2.5	*	6.4
Blacktoft	6	0	10.8	5.6	*	7.8
AIRE						
Snaith	7	0	16.3	5.4	*	10.6
DON						
Kirk Bramwith	7	0	21.1	10.3	*	18.4
Rawcliffe	7	0	22.1	5.9	*	10.9
TRENT						
Gainsborough	7	0	27.9	8.8	*	16.8
Keadby	5	0	12.5	5.7	*	8.9
WHARFE						
Ryther	4	3	1.9	< 1.0	1.2 - 1.4	1.3
EQS						200 D
ESTUARY						
Brough	7	1	10.4	< 5.0	6.8 - 7.5	7.2
New Holland	7	0	5.6	3.5	*	4.6
Albert Dock	7	3	9.8	< 5.0	4.7 - 6.8	5.8
Saltend	7	1	10.2	< 5.0	6.1 - 6.8	6.4
Killingholme	7	0	3.7	2.9	*	3.4
Spurn	7	2	8.1	< 2.4	3.7 - 5.1	4.4
EQS						30 D

Lead (ug/l)

STATION	No of Samples	No of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	2	1.7	< 1.0	1.0 - 1.3	1.1
Selby	7	4	1.5	< 1.0	0.5 - 1.1	0.8
Drax	7	6	1.3	< 1.0	0.2 - 1.0	0.6
Boothferry	7	6	1.9	< 1.0	0.3 - 1.1	0.7
Blacktoft	7	4	8.9	< 1.0	1.9 - 2.6	2.2
AIRE						
Snaith	7	3	1.6	< 1.0	1.1 - 1.3	1.2
DON						
Kirk Bramwith	7	2	1.7	< 1.0	0.9 - 1.2	1.1
Rawcliffe	7	3	2.1	< 1.0	0.9 - 1.4	1.2
TRENT						
Gainsborough	*	*	*	*	*	*
Keadby	*	*	*	*	*	*
WHARFE						
Ryther	5	0	1.9	1.0	*	1.3
EQS						250 D
ESTUARY						
Brough	6	4	2.9	< 1.0	1.0 - 1.9	1.4
New Holland	7	7	< 2.5	< 2.5	0.0 - 2.5	1.3
Albert Dock	5	3	13.9	< 1.0	3.2 - 4.1	3.7
Saltend	6	2	13.9	< 1.0	4.5 - 4.9	4.7
Killingholme	7	7	< 2.5	< 2.5	0.0 - 2.5	1.3
Spurn	7	2	5.3	< 1.0	2.1 - 2.5	2.3
EQS						25 D

Zinc (ug/l)

STATION	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	1	211.0	< 20.0	77.7 - 80.6	79.1
Selby	7	0	952.0	21.0	*	236.1
Drax	7	0	734.0	37.0	*	282.1
Boothferry	7	1	378.0	< 20.0	134.6 - 137.4	136.0
Blacktoft	7	0	211.0	78.0	*	125.8
AIRE						
Snaith	7	0	281.0	43.0	*	113.1
DON						
Kirk Bramwith	6	0	70.0	34.0	*	48.8
Rawcliffe	7	0	148.0	36.0	*	90.4
TRENT						
Gainsborough	7	0	319.0	35.8	*	128.8
Keadby	7	0	215.0	64.9	*	107.3
WHARFE						
Ryther	5	3	48.0	< 20.0	16.6 - 28.6	22.6
EQS						500 T
ESTUARY						
Brough	7	0	24.2	5.8	*	15.0
New Holland	7	0	18.6	6.0	*	12.3
Albert Dock	7	0	24.1	9.2	*	14.5
Saltend	7	0	33.0	14.2	*	20.8
Killingholme	7	0	15.1	7.3	*	11.4
Spurn	6	0	21.3	9.0	*	15.4
EQS						40 D

T = Total D = Dissolved

* No data available

Range of mean is calculated by taking the 'less than' values as equal to zero for the lower value and as equal to the LOD for the higher value (see section 3.4.2).

Table A2.5 1995 Results vs. EOS: Fe, B, V

STATION	Iron (ug/l) No of Samples	No of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	2	127	< 30	61 - 71	66
Selby	7	1	104	< 35	62 - 67	64
Drax	7	2	98	< 30	52 - 62	57
Boothferry	7	3	97	< 30	38 - 54	46
Blacktoft	7	6	46	< 30	7 - 37	22
AIRE						
Snaith	7	1	174	< 30	110 - 115	112
DON						
Kirk Bramwith	7	0	138	31	*	99
Rawcliffe	7	1	1360	< 30	239 - 243	241
TRENT						
Gainsborough	7	5	78	< 30	19 - 40	30
Keadby	6	3	176	< 30	47 - 62	55
WHARFE						
Ryther	5	1	112	< 30	65 - 71	68
EQS						1000 D
ESTUARY						
Brough	7	4	44	< 30	18 - 37	28
New Holland	7	7	< 100	< 100	0 - 100	50
Albert Dock	7	5	46	< 30	13 - 37	25
Saltend	7	5	60	< 30	15 - 39	27
Killingholme	6	6	< 100	< 100	0 - 100	50
Spurn	7	6	90	< 30	13 - 43	28
EQS						1000 D

STATION	Boron (ug/l) No of Samples	No of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	2	158	< 30	65 - 94	79
Selby	6	1	408	< 45	187 - 204	195
Drax	6	0	670	73	*	359
Boothferry	7	0	921	80	*	440
Blacktoft	7	0	2400	232	*	1462
AIRE						
Snaith	6	0	568	149	*	423
DON						
Kirk Bramwith	7	0	743	195	*	541
Rawcliffe	6	0	1310	256	*	604
TRENT						
Gainsborough	7	0	726	208	*	483
Keadby	7	0	1080	197	*	610
WHARFE						
Ryther	5	1	104	< 24	50 - 70	60
EQS						1000 T
ESTUARY						
Brough	7	0	2930	425	*	1926
New Holland	6	0	3	1	*	2
Albert Dock	7	0	3480	991	*	2837
Saltend	7	0	3924	1255	*	3208
Killingholme	6	0	3	3	*	3
Spurn	6	0	4660	3973	*	4354
EQS						7000 T

STATION	Vanadium (ug/l) No of Samples	No of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	1	55.90	< 1.00	20.50 - 20.65	20.58
Selby	7	0	312.00	2.26	*	79.82
Drax	7	0	175.00	7.02	*	76.37
Boothferry	7	0	133.00	2.40	*	44.53
Blacktoft	7	3	26.40	< 1.00	9.78 - 12.92	11.35
AIRE						
Snaith	6	0	75.30	1.10	*	21.64
DON						
Kirk Bramwith	7	0	14.70	1.06	*	4.55
Rawcliffe	6	1	30.50	< 1.00	11.61 - 11.77	11.69
TRENT						
Gainsborough	7	0	71.60	3.42	*	25.60
Keadby	7	0	61.60	11.30	*	31.17
WHARFE						
Ryther	5	3	10.00	< 1.00	2.65 - 3.25	2.95
EQS						60 T
ESTUARY						
Brough	6	1	55.10	< 4.59	17.07 - 20.40	18.73
New Holland	6	3	30.00	< 20.00	12.33 - 22.33	17.33
Albert Dock	7	1	30.30	< 1.46	11.02 - 13.88	12.45
Saltend	7	1	40.70	< 7.60	14.15 - 17.00	15.58
Killingholme	6	5	20.00	< 20.00	3.33 - 20.00	11.67
Spurn	7	1	35.20	< 3.33	10.35 - 13.21	11.78
EQS						100 T

T = Total D = Dissolved
* No data available
Range of mean is calculated by taking the 'less than' values as equal to zero for the lower value and as equal to the LOD for the higher value (see section 3.4.2)

Table A2.6 1995 Results vs. EOS: TCB, TCE, DCE

STATION	Trichlorobenzene (ug/l) No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	*	*	*	*	*	*
Selby	*	*	*	*	*	*
Drax	*	*	*	*	*	*
Boothferry	*	*	*	*	*	*
Blacktoft	*	*	*	*	*	*
AIRE						
Snaith	*	*	*	*	*	*
DON						
Kirk Bramwith	*	*	*	*	*	*
Rawcliffe	*	*	*	*	*	*
TRENT						
Gainsborough	1	0	*	*	*	0.15
Keadby	1	0	*	*	*	0.15
WHARFE						
Ryther	*	*	*	*	*	*
EQS						0.4 T
ESTUARY						
Brough	*	*	*	*	*	*
New Holland	*	*	*	*	*	*
Albert Dock	*	*	*	*	*	*
Saltend	*	*	*	*	*	**
Killingholme	*	*	*	*	*	*
Spurn	*	*	*	*	*	*
EQS						0.4 T

STATION	Trichloroethylene (ug/l) No of Samples	No of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	0	0.1	0.1	*	0.1
Selby	7	0	0.1	0.1	*	0.1
Drax	7	0	0.1	0.1	*	0.1
Boothferry	7	0	0.6	0.1	*	0.2
Blacktoft	7	0	0.3	0.1	*	0.1
AIRE						
Snaith	7	0	0.1	0.1	*	0.1
DON						
Kirk Bramwith	5	5	< 0.1	< 0.1	0.0 - 0.1	0.1
Rawcliffe	4	0	0.1	0.1	*	0.1
TRENT						
Gainsborough	5	4	0.2	< 0.1	0.0 - 0.1	0.1
Keadby	5	5	< 0.1	< 0.1	0.0 - 0.1	0.1
WHARFE						
Ryther	2	0	0.1	0.1	*	0.1
EQS						10 T
ESTUARY						
Brough	7	0	0.1	0.1	*	0.1
New Holland	*	*	*	*	*	*
Albert Dock	6	0	0.1	0.1	*	0.1
Saltend	5	0	0.1	0.1	*	0.1
Killingholme	*	*	*	*	*	*
Spurn	7	0	0.1	0.1	*	0.1
EQS						10 T

STATION	1,2,Dichloroethane (ug/l) No of Samples	No of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS						
OUSE						
Cawood	7	0	0.1	0.1	*	0.1
Selby	7	0	0.1	0.1	*	0.1
Drax	7	0	0.2	0.1	*	0.1
Boothferry	7	0	0.4	0.1	*	0.2
Blacktoft	7	0	2.6	0.1	*	0.5
AIRE						
Snaith	7	0	1.0	0.1	*	0.3
DON						
Kirk Bramwith	*	*	*	*	*	*
Rawcliffe	4	0	0.1	0.1	*	0.1
TRENT						
Gainsborough	5	5	< 1.0	< 1.0	0.0 - 1.0	0.5
Keadby	5	5	< 1.0	< 1.0	0.0 - 1.0	0.5
WHARFE						
Ryther	2	0	0.1	0.1	*	0.1
EQS						10 T
ESTUARY						
Brough	7	0	0.1	0.1	*	0.1
New Holland	*	*	*	*	*	*
Albert Dock	6	0	0.1	0.1	*	0.1
Saltend	5	0	1.4	0.1	*	0.4
Killingholme	*	*	*	*	*	*
Spurn	7	0	0.1	0.1	*	0.1
EQS						10 T

* No data available
Range of mean is calculated by taking the 'less than' values as equal to zero for the lower value and as equal to the LOD for the higher value (see section 3.4.2).

Table A2.7 1995 Results vs. EQS: PER, PCP, CTC

STATION	Tetrachloroethylene (ug/l)						Pentachlorophenol (ug/l)						Carbon Tetrachloride (ug/l)					
	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS																		
OUSE																		
Cawood	7	0	0.28	0.1	*	0.13	6	0	0.2	0.2	*	0.2	7	0	0.1	0.1	*	0.10
Selby	7	0	0.25	0.1	*	0.12	7	0	0.2	0.2	*	0.2	7	0	0.1	0.1	*	0.10
Drax	7	0	0.10	0.1	*	0.10	7	0	0.2	0.2	*	0.2	7	0	0.1	0.1	*	0.10
Boothferry	7	0	0.29	0.1	*	0.13	6	0	0.2	0.2	*	0.2	7	0	0.1	0.1	*	0.10
Blacktoft	7	0	0.62	0.1	*	0.20	7	0	0.2	0.2	*	0.2	7	0	0.4	0.1	*	0.14
AIRE																		
Snaith	7	0	0.13	0.1	*	0.10	6	0	0.2	0.2	*	0.2	7	0	0.1	0.1	*	0.10
DON																		
Kirk Bramwith	6	6	< 0.10	< 0.1	0.0 - 0.10	0.05	6	0	0.2	0.2	*	0.2	5	0	0.1	0.1	*	0.10
Rawcliffe	4	0	0.10	0.1	*	0.10	6	0	0.2	0.2	*	0.2	4	0	0.1	0.1	*	0.10
TRENT																		
Gainsborough	5	5	< 0.10	< 0.1	0.0 - 0.10	0.05	*	*	*	*	*	*	*	*	*	*	*	*
Keadby	6	6	< 0.10	< 0.1	0.0 - 0.10	0.05	*	*	*	*	*	*	*	*	*	*	*	*
WHARFE																		
Ryther	2	0	0.10	0.1	*	0.10	5	0	0.2	0.2	*	0.2	4	0	0.1	0.1	*	0.10
EQS						10 T						2 T						12 T
ESTUARY																		
Brough	7	0	0.36	0.1	*	0.14	6	0	0.2	0.2	*	0.2	7	0	0.1	0.1	*	0.10
New Holland	*	*	*	*	*	*	7	7	< 0.1	< 0.1	0.0 - 0.1	0.1	*	*	*	*	*	*
Albert Dock	6	0	0.38	0.1	*	0.15	7	0	0.2	0.2	*	0.2	6	0	0.1	0.1	*	0.10
Saltend	5	0	0.33	0.1	*	0.15	7	0	0.2	0.2	*	0.2	5	0	0.2	0.1	*	0.12
Killingholme	*	*	*	*	*	*	7	7	< 0.1	< 0.1	0.0 - 0.1	0.1	*	*	*	*	*	*
Spurn	7	0	0.10	0.1	*	0.10	7	0	0.2	0.2	*	0.2	7	0	0.1	0.1	*	0.10
EQS						10 T						2 T						12 T

* No data available

Range of mean is calculated by taking the 'less than' values as equal to zero for the lower value and as equal to the LOD for the higher value (see section 3.4.2).

Table A2.8 1995 Results vs. EQS: HCH, 'drins, Endrin

STATION	Hexachlorocyclohexane (ug/l)						Total 'drins (ug/l)						Endrin (ug/l)					
	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS																		
OUSE																		
Cawood	7	6	0.0060	< 0.0010	0.0027 - 0.0037	0.0032	7	7	< 0.005	< 0.001	0.0001 - 0.0089	0.0045	7	7	< 0.005	< 0.002	0 - 0.0024	0.0012
Selby	7	5	0.0160	< 0.0010	0.0066 - 0.0076	0.0071	7	7	< 0.004	< 0.001	0.0004 - 0.0087	0.0046	7	7	< 0.002	< 0.002	0 - 0.0020	0.0010
Drax	7	3	0.0420	< 0.0010	0.0133 - 0.0137	0.0135	7	7	< 0.005	< 0.001	0.0011 - 0.0094	0.0053	7	7	< 0.005	< 0.002	0 - 0.0024	0.0012
Boothferry	5	2	0.0320	< 0.0010	0.0144 - 0.0148	0.0146	5	5	< 0.005	< 0.001	0.0000 - 0.0092	0.0046	5	5	< 0.005	< 0.002	0 - 0.0026	0.0013
Blacktoft	6	5	0.0085	< 0.0010	0.0028 - 0.0038	0.0033	6	6	< 0.004	< 0.001	0.0007 - 0.0085	0.0046	6	6	< 0.002	< 0.002	0 - 0.0020	0.0010
AIRE																		
Snaith	7	1	0.1890	< 0.0020	0.0619 - 0.0633	0.0626	7	7	< 0.010	< 0.001	0.0011 - 0.0146	0.0079	7	7	< 0.010	< 0.002	0 - 0.0036	0.0018
DON																		
Kirk Bramwith	6	6	< 0.0510	< 0.0010	0.0170 - 0.0180	0.0175	6	6	< 0.004	< 0.001	0.0000 - 0.0090	0.0045	6	6	< 0.002	< 0.002	0 - 0.0020	0.0010
Rawcliffe	5	4	0.0270	< 0.0010	0.0082 - 0.0092	0.0087	5	5	< 0.005	< 0.001	0.0000 - 0.0104	0.0052	5	5	< 0.005	< 0.002	0 - 0.0026	0.0013
TRENT																		
Gainsborough	7	7	< 0.0230	< 0.0050	0.0060 - 0.0146	0.0103	7	7	< 0.005	< 0.005	0.0000 - 0.0200	0.0100	7	7	< 0.005	< 0.005	0 - 0.0050	0.0025
Keadby	7	7	< 0.0130	< 0.0050	0.0019 - 0.0111	0.0065	7	7	< 0.005	< 0.005	0.0000 - 0.0200	0.0100	7	7	< 0.005	< 0.005	0 - 0.0050	0.0025
WHARFE																		
Ryther	5	5	< 0.0030	< 0.0010	0.0016 - 0.0030	0.0023	5	5	< 0.004	< 0.001	0.0000 - 0.0074	0.0037	5	5	< 0.002	< 0.002	0 - 0.0020	0.0010
EQS						0.1 T						0.03 T						0.005 T
ESTUARY																		
Brough	7	5	0.0150	< 0.0010	0.0049 - 0.0056	0.0052	7	7	< 0.004	< 0.001	0.0006 - 0.0087	0.0046	7	7	< 0.002	< 0.002	0 - 0.0020	0.0010
New Holland	7	7	< 0.0060	< 0.0050	0.0009 - 0.0051	0.0030	7	7	< 0.005	< 0.005	0.0000 - 0.0150	0.0075	7	7	< 0.005	< 0.005	0 - 0.0050	0.0025
Albert Dock	7	6	0.0065	< 0.0010	0.0024 - 0.0033	0.0029	7	7	< 0.004	< 0.001	0.0003 - 0.0084	0.0044	7	7	< 0.002	< 0.002	0 - 0.0020	0.0010
Saltend	7	7	< 0.0180	< 0.0010	0.0040 - 0.0050	0.0045	7	7	< 0.004	< 0.001	0.0000 - 0.0084	0.0042	7	7	< 0.002	< 0.002	0 - 0.0020	0.0010
Killingholme	7	7	< 0.0050	< 0.0050	0.0000 - 0.0050	0.0025	7	7	< 0.005	< 0.005	0.0000 - 0.0150	0.0075	7	7	< 0.005	< 0.005	0 - 0.0050	0.0025
Spurn	6	6	< 0.0020	< 0.0010	0.0012 - 0.0023	0.0018	6	6	< 0.005	< 0.001	0.0000 - 0.0085	0.0043	6	6	< 0.005	< 0.002	0 - 0.0025	0.0013
EQS						0.02 T						0.3 T						0.005 T

* No data available

Range of mean is calculated by taking the 'less than' values as equal to zero for the lower value and as equal to the LOD for the higher value (see section 3.4.2).

Table A2.9 1995 Results vs. EQS: DDT. DDT (PP)

STATION	Total DDT (ug/l)						DDT - PP isomer (ug/l)					
	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD	No. of Samples	No. of Samples < LOD	Max with < at half LOD	Min with < at half LOD	Range of Mean	Mean with < at half LOD
TIDAL RIVERS												
OUSE												
Cawood	7	7	< 0.004	< 0.001	0.000 - 0.005	0.002	7	7	< 0.004	< 0.002	0.000 - 0.003	0.002
Selby	7	6	0.097	< 0.001	0.014 - 0.018	0.016	7	6	0.042	< 0.002	0.006 - 0.009	0.007
Drax	7	7	< 0.024	< 0.001	0.003 - 0.007	0.005	6	5	0.024	< 0.002	0.004 - 0.007	0.005
Boothferry	5	5	< 0.009	< 0.001	0.002 - 0.006	0.004	5	4	0.009	< 0.002	0.002 - 0.004	0.003
Blacktoft	6	6	< 0.004	< 0.001	0.000 - 0.005	0.002	6	6	< 0.004	< 0.002	0.000 - 0.003	0.002
AIRE												
Snaith	7	7	< 0.010	< 0.001	0.000 - 0.008	0.004	7	6	0.005	< 0.002	0.000 - 0.004	0.002
DON												
Kirk Bramwith	6	6	< 0.004	< 0.001	0.000 - 0.005	0.002	6	6	< 0.004	< 0.002	0.000 - 0.003	0.002
Rawcliffe	5	5	< 0.004	< 0.001	0.000 - 0.005	0.002	5	5	< 0.004	< 0.002	0.000 - 0.004	0.002
TRENT												
Gainsborough	7	7	< 0.025	< 0.005	0.000 - 0.016	0.008	7	7	< 0.025	< 0.005	0.000 - 0.008	0.004
Keadby	7	7	< 0.008	< 0.005	0.001 - 0.010	0.006	7	6	0.008	< 0.005	0.001 - 0.005	0.003
WHARFE												
Ryther	5	5	< 0.004	< 0.001	0.000 - 0.004	0.002	5	5	< 0.004	< 0.002	0.000 - 0.003	0.001
EQS						0.025 T						0.01 T
ESTUARY												
Brough	7	7	< 0.004	< 0.001	0.000 - 0.005	0.002	7	7	< 0.004	< 0.002	0.000 - 0.003	0.002
New Holland	7	7	< 0.005	< 0.005	0.000 - 0.009	0.005	6	7	0.003	< 0.005	0.000 - 0.005	0.003
Albert Dock	7	7	< 0.004	< 0.001	0.000 - 0.005	0.002	7	7	< 0.004	< 0.002	0.000 - 0.003	0.002
Saltend	7	7	< 0.004	< 0.001	0.000 - 0.005	0.002	7	7	< 0.004	< 0.002	0.000 - 0.003	0.002
Killingholme	7	7	< 0.005	< 0.005	0.000 - 0.010	0.005	7	7	< 0.005	< 0.005	0.000 - 0.005	0.003
Spurn	6	6	< 0.004	< 0.001	0.000 - 0.005	0.002	6	6	< 0.004	< 0.002	0.000 - 0.003	0.002
EQS						0.025 T						0.01 T

* No data available

Range of mean is calculated by taking the 'less than' values as equal to zero for the lower value and as equal to the LOD for the higher value (see section 3.4.2).

APPENDIX 3
Sites Used in Load Calculations

Included in Humber Routine Survey and Parcom/A1A:

Rivers	Sewage	Trade
Ancholme	Pyewipe	Ciba Geigy
Aire @ Beal	Hull East	Courtaulds
Derwent @ Loftsome Bridge	Hull West	Hydro Fertilisers
Ouse @ Naburn Weir	Newton Marsh	MTM @ Barton
Don @ North Bridge		SCM Chemicals
Wharfe @ Tadcaster		Tioxide UK
Trent @ Dunham		Howden Products (ex-Britag)
		British Aerospace
		Croda (Goole)
		Haarmann & Reimer
		BP Chemicals

Included in Humber Routine Survey but not in Parcom/A1A:

Rivers	Sewage	Trade
Idle @ Misterton	Sandall	British Steel
Bottesford Beck @ Snake Plantation	Thorne	Keadby Power Station
Three Rives @ Keadby		Pilkingtons
Hull @ Drypool		Rigid Paper Products
		BOCM Olympia Mills
		Doverstrand
		Harlow Chemicals

Included in Parcom/A1A but not in Humber Routine Survey:

Rivers	Sewage	Trade
Idle @ Bawtry	Immingham	British Sugar
Hull @ Hempholme Lock	Louth	Hazelwoods
	Beverley	Capper Pass
	Goole	
	Selby	

APPENDIX 4
Biological Monitoring Working Party Score

Following the disappointing results of the 1970 biological classification of rivers, a Biological Monitoring Working Party (BMWP) was set up to recommend a biological classification of river water quality for use in national river pollution surveys. This finally recommended a classification of "...the biological condition of rivers based on a score system." Economic constraints, in terms of resources available for such surveys, dictated that the system should be simple, necessitating a compromise between ecological validity and logistic feasibility. The simple system resulting should, however, satisfy the not-very-demanding requirements of a broad classification system. More ecologically exacting systems can still be used for specific purposes.

The BMWP Score is the sum of the points attributed to different invertebrate families according to their degree of tolerance to organic pollution. Erring on the safe-side, the most tolerant species within each family is used in allocating the points. Each family occurring in a sample is scored only once - no matter how many species are represented.

The Average Score Per Taxon (ASPT) allows comparison between different sampling sites where the varying numbers of organisms may give considerably different BMWP Scores.

FAMILIES	SCORE
Siphlonuridae; Heptageniidae; Leptophlebiidae; Ephemerellidae; Potamanthidae Ephemeridae Taeniopterygidae; Leuctridae; Capniidae; Perlodidae; Perlidae; Chloroperlidae Aphelocheiridae Phryganeidae; Molannidae; Beraeidae; Odontoceridae; Leptoceridae; Goeridae; Lepidostomatidae; Brachycentridae; Sericostomatidae	10
Astacidae Lestidae; Agriidae; Gomphidae; Cordulegasteridae; Aeshnidae; Corduliidae; Libellulidae Psychomyiidae (Ecnomidae) Philopotamidae	8
Caenidae Nemouridae Rhyacophilidae (Glossosomatidae); Polycentropodidae; Limnephilidae	7
Neritidae; Viviparidae; Ancylidae (Acroloxidae) Hydroptilidae Unionidae Corophiidae; Gammaridae (Crangonyctidae) Platycnemididae; Coenagriidae	6
Mesoveliidae; Hydrometridae; Gerridae; Nepidae; Naucoridae; Notonectidae; Pleidae, Corixidae Haliplidae; Hygrobiidae; Dytiscidae (Noteridae) Gyrinidae Hydrophilidae (Hydraenidae) Clambidae; Scirtidae; Dryopidae; Elmidae; Chrysomelidae; Curculionidae Hydrophsychidae Tipulidae; Simuliidae Planariidae (Dugesiidae); Dendrocoelidae	5
Baetidae Sialidae Piscicolidae	4
Valvatidae; Hydrobiidae (Bithyniidae); Lymnaeidae; Physidae; Planorbidae; Spaeridae Glossiphoniidae, Hirudinidae; Erpobdellidae Asellidae	3
Chironomidae	2
Oligochaeta (whole class)	1

APPENDIX 5
Results of Humber Routine Survey: Tidal Rivers Biological Sampling

TAXA	TRENT Dunham	TRENT Gainsborough	TRENT Keadby	AIRE Snaith	DON Thorne Bridge	WHARFE Ryther	HULL Beverley	HULL Sutton Rd Br	OUSE Cawood	OUSE Drax	OUSE Saltmarsh
FLATWORMS											
Dugesiidae	-	-	-	-	-	7	-	-	-	-	-
Dendrocoelidae	-	-	-	-	-	1	-	-	-	-	-
ROUNDWORMS											
Nematoda	-	-	-	-	-	1	-	-	-	-	1
SNAILS											
Theodoxus fluviatilis	-	-	-	-	-	40	-	-	-	-	-
Potamopyrgus jenkinsi	FEW	-	-	-	-	-	-	-	-	-	-
Bithynia tentaculata	PRESENT	-	-	-	-	-	-	-	-	-	-
Bithynia leachii	-	-	-	-	-	1	-	-	-	-	-
Lymnea peregra	PRESENT	-	-	-	-	-	-	-	-	-	-
Planorbidae	-	-	-	-	-	-	1	-	-	-	-
Ancylus fluviatilis	-	-	-	-	-	2	-	-	-	-	-
BIVALVES											
Sphaerium sp.	FEW	-	-	-	-	-	4	-	-	-	-
Sphaerium corneum	-	-	-	-	-	80	-	-	-	-	-
Pisidium sp.	COMMON	-	-	-	-	40	-	-	-	-	-
WORMS											
OLIGOCHAETA	-	-	-	-	-	656	248	1	-	-	-
Tibificidae	COMMON	PRESENT	-	-	6	-	-	-	-	-	-
Tubifex/Potamothrix indet.	-	-	-	-	-	-	-	-	5	-	-
Limnodrilus sp.	-	-	-	-	18	-	-	-	-	-	-
Limnodrilus/Potamothrix indet.	-	-	-	-	-	-	-	-	24	-	-
Limnodrilus claparedeanus	-	-	-	-	-	-	-	-	2	-	-
L. hoffmeisteri	-	-	-	-	107	-	-	-	3	-	-
Potamothrix moldaviensis	-	-	-	-	-	-	-	-	1	-	-
LEECHES											
Glossipphonia complanata	PRESENT	-	-	-	-	2	-	-	-	-	-
Erpobdellidae (indet.)	PRESENT	-	-	-	-	-	1	-	-	-	-
Trocheta spp.	-	-	-	-	-	9	-	-	-	-	-
CRUSTACEANS											
Asellus aquaticus	-	-	-	-	-	2	3	-	-	-	-
Gammarus zaddachi	ABUNDANT	FEW	COMMON	-	-	125	752	2	4	8	1
OSTRACODA	-	-	-	-	-	-	10	-	-	-	-
MAYFLIES											
Caenidae	-	-	-	-	-	-	2	-	-	-	-
BUGS											
Corixidae	-	-	-	-	-	-	2	-	-	-	-
BEETLES											
Noteridae	-	-	-	-	-	-	2	-	-	-	-
Gyrinidae	-	-	-	-	-	-	2	-	-	-	-
Elmidae	-	-	-	-	-	-	1	-	-	-	-
Elmis aenea	-	-	-	-	-	17	-	-	-	-	-
Limnius volckmari	-	-	-	-	-	2	-	-	-	-	-
Oulimnus sp.	-	-	-	-	-	13	-	-	-	-	-
SPONGE FLIES											
Sisyridae	-	-	-	-	-	1	-	-	-	-	-
CADDIS FLIES											
Rhyacophila dorsalis	-	-	-	-	-	1	-	-	-	-	-
FLIES											
Tipula paludosa	-	-	-	-	-	1	-	-	-	-	-
Chironomidae	-	-	-	-	-	4	13	-	-	-	-
Chironomus riparius	PRESENT	-	-	-	-	-	-	-	-	-	-
Dolichopodidae	-	-	-	-	-	1	-	-	-	-	-
Limnophora riparia	-	-	-	-	-	1	-	-	-	-	-
BMWP SCORE	24	7	6	1	1	63	48	7	7	6	6
No. scoring taxa	8	2	1	1	1	15	12	2	2	1	1
ASPT	3.0	3.5	6.0	1.0	1.0	4.2	4.0	3.5	3.5	6.0	6.0
Total taxa	10	2	1	1	1	19	13	2	2	1	2
Total no. individuals	n/a	n/a	n/a	0	131	1007	1041	3	39	8	2
Biological classification	B3	B4	B4	B4	B4	B2+	B3	B4	B3-	B4	B4

APPENDIX 6
Results of Humber Routine Survey: North Bank Intertidal Biological Sampling

Table A6.1 1995 Results: North Bank Mid Shore Intertidal Biology

SITE	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
SPECIES (No. per sq m)												
#Nematoda	48	0	333	167	357	3124	10900	41936	19326	30155	38318	1654
Nemertea spp.	0	0	0	0	0	30	0	0	0	0	0	0
Paranais litoralis/frici	42745	5926	619	0	48	208	24	0	0	0	0	0
Tubificoides benedii	0	0	0	0	24	17761	48433	32511	71	46315	24	0
Oligochaetae spp.	6688	10282	6402	29988	167	2410	71	0	1404	286	24	762
Streptosyllis websteri	0	0	0	0	0	0	0	0	0	0	0	452
Nereis diversicolor	0	0	1523	333	190	1369	2071	1285	1071	333	190	0
Nephtys homgergii	0	0	0	0	0	0	0	0	143	143	0	0
Nephtys kersivalensis	0	0	0	0	0	0	0	0	24	0	405	48
Nephtys indet (juv < 2cm) #	0	0	0	0	0	0	0	0	0	24	0	0
Eteone longa/flava gp.	0	0	0	0	0	268	547	666	452	1190	309	36
Aricidea minuta	0	0	0	0	0	0	0	0	0	0	0	24
Levinsenia gracillis	0	0	0	0	0	0	0	0	0	0	0	24
Paraonis sp. nov.	0	0	0	0	0	0	0	0	0	0	0	36
Polydora sp.	0	0	0	0	0	0	0	0	0	0	0	24
Pygospio elegans	0	0	0	0	0	149	833	143	2865	1833	500	83
Scolelepsis foliosa	0	0	0	0	0	0	0	0	0	0	0	238
Scolelepsis juv. #	0	0	0	0	0	0	0	0	0	0	0	12
Scoloplos armiger	0	0	0	0	0	0	0	0	0	0	0	24
Spio decorata	0	0	0	0	0	0	0	0	595	238	1000	107
Spio filicornis	0	0	0	0	0	0	0	0	0	547	0	0
Streblospio schrubsolii	0	0	0	0	119	89	24	0	24	904	95	0
Spionis indet	0	0	0	0	24	0	48	0	0	24	0	60
Tharyx sp.	0	0	0	0	0	0	0	0	95	24	24	24
Manayunkia aestuarina	0	0	0	0	24	1041[illegible]	12281	904	0	0	0	0
Travisia sp.	0	0	0	0	0	0	0	0	0	0	0	36
Psammodrilus balanoglossoides	0	0	0	0	0	0	0	0	0	0	0	869
Polychaete indet	0	0	0	0	0	0	0	0	0	48	0	381
Hydrobia ulvae	0	0	0	0	0	89	595	214	2142	1380	24	1809
Retusa obtusa	0	0	0	0	0	0	0	0	71	666	619	36
Cerastoderma edule	0	0	0	0	0	0	0	0	0	48	214	60
Macoma balthica	0	0	0	0	24	3302	3380	10305	5474	4213	7878	60
Mytilus edulis	0	0	0	0	24	0	0	0	0	0	0	0
Bivalve indet	0	0	0	0	0	0	0	0	0	24	0	0
Bathyporeia pilosa	0	0	0	0	0	0	0	0	0	0	0	0
Corophium volutator	0	357	8520	24	71	476	0	24	0	24	0	0
Tanaissus lilljeborgi	0	0	0	0	0	0	0	0	0	0	0	131
Lembos longipes	24	0	0	0	0	0	0	0	0	0	0	0
#Carcinus maenus juv.	0	0	0	0	0	30	24	0	24	48	0	0
#Ostracoda	0	0	0	0	0	0	0	0	214	0	24	143
#Collembola	0	0	0	0	0	0	476	476	0	0	0	0
#Copepoda	0	0	48	0	0	0	0	0	1452	119	5426	309
#barnacle	0	0	0	0	24	0	0	0	0	0	0	0
TOTAL	49457	16565	17064	30345	715	27192	68307	46052	14431	58264	11306	5336
No. TAXA (excluding species marked #)	3	3	4	3	10	12	11	8	13	18	13	22

Table A6.2 1995 Results: North Bank Low Shore Intertidal Biology

SITE	N1	N3	N4	N5	N6
SPECIES (No. per sq m)					
#Nematoda	48	24	48	0	619
Nemertea spp.	0	0	0	0	0
Paranais litoralis/frici	928	0	0	0	0
Tubificoides benedii	24	0	0	24	547
Oligochaetae spp.	95	71	48	0	190
Streptosyllis websteri	0	0	0	0	0
Nereis diversicolor	0	95	0	24	48
Nephtys homgergii	0	0	0	0	0
Nephtys kersivalensis	0	0	0	0	48
Nephtys indet (juv < 2cm) #	0	0	0	0	0
Eteone longa/flava gp.	0	0	0	0	0
Aricidea minuta	0	0	0	0	0
Levinsenia gracillis	0	0	0	0	0
Paraonis sp. nov.	0	0	0	0	0
Polydora sp.	0	0	0	0	0
Pygospio elegans	0	0	0	0	0
Scolelepsis foliosa	0	0	0	0	0
Scolelepsis juv. #	0	0	0	0	0
Scoloplos armiger	0	0	0	0	0
Spio decorata	0	0	0	0	0
Spio filicornis	0	0	0	0	0
Streblospio schrubsolii	0	0	0	0	0
Spionis indet	0	0	0	0	0
Tharyx sp.	0	0	0	0	0
Manayunkia aestuarina	0	0	0	0	0
Travisia sp.	0	0	0	0	0
Psammodrilus balanoglossoides	0	0	0	0	0
Polychaete indet	0	0	24	0	0
Hydrobia ulvae	0	0	0	0	0
Retusa obtusa	0	0	0	0	0
Cerastoderma edule	0	0	0	0	0
Macoma balthica	0	0	0	0	119
Mytilus edulis	0	0	0	0	24
Bivalve indet	0	0	0	0	0
Bathyporeia pilosa	0	0	0	0	24
Corophium volutator	71	24	24	0	0
Tanaissus lilljeborgi	0	0	0	0	0
Lembos longipes	0	0	0	0	0
#Carcinus maenus juv.	0	0	0	0	0
#Ostracoda	0	0	0	0	0
#Collembola	0	0	0	0	0
#Copepoda	0	0	0	0	0
#barnacle	0	0	0	0	0
TOTAL	1166	214	144	48	1619
No. TAXA (excluding species marked #)	5	4	4	2	8

APPENDIX 7
Results of Humber Routine Survey: South Bank Intertidal Biological Sampling

Table A7.1 1995 Results: South Bank Mid Shore Intertidal Biology

SITE	S1	S2	S2b	S3	S4	S5	S6	S7	S8	S9	S10
SPECIES (No. per 5 cores - 10 cores at S9& S10)											
NEMERTEA											
Nemertea spp.	0	0	0	0	0	0	0	0	0	3	6
(Blobs)	0	0	0	0	0	0	1	0	0	0	0
POLYCHAETA											
Eteone longa	0	0	0	1	0	0	1	1	12	0	0
Nereis diversicolor	1	0	35	84	11	0	93	0	1	0	0
Nephtys cirrosa	0	0	0	0	0	0	0	0	0	7	5
Nephtys caeca	0	0	0	0	0	0	0	0	0	1	0
Nephtys hombergii	0	0	0	0	0	0	0	10	2	0	0
Nephtys spp. juv. #	0	0	0	0	0	0	0	20	0	0	0
Sphaerodorpsis minuta	0	0	0	0	0	0	0	0	0	0	0
Paraonis fulgens	0	0	0	0	0	0	0	0	0	7	36
Spio spp.	0	0	0	0	0	0	0	0	0	0	4
Polydora spp.	0	0	0	2	0	0	0	0	1	0	0
Pygospio elegans	0	0	0	6	0	3	62	4	130	0	0
Streblospio schrubsolii	0	0	0	106	3	3	1	33	2	3	1
Spionid spp. juv.	0	0	0	0	0	0	0	0	0	0	0
Tharyx spp.	0	0	0	0	0	0	0	50	44	0	0
Capitella capitata	0	0	0	0	0	0	7	0	0	0	0
Alkmaria romijni	0	0	0	0	0	0	0	0	0	0	0
Ampharatid spp. juv.	0	0	0	0	0	0	0	0	0	0	0
Manayunkia aestuarina	0	0	0	6	12	0	1	0	0	0	0
OLIGOCHAETA											
Paranais litoralis	8	0	0	0	0	0	9	11	0	0	0
Enchytraeidae	0	2	0	1	40	0	0	0	0	0	1
Tubificoides benedii	0	2	0	0	0	4	1567	29	2	0	0
Tubificoides swirencoides	0	0	0	0	0	0	0	1	0	0	0
Tubifex costatus	41	0	0	1	0	0	2	0	0	0	0
Tubificid spp. juv.	0	0	0	0	1	0	0	0	0	0	0
CRUSTACEA											
Mysidacea	0	0	0	0	0	0	0	0	0	0	2
Cumacea.	0	0	0	0	0	0	0	0	1	0	1
Tanaidacea	0	0	0	0	0	0	0	0	0	0	0
Cyathura carinata	0	0	0	0	0	0	0	0	0	0	0
Eurydice pulchra	0	0	0	0	0	0	0	0	0	1	2
Bathyporeia spp.	0	0	0	0	0	0	0	0	0	11	15
Urothoe spp.	0	0	0	0	0	0	0	0	0	11	97
Haustirius spp. juv.	0	0	0	0	0	0	0	0	0	1	0
Pontocrates/Periculoides	0	0	0	0	0	0	0	0	0	0	1
Corophium volutator	0	0	56	223	705	662	1169	0	2	0	0
MOLLUSCA											
Hydrobia ulvae	0	0	0	0	0	0	0	2	11	0	0
Cerastoderma juv.	0	0	0	0	0	0	0	1	0	0	0
Macoma balthica	0	0	0	4	3	34	29	194	3	0	0
Ensis spp. juv.	0	0	0	0	0	0	0	0	0	0	0
Bivalve spp. juv.	0	0	0	0	0	0	0	0	0	0	0
TOTAL	50	4	91	434	775	706	2942	356	211	45	171
No. Taxa	3	2	2	10	7	5	11	12	12	9	12

Table A7.2 1995 Results: South Bank Low Shore Intertidal Biology

SITE	S2	S2b	S3	S4	S5	S6	S7	S8	S9
SPECIES (No. per 5 cores - 10 cores at S9 & S10)									
NEMERTEA									
Nemertea spp.	0	0	0	0	0	0	0	0	0
(Blobs)	0	0	0	1	0	0	0	0	0
POLYCHAETA									
Eteone longa	0	0	0	0	1	0	0	0	0
Nereis diversicolor	0	0	0	2	0	2	0	0	0
Nephtys cirrosa	0	0	0	0	0	0	0	0	6
Nephtys caeca	0	0	0	0	0	0	0	0	0
Nephtys hombergii	0	0	0	0	0	0	11	6	0
Nephtys spp. juv. #	0	0	0	0	0	0	10	9	0
Sphaerodorpsis minuta	0	0	0	0	0	0	1	0	0
Paraonis fulgens	0	0	0	0	0	0	0	0	5
Spio spp.	0	0	0	0	0	0	0	0	0
Polydora spp.	0	0	1	0	66	0	0	0	0
Pygospio elegans	0	0	0	0	10	4	6	11	0
Streblospio schrubsolii	0	0	20	5	2	21	9	58	0
Spionid spp. juv.	0	0	0	8	0	0	0	0	0
Tharyx spp.	0	0	0	0	0	0	179	100	0
Capitella capitata	0	0	0	0	0	0	0	0	1
Alkmaria romijni	0	0	0	1	0	0	0	0	0
Ampharatid spp. juv.	0	0	0	0	1	0	0	0	0
Manayunkia aestuarina	0	0	0	0	0	0	0	0	0
OLIGOCHAETA									
Paranais litoralis	0	0	0	0	0	0	10	2	0
Enchytraeidae	0	0	0	4	1	0	0	0	0
Tubificoides benedii	0	1	0	0	0	12	15	8	0
Tubificoides swirencoides	0	0	0	0	0	62	103	13	0
Tubifex costatus	0	1	0	0	0	0	0	0	0
Tubificid spp. juv.	0	0	0	0	0	0	0	0	0
CRUSTACEA									
Mysidacea	0	0	0	0	0	0	0	0	0
Cumacea.	0	0	0	0	0	0	0	0	4
Tanaidacea	0	0	0	0	0	0	0	0	12
Cyathura carinata	0	0	0	1	0	0	0	0	0
Eurydice pulchra	0	0	0	0	0	0	0	0	0
Bathyporeia spp.	0	0	0	0	0	0	0	0	5
Urothoe spp.	0	0	0	0	0	0	0	0	17
Haustirias spp. juv.	0	0	0	0	0	0	0	0	0
Pontocrates/Periculoides	0	0	0	0	0	0	0	0	1
Corophium volutator	1	1	0	4	779	1	3	0	1
MOLLUSCA									
Hydrobia ulvae	0	0	0	0	0	0	0	0	0
Cerastoderma juv.	0	0	0	0	0	0	3	10	0
Macoma balthica	0	0	0	0	0	5	3	0	0
Ensis spp. juv.	0	0	0	0	0	0	0	0	1
Bivalve spp. juv.	0	0	0	0	0	0	0	0	1
TOTAL	1	3	3	26	860	107	353	217	54
No. Taxa	1	3	2	8	7	7	11	8	11

APPENDIX 8
Results of Humber Routine Survey: Fish Sampling

Table A8.1 Fish Distribution in Humber Survey September 1995

Species		Whitton	Read's Island	Humber Bridge	Hessle	Skitter	Halton Flat	Paull	Burcom Shoal A	Burcom Shoal B	Hawkin's Point
Sprat	*Sprattus sprattus*										
Herring	*Clupea harengus*										
Nilsson's pipefish	*Sygnathus rostellatus*										
Cod	*Gadus morhua*										
Whiting	*Merlanguis merlangus*						2.1		9.3	13.2	12.5
5-b. Rockling	*Ciliata mestela*								1.6		1.1
Sand Eel	*Ammodytes tobianus*										
Lesser weever	*Trachinus vipera*										
Sand Goby	*Pomatoschistus minutus*		4.6	4	0.8	1.4			51.2	1.7	4.6
Pogge	*Agonus cataphractus*										
Sea Snail	*Liparis liparis*								6.4		
3-sp. Stickleback	*Gasterosteus aculeatus*			1							
Dab	*Limand limanda*							1.4	1.6	1.7	
Flounder	*Platychthys flesus*							4.1		3.3	2.3
Plaice	*Pleuronectes platessa*									5	
Dover Sole	*Solea solea*						9.3		3.1	24.8	
Number of species			1	2	1	1	2	2	6	6	4
Abundance per 1000 sq m			4.6	5.0	0.8	1.4	11.4	5.5	73.2	49.7	20.5
No. species - amalgamated			1	2	1	1	2	2	8		4
Abundance per 1000 sq m - amalgamated			4.6	5.0	0.8	1.4	11.4	5.5	61.5		20.5

Species		Grimsby Middle		Clee Ness		Bull Sand Fort		Spurn	Haile Sand		
		A	B	A	B	A	B		A	B	C
Sprat	*Sprattus sprattus*									1.2	1.2
Herring	*Clupea harengus*							1.8			2.5
Nilsson's pipefish	*Sygnathus rostellatus*							1.8		4.9	
Cod	*Gadus morhua*										1.2
Whiting	*Merlanguis merlangus*	1.25	3.8	3.9		22.1	5	15.9		2.4	16.4
5-b. Rockling	*Ciliata mestela*	0									
Sand Eel	*Ammodytes tobianus*	2.5	1.25			2.4	6.25		5.3	1.2	
Lesser weever	*Trachinus vipera*							3.5		1.2	3.8
Sand Goby	*Pomatoschistus minutus*	2.5	1.25	3.9		34.3	2.5	7.1	28.3	36.4	26.5
Pogge	*Agonus cataphractus*	1.25				2.4		1.8			
Sea Snail	*Liparis liparis*			3.9	1.4	4.9	1.25		8.8		
3-sp. Stickleback	*Gasterosteus aculeatus*										
Dab	*Limand limanda*								3.5	18.2	
Flounder	*Platychthys flesus*										
Plaice	*Pleuronectes platessa*									6.1	8.8
Dover Sole	*Solea solea*		3.8	3.9	6			8.8		1.2	
Number of species		4	4	4	2	5	4	7	4	9	7
Abundance per 1000 sq m		7.5	10.1	15.6	7.4	66.1	15	40.7	45.9	72.8	60.4
No. species - amalgamated		5		4		5		7	12		
Abundance per 1000 sq m - amalgamated		8.8		11.5		40.6		40.7	59.7		

Table A8.2 Push-net Results from Humber Survey September 1995

Species		CLEETHORPES						SPURN POINT					
		1990	1991	1992	1993	1994	1995	1990	1991	1992	1993	1994	1995
Sprat	*Sprattus sprattus*		1.9										
Herring	*Clupea harengus*		2.9	1		1.9		1	1				1.9
Nilsson's pipefish	*Sygnathus rostellatus*	4	1	10.5		1.9							
Whiting	*Merlanguis merlangus*			1									
Sand Eel	*Ammodytes tobianus*		1	1.1				1	1.9	5.7			1
Lesser Weever	*Trachinus vipera*		1.9	1.9	1.9		1		1.9	2.9	1	3.8	6.7
Sand Goby	*Pomatoschistus minutus*	168	82.9	108.6	10.5	74.5	16.2	3	2.9	4.8	21.9	43.8	14.3
Common Goby	*P. microps*	5	1	48.6							2.9		
Painted Goby	*P. pictus*												
Turbot	*Scophthalmus maximus*	1	2.9		4.8		1.9	18	11.4	3.8	1	7.6	28.6
Brill	*S. rhombus*			1.9	1.9		1.9		3.8	1	1	1.9	1.9
Dab	*Limand limanda*			1	1		1	1					
Flounder	*Platychthys flesus*			1									
Plaice	*Pleuronectes platessa*	250	33.3	99	46.7	31.4	58.1	41	34.3	46.7	43.8	59	40
Dover Sole	*Solea solea*				12.4					1.9	2.9	1	1
Number of species per 1000 sq m		5	9	11	7	4	6	6	7	7	7	6	8
Abundance per 1000 sq m		428	128.8	275.6	79.2	109.7	80.1	65	57.2	66.8	74.5	117.1	95.4

APPENDIX 9
CEWP Scheme for Classifying Estuaries

DESCRIPTION	Points awarded if the estuary meets this description
Biological Quality (scores under a, b, c and d to be summed)	
a) Allows the passage to and from freshwater of all the relevant species of migratory fish, when this is not prevented by physical barriers	2
b) Supports a resident fish population which is broadly consistent with the physical and hydrographical conditions	2
c) Supports a benthic community which is broadly consistent with the physical and hydrographical conditions	2
d) Absence of substantially elevated levels in the biota of persistent, toxic or tainting substances from whatever source	4
Maximum number of points	10
Aesthetic Quality	
a) Estuaries or zones of estuaries that either do not receive a significant polluting input or which receive inputs that do not cause significant aesthetic pollution	10
b) Estuaries or zones of estuaries that receive inputs which cause a certain amount of pollution but do not seriously interfere with estuary usage	6
c) Estuaries or zones of estuaries that receive inputs which result in aesthetic pollution sufficiently serious to affect estuary usage	3
d) Estuaries or zones of estuaries that receive inputs which cause widespread public nuisance	0
Water Quality (score according to quality)	
Dissolved oxygen exceeds the following saturation levels:	
60%	10
40%	6
30%	5
20%	4
10%	3
below 10%	0

The points awarded under each of the heading (biological quality, aesthetic quality, water quality) are summed. Waters are classified on the following scales:

Class A	Good Quality	24 to 30 points
Class B	Fair Quality	16 - 23 points
Class C	Poor Quality	9 to 15 points
Class D	Bad Quality	0 to 8 points