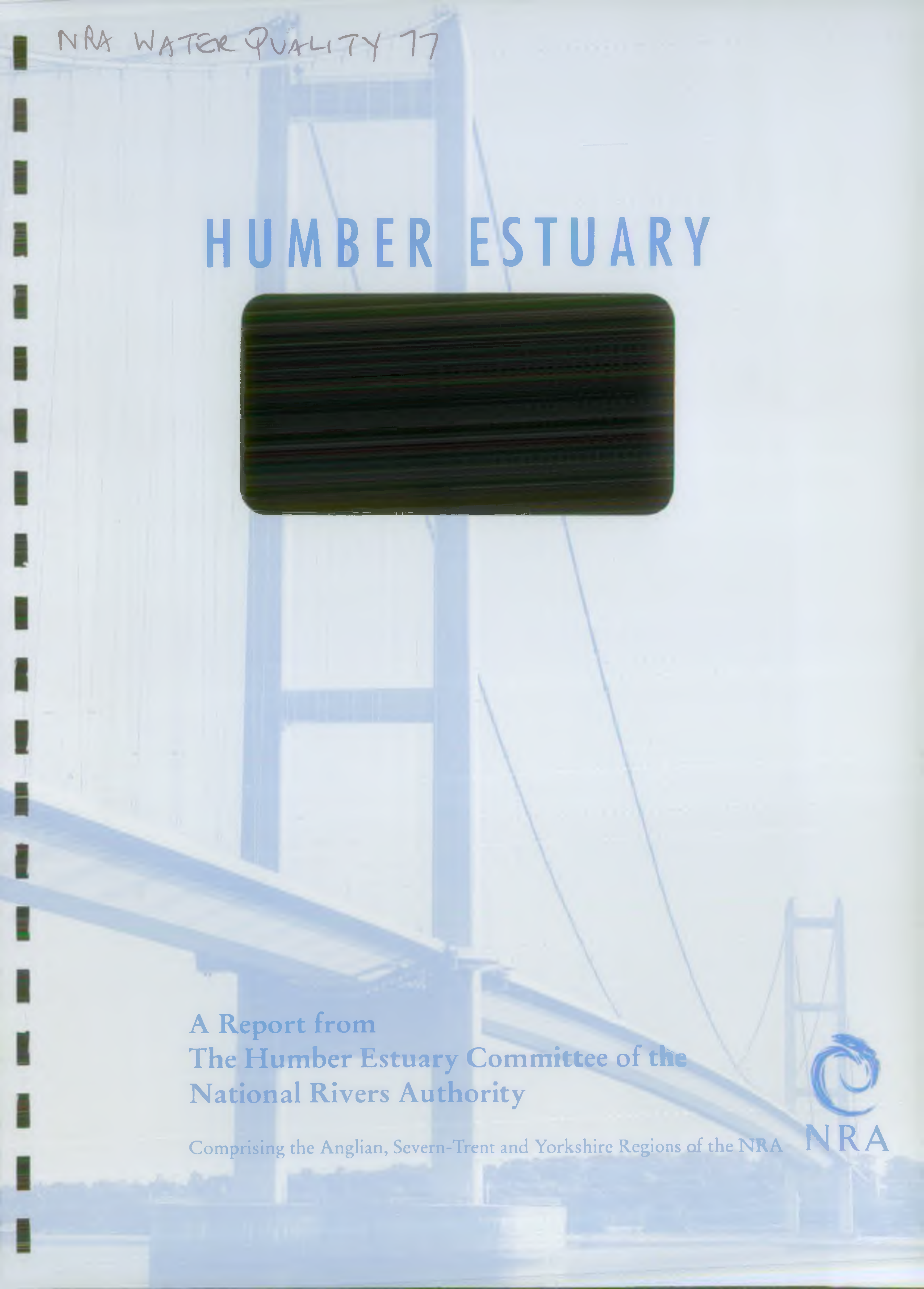
NRA WATER QUALITY 77



HUMBER ESTUARY

A Report from
The Humber Estuary Committee of the
National Rivers Authority

Comprising the Anglian, Severn-Trent and Yorkshire Regions of the NRA

NRA

THE WATER QUALITY OF THE HUMBER ESTUARY 1992

NATIONAL RIVERS AUTHORITY REGIONS

NORTHUMBRIA AND YORKSHIRE REGION

Rivers House
21 Park Square South
Leeds LS1 2QG
Tel. 0532 440191

ANGLIAN REGION

Kingfisher House
Goldhay Way
Peterborough PE2 0ZR
Tel. 0733 371811

SEVERN-TRENT REGION

Sapphire East
550 Streetsbrook Road
Solihull B93 9QT
Tel. 021 7112324

THE WATER QUALITY OF THE HUMBER ESTUARY 1992

SUMMARY

The Humber Committee of the Anglian, Severn-Trent and Northumbria and Yorkshire Regions of the National Rivers Authority co-ordinates the management and monitoring of the water quality of the Humber Estuary. Environmental Quality Objectives, designed to protect existing and potential uses of estuary waters, are defined in terms of chemical environmental quality standards set for the water column. Routine monitoring programmes, augmented by intensive special surveys, provide data on the chemical quality of the Humber and its tidal tributaries, freshwater rivers and industrial inputs, metal accumulation in sediments and organisms, and the nature and diversity of the invertebrate fauna of the estuary.

The following report gives results from surveys carried out during 1992.

THE WATER QUALITY OF THE HUMBER ESTUARY 1992

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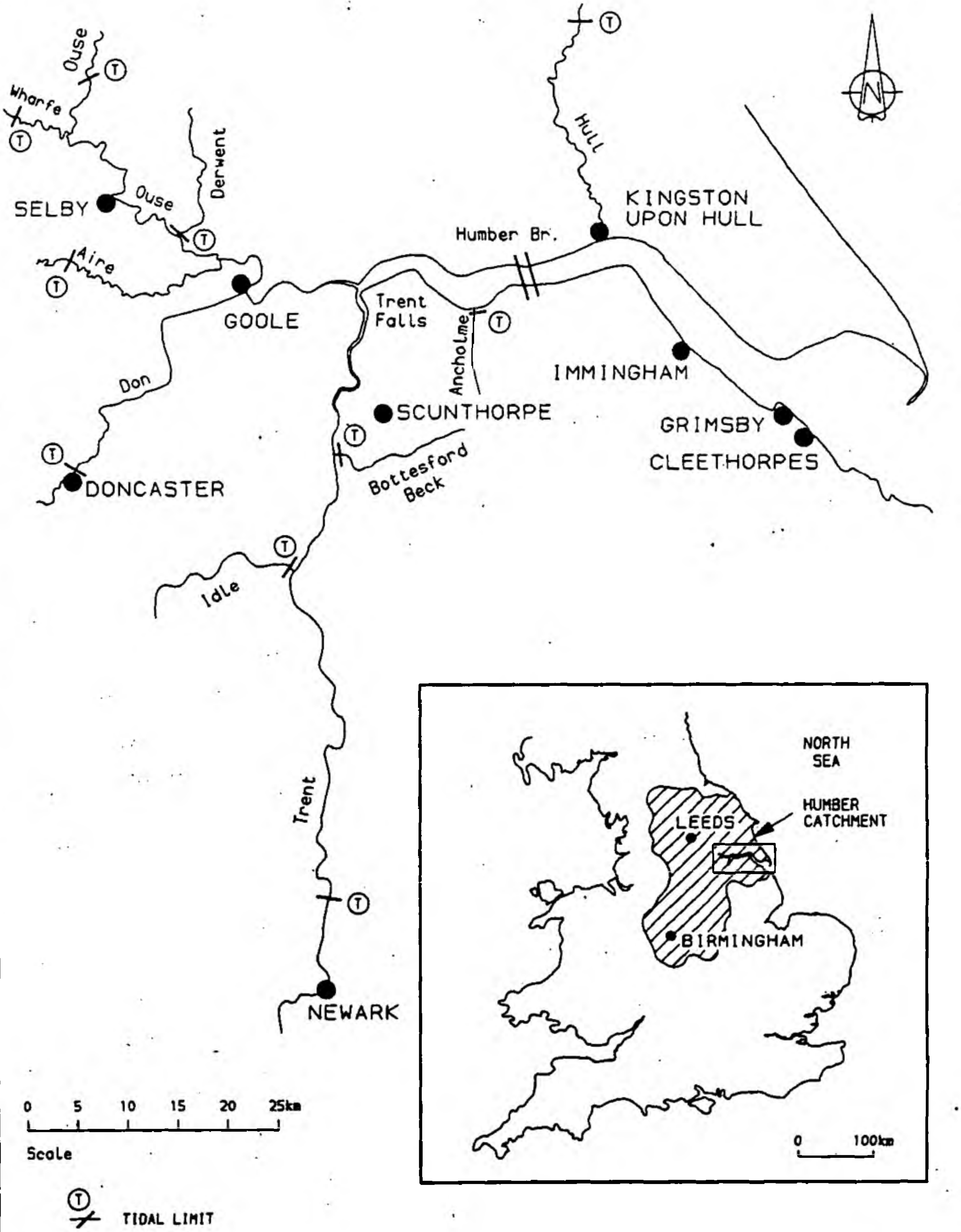

FIGURE 1.1 THE HUMBER ESTUARY AND ITS CATCHMENT

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SECTION 1
THE WATER QUALITY OF THE HUMBER ESTUARY
1992

1.1 INTRODUCTION

The Humber has the largest catchment (24,240km2) of any estuary in the United Kingdom and is one of the main freshwater inputs into the North Sea. One fifth of the UK population live within this area and parts of it are highly industrialised. The Humber receives water from the Ouse, Don, Aire and Trent rivers. (Figure 1.1)

The land around the estuary has been greatly modified over the centuries by man, with large areas drained for agriculture and industrial development. Today the Humber is a busy commercial waterway, with traffic from the ports of Hull, Goole, Grimsby and Immingham. There is also the popular holiday resort of Cleethorpes on the South Bank, which is an EC designated bathing beach.

The remaining natural areas of saltmarsh, intertidal mud and sand flats and natural shoreline are of international importance in wildlife conservation, and large areas of the estuary shoreline are designated as Sites of Special Scientific Interest (SSSI). There are also several nature reserves managed by the RSPB and other conservation bodies, and the whole area is popular with birdwatchers due to the high numbers of migrating birds which pass through the estuary area. The outer estuary supports a small scale commercial fishery and is also important as a nursery area for flat-fish, especially plaice.

The Humber Estuary System falls into the National Rivers Authority's Anglian, Severn-Trent and Northumbria and Yorkshire Regions. The Yorkshire and Northumbria Regions of the NRA merged in 1993 to form the Northumbria and Yorkshire Region, covering the area from Chesterfield to the Scottish Border. Water Quality monitoring and management is co-ordinated by the NRA's Humber Estuary Committee which includes staff from the three regions. The Committee also benefits from the membership of representatives from the Department of the Environment (DOE), Ministry of Agriculture, Fisheries and Food (MAFF), Water Research Centre (WRc) and the Institute of Estuarine and Coastal Studies, University of Hull. The objectives of the Committee are given in Appendix A. The former regional water authorities set water quality objectives for the Humber which are given in Appendix B. These objectives guide the management of the system at present although they will be superseded within the next few years by the statutory Water Quality Objectives set under the Water Resources Act 1991.

The water quality objectives are defined by numerical Environmental Quality Standards (EQS) set for certain chemical substances, pH and temperature of the water column. Mandatory standards are given for highly toxic, persistent and bio-accumulative substances on List I of Directive 76/464/EEC on "Pollution caused by Certain Dangerous Substances Discharged into the Aquatic Environment of the Community". National standards are set for List I substances which are considered less dangerous than List I substances. The lists of substances included so far on Lists I and II are shown in Appendix B.

Discharges from industries and sewage works along the Humber Estuary are regularly monitored by the NRA and factories and sewage treatment works have set concentration limits ("consent standards") for the major chemical components of each discharge. They can be prosecuted if they break the terms of their consent. The discharges to the Humber in 1992 generally met their consent standards, and no prosecutions were taken out on discharges to the main estuary. There were prosecutions of firms and sewage treatment works discharging to rivers such as the Aire and Don which feed the Humber, and the quality of these rivers remains arguably the most serious problem in reducing pollution in the Humber. Many improvement schemes are underway on these rivers, but it will be some years before the benefits of these large projects will be seen in the Humber.

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

To review the changes in the estuary over the last 10 years, a long-term report was commissioned by the Humber Estuary Committee. This report summarises the results of survey work carried out between 1980 and 1990, and follows on from the previous eport "The Quality of the Humber Estuary:- A Review of the Results of Monitoring 1961 - 1981, Humber Estuary Committee 1982". The report will be available from the NRA in the autumn of 1993.

1.3 CATCHMENT MANAGEMENT PLANS

The NRA has introduced catchment management planning in order to provide comprehensive integration of the planning and implementation of tasks related to water quality, flood defence, fisheries, recreation and conservation. An important aspect of developing these plans is wide-ranging consultation with interested organisations before a final plan is introduced.

The first completed plan for a catchment draining into the Humber covers the River Aire, and was published in May 1993. Other catchment plans to follow in 1993 and 1994 will be the Calder, Don, Wharfe, Ouse, Derwent, Hull, Lower Trent and Ancholme.

A plan for the Humber itself is due to be the subject of consultation in early 1994 for completion by the end of that year. The upstream boundaries of the plan will be at Boothferry Bridge on the Ouse and Keadby on the Trent.

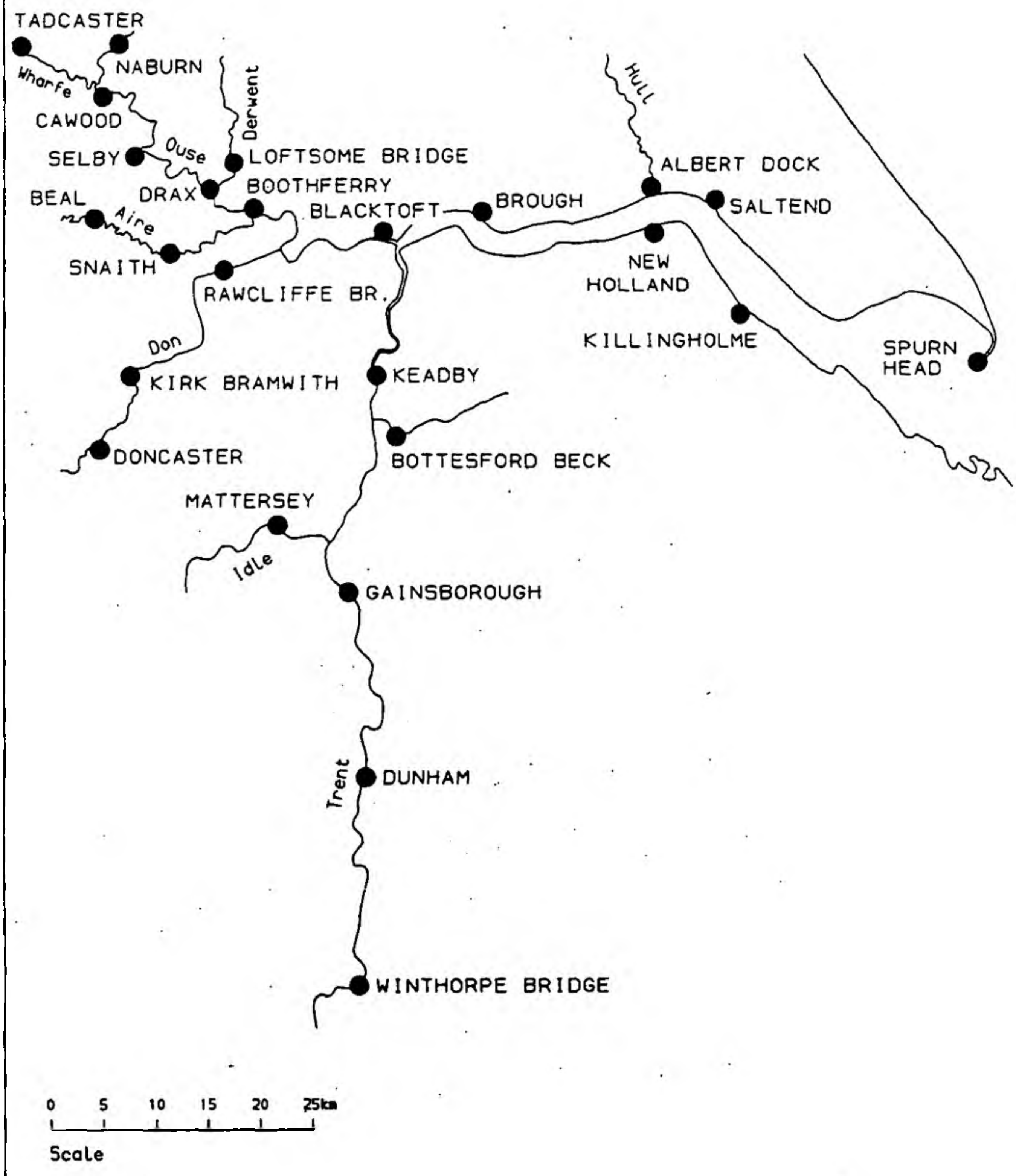

FIGURE 2:1 THE HUMBER ESTUARY SYSTEM
CHEMICAL MONITORING POINTS

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SECTION 2
MONITORING PROGRAMMES

Co-ordinated monitoring of the Humber system was initiated in 1961 and has been modified at intervals since then. The routine programmes for 1992 were as given below:-

(1) Chemical analysis of water samples from eighteen shore stations at high and low slack water seven times per year.

(2) Chemical analysis of eight rivers at their tidal limits.

(3) Continuous monitoring of dissolved oxygen at five sites on the estuary and tidal rivers.

(4) Chemical analysis of significant effluent discharges to the system. Samples for the Humber survey are taken one week before the sampling of the river and estuary water, and are in addition to the routine samples of effluents taken for testing compliance with consent standards.

(5) Analysis of shore and subtidal sediments for metals and pesticides twice per year.

(6) Analysis of seaweed (*Fucus*) twice per year and ragworms (*Nereis*) (once per year) from shores to determine the bioaccumulation of metals and toxic organic substances.

(7) Sampling for invertebrates at intertidal and subtidal levels on the estuary shore once per year, to assess the well-being of biological communities.

(8) Sampling of fish populations (in conjunction with MAFF) once per year.

(9) Quarterly sampling at three mid-estuary stations for the Marine Pollution Monitoring Management Group (MPMMG) National Monitoring Plan

(10) The NRA continuously monitors the flow of tidal rivers close to their tidal limits, and data from these automatic stations is used to calculate mean monthly flows and discharge loads.

Figure 2:1 shows the location of the chemical monitoring points.

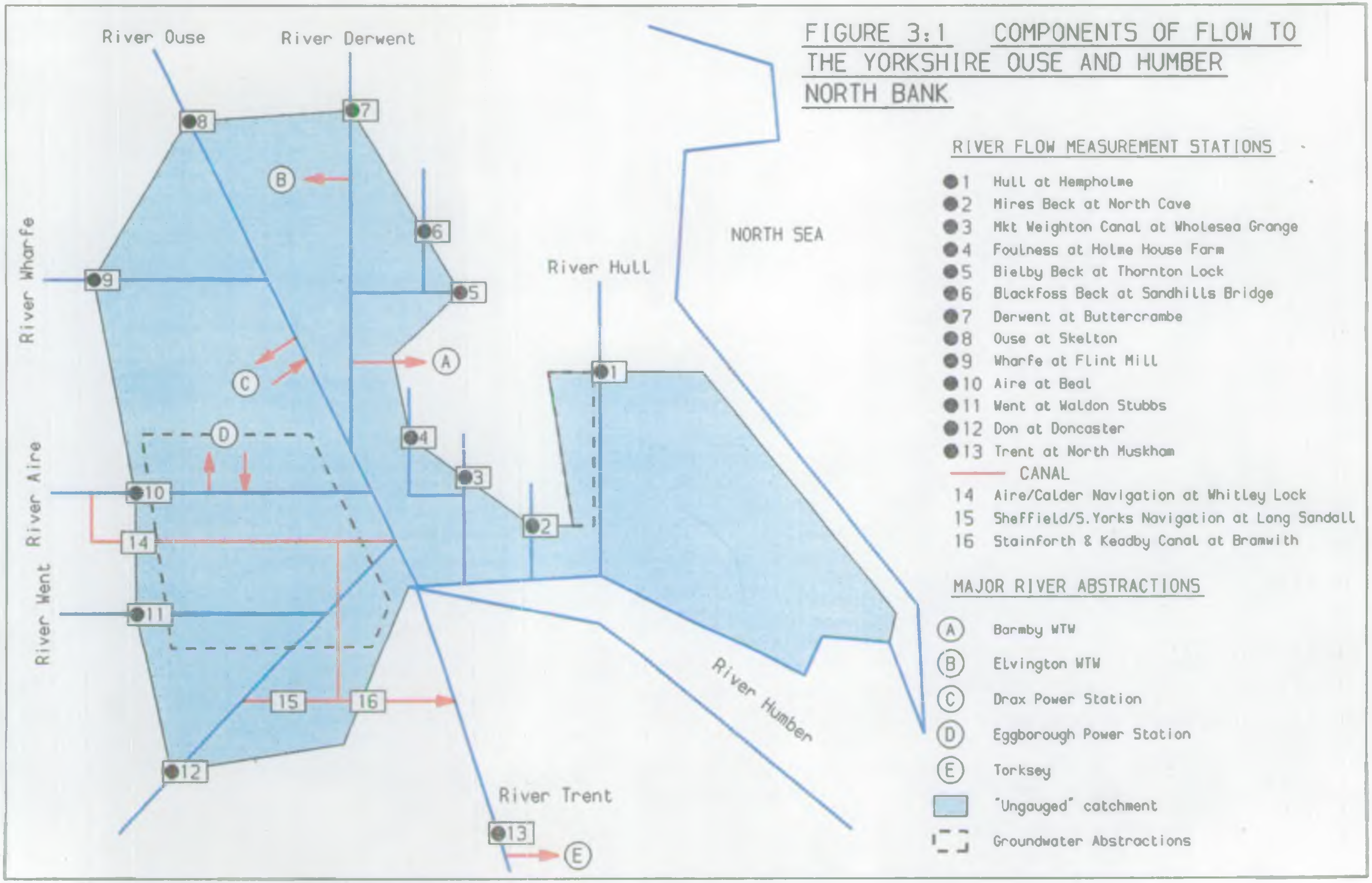

FIGURE 3:1 COMPONENTS OF FLOW TO THE YORKSHIRE OUSE AND HUMBER NORTH BANK

STAT129

SECTION 3
FRESHWATER RIVER FLOWS

3.1 INTRODUCTION

The major flows to the Humber Estuary are from the Yorkshire Ouse and the River Trent. Total flows are approximately 200 cumecs (cubic metres per second), of which the Ouse system is approximately 60% and the Trent 30%. The River Hull contributes approximately 2% of the mean flow, with other minor sources being the Ancholme, Foulness, Mires Beck and Holderness Drain. There are several important water abstraction sites on the Derwent, Aire and Ouse and Trent. Drinking water is abstracted from the Derwent at Elvington and Barmby (3.35 cumecs) and cooling water for power stations at Drax and Eggborough (2.47 cumecs). Approximately 60% of the cooling water is returned to the river. The drinking water is for supply to West and South Yorkshire and is returned down the Aire and Don systems. Water is abstracted from the Trent at Torksey (approximately 0.58 cumecs). There are also several diversions of water via canals which connect the lower Aire and Don. Water is taken from the Aire at Beal for the Aire and Calder Navigation and returned to the river network near Goole. Water for the Sheffield and South Yorkshire Navigation is taken from the Don at Long Sandall Lock, near Doncaster. Of this, half feeds the Aire and Calder navigation, while the other half flows into the Trent via the Stainforth and Keadby Canal. The flows, measurement stations and abstractions for the Yorkshire Ouse and River Hull are shown in Figure 3.1. The areas downstream of the flow gauging stations drain directly into the river network and Humber and the flow from these areas is not measured. The estimated flow from this land area is 10.7 cumecs, and two areas of this catchment are important for groundwater abstractions. An abstraction of 0.58 cumecs is taken from the Yorkshire Wolds, much of which is returned to the system, and 0.52 cumecs is taken from the Sherwood Sandstone in the Selby area for public water supply.

3.2 FLOWS TO THE HUMBER IN 1992

The mean monthly freshwater flows at the time of the Humber Survey are calculated every year, using the mean daily flows for the week preceding each Humber Survey. This is to give an indication of the actual flow conditions in the Humber during the surveys.
Table 3:1 shows the mean flows to the Humber from the tidal rivers for the past 9 years. Flows in 1992 were slightly less than in 1991, although higher than in 1989 and 1990. Mean monthly flow figures calculated using the daily flows are also included in the table for comparison.
Improved flow calculating and gauging methods will be available from 1993, and will be used in the next annual report to give a more accurate picture of freshwater flows into the Humber.

3.2 WINTER AND SUMMER FLOWS IN TIDAL RIVERS 1983-1992

There has been much concern in recent years about lack of rainfall and low river flows, particularly on the Eastern side of the country. Many areas have had hosepipe bans through the summer months for the last three years, and drinking water reservoirs have been low. Figure 3:2 shows the mean monthly flows for the past 10 years for each of the five major Yorkshire rivers feeding the Humber (Aire, Don, Wharfe Ouse and Hull), close to their tidal limit. These flows have been separated into winter (January to March) and summer (June to August) mean flows.
The summer flows for all these rivers shows a clear reduction between 1989 and 1991, with a slight

improvement in 1992. The winter flows were more variable, although there were low flows in all rivers in 1985 and 1989. In 1989 this was followed by low summer flows, while in 1985, summer flows were

TABLE 3:1

MEAN MONTHLY FRESHWATER FLOWS TO THE HUMBER ESTUARY

MEAN FLOWS IN M3/SEC BASED ON THE SEVEN DAYS PRIOR TO EACH HUMBER SURVEY AND ON DAILY FLOWS

RIVER	YEAR								
	1984	1985	1986	1987	1988	1989	1990	1991	1992
OUSE	121	92	183	168	151	102	118	164	139
TRENT	91	77	116	96	91	77	70	71	78
TOTAL	212	169	299	264	242	179	188	235	217
OUSE MEAN MONTHL FLOWS FROM DAILY FLOWS	136	121	166	133	150	93	114	116	112

high.

Figure 3:3 shows the flows for the same period in the River Hull, which enters the Humber Estuary near Hull. This shows that the river has recently suffered reduced flows in both winter and summer, with the lower summer flows beginning in 1988, and the lower winter flows beginning in 1989, although 1991 had slightly higher flows.

The River Hull drains the Chalk aquifer between Kilham (near Driffield) and Hull. It rises as springs and in its uppermost reaches is an SSSI (Site of Special Scientific Interest) as it is the most northerly Chalk stream in Britain, supporting a wide range of invertebrate and fish species, as well as being an important source of drinking water. The lack of rainfall in this area over the last few years has caused serious concern and it is hoped that there will be increased rainfall in 1993, although as the river Hull is spring-fed it does not respond rapidly to rainfall events.

The NRA is currently developing a mathematical model of the River Hull system, which will be used to set consent standards for a number of discharges on the river. The model will take into account water quality and resource issues. There are a number of important sewage discharges to the River Hull, and the modelling will concentrate on the effects of these, and the way the polluted water is pushed up and down river by the tide.

Exceptionally low summer flows can exacerbate water quality problems which already exist in rivers, as there is less water to dilute effluents from industry and sewage, which continues to be produced at almost the same level regardless of rainfall. Flow from sewage works are generally lower in dry weather as there is less surface water flow to the works, but the amount of organic matter to be discharged remains the same.

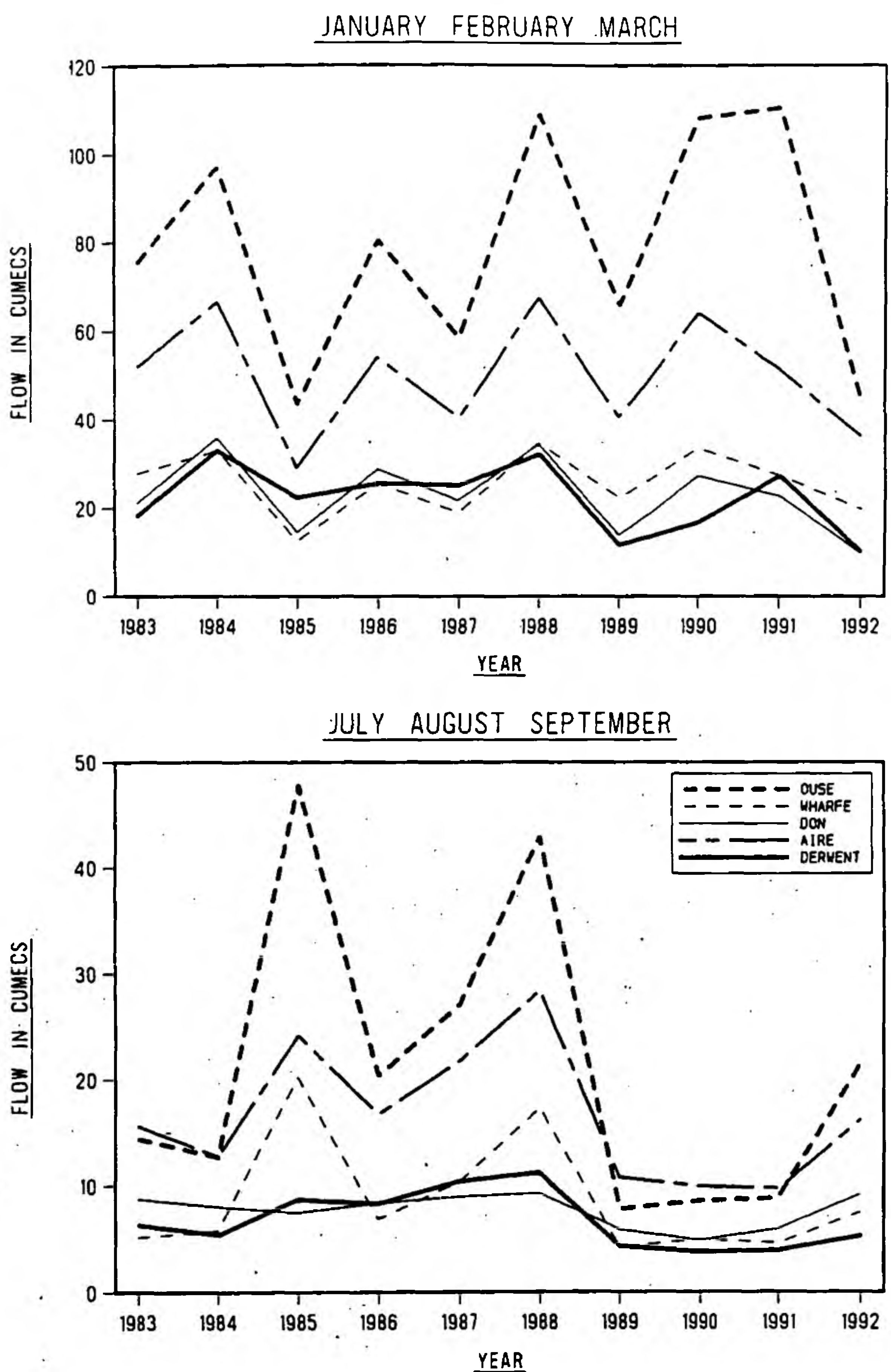

FIGURE 3:2 MEAN MONTHLY FRESHWATER FLOWS TO THE HUMBER BETWEEN 1983 AND 1992

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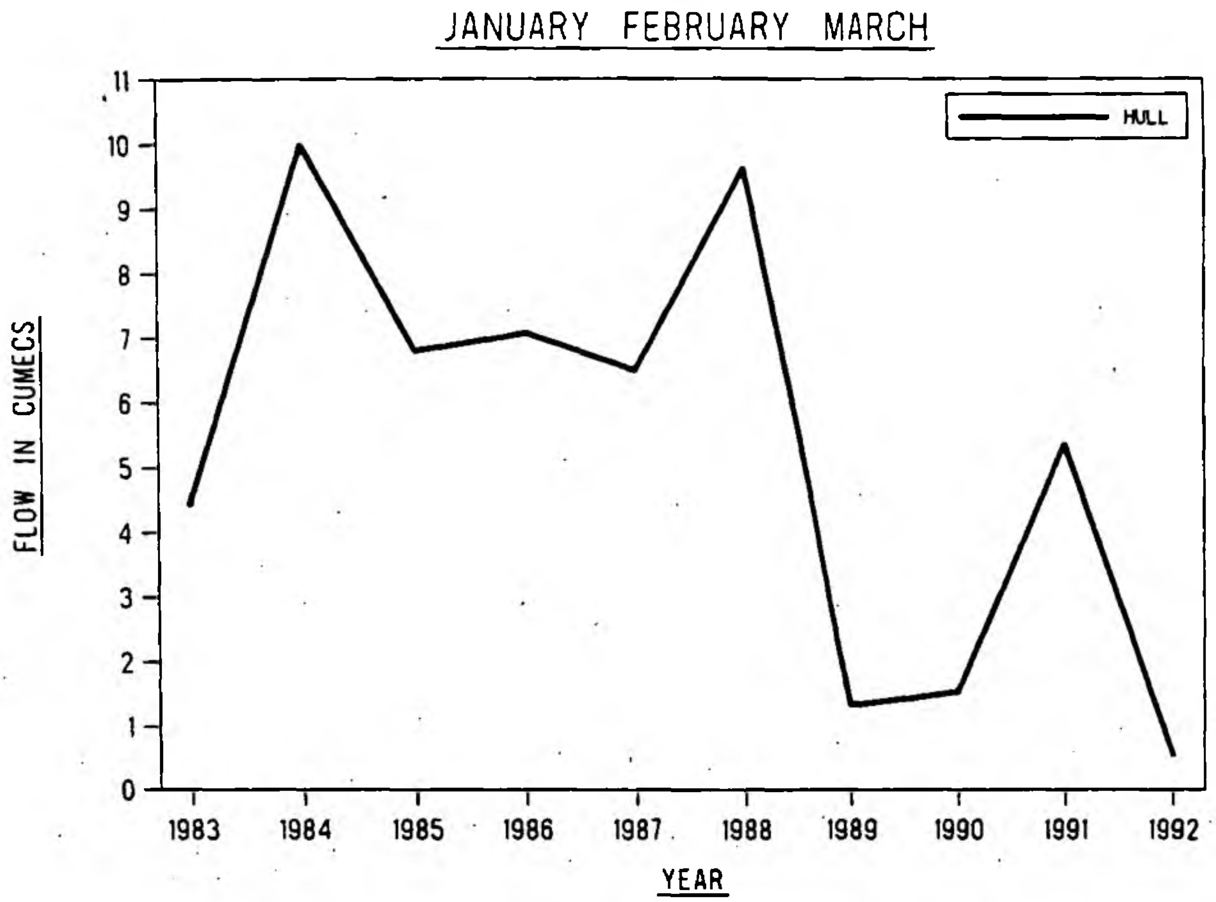

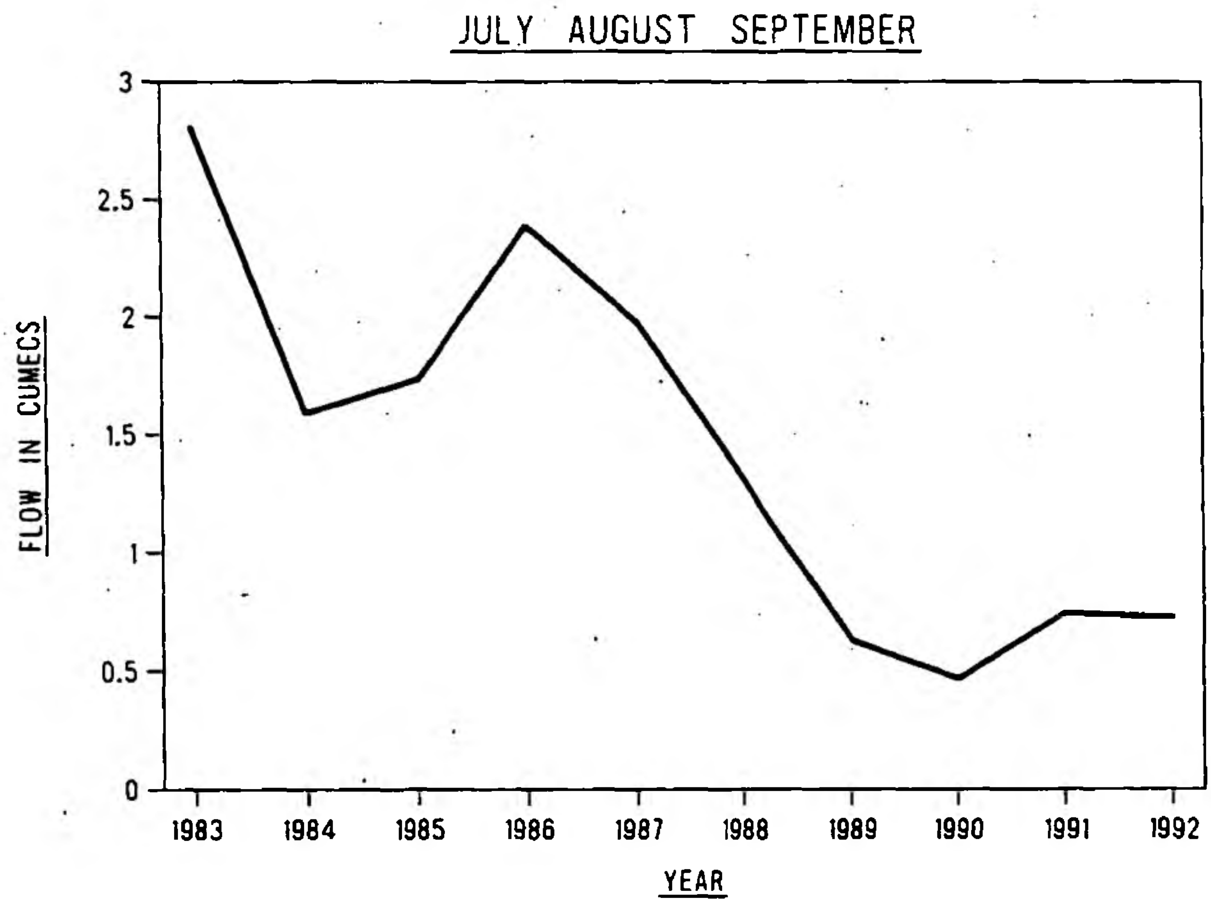

FIGURE 3:3 MEAN MONTHLY FRESHWATER FLOWS TO THE HUMBER BETWEEN 1983 AND 1992

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SECTION 4
CHEMICAL QUALITY

4.1 EQS VALUES

EQS (Environmental Quality Standard) values are set for many of the chemicals dissolved in or carried by river and estuarine water. Water quality can be assessed by comparison with these standards. The most common types of standard are:-

1. Annual average; eg metals
2. Percentiles; eg dissolved oxygen, ammonia
3. Ranges; eg pH
4. Maximum permitted levels; eg Temperature

Comparing the results of Humber Survey chemical analysis to these standards is not always as straightforward as it may seem, and some of the considerations are described below.

4.1.1 ANNUAL AVERAGE

This is the simplest of the EQS standards. It does not, however, take into account the effects of one short period of high levels of a substance if sufficient samples have been taken to allow the average level to pass. This standard is therefore used for substances where short periods of high levels do not cause harmful effects. The maximum level recorded is often reported with the average. There is a difficulty in calculating an average where some results are less than (<) the limit of detection. This happens when the levels of a substance in the water are lower than the levels which can be detected by the current analytical methods. The generally accepted method of calculating averages when there are less than (<) values is to assume that levels are half the limit of detection (LOD) and use this number in calculations. The LOD is generally half or less than the EQS, so less than values do not generally cause problems of unwarranted EQS failures.

4.1.2 PERCENTILES

The most commonly used percentiles for Environmental Quality Standards are the 95 percentile and the 5 percentile, and are applied when the maximum or minimum level of a substance is of concern. These are calculated values which estimate the levels which should not be exceeded for more than 5% of the time. For a 95 percentile, the results should not be above the standard, and for a 5 percentile, the results should not be below the standard. If more than 20 samples have been taken, this can be calculated mathematically, but if less than 20 samples have been taken, the 95 percentile is equal to 95% of ranked samples. For example, if 20 samples are taken and 19 meet the standard, the 20th sample could fail the standard and the site would still meet the EQS. If, however, seven samples are taken, all must be less than the EQS for the site to pass the EQS. This is the case for the Humber Survey.

4.1.3 RANGES

EQS standards based on ranges are used for determinands such as pH, where both high and low levels can be harmful to animals and plants.

FIGURE 4:1 QUALITY CLASSIFICATION OF HUMBER TRIBUTARY RIVERS TIDAL RIVERS AND HUMBER ESTUARY

STAT130

TABLE 4:1										
HUMBER ROUTINE CHEMICAL SURVEY 1992										
COMPARISON BETWEEN 1991 AND 1992 FOR NON-TIDAL RIVERS										
STATION	BOD (ATU) mg/l				AMMONIA (mg/l - N)				UNIONISED AMMONIA (mg/l)	
	MEAN		95 %ILE		MEAN		95 %ILE		95 %ILE	
	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
Ouse at Naburn	2.4	2.33	4.3	3.37	0.41	0.36	0.91	0.86	0.03	0.016
Wharfe at Tadcaster	2.2	2.07	4.1	4.64	0.13	0.06	0.36	0.15	0.005	0.005
Aire at Beal	6.0	5.18	10.1	8.26	2.09	1.93	3.67	3.39	0.029	0.042
Don at North Bridge	4.9	4.19	8.0	6.33	5.86	3.08	10.40	5.75	0.099	0.038
Trent at Winthorpe Bridge	3.1	3.82	5.6	5.75	0.79	0.33	1.34	0.85	0.040	0.017
Derwent at Loftsome Bridge	1.9	1.88	3.0	3.91	0.11	0.12	0.26	0.31	0.003	0.004
Idle at Misterton	4.1	2.43	5.8	4.84	0.49	0.26	0.62	0.6	0.011	0.005
Bottesford Beck at Snake Plantation	5.5	6.21	9.5	16.00	9.40	6.46	13.5	10.6	0.262	0.246
Three Rivers at Keadby	3.2	3.55	6.2	10.37	0.46	0.34	1.38	1.64	0.005	0.005
Hull at Drypool Bridge	2.8	3.20	6.4	8.23	1.32	1.49	4.23	4.51	0.087	0.0615

TABLE 4:2

1992 HUMBER ROUTINE CHEMICAL SURVEY DATA

COMPARISON WITH ENVIRONMENTAL QUALITY STANDARDS

STATION	TEMPERATURE C			DISSOLVED OXYGEN (% SATURATION)			UNIONISED AMMONIA (mg/l)			pH range		
	MAXIMUM			5 PERCENTILE			95 PERCENTILE					
	LOW TIDE	HIGH TIDE	ALL TIDES	LOW TIDE	HIGH TIDE	ALL TIDES	LOW TIDE	HIGH TIDE	ALL TIDES	LOW TIDE	HIGH TIDE	ALL TIDES
TIDAL RIVERS												
OUSE												
Cawood	20	19.5	20	87	21	21	0.0124	0.0024	0.0124	7.68-8.11	7.43-8.19	7.43-8.19
Selby	18.9	19	19	53	11	11	0.0073	0.0148	0.0148	7.42-7.86	7.53-7.87	7.42-7.87
Drax	18.5	19	19	29	24	24	0.0119	0.0069	0.0119	7.38-7.78	7.51-8.34	7.38-8.34
Boothferry	18	18	18	16	31	16	0.0347	0.0034	0.0347	7.41-8.09	7.41-7.69	7.41-8.09
Blacktoft	17.5	17.6	17.6	52	68	52	0.0036	0.0038	0.0038	7.57-7.88	7.57-7.99	7.57-7.99
AIRE												
Snaith	18	19.5	19.5	58	22	22	0.0368	0.0219	0.0368	7.26-7.63	7.17-7.62	7.17-7.63
DON												
Kirk Bramwith	18.9	18.9	18.9	70	68	68	0.0262	0.0383	0.0383	7.34-7.53	7.26-7.53	7.26-7.53
Rawcliffe	18	18	18	44	58	44	0.0468	0.0125	0.0468	7.4-7.77	7.36-7.93	7.36-7.93
TRENT												
Dunham	20	-	20	90	-	90	0.0090	-	0.0090	7.60-8.40	-	7.60-8.40
Gainsborough	19	20	20	84	66	66	0.0110	0.0120	0.012	7.7-8.4	7.7-8.4	7.7-8.4
Keadby	19	18	19	65	63	63	0.0050	0.0030	0.0050	7.8-8.0	7.7-7.9	7.7-8.0
WHARFE												
Ryther	18.4	19.8	19.8	69	75	69	0.0080	0.0090	0.0090	7.53-8.47	7.05-8.47	7.05-8.47
EQS			25			40			0.021			5.5-9.0
ESTUARY												
Brough	-	17	17	-	62	62	-	0.0038	0.0038	-	7.32-8.05	7.32-8.05
New Holland	17.9	17.5	17.9	80	80	80	0.0307	0.0183	0.0307	7.42-7.67	7.68-7.71	7.68-7.71
Albert Dock	17.8	17	17.8	71	72	71	0.0057	0.0028	0.0057	7.58-8.09	7.56-8.06	7.56-8.06
Saltend	18	17	18	83	74	74	0.0051	0.0039	0.0051	7.56-7.99	7.68-8.44	7.56-8.44
Killingholme	18.2	17.5	18.2	64	82	64	0.0234	0.0308	0.0308	7.4-7.7	7.23-7.70	7.23-7.70
Spurn	18	17	18	91	83	83	0.0504	0.0717	0.0717	7.47-8.46	7.36-8.57	7.36-8.57
EQS			25			55			0.021			6.0-8.5

T = TOTAL D = DISSOLVED

4.1.4 MAXIMUM

These standards are easy to apply, but are affected by sampling frequency. They are applied either when short periods of exposure to high levels would have an adverse effect on animals or plants, or where there is insufficient knowledge of the toxicity of a substance.

4.2 CHEMICAL QUALITY OF TRIBUTARY RIVERS UPSTREAM OF TIDAL LIMITS

Table 4:1 shows the comparison between 1991 and 1992 results for BOD, ammonia and unionised ammonia at sites upstream of the tidal limits. In general, the results are similar between the two years, but the Don at North Bridge (near Doncaster) shows a reduction in both BOD and ammonia levels. This is due to the implementation of the first phase of improvements at Blackburn Meadows STW, near Sheffield. Further improvements are in progress at this works, and should be completed in 1995, when further reductions in ammonia and BOD loads are expected. BOD was lower in the Rivers Aire and Idle, and although Bottesford Beck and Three Rivers had higher 95 percentile levels of BOD in 1992, the means were not significantly higher. Ammonia levels were not significantly higher. The River Hull also had slightly higher levels of BOD and ammonia. Figure 4:1 shows the chemical classes of the freshwater rivers and estuary. The rivers are classified under the NWC (National Water Council) scheme, where the class is based on the annual levels of BOD, ammonia and dissolved oxygen in the water. The saline river reaches and estuary are classified according to the estuary classification scheme. Details of both these schemes are given in Appendix C.

4.3 COMPLIANCE WITH EQS STANDARDS IN TIDAL WATERS

4.3.1 TEMPERATURE (Table 4:2)

The EQS for temperature, which is a maximum of 25°C in the tidal rivers and estuary, was not exceeded during the year at any site.

4.3.2 pH (Table 4:2)

The pH range specified for the tidal rivers is between 5.5 and 9.0, and all the rivers were within this range on all sampling occasions. The range for the estuary is between 6.0 and 8.5, and all sites met this standard except for Spurn, which on one occasion had a reading slightly above the standard (8.57).

4.3.3 DISSOLVED OXYGEN (TABLE 4.2)

The dissolved oxygen standard (a 5 percentile of 40% in the tidal rivers and 55% in the Estuary) was met at all sites on the Estuary, and on the rivers Don, Trent and Wharfe. The tidal Ouse failed the standard at high tide between Cawood and Boothferry, as was found in 1991, but passed at Blacktoft Sands, which is close to the Estuary Head. The Ouse also failed at low tide at Drax and Boothferry. The Aire at Snaith failed at high water, perhaps due to intrusion of water from the Ouse.

4.3.4 UNIONISED AMMONIA (TABLE 4.2)

The sites on the rivers Aire and Don failed the EQS standard for unionised ammonia (95 percentile of 0.021mg/l), as they did in 1991. The Ouse at Boothferry also failed, due to one high reading in June at low tide. The Humber at Spurn also failed due to two very high readings in September and

November, and the two South Bank sites at New Holland and South Killingholme failed due to high readings on 22nd June. The results for the rest of the year at these two sites are very low (<0.0007mg/l). There is no record of a pollution incident or failure of an industrial consent large enough to cause these results anywhere in the estuary or on the tidal rivers, and the levels in the tidal rivers on the dates in question are not unusual. There is no obvious source of ammonia near to Spurn. The results for 1993 are being closely monitored to check for any recurrence.

4.3.5 METALS

Metals EQS standards are set as the annual average of either total or dissolved metal. Metals in water can, however, be present in many different forms, either as inorganic compounds or bound to organic molecules, or bound to particles of sediment when total metals are measured. Some of these forms are more toxic than others, but it is difficult to separate the different types during analysis. For this reason, the EQS for each metal is set assuming that all the metal measured is in the most toxic form. This is the most cautious position, which allows more rapid analysis of samples (since the different forms of the metal do not have to be stabilised and separated) and a greater margin of safety. The only exception to this is copper, where the EQS has been set only for inorganic forms of copper. This causes problems in comparing analytical results to the EQS, as only total dissolved copper present (inorganic and organic forms) can be measured on a routine basis. Research work carried out by WRc (Water Research Centre 1990) has shown that a high proportion (80%) of the copper measured is in organic forms, and thus in theory excluded from the EQS comparison.

4.3.5.1 LIST I METALS (DANGEROUS SUBSTANCES DIRECTIVE) (TABLE 4:3)

The metals on List I, cadmium and mercury, are considered the most toxic due to their tendency to accumulate in living tissue and cause physiological harm. Levels of these two metals are very low in the Humber and in the tidal rivers. In the tidal rivers, the highest average for mercury was 0.19ug/l, less than one fifth of the EQS (1.0ug/l total mercury). In the estuary, levels were also less than one fifth of the EQS (0.3ug/l dissolved mercury). Levels of cadmium were low (below one fifth of the EQS) in the tidal rivers and the North Bank of the estuary, and slightly higher (about half the EQS) at the South Bank sites.

4.3.5.2 LIST II METALS (DANGEROUS SUBSTANCES DIRECTIVE) (TABLES 4:3, 4:4 AND 4:5)

Zinc, nickel and lead levels were below the EQS at all sites on both the tidal rivers and the estuary, with many samples below the limit of detection, particularly for lead, where the limit of detection is 1ug/l.

Arsenic failed the EQS at one site, Brough, on the North Bank of the Estuary, due to one sample which contained a very high level of arsenic. This site is close to the former metal smelter at Capper Pass, and during the period before the high reading at Brough, there were several days when levels of arsenic discharged from the factory were quite high, although within the consent standard. This was due to site clearing, which is now complete, and the smelter has now ceased operation. The high level of arsenic at Brough was not repeated later in the year, and the discharge has now ceased.

Chromium failed the EQS by a small margin at Spurn. There are no discharges of chromium close to Spurn, and the elevated levels may have arisen either from discharges from the South Bank of the Estuary, or desorption of metals bound to sediments deposited in the Spurn area. Further

TABLE 4:3

1992 HUMBER ROUTINE CHEMICAL SURVEY DATA

COMPARISON WITH ENVIRONMENTAL QUALITY STANDARDS

STATION		CADMIUM (ug/l)					MERCURY (ug/l)					CHROMIUM (ug/l)				
	NO OF SAMPL	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD
TIDAL RIVERS																
OUSE																
Cawood	7	4	<0.68	<0.1	0.06-0.35	0.21	4	0.252	<0.1	0.07-0.22	0.15	5	1.90	<1.0	0.49-1.21	0.85
Selby	7	3	0.653	0.124	0.21-0.42	0.31	5	0.291	<0.1	0.06-0.21	0.13	4	1.60	<1.0	0.32-1.12	0.72
Drax	7	3	1.08	0.15	0.25-0.46	0.36	5	0.28	<0.1	0.06-0.22	0.14	1	2.90	<1.0	1.53-1.70	1.62
Boothferry	7	3	0.57	0.35	0.21-0.46	0.34	4	0.39	<0.1	0.11-0.25	0.18	2	2.72	<1.0	1.1-1.5	1.3
Blacktoft	7	0	1.45	0.44	-	0.81	3	<0.3	0.13	0.10-0.23	0.17	1	57.60	<1.0	13.5-13.7	13.6
AIRE																
Snaith	7	5	0.54	<0.5	0.09-0.51	0.31	3	0.27	0.14	0.11-0.24	0.17	1	5.39	<1.0	3.1-3.27	2.73
DON																
Kirk Bramwith	7	6	0.19	<0.1	0.1-0.51	0.30						3	1.7	<1.0	0.78-1.21	0.99
Rawcliffe	7	2	0.83	0.163	0.32-0.47	0.39	4	0.399	<0.1	0.13-0.27	0.19	1	2.16	<1.0	0.78-1.21	0.99
TRENT																
Dunham	7	0	1.1	0.26	-	0.52	7	<0.1	<0.1	0 - 0.1	0.05	0	4.29	0.8	-	2.10
Gainsboro'	7	0	1.12	0.24	-	0.48	6	0.16	<0.1	0.02-0.11	0.06	0	2.91	1.09	-	1.72
Keadby	7	0	2.44	0.29	-	0.73	5	0.18	<0.1	0.04-0.11	0.07	0	5.32	1.0	-	2.06
WHARFE																
Ryther	7	4	0.52	<0.1	0.23-0.33	0.22	7	<0.3	<0.1	0 - 0.18	0.09	3	2.17	<1.0	0.64-1.24	0.99
EQS						5.0T					1.0T					250D
ESTUARY																
BROUGH	7	2	<0.5	<0.5	0 - 0.5	0.25	6	<0.3	<0.1	0 - 0.16	0.08	0	3.5	13.4	-	5.95
NEW HOLLAND	7	5	0.45	0.28	0.13-0.29	0.22	6	0.18	<0.05	0.03-0.1	0.06	5	5.9	<1.5	1.13-2.2	1.82
ALBERT DOCK	7	2	0.89	<0.5	0.3-0.63	0.46	7	<0.3	<0.1	0 - 0.19	0.095	0	20	2.4	-	11.12
SALTEND	7	3	<0.5	<0.5	0 - 0.5	0.25	7	<0.3	<0.1	0 - 0.19	0.095	0	17	1.2	-	6.99
KILLING-HOLME	7	4	6.65	<0.25	1.03-1.18	1.11	7	0.07	<0.5	0.04-0.06	0.047	6	2.5	<1.5	0.31-1.63	0.97
SPURN	7	4	<0.5	<0.25	0 - 0.46	0.22	7	<0.3	<0.1	0 - 0.19	0.095	0	29	3.6	-	15.62
EQS						2.5D					0.3D					15D

T = TOTAL D = DISSOLVED

TABLE 4:4																
1992 HUMBER ROUTINE CHEMICAL SURVEY DATA																
COMPARISON WITH ENVIRONMENTAL QUALITY STANDARDS																
STATION		COPPER (ug/l)					NICKEL (ug/l)					LEAD (ug/l)				
	NO OF SAMPL	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD
TIDAL RIVERS																
OUSE																
Cawood	7	1	5.34	1.0	2.22-2.46	2.29	3	7.85	<5.0	2.08-4.58	5.83	3	5.19	1.0	1.7-2.19	1.94
Selby	7	0	19.0	1.3	-	6.99	3	15.5	3.15	3.73-6.73	5.23	1	3.03	<1.0	1.98-2.23	2.10
Drax	7	0	19.0	4.9	-	9.14	3	7.51	<5.0	2.64-5.64	4.14	4	2.09	<1.0	0.56-1.23	1.23
Boothferry	7	0	9.71	3.9	-	6.09	2	7.48	<5.0	3.24-5.74	4.49	3	2.19	<1.0	0.7-1..3	1.15
Blacktoft	7	0	30.8	4.36	-	11.55	0	13.3	6.6	-	8.23	4	68.6	<1.0	13.7-14.5	14.12
AIRE																
Snaith	7	0	17.3	6.75	-	9.97	0	18.1	5.0	-	9.93	1	2.04	<1.0	1.32-1.46	1.39
DON																
Kirk Bramwith	7	0	13.0	3.12	-	7.08	1	36.8	<1.0	23.4-23.6	23.5	6	1.3	<1.0	0.19-1.04	0.61
Rawcliffe	7	0	8.33	3.53	-	5.48	0	17.7	5.7	-	8.88	6	1.63	<1.0	0.23-1.09	0.66
TRENT																
Dunham	7	0	11.9	7.16	-	8.23	0	38.1	11.1	-	21.35	1	1.63	<0.5	1.09-1.16	1.12
Gainsboro'	7	0	19.2	7.39	-	10.74	0	27.7	9.79	-	15.67					
Keadby	7	0	14.6	7.62	-	10.71	0	17.0	9.55	-	12.46	2	7.09	<0.5	1.83-1.97	1.90
WHARFE																
Ryther	7	0	4.01	1.6	-	2.56	3	4.82	<5.0	1.2-4.96	3.08	1	2.53	<1.0	1.36-1.50	1.43
EQS						28D					200D					250D
ESTUARY																
BROUGH	7	4	10.8	<1.0	6.37-6.63	6.5	1	15	1.74	6.75-7.75	6.85	4	4.9	<1.0	0.98-1.78	1.38
NEW HOLLAND	7	1	12.0	2.5	5.42-6.05	5.73	1	40.0	<3.0	12.3-12.7	12.52	7	<5.0	<2.5	0.2.54	1.41
ALBERT DOCK	7	0	50.1	5.1	-	18.5	1	17.7	<5.0	9.16-10.2	9.66	3	<1.0	<1.0	0 - 1.0	0.5
SALTEND	7	0	48.3	7.32	-	18.56	1	5.1	11.2	5.7-6.95	6.32	3	3.5	<1.0	0.87-1.63	1.25
KILLING-HOLME	7	0	13.0	0.66	-	5.22	2	95.0	<3.0	22.8-23.5	23.16	7	<2.5	<2.5	0 - 25	1.25
SPURN	7	0	94.7	9.82	-	26.64	3	20.3	<5.0	7.9-10.4	9.15	3	28	<1.0	6.37-6.87	6.62
EQS						5.0D					30D					25D

T = TOTAL D= DISSOLVED

TABLE 4:5															
1992 HUMBER ROUTINE CHEMICAL SURVEY DATA															
COMPARISON WITH ENVIRONMENTAL QUALITY STANDARDS															
STATION		ZINC (ug/l)					ARSENIC (ug/l)					IRON (ug/l)			
	NO OF SAMPLES	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD
TIDAL RIVERS																
OUSE																
Cawood	7	1	251	<20	85 - 88	87.04	5	<5	<5	0 - 5	2.50	1	241	<40	122-128	125
Selby	7	1	302	<20	93 - 96	94.60										
Drax	7	0	228	28	-	100.86	5	6.7	<5	1.7-5.3	3.53	1	165	<40	104-110	107
Boothferry	7	0	243	31	-	114.17	3	6.3	<5	2.5-5.5	4.00	0	224	48	-	123
Blacktoft	7	0	198	89	-	146.71	6	<5	<5	0 - 5	2.50	1	153	67	-	95
AIRE																
Snaith	7	0	366	33	-	111.43	6	6.4	<5	0.9-5.2	3.06	0	380	74	-	171
DON	7															
Kirk Bramwith	7	0	97	23	-	46.86						0	182	64	-	137
Rawcliffe	7	0	323	26	-	134.42	5	6.6	<5	1.67-5.24	3.46	1	443	<40	148-154	145
TRENT																
Dunham	7	0	109	37	-	63.00	0 *	7.7*	1.6*	-	4.2*	2	42	<10	20.4-25.6	22.8
Gainsboro'	7	0	135	34	-	59.30	0 *	21.8*	3.6*	-	8.6*	1	237	<10	55.5-57.2	56.3
Keadby	7	0	391	76.2	-	150.80	0 *	45.6*	8.5*	-	22.73*	2	1040	<10	210-355	213.5
WHARFE																
Ryther	7	5	106	<20	24-38	30.70	0	6.7	5.0	-	5.34	2	132	<40	64-77	70
EQS						500T					50D					1000D
ESTUARY																
BROUGH	7	5	27	<20	7.3-21.54	14.43	6	281	<5	40-44.4	42.28	0	492	40	-	132.71
NEW HOLLAND	7	0	50	8.6	-	19.62	2	2.05	<0.5	1.1-1.2	1.18	3	100	<10	22.3-27.3	24.83
ALBERT DOCK	7	5	31	<20	8.1-22.4	15.28	7	<5	<5	0 - 5	2.50	1	78	<40	48.7-54.4	51.57
SALTEND	7	4	35	<20	10.7-20.6	17.35	7	<5	<5	0 - 5	2.50	1	129	<40	57.8-64.5	61.17
KILLINGHOLME	7	0	61	13	-	28.50	2	2.62	<0.5	1.08-1.21	1.09	5	15	0.42	2.2-9.34	5.77
SPURN	7	6	24	<20	3.4-20.6	12.00	7	<5	<5	0 - 5	2.50	1	270	<40	79 - 84.7	81.86
EQS						40D					25D					1000D

T = TOTAL D = DISSOLVED * = FIGURES FOR TOTAL METAL COMPARED TO AN EQS FOR DISSOLVED METAL

TABLE 4:6																
1992 HUMBER ROUTINE CHEMICAL SURVEY DATA																
COMPARISON WITH ENVIRONMENTAL QUALITY STANDARDS																
RESULTS OF ANALYSIS OF SUBSTANCES NEW TO THE HUMBER PROGRAMME																
STATION		BORON (ug/l)						VANADIUM (ug/l)					ISODRIN (ug/l)				
	NO OF SAMPL	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF LOD
TIDAL RIVERS																
OUSE																
Cawood	7	0	147	43	-	92.3	2	79	3.67	20.7-30.7	25.7	5	<0.001	<0.001	0 - 0.001	0.0005
Selby	7	2	161	<50	68.5-88.5	78.5	3	105	4.21	21.8-33.8	27.8		<0.001	<0.001	0 - 0.001	0.0005
Drax	7	0	768	64.4	-	309.5	1	98	8.89	35.9-39.9	37.9		<0.001	<0.001	0 - 0.001	0.0005
Boothferry	7	0	1100	100	-	421.4	2	112	<20	48-58	53.7		0.009	0.005	-	0.007
Blacktoft	7	0	1700	189	-	950.2	1	96	<20	58.8-62.8	60.8		<0.001	<0.001	0 - 0.001	0.0005
AIRE																
Snaith	7	0	489	78	-	268.0	3	131	2.36	25.7-45.9	10.2		<0.001	<0.001	0 - 0.001	0.0005
DON																
Kirk Bramwith													<0.001	<0.001	0 - 0.001	0.0005
Rawcliffe	7	0	923	151	-	438	1	111	7.92	53.9-57.9	55.98		<0.001	<0.001	0 - 0.001	0.0005
TRENT																
Denham	7	0	649	53	-	402	0	47.1	1.78	-	9.4		<0.005	<0.005	0 - 0.005	0.0025
Gainsboro'													<0.005	<0.005	0 - 0.005	0.0025
Keadby													<0.005	<0.005	0 - 0.005	0.0025
WHARFE																
Ryther							4	<20	<1	0 - 15.25	7.6		<0.001	<0.001	0 - 0.001	0.0005
EQS						1000T					60T					
ESTUARY																
BROUGH	7	0	2500	324	-	1344	2	80	<50	39.8-56.5	48.17		<0.001	<0.001	0 - 0.001	0.0005
NEW HOLLAND													<0.004	<0.001	0 - 0.0006	0.0003
ALBERT DOCK	7	0	3300	1272	-	2371	1	120	<50	76.2-84.5	80.33		<0.001	<0.001	0 - 0.001	0.0005
SALTEND	7	0	4217	1114	-	3032	2	74	<50	31.5-56.5	44.00		<0.001	<0.001	0 - 0.001	0.0005
KILLING-HOLME																
SPURN	7	0	3743	1059	-	3788	1	71	<50	32.7-42.2	39.00		<0.001	<0.001	0 - 0.001	0.0005
EQS						7000T					100T					

TABLE 4:7															
1992 HUMBER ROUTINE CHEMICAL SURVEY DATA															
COMPARISON WITH ENVIRONMENTAL QUALITY STANDARDS															
STATION		TOTAL 'DRINS (ug/l)					TOTAL HCH (+) (ug/l)					DDT (op + pp) (ug/l)			
	NO OF SAMPL	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF FACE VALUE	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF FACE VALUE	NO OF LESS THAN (<)	MAX	MIN	RANGE OF MEAN	MEAN WITH < AT HALF FACE VALUE
TIDAL RIVERS																
OUSE																
Cawood	7	18	0.003	<0.001	0.0025-0.0014	0.0008	5	0.1	<0.001	0.0007-0.0014	0.023	28	<0.002	<0.002	0 - 0.002	0.001
Selby	7	18	0.003	<0.001	0.0025-0.0014	0.0008	5	0.101	<0.002	0 - 0.022	0.0225	28	<0.002	<0.002	0 - 0.002	0.001
Drax	7	25	0.004	<0.001	0.0003-0.0011	0.0005	5	0.015	<0.002	0.0007-0.006	0.007	28	<0.002	<0.002	0 - 0.002	0.001
Boothferry	7	21	0.009	<0.001	0.0018-0.0024	0.002										
Blacktoft	7	28	<0.002	<0.001	0-0.005	0.0025	7	<0.009	<0.002	0 - 0.004	0.0093	28	<0.002	<0.002	0 - 0.002	0.001
AIRE																
Snaith	7	21	0.004	0.002	0.0007-0.0017	0.001	1	0.024	0.001	0.0202-0.0203	0.0205					
DON																
Kirk Bramwith	7	28	<0.002	<0.001	0 - 0.005	0.0025										
Rawcliffe	7	27	0.002	<0.001	0.00007-0.005	0.0025	11	0.011	<0.002	0.0002-0.0057	0.0336	28	<0.002	<0.002	0 - 0.002	0.001
TRENT																
Dunham	7	28	<0.005	<0.005	0 - 0.005	0.0025	10	0.036	<0.01	0.003-0.00075	0.011					
Gainsboro'	7	28	<0.005	<0.005	0 - 0.005	0.0025	10	0.028	<0.01	0.004-0.015	0.008	26	0.005	<0.005	.0007-0.005	0.015
Keadby	7	28	<0.005	<0.005	0 - 0.005	0.0025	12	<0.03	<0.01	0.0042-0.013	0.015	28	<0.005	<0.005	0 - 0.005	0.0025
WHARFE																
Ryther	7	24	0.002	<0.001	0.0001-0.001	0.0005	9	<0.008	<0.002	0.002-0.0033	0.0025	28	<0.002	<0.002	0 - 0.002	0.001
EQS																
ESTUARY																
BROUGH	7	27	0.001	<0.001	0.0004-0.005	0.0029	9	,0.007	<0.002	0.005-0.0044	0.0038	24	0.009	<0.002	0.001-0.003	0.002
NEW HOLLAND	7	28	<0.0003	<0.001	0 - 0.0012	0.0006	3	0.003	<0.0005	0.0008-0.003	0.0019	28	<0.0038	<0.001	0 - 0.0015	0.0008
ALBERT DOCK	7	25	0.003	<0.0043	0.0002-0.005	0.003	9	<0.004	<0.002	0.0027-0.001	0.002	28	<0.002	<0.002	0 - 0.002	0.001
SALTEND	7	28	<0.002	<0.001	0 - 0.006	0.003	9	<0.003	<0.002	0.0008-0.0023	0.0016	28	<0.002	<0.002	0 - 0.002	0.001
KILLING-HOLME	7	28	<0.004	<0.0005	0 - 0.0008	0.0004	9	<0.001	<0.001	0.009-0.011	0.0095	26	0.014	<0.001	0.002-0.022	0.0026
SPURN	7	28	<0.002	<0.001	0 - 0.006	0.003	10	<0.005	<0.002	0.001-0.0026	0.0018	28	<0.002	<0.002	0 - 0.002	0.001
EQS																

TABLE 4:8											
RANGES AND MEAN CONCENTRATIONS OF DISSOLVED METALS IN ESTUARIES AND SEA WATER 1991 COMPARED TO HUMBER 1992 SURVEY DATA											
		HUMBER	HUMBER SURVEY 1992	TEES	WEAR	TYNE	TWEED	NORTH SEA	ENGLISH CHANNEL	IRISH SEA	MERSEY
CADMIUM	RANGE	0.049-0.122	0.22-1.39	0.02-0.042	0.013-0.025	0.011-0.126	0.007-0.011	0.010-0.032	0.011-0.018	0.018-0.081	0.009-0.052
	MEAN	0.120	0.57	0.30	0.020	0.08	0.01	0.018	0.015	0.030	0.030
COPPER	RANGE	0.75-2.80	5.22-26.64	1.30-10.30	0.33-1.3	0.30-1.61	0.58-4.67	0.24-0.83	0.2-0.48	0.33-1.50	1.4-3.3
	MEAN	2.22	13.52	3.80	0.83	1.03	2.01	0.48	0.32	0.69	2.50
NICKEL	RANGE	0.90-6.30	6.32-23.16	0.21-1.00	0.51-2.93	0.36-2.75	0.48-0.81	0.20-1.00	0.22-0.47	0.26-0.87	0.8-9.4
	MEAN	3.09	11.27	0.70	1.61	1.55	0.67	0.54	0.33	0.48	5.36
LEAD	RANGE	0.023-0.422	0.5-6.62	0.096-0.815	0.069-0.408	0.086-1.09	0.096-0.169	0.021-0.81	0.023-0.032	0.024-0.169	0.032-0.464
	MEAN	0.210	2.06	0.46	0.29	0.59	0.13	0.103	0.030	0.070	0.310
ZINC	RANGE	5.1-12.6	12.0-28.5	2.6-14.0	0.5-6.1	0.6-21.7	0.6-1.9	0.3-2.2	0.2-1.0	0.3-1.8	1.5-15.6
	MEAN	9.3	17.86	8.4	3.6	14.5	1.1	0.8	0.7	0.8	1.05
ALL FIGURES IN ug/l											
DATA FROM MAFF (1993) AQUATIC ENVIRONMENT MONITORING REPORT NUMBER 36											

investigations are in progress in 1993.

Copper was above the EQS standard at all the estuary sites. However, as explained above, this is not a direct comparison, as the results are for total dissolved copper, and the EQS is for dissolved inorganic copper. Analyses by other organisations such as MAFF and WRc (Section 4.4) have shown lower levels of copper in the outer Estuary.

4.3.5.3 VANADIUM AND BORON (TABLE 4:6)

Levels of vanadium and boron are reported as part of the Humber Survey for the first time in 1992. Levels of vanadium were relatively high in all the tidal rivers, although there was only one failure, at Blacktoft on the tidal Ouse. The major source of vanadium is power station discharges, of which there are many to the Ouse, Aire Don and Trent. Levels of boron were also elevated, but no site failed the EQS.

4.3.6 ORGANIC COMPOUNDS (TABLE 4:6 and 4:7)

HCH (Lindane and other isomers) (Table 4:7).
There were some results above the limit of detection for these substances throughout the estuary and tidal rivers, although none of the levels were greater than one tenth of the EQS (0.1 ug/l of total HCH) Dieldrin, Endrin, Aldrin and Isodrin. No sites failed the EQS for total 'Drins and most of the samples were below the limit of detection. There were some positive results for dieldrin on the Ouse, Aire and Don, but these were below the EQS. The only positive results for aldrin and isodrin were at Boothferry on the Ouse. Isodrin (Table 4:6) is reported for the first time this year.

PCB's (Polychlorinated Biphenyls).
There were no samples of any of the seven measured isomers of PCB above the limit of detection at any site on the tidal rivers or estuary.

Carbon Tetrachloride, DDT (op and pp).
There were no sites above the EQS for these substances, which were above the limit of detection only at South Killingholme and New Holland.

4.4 COMPARISON BETWEEN HUMBER SURVEY DATA AND MAFF DATA FROM THE HUMBER AND OTHER ESTUARIES(TABLE 4:8)

During 1991 and 1992, MAFF (Ministry of Agriculture, Fisheries and Food) conducted chemical surveys in the major estuaries and coastal waters of Britain. Levels of trace metals in mid estuary were measured from the MAFF Research Vessel in the Humber, Tees, Tyne, Wear, Tweed and Mersey, and from the surrounding open seas. A range and mean was calculated for the sites sampled (between 3 and 6 sites per estuary, 20 sites in the sea), and these are shown in Table 4:8, with the 1992 Humber survey means and ranges for comparison. The Humber Survey data are not directly comparable with the MAFF analyses since Humber Survey samples are collected from shore-based sample sites, rather than in mid-estuary as are the MAFF samples, but is useful for general comparison of levels. Mid-estuary samples should generally have lower levels of metals due to more complete mixing away from the shore. The MAFF mid-estuary metals levels were in all cases much lower than the Humber Survey results. On the basis of the MAFF data, the Humber and Mersey had the highest nickel levels when compared to other estuaries, the second highest cadmium and zinc, and the third highest copper. Other estuaries with comparable metals levels were the Tees and Mersey. Levels in the open sea were generally much lower than in the estuaries.

4.5 METALS LEVELS IN SEDIMENTS

4.5.1 SAMPLING METHODS

Sediment samples are taken by removing the top 1-2cm of the sediment which is freshly exposed at low tide, as close as possible to the low tide mark. However, at some of the estuary sites it is not safe to walk out into the estuary that far, and these sites are sampled at mid shore. The samples are stored in plastic containers for drying and sieving before analysis. The analysis is carried out on the less than 63 micron fraction of the sediment. It should be noted that this was adopted in 1990, and prior to this the analysis was carried out on the less than 90 micron sediment fraction.

4.5.2 GENERAL PATTERNS

Figures 4:2A, B and C and 4:3A, B and C show the levels of metals in the tidal rivers and Estuary sediments. Levels of all metals were generally similar in the tidal rivers and estuary, although cadmium was slightly higher in the tidal rivers. When compared to the 5-year means, Saltmarshe on the Ouse had lower levels than the average for all metals, while Weighton Lock, Thorngumbald and Stone Creek had higher levels. On the tidal rivers, levels at Ryther were lower than long-term means. Sediments are very mobile both in the tidal rivers and estuary and it is difficult to form a link between a discharge, for example, and a high sediment level nearby. It is more informative to study the changes throughout the estuary system, and look for general patterns of increase or decline.

4.5.2.1 Mercury and Cadmium (FIGURE 4:2A AND 4:2B)

There is, as yet, insufficient data to calculate long-term means for mercury at most of the tidal river sites. The Estuary sites were very similar to long-term means, except for Weighton Lock, where levels were lower, and East Clough, where they were higher. Cadmium levels were slightly higher in the tidal rivers than in the Estuary. There was one high reading at Thorne on the Don in 1992, and one high reading at Ryther three years ago. The Estuary sites were generally similar to the long-term mean, although Weighton Lock, Thorngumbald, Stone Creek and Kilnsea had slightly higher levels and East Clough, North Ferriby and Hessle were slightly lower.

4.5.2.2 Other Metals (FIGURES 4:2A & B, 4:3A & B, 4:4A & B)

Levels of zinc, nickel, copper and iron were similar in the tidal rivers and estuary. Levels at Weighton Lock, Thorngumbald and Stone Creek were higher than the means, while Ryther and Saltmarshe were lower.

There were generally lower levels of lead and chromium in the tidal rivers than in the Estuary. Levels at Weighton Lock, Thorngumbald and Stone Creek were higher than the means, while Ryther and Saltmarshe were lower.

Levels of zinc and arsenic were similar in the tidal rivers and Estuary. Arsenic levels declined at Brough and Welton Ings, but were higher at Thorngumbald, Stone Creek and Kilnsea. There were very much lower levels at Saltmarshe.

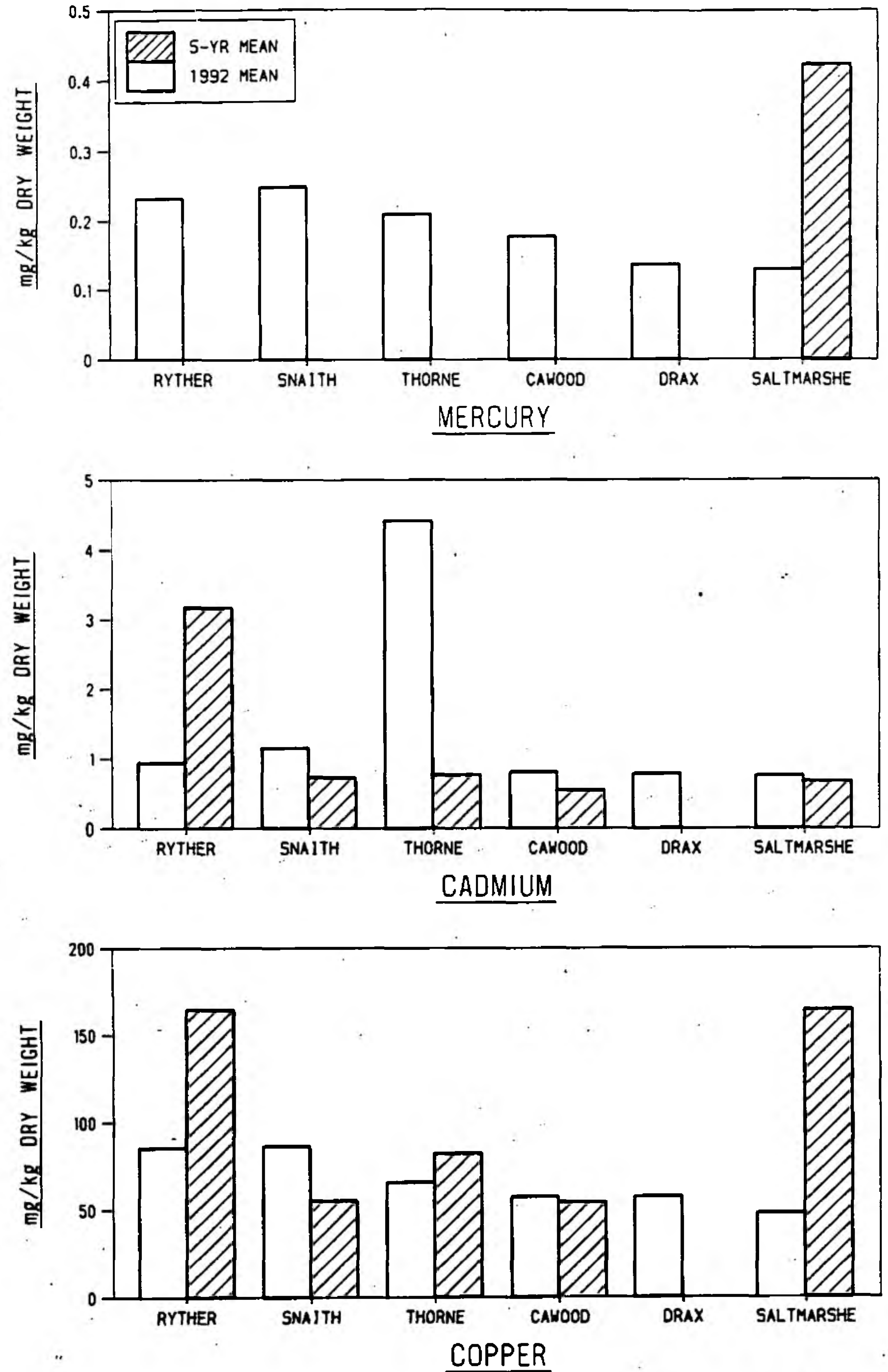


FIGURE 4:2A METALS IN TIDAL RIVER SEDIMENTS
COMPARISON BETWEEN 5-YEAR MEAN & 1992 MEAN

STAT115

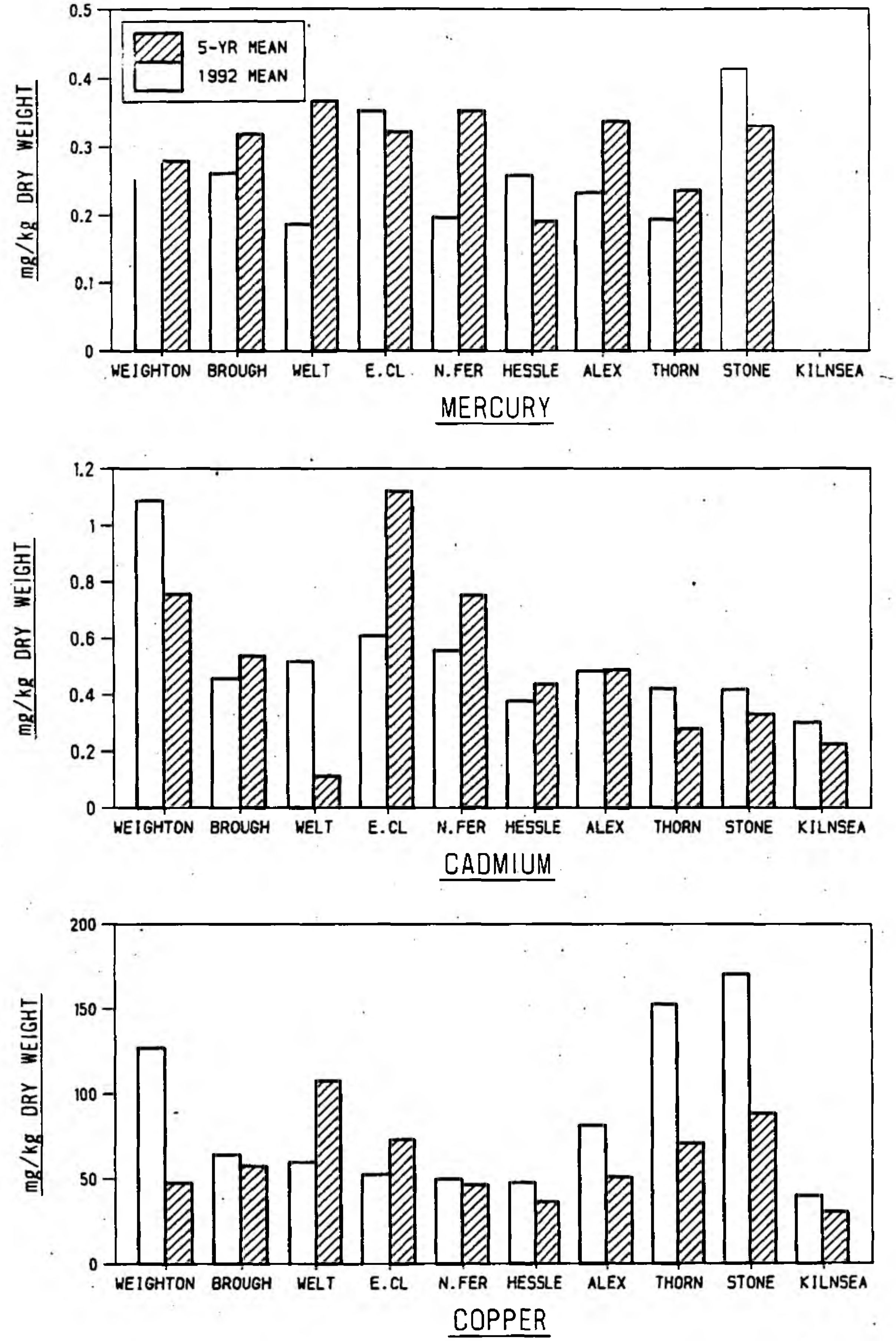


FIGURE 4:2B METALS IN HUMBER SEDIMENTS - NORTH BANK
COMPARISON BETWEEN 5-YEAR MEAN & 1992 MEAN

STAT110

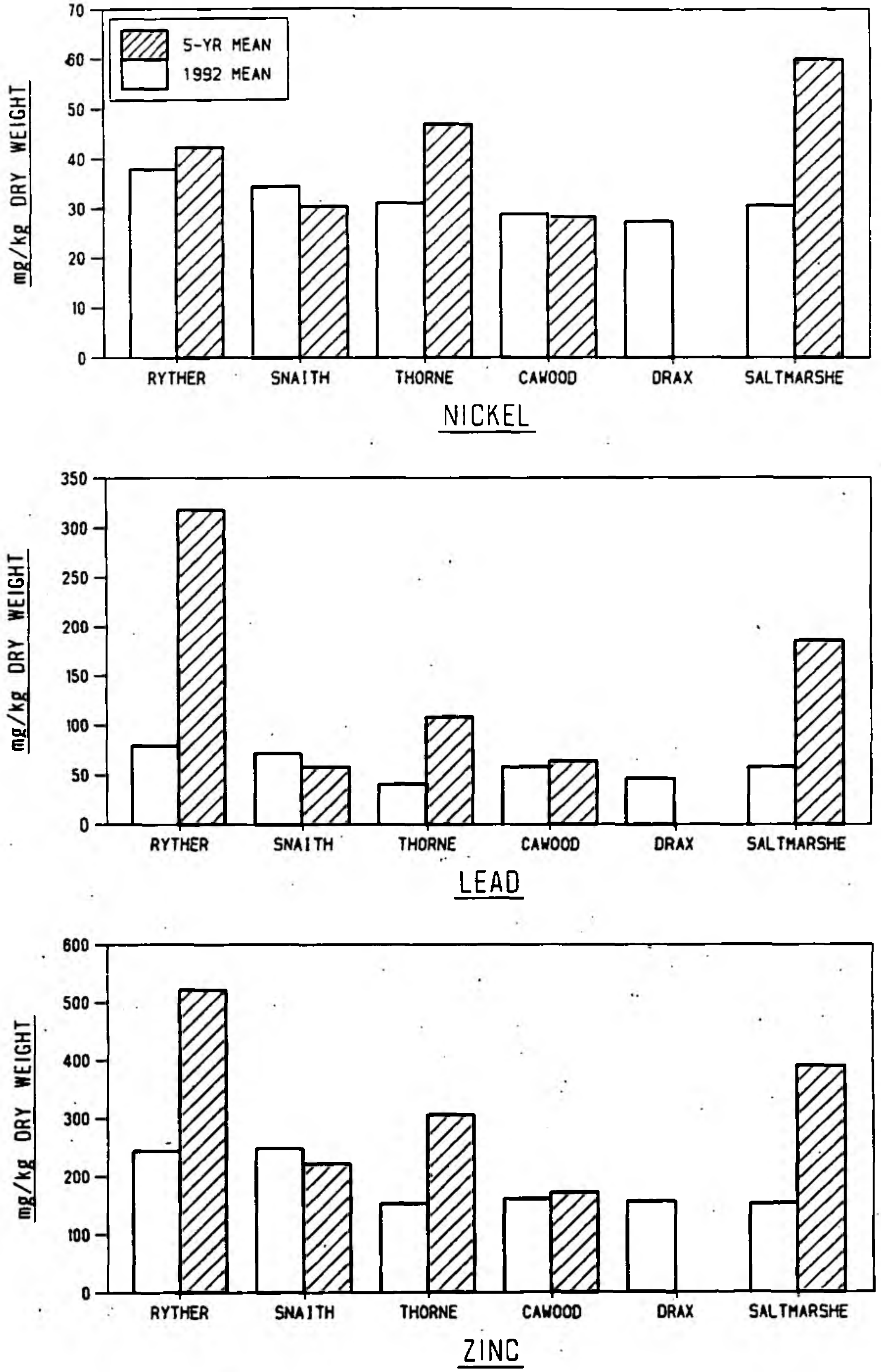


FIGURE 4:3A METALS IN TIDAL RIVER SEDIMENTS
COMPARISON BETWEEN 5-YEAR MEAN & 1992 MEAN

STAT116

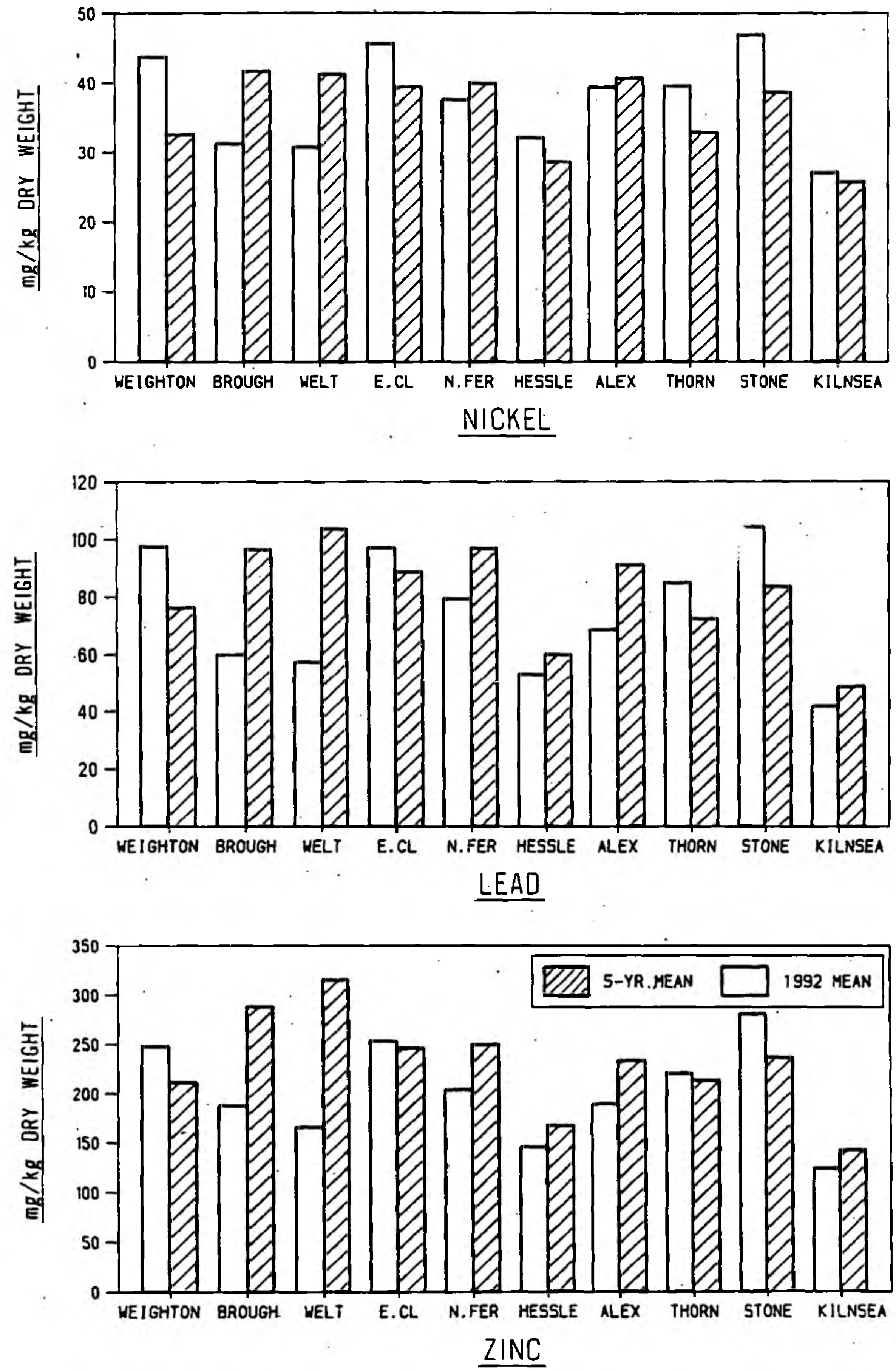


FIGURE 4:3B METALS IN HUMBER SEDIMENTS - NORTH BANK
COMPARISON BETWEEN 5-YEAR MEAN & 1991 MEAN

STAT111

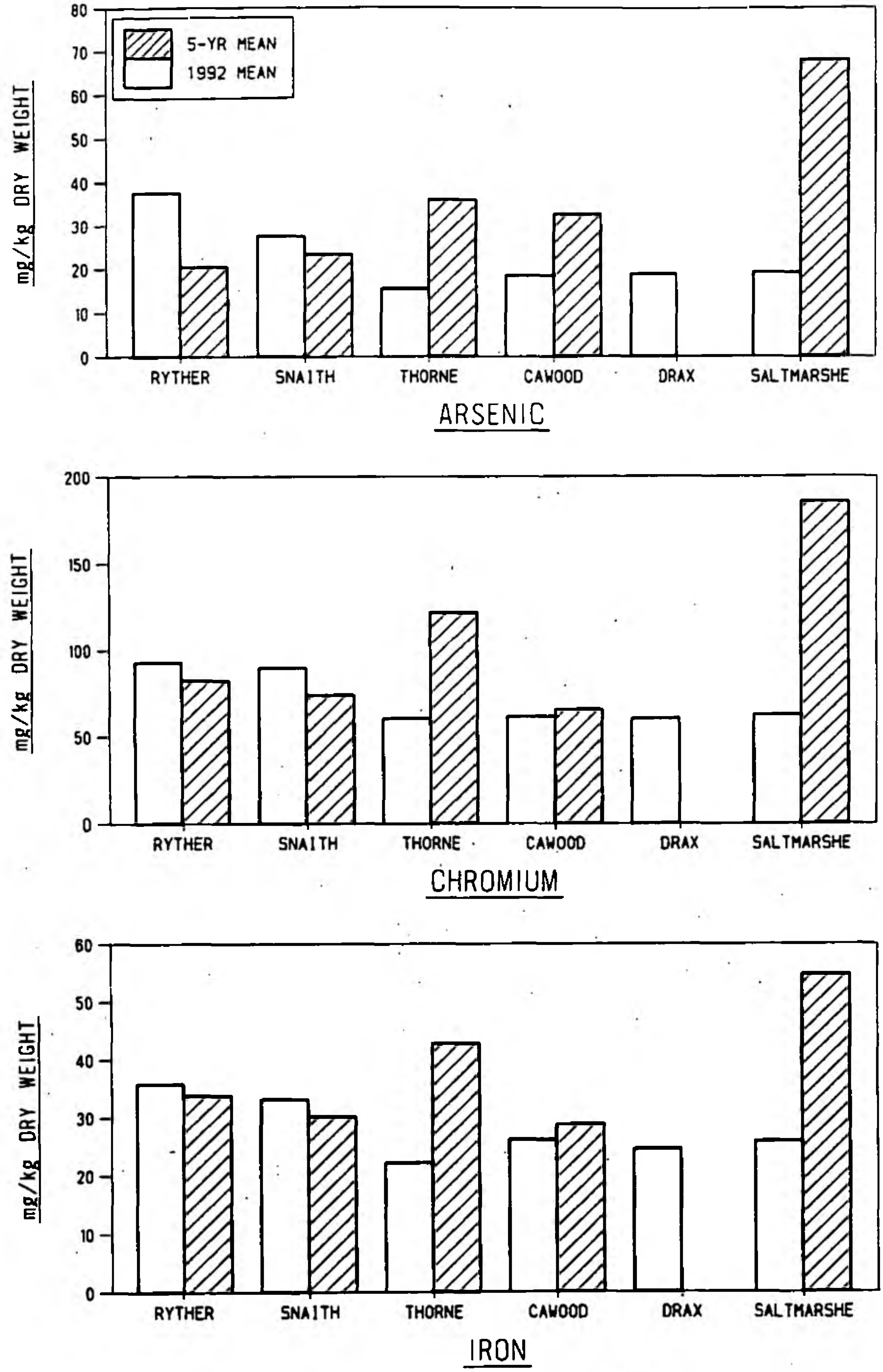


FIGURE 4:4A HEAVY METALS IN TIDAL RIVER SEDIMENTS
COMPARISON BETWEEN 5-YEAR MEAN & 1992 MEAN

STAT117

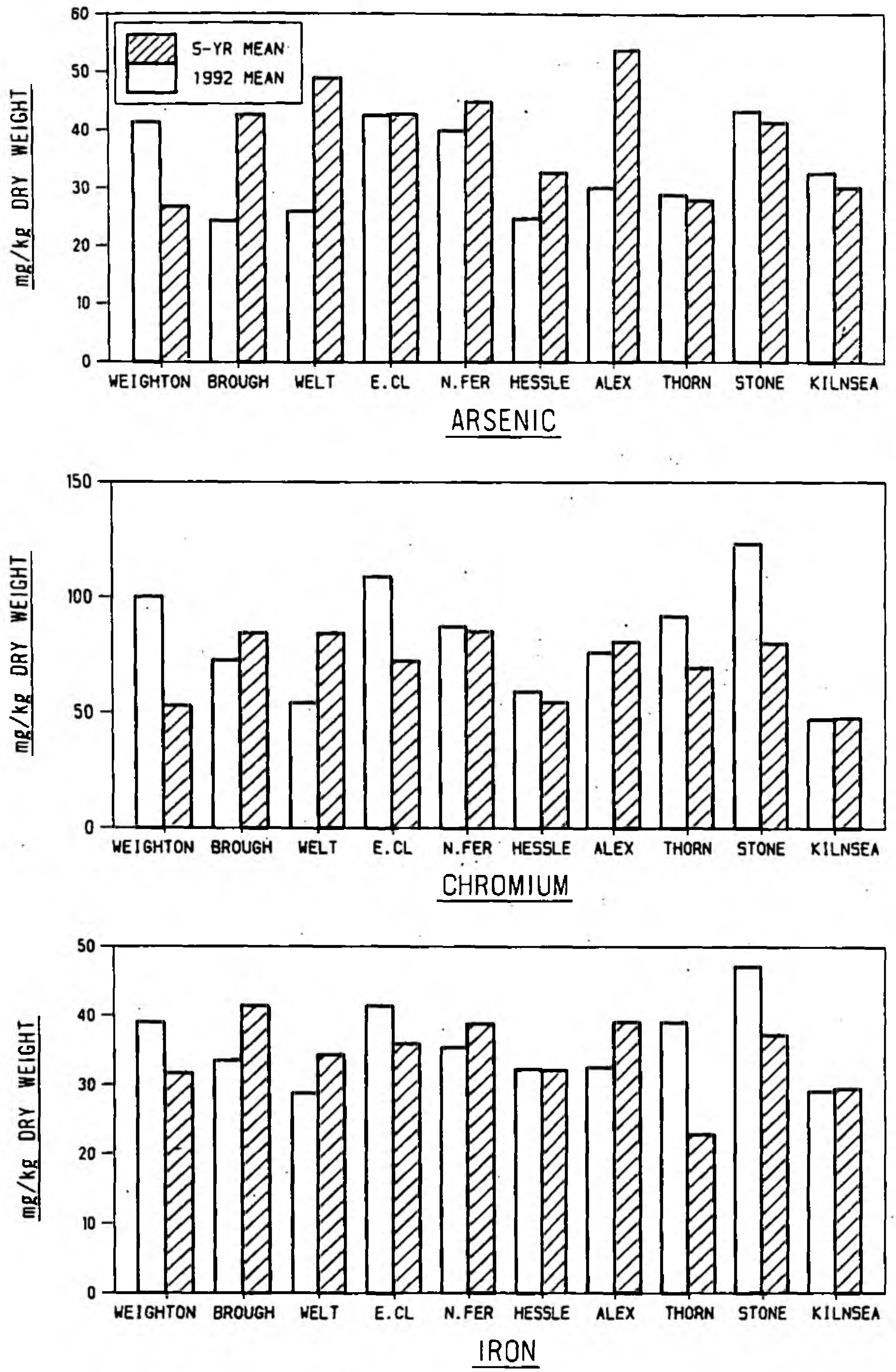


FIGURE 4:4B METALS IN HUMBER SEDIMENTS - NORTH BANK
COMPARISON BETWEEN 5-YEAR MEAN & 1992 MEAN

STAT112

4.6 BIOACCUMULATION

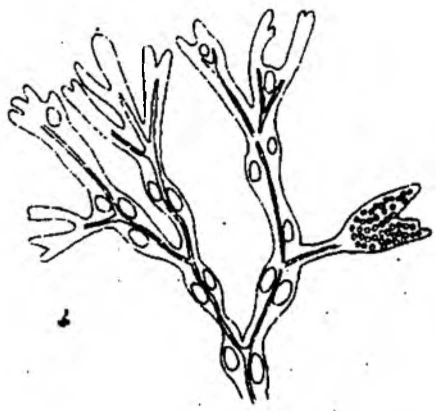
4.6.1 INTRODUCTION

Some substances, including metals, can accumulate in the tissues of small animals and seaweeds living in the Estuary. These may then be eaten by birds and fish, where levels of pollutants can become concentrated. To determine whether significant bioaccumulation is occurring in the Humber Estuary, samples of seaweed *(Fucus vesiculosus)* and ragworms (*Nereis* spp) are collected every year, and the levels in these compared to the levels in the sediments where the organisms are living. This can be difficult at some sites, as *Fucus* and *Nereis* do not necessarily occur everywhere, but these two groups have proved the most reliably found organisms for accumulation studies. There are no EQS standards for levels of metals in sediments and biota, but MAFF publish guidelines levels for some substances for fish and mussel flesh for human consumption, and these have been used to give an indication of the level of contamination in Humber organisms.

4.6.2 CADMIUM AND MERCURY (FIGURE 4:5A)

Cadmium and mercury are included on List I of the Dangerous Substances Directive, as they are the metals which most readily bioaccumulate, and the most toxic once they are within an organism. Figure 4:5A shows the levels of Cadmium and Mercury in sediment, *Fucus* and *Nereis* at the sample sites on the North and South Bank. Levels of cadmium in sediments were slightly higher on average at the South Bank sites. There was evidence of accumulation in *Fucus* at all sites where it was found, and some accumulation, although at lower levels, in *Nereis*. Levels of mercury were similar in North Bank and South Bank sediments, and there were low concentrations in *Fucus*. There was some accumulation in *Nereis* in the lower Estuary, at Grimsby and Stone Creek. The guideline concentrations for mercury in molluscs are <0.6 mg/kg dry weight for the lowest band, 0.6-1.0 mg/kg for the medium band, and >1.0 mg/kg for the highest band. Comparing the *Nereis* results with these standards, samples from all the sites fall into the low or medium bands except for Grimsby, which was in the highest band. The guideline concentration bands for cadmium are:- <2mg/kg dry weight = low band, 2 - 5 mg/kg = medium band and >5 mg/kg = high band. Compared with these guidelines, all the *Nereis* samples taken from the Humber fall into the low band.

Fucus vesiculosus



4.6.3 OTHER METALS (FIGURES 4:5B, 4:5C AND 4:5D)

Sediment levels of lead, zinc, chromium and iron were slightly higher on the South Bank than on the North Bank. Copper was higher on the North bank than on the South bank. There were very similar levels of copper in sediments, *Fucus* and *Nereis* on the South Bank, but where copper levels were high on the North Bank, levels in *Fucus* and *Nereis* were lower and similar to South bank levels. Levels of chromium, arsenic and lead were higher in sediments than in biota. Levels of nickel in *Fucus* were higher on the South Bank than on the North Bank, but levels in *Nereis* were similar.

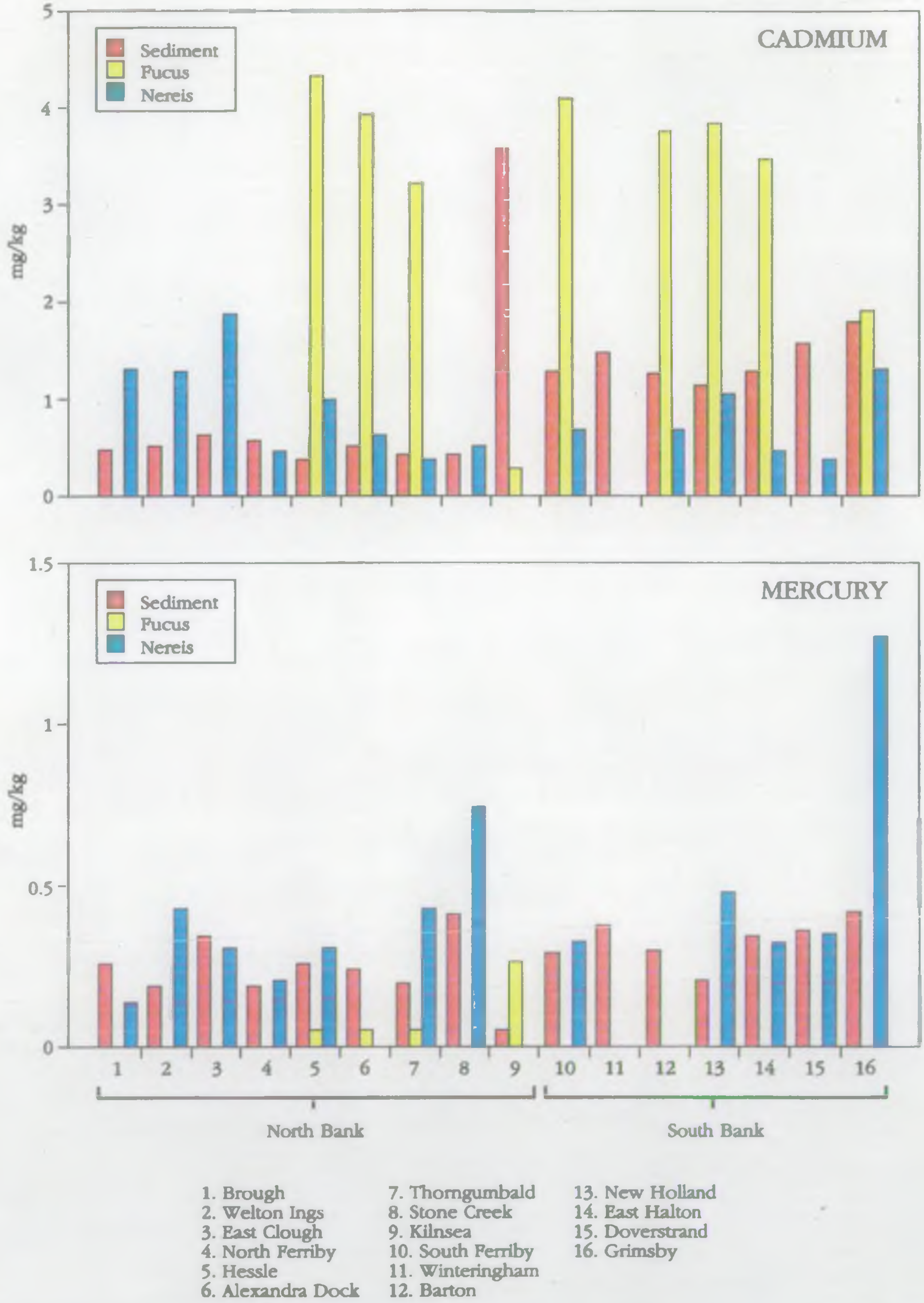


FIGURE 4:5A METALS IN HUMBER ESTUARY SEDIMENTS AND BIOTA

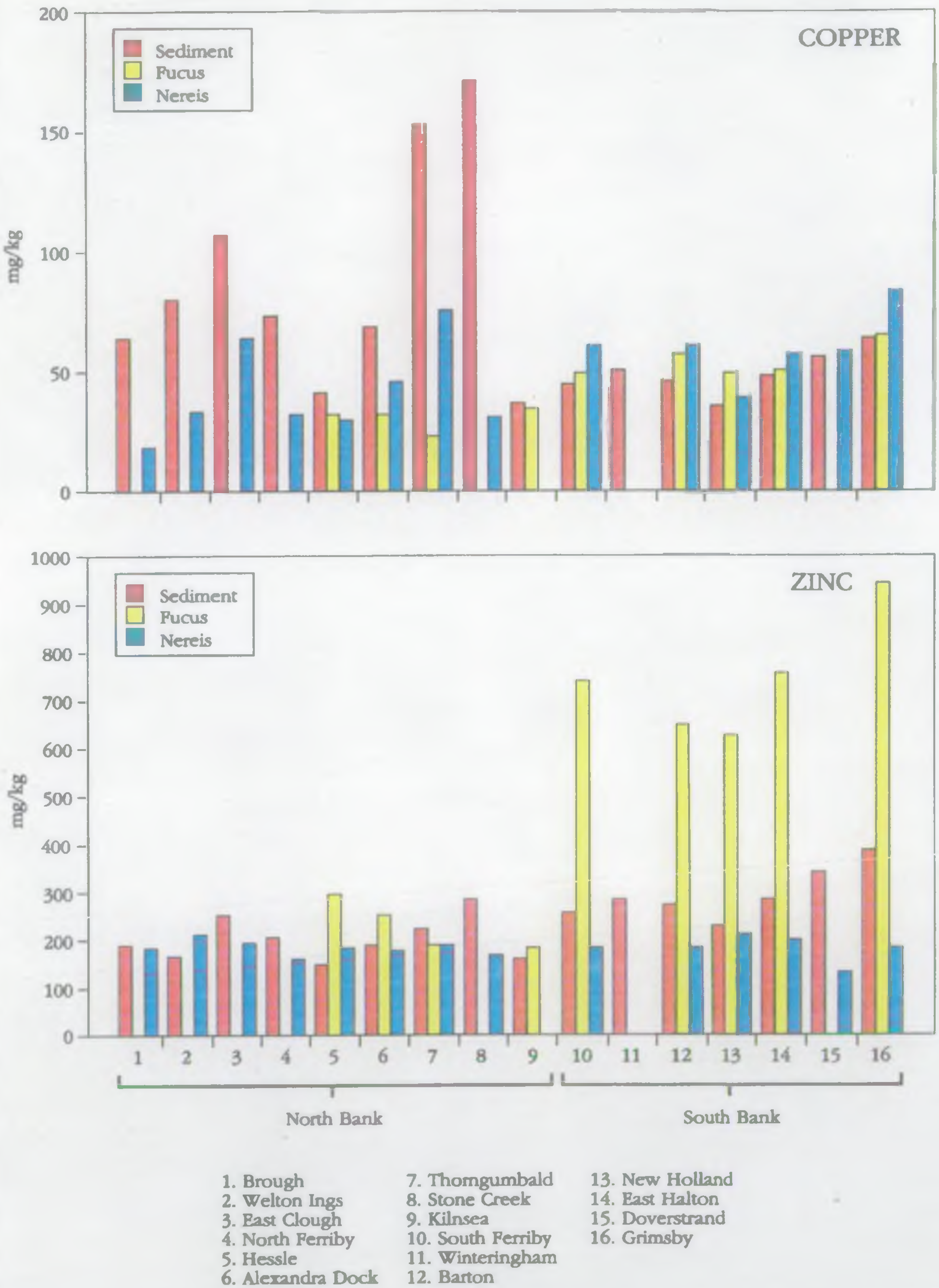


FIGURE 4:5B METALS IN HUMBER ESTUARY SEDIMENTS AND BIOTA

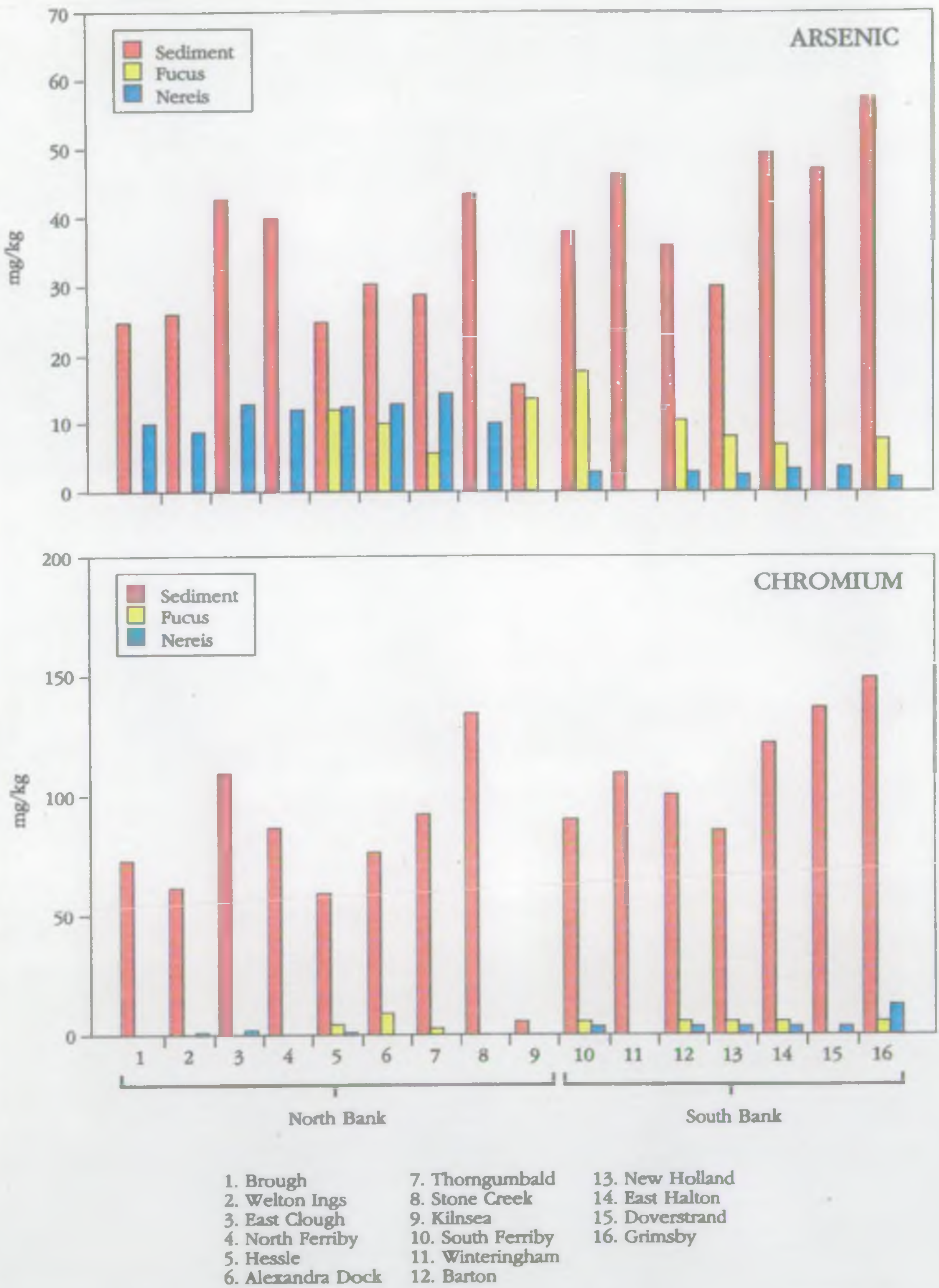
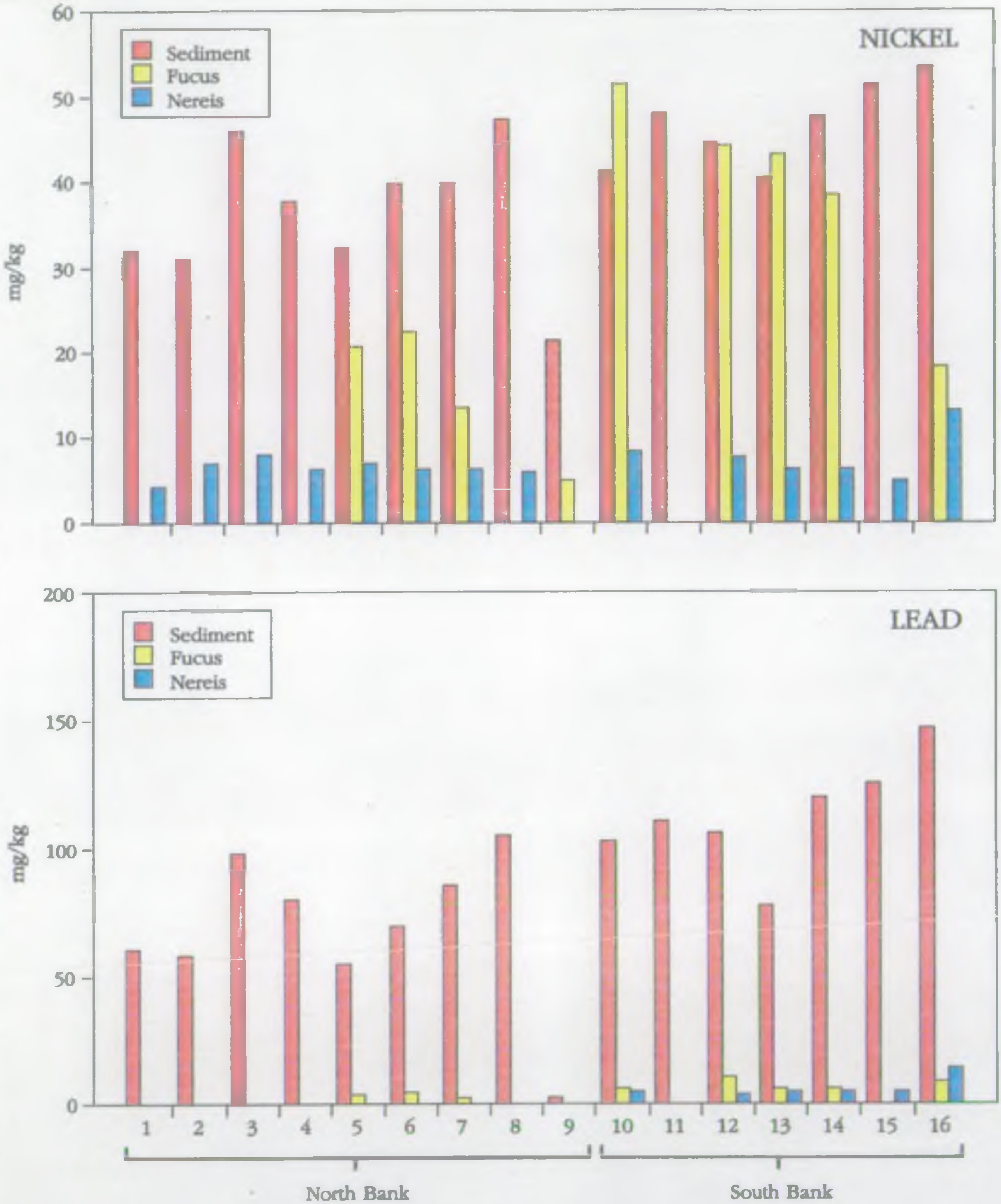


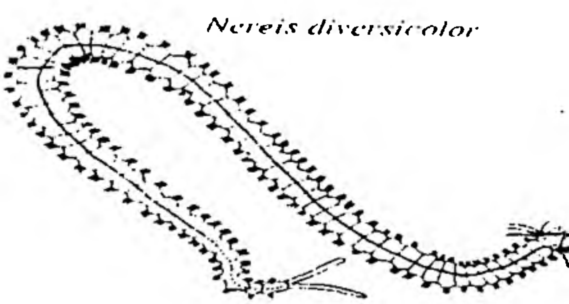
FIGURE 4.5C METALS IN HUMBER ESTUARY SEDIMENTS AND BIOTA



1. Brough
2. Welton Ings
3. East Clough
4. North Ferriby
5. Hessle
6. Alexandra Dock
7. Thorngumbald
8. Stone Creek
9. Kilnsea
10. South Ferriby
11. Winteringham
12. Barton
13. New Holland
14. East Halton
15. Doverstrand
16. Grimsby

FIGURE 4:5D METALS IN HUMBER ESTUARY SEDIMENTS AND BIOTA

4.7 COMPARISON OF METAL LEVELS IN *NEREIS* WITH 5-YEAR MEANS (FIGURES 4:6A & B)



To determine whether there has been a change in levels of metals in *Nereis* over the last 5 years, the 1992 levels were compared with the long-term mean. Figure 4:6 shows the data for mercury, cadmium, chromium and arsenic. The 1992 means for mercury were close to the maximum recorded at most sites, especially East Clough. The levels of mercury in the water have also declined over the last few years. The levels of cadmium and chromium in 1992 were much lower than the long term maxima at all sites. Levels of arsenic showed a marked decline at Brough, Hessle, Alexandra Dock and Kilnsea. This could be the result of the declining amounts of arsenic discharged from Capper Pass, near Brough, over the last three years, although levels have not declined at Welton Ings, North Ferriby and East Clough.

4.8 LOADS OF SUBSTANCES DISCHARGED TO THE HUMBER

4.8.1 INTRODUCTION

The EQS levels give guidance on the maximum permitted concentration of specified substances in the water, but information is also required concerning the actual amount of a substance discharged to the Humber, that is, the loading. The loads are calculated from the concentration of a substance in the water and the flow at the time the level is measured. The loads discharged from the major inputs to the Humber and tidal rivers below the tidal limit are calculated each year, in addition to the loads from the non-tidal rivers at their tidal limit. These loads can then be compared with the long-term (6-yr) means. In 1992 the loads are calculated as 'High Loads' and 'Low Loads'. This is because of the number of results which are now below the limit of detection, and from which, therefore, a load cannot be accurately calculated. For the high load calculations, any result which is less than the limit of detection is assumed to be at the limit of detection, and for low loads the same value is assumed to be zero. This therefore gives an estimation of the maximum and minimum loads possible, and is the standard method for reporting loads to the Paris Commission and for North Sea input purposes (See Section 7).

4.8.2 CADMIUM AND MERCURY (FIGURE 4:7A)

'High loads' of cadmium discharged by the tidal rivers were very much higher than high loads from trade effluent and sewage works. The high load from the rivers was slightly higher in 1992 when compared to the long-term mean, but the low load was significantly lower. There was a decline in the amount of cadmium discharged from industrial sources when compared with the 6 year mean. The difference between high and low mercury loads was very marked for tidal rivers. This was due to the large numbers of river samples which have analyses that are below the limit of detection. The true load could be anywhere between the high and low load, and it is likely that the high loads reported alone in the past have presented a distorted picture of the amount of mercury discharged from the tidal rivers. The sewage mercury load was similar to the long-term mean, but the industrial load was much lower than the mean. This was due to unusually high levels of mercury in 1991, and the 1992 level was closer to the previous results.

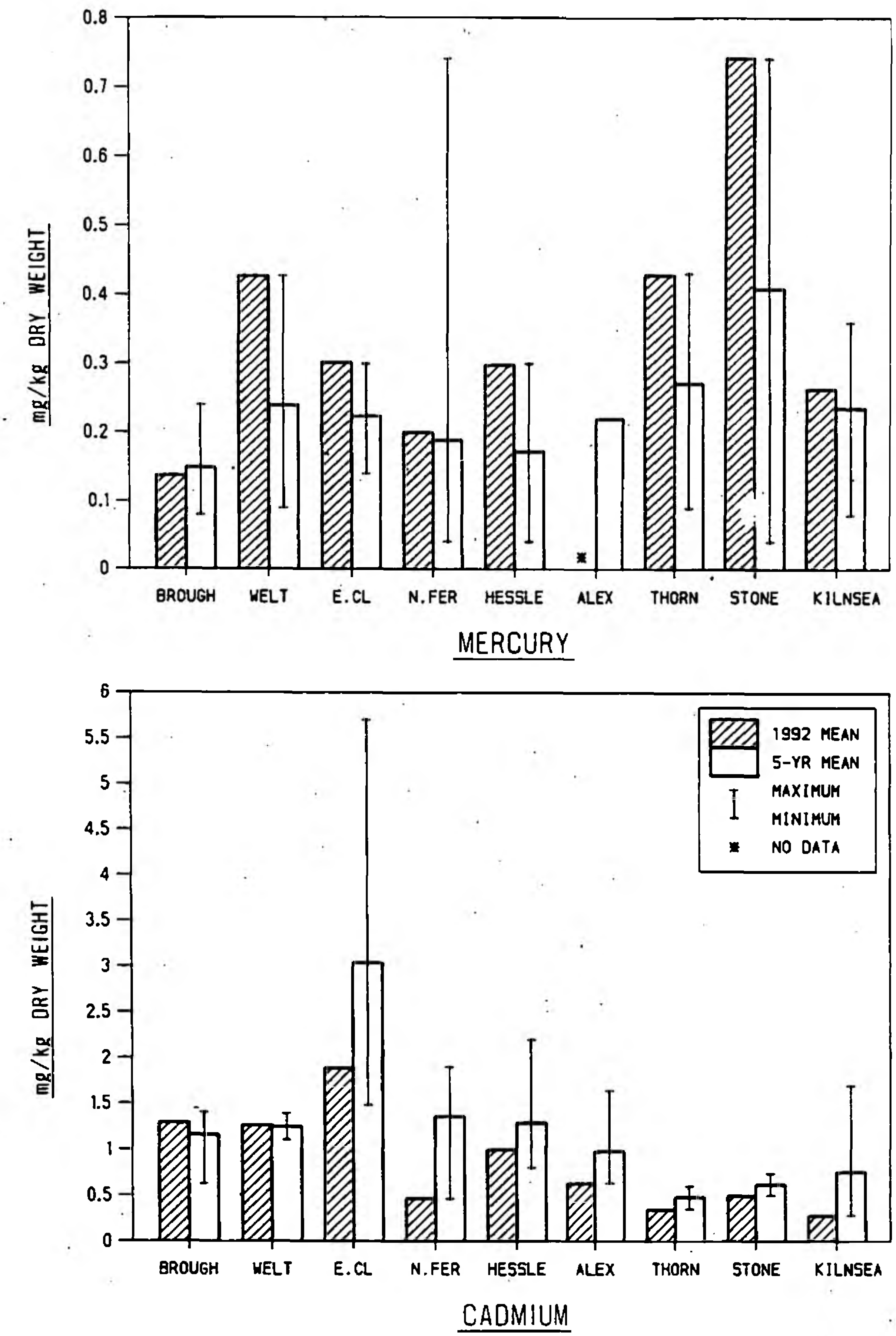
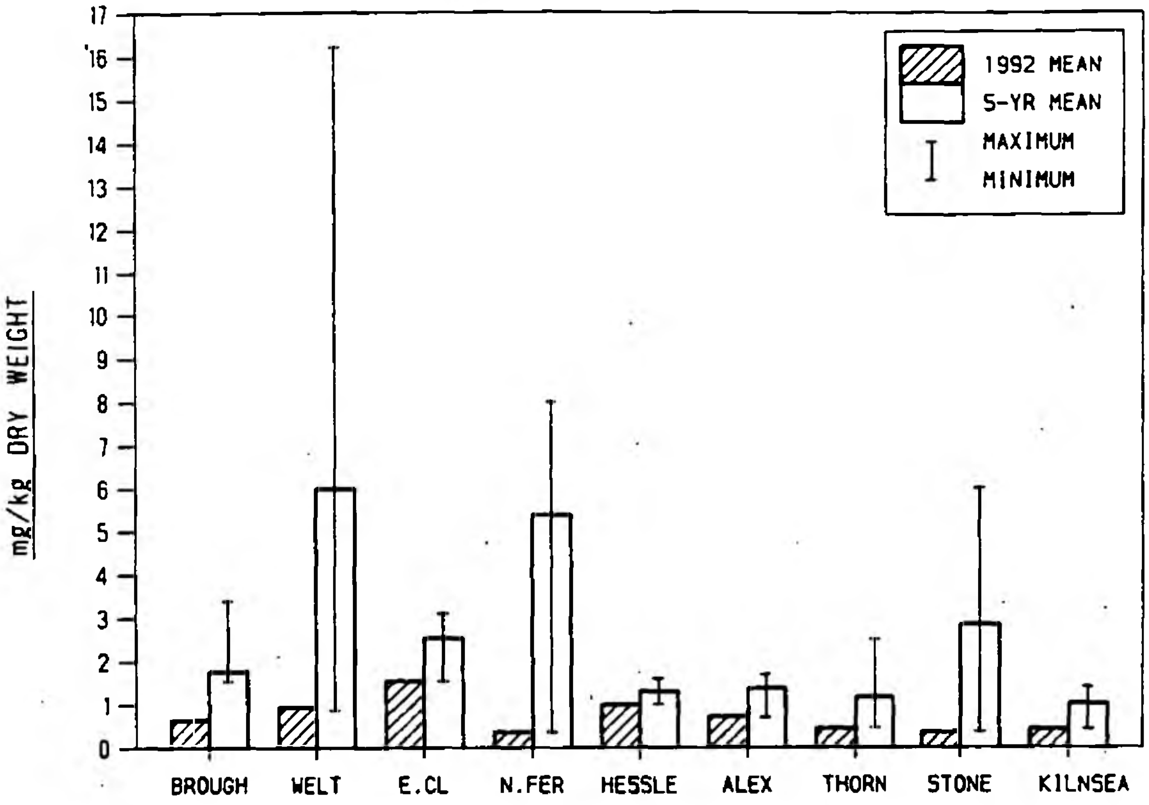
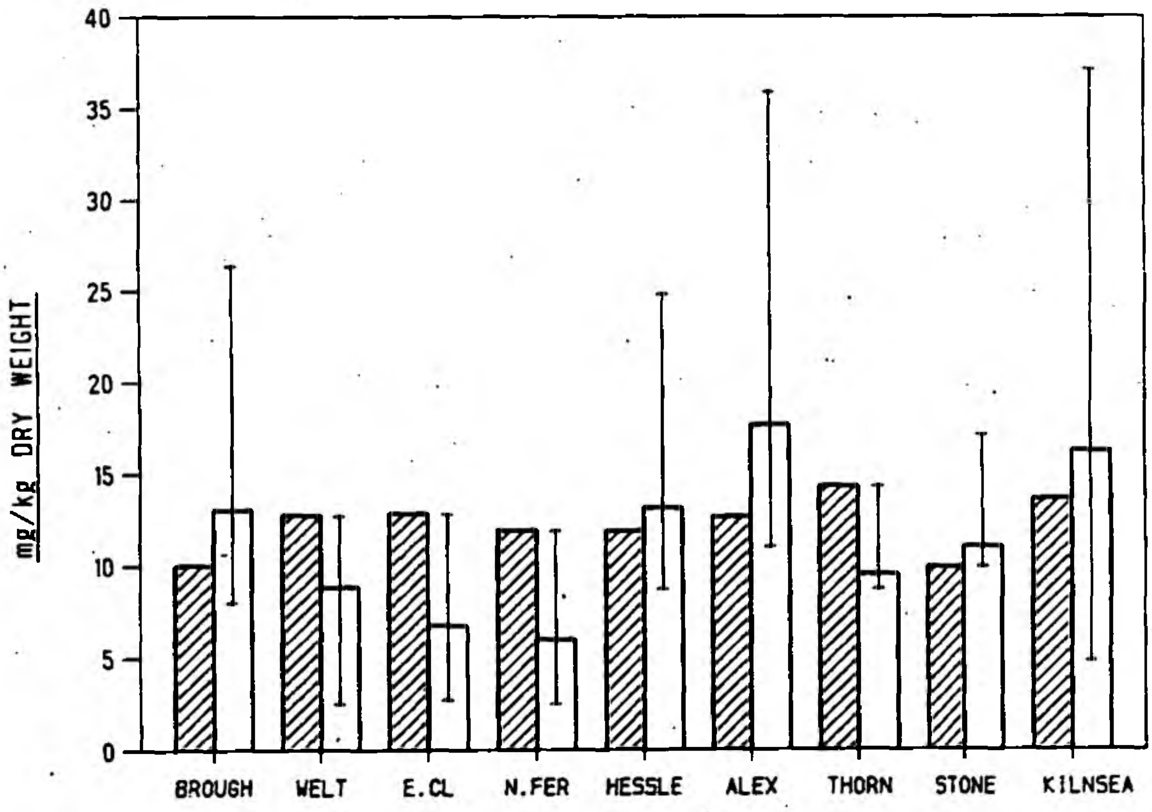


FIGURE 4:6A METALS IN RAGWORMS
1992 DATA COMPARED WITH 5 YEAR MEAN

STAT113



CHROMIUM



ARSENIC

FIGURE 4:6B METALS IN RAGWORMS
1992 DATA COMPARED WITH 5 YEAR MEAN

STAT114

TABLE 49

LOADS OF METALS FROM TIDAL RIVER, TRADE AND SEWAGE SOURCES

	TIDAL RIVERS		NORTH BANK INDUSTRY		SOUTH BANK INDUSTRY		NORTH BANK SEWAGE		SOUTH BANK SEWAGE		TOTAL	TOTAL	
METAL	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	6 YEAR MEAN	1991	1992
CADMIUM KG/DAY	6.03	8.398	1.2	0.618	0.36	0.4	0.31	0.29	0.01	0.01	7.16	7.91	9.716
MERCURY KG/DAY	4.98	2.509	0.01	0.018	0.046	0.038	0.03	0.08	0.004	0.002	3.13	5.07	2.648
COPPER TONNES/DAY	0.168	0.135	0.005	0.004	0.045	0.057	0.0057	0.008	0.00095	0.001	0.25	0.225	0.205
CHROMIUM TONNES/DAY	0.072	0.30	0.0017	0.031	0.54	0.45	0.036	0.138	0.0054	0.002	0.11	0.655	0.921
NICKEL TONNES/DAY	0.289	0.161	0.0036	0.0023	0.027	0.027	0.002	0.002	0.0002	0.0007	0.094	0.32	0.193
LEAD TONNES/DAY	0.473	0.191	0.0024	0.00068	0.06	0.057	0.0037	0.008	0.00055	0.0008	0.287	0.54	0.258
ZINC TONNES/DAY	0.696	0.652	0.039	0.049	1.3	1.25	0.016	0.064	0.0039	0.0046	1.06	2.05	2.02
ARSENIC TONNES/DAY	0.05	0.20	0.006	0.00464	0.0078	0.006	0.00068	0.00061	0.00003	0.00003	0.076	0.065	0.212

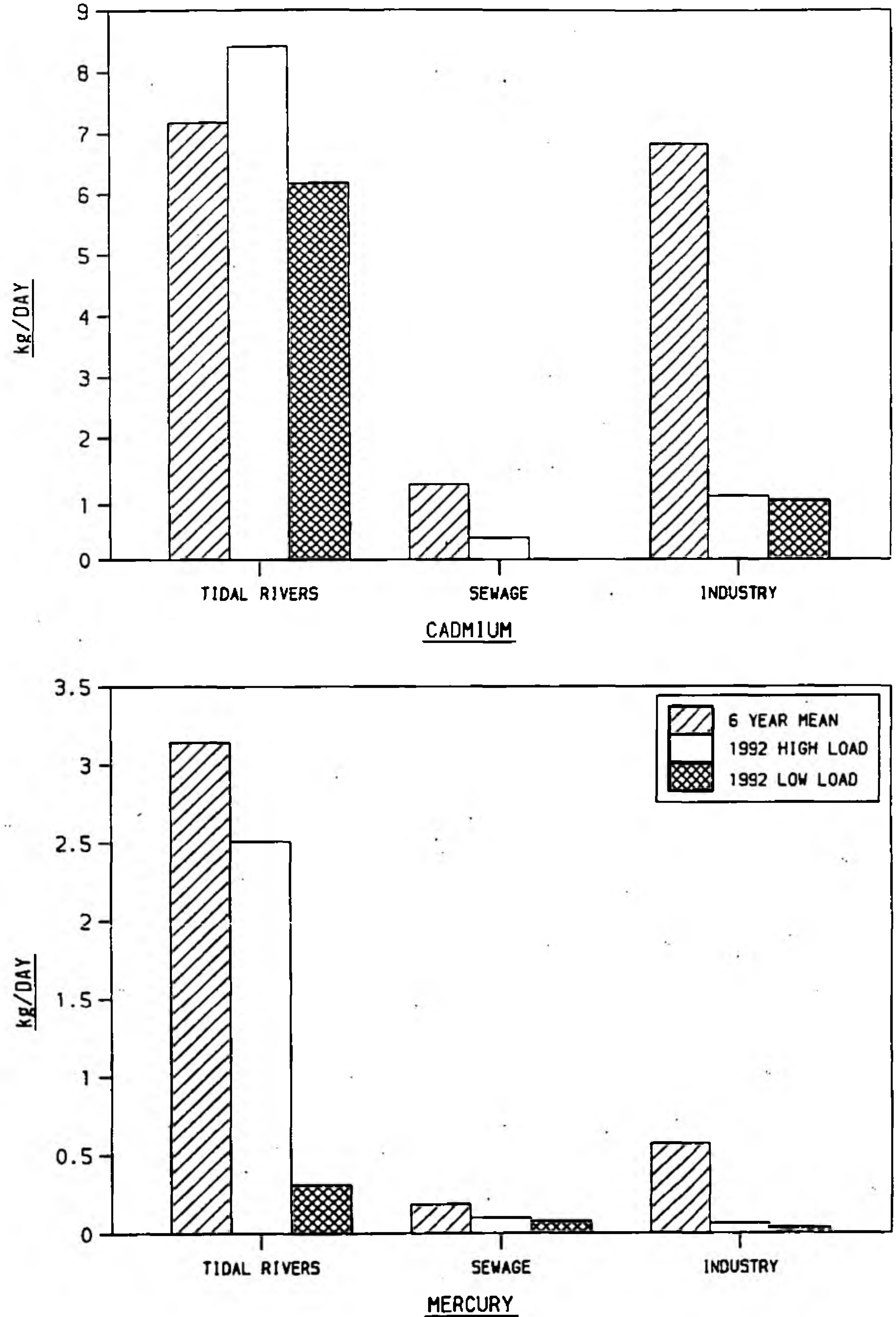


FIGURE 4:7A LOADS DISCHARGED TO THE HUMBER IN 1992 FROM INDUSTRY, SEWAGE AND TIDAL RIVERS COMPARED TO THE 6 YEAR MEAN

STAT103

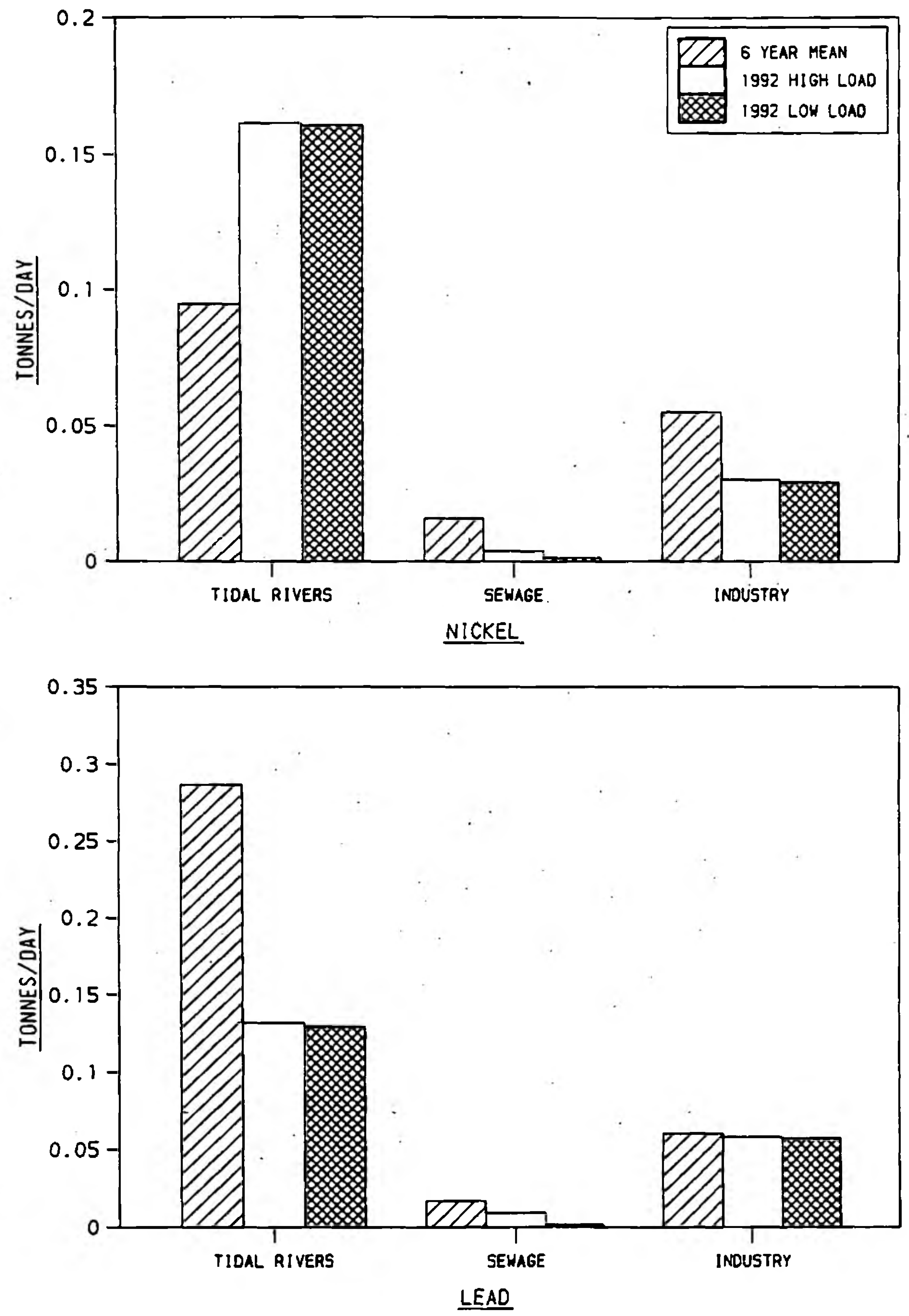
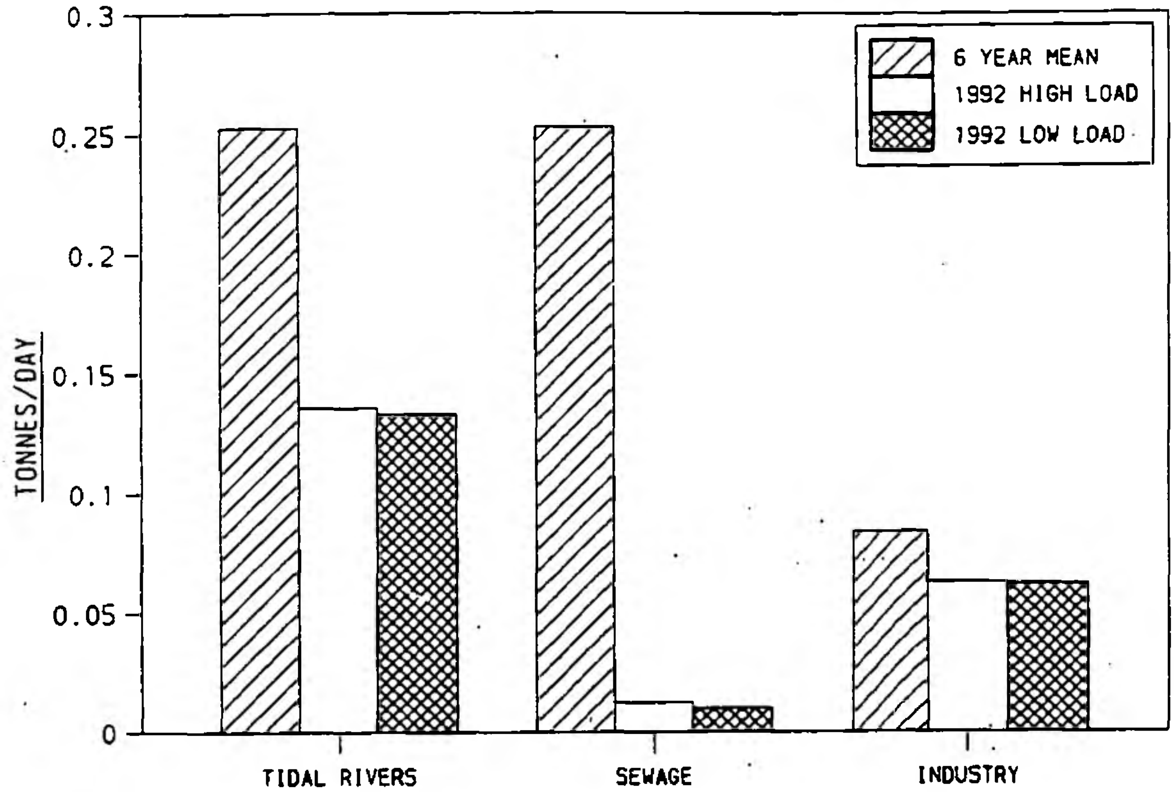
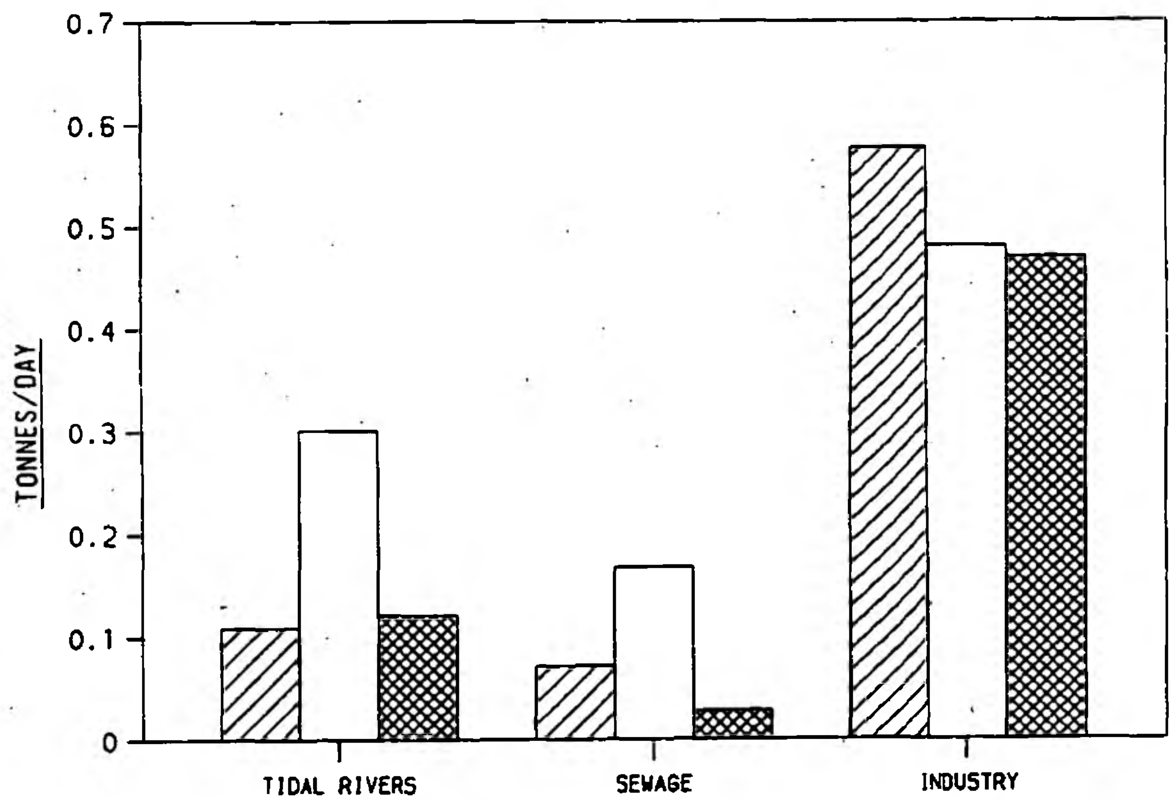


FIGURE 4:7B LOADS DISCHARGED TO THE HUMBER IN 1992 FROM INDUSTRY, SEWAGE AND TIDAL RIVERS COMPARED TO THE 6 YEAR MEAN

STAT104



COPPER



CHROMIUM

FIGURE 4:7C LOADS DISCHARGED TO THE HUMBER IN 1992 FROM INDUSTRY, SEWAGE AND TIDAL RIVERS COMPARED TO THE 6 YEAR MEAN

STAT105

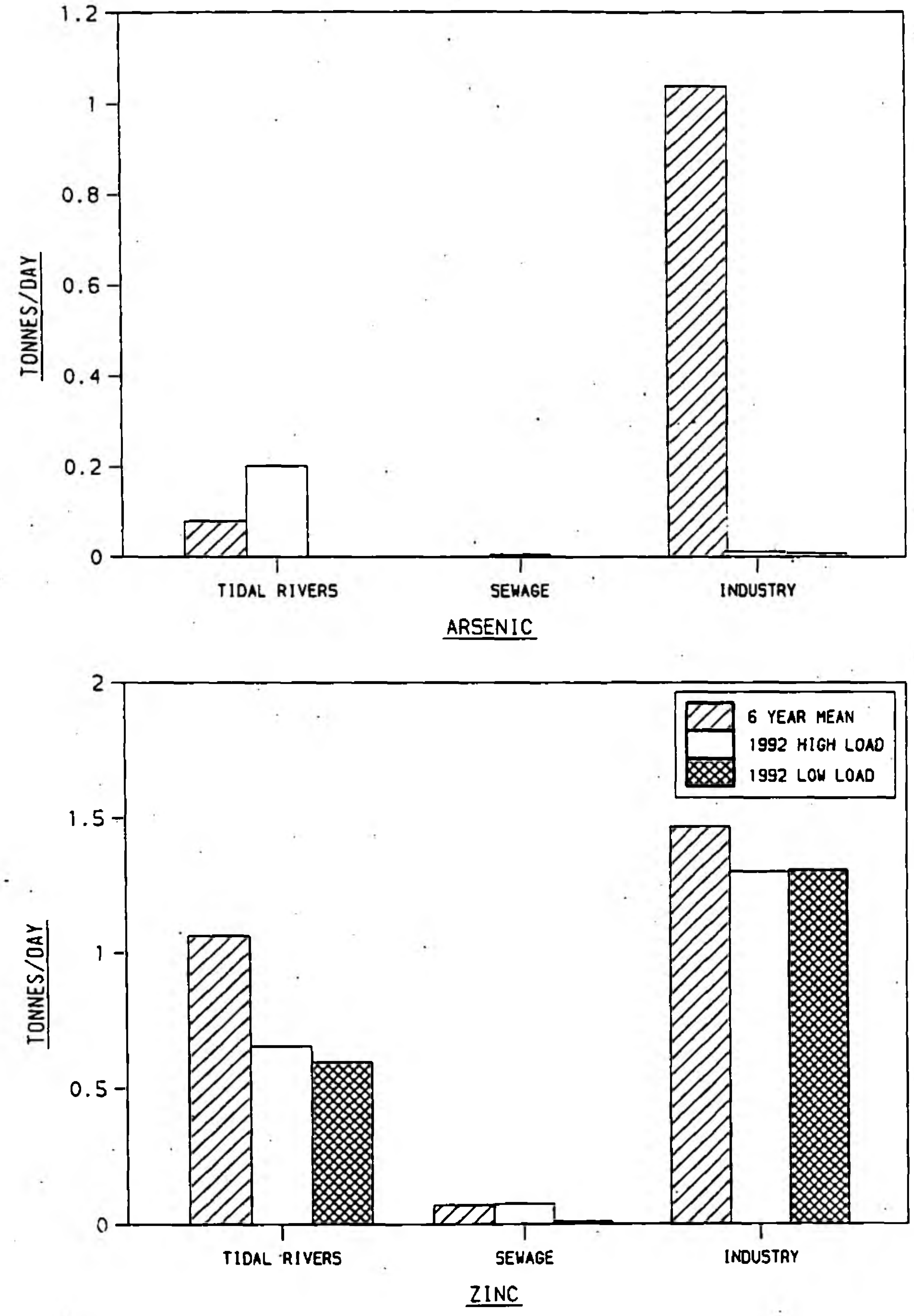


FIGURE 4:7D LOADS DISCHARGED TO THE HUMBER IN 1992 FROM INDUSTRY, SEWAGE AND TIDAL RIVERS COMPARED TO THE 6 YEAR MEAN

STAT106

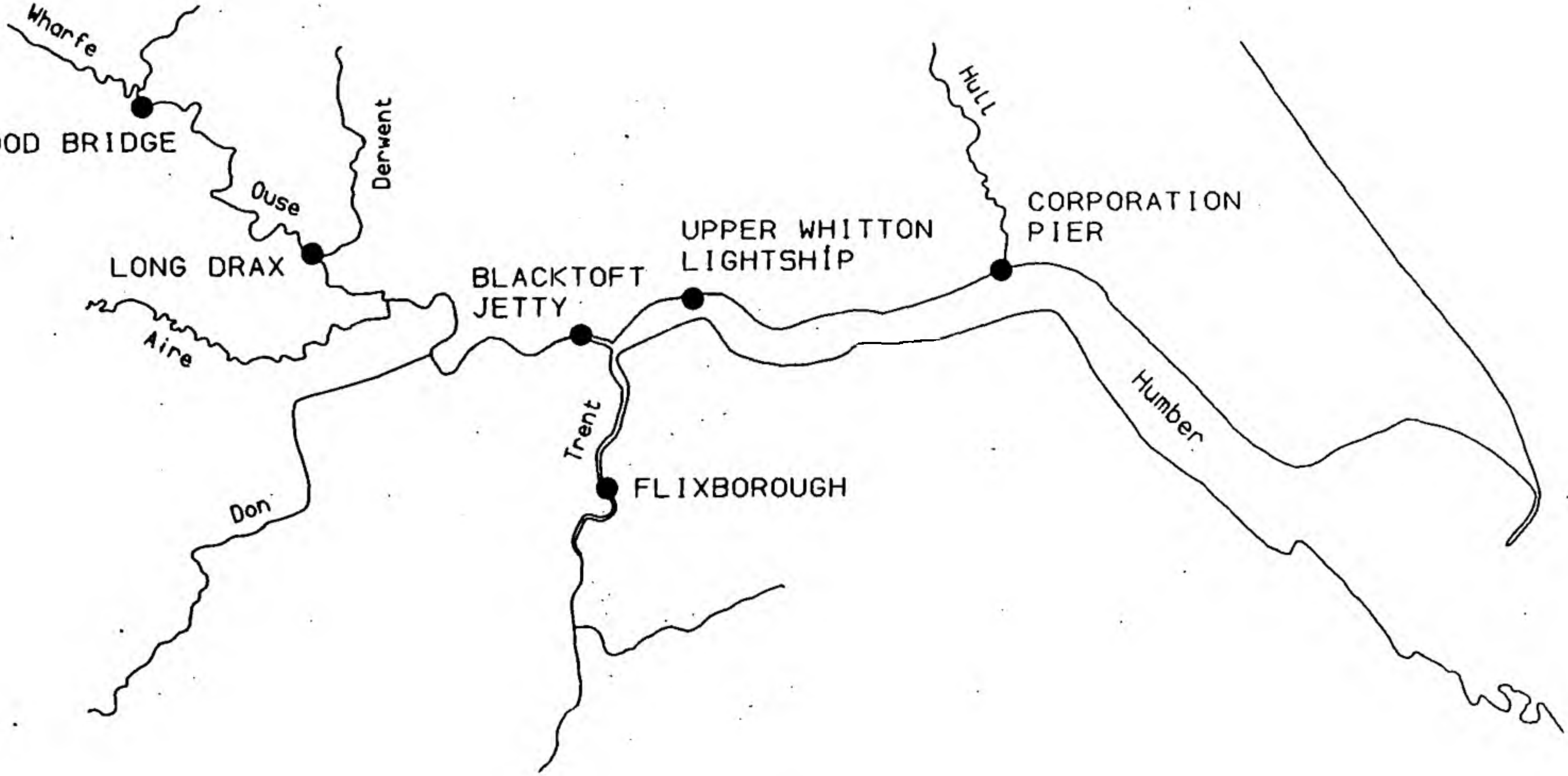


FIGURE 4:8 DISSOLVED OXYGEN MONITORS ON THE RIVERS OUSE AND TRENT AND HUMBER ESTUARY

STAT78

4.8.3 OTHER METALS (FIGURE 4:7B, 4:7C and 4:7D)

The difference between high and low loads was not so pronounced in the other metals, except for chromium, where the tidal rivers and sewage high and low loads were considerably different. There was a decrease in the amount of copper discharged by sewage works and the tidal rivers in 1992, and a substantial decrease in the load of arsenic from industrial sources compared to the long term mean. This reduction in arsenic was due mainly to lower discharges from Capper Pass, which although still operating in 1992, and occasionally discharging effluent with a similar concentration to 1991, did not produce as large a total volume of effluent as in 1991. This outlet will cease in 1993. There were higher levels of nickel discharged by the tidal rivers when compares to the long-term mean, but lower levels of lead.

4.8.4 LOADS OF METALS DISCHARGED IN 1992 COMPARED TO 1991

Table 4:9 shows the loads from the North and South Banks of the estuary, divided into industrial and sewage sources, and compared to the tidal rivers. Overall, there was a slight increase in cadmium, chromium, nickel and zinc in 1992 compared to the long-term means, and a decrease in mercury. Copper and lead remained stable. Mercury, nickel, and lead were lower than in 1991. The major sources of industrial metals remain from the South Bank, particularly zinc and chromium, while the sewage discharges from Hull result in the North bank having the highest sewage load.

4.9 CONTINUOUS CHEMICAL MONITORS IN THE HUMBER ESTUARY

Monitors which continuously measure levels of dissolved oxygen, pH, salinity and temperature are permanently in place at several sites on the Ouse and Humber North Bank, and monitors which measure dissolved oxygen and temperature are located on the Trent. Figure 4:8 shows the location of these monitors. The salinity variations and scouring effect of suspended sediments in tidal currents mean that the estuary is a testing location for chemical monitoring equipment, but the modern monitors now used provide reasonably continuous information, although there were some problems with the data from Long Drax on the Ouse during the summer of 1992, and problems throughout the year at the monitor at Burton Stather on the Trent. The other monitors worked reliably throughout the year.

4.9.1 OUSE

The monitors on the Ouse, at Long Drax and Blacktoft, all recorded dissolved oxygen levels below the EQS (40% saturation) at low tide, when river flows predominate over the saline water from the estuary. At Blacktoft, the EQS was met at high tide throughout the year, while at Long Drax and Cawood there were some periods below the EQS at high tide in the summer. This corresponds with the spot samples, which also showed failures in the summer at these sites.

4.9.2 HUMBER

Figure 4:9A & B shows data from Upper Whitton, just beyond Trent Falls on the Humber. The effects of the dissolved oxygen sag can be seen in summer at this site, with very low DO readings corresponding to low salinity (low tide). This reflects the influence of the river water, which is less marked in winter, when the DO is above the EQS for most of the time at both low and high tide. Figure 4:10A & B shows data from Corporation Pier, near Hull, in January and August. It can be seen that the DO remains above the EQS (55% saturation) at all times, as here the influence of river water in much less. There is a slight DO decline at low tide in winter, when the effects of the tidal rivers are greater, due to higher flows than in summer.

4.9.3 TRENT

The February and July DO data from the monitor at Flixborough are shown in Figure 4:11. This monitor is located in the tidal section of the Trent, so that at high tide, most of the water it is testing is Estuary water, and at low tide, most of the water is river water. In February, the DO levels were above the EQS at all times, but in early and late July, the DO was below the EQS at high tide, when deoxygenated water from the upper Humber was pushed upriver.

4.9.4 DISSOLVED OXYGEN LEVELS IN THE LOWER OUSE

The low DO levels in the tidal Ouse and upper Humber have been present for many years, and work to resolve the problem is proceeding. The major cause of the low DO levels are the unsatisfactory sewage works on the rivers feeding the Humber, in particular the on the Aire and Don, and some organic industrial effluents discharged in the Selby area. There are large scale improvements in progress at several of these sewage works, for example at Esholt and Knostrop on the River Aire and Blackburn Meadows on the Don. The first phase of improvements has been completed at Blackburn Meadows, which has resulted in some improvement in the water quality of the Don below Sheffield, but the next phase will not be completed until 1995. Other works in the Don catchment include major improvements at Chesterfield STW, which should be completed in mid 1993.

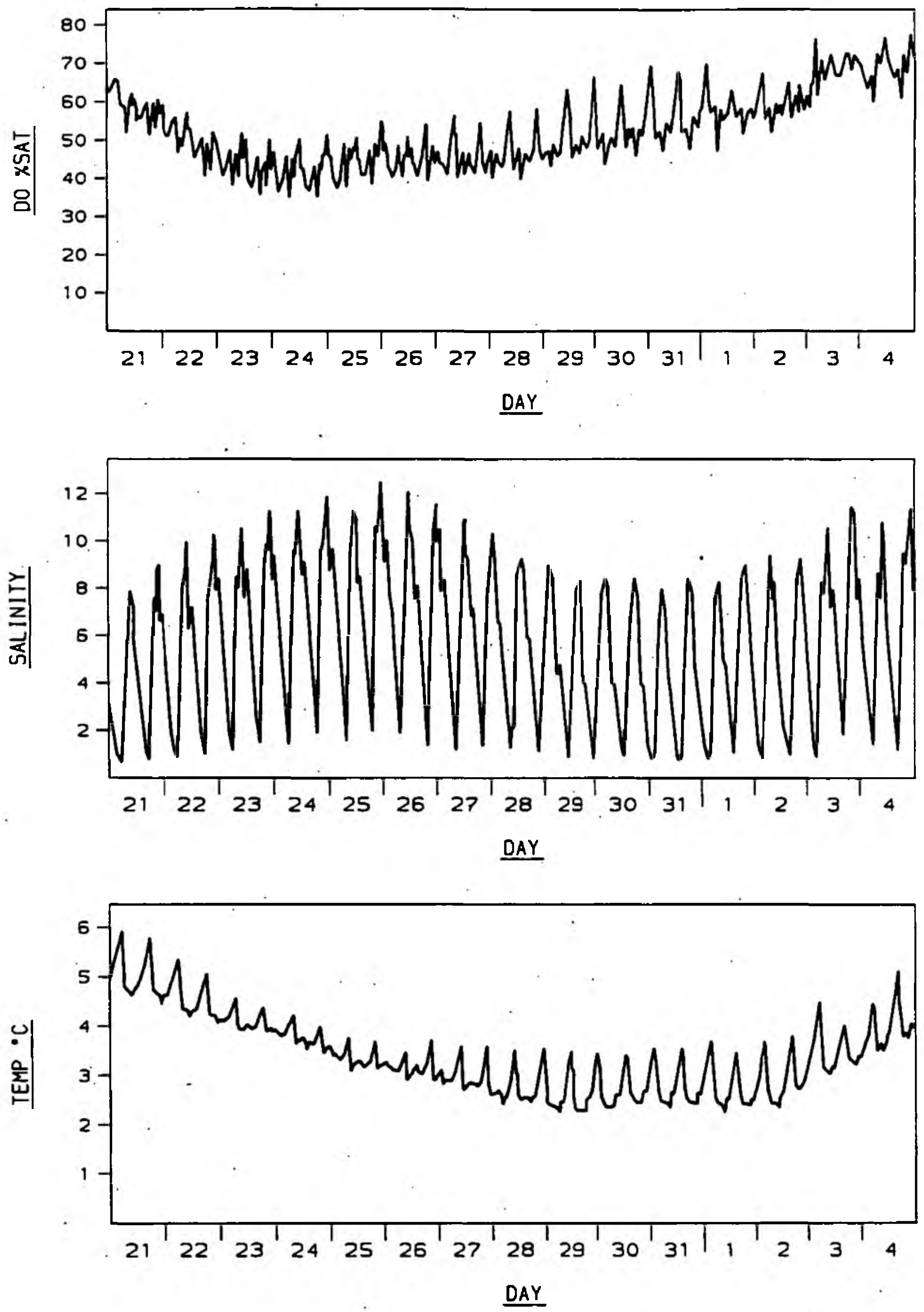


FIGURE 4:9A HUMBER AT UPPER WHITTON LIGHTSHIP
21 JANUARY 1992 TO 4 FEBRUARY 1992

STAT99

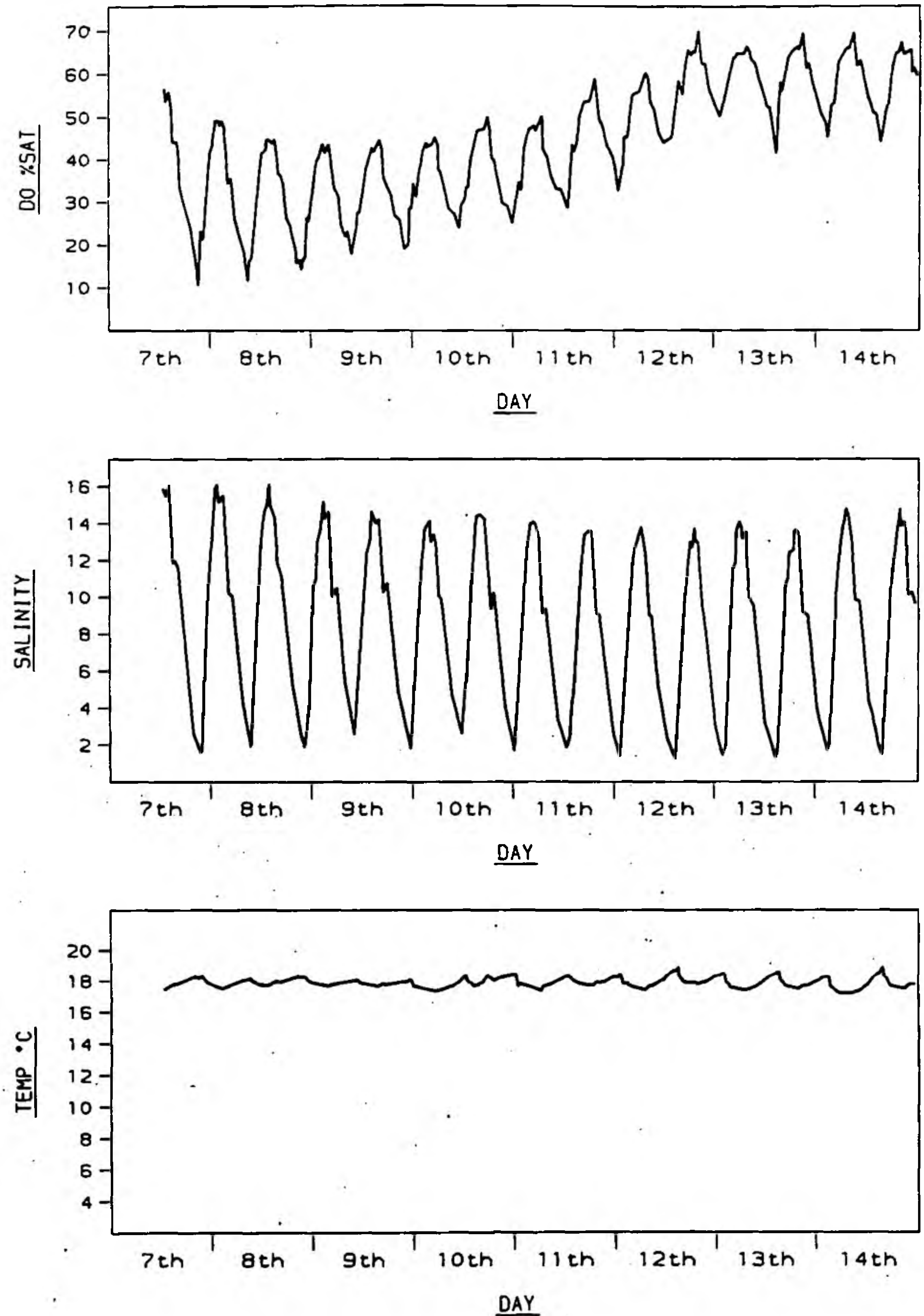


FIGURE 4:9B HUMBER AT UPPER WHITTON LIGHTSHIP
7 JULY 1992 TO 14 JULY 1992

STAT9B

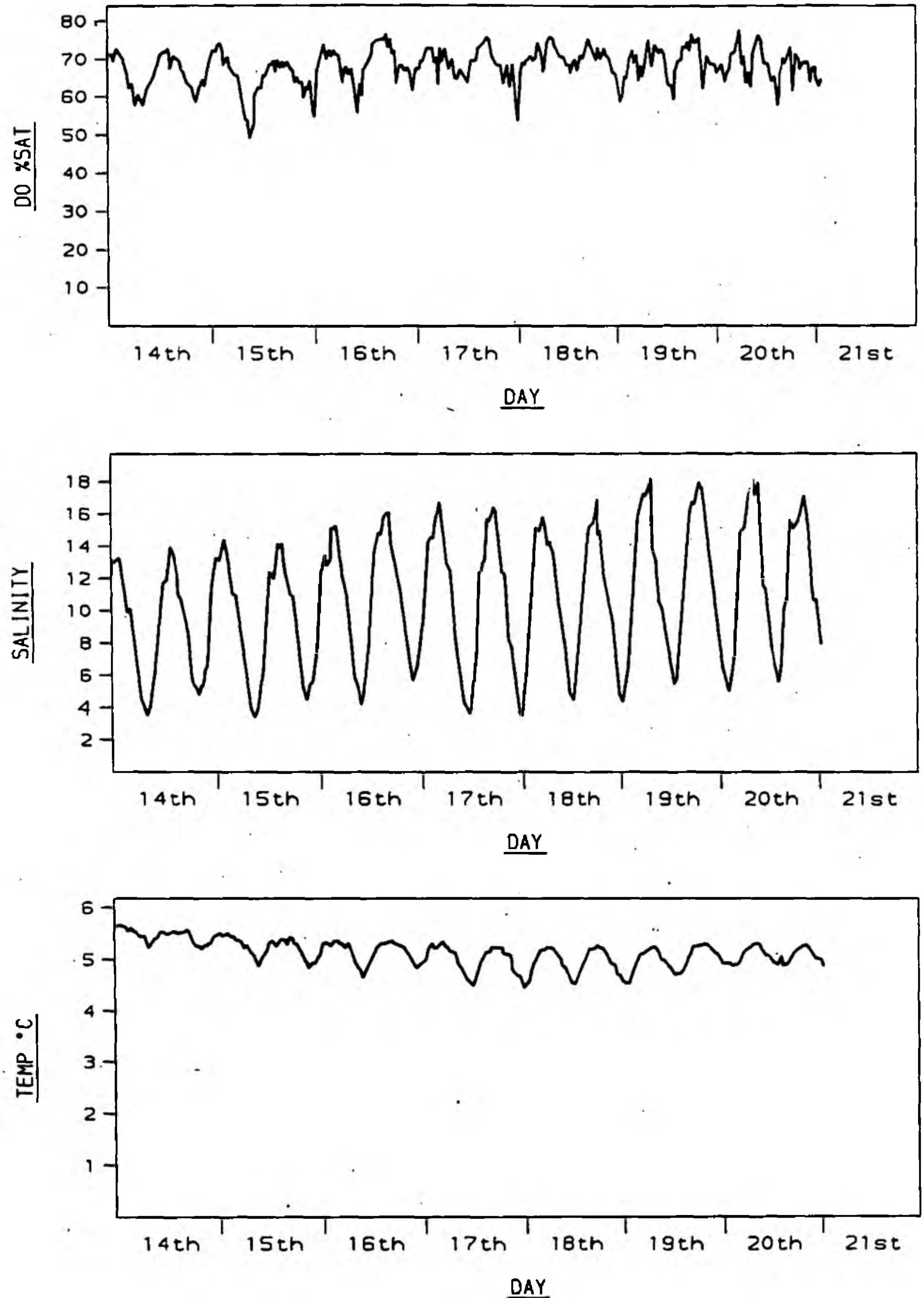


FIGURE 4:10A HUMBER AT CORPORATION PIER
14 JANUARY 1992 TO 21 JANUARY 1992

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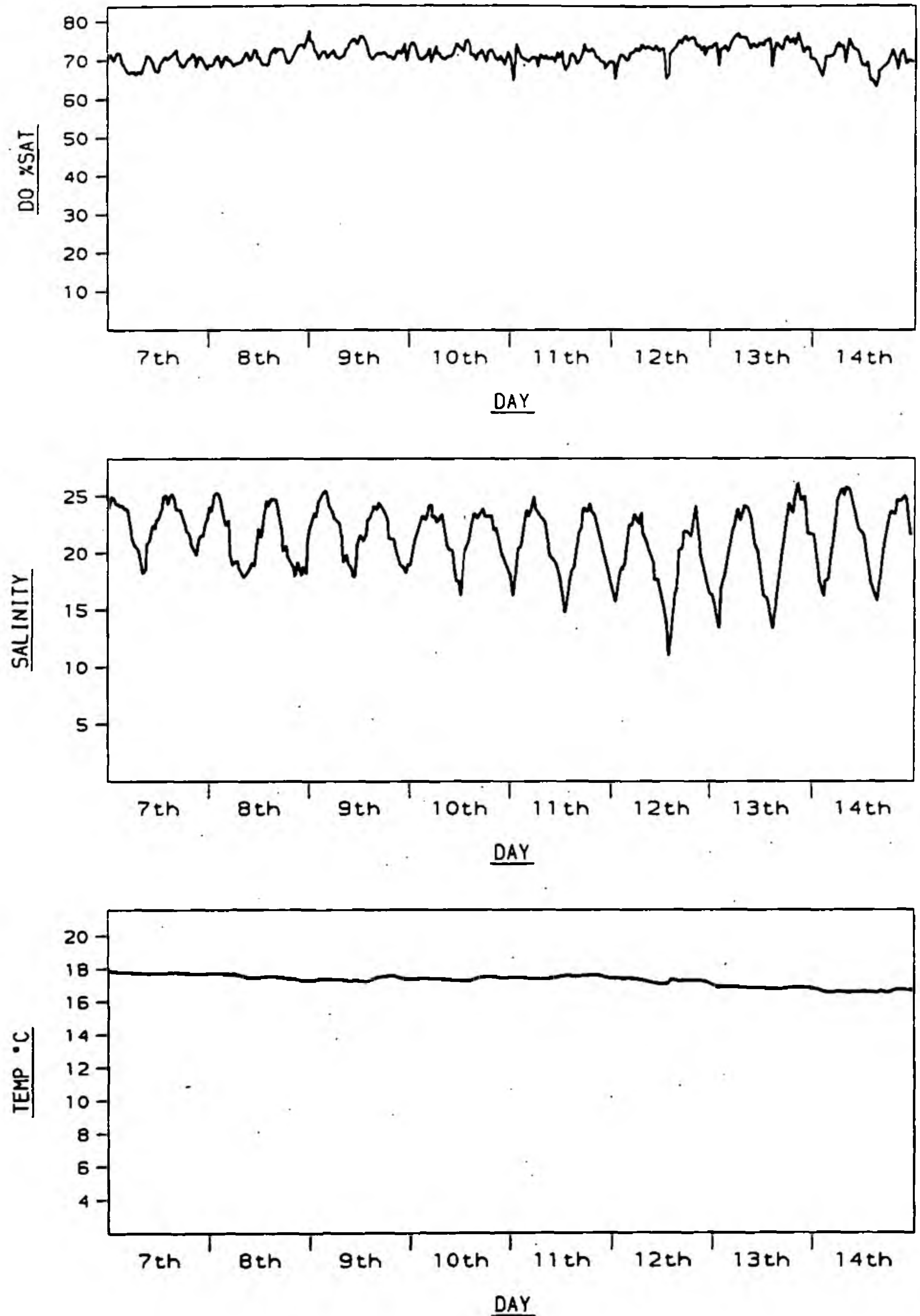

FIGURE 4:10B HUMBER AT CORPORATION PIER
7 AUGUST 1992 TO 14 AUGUST 1992

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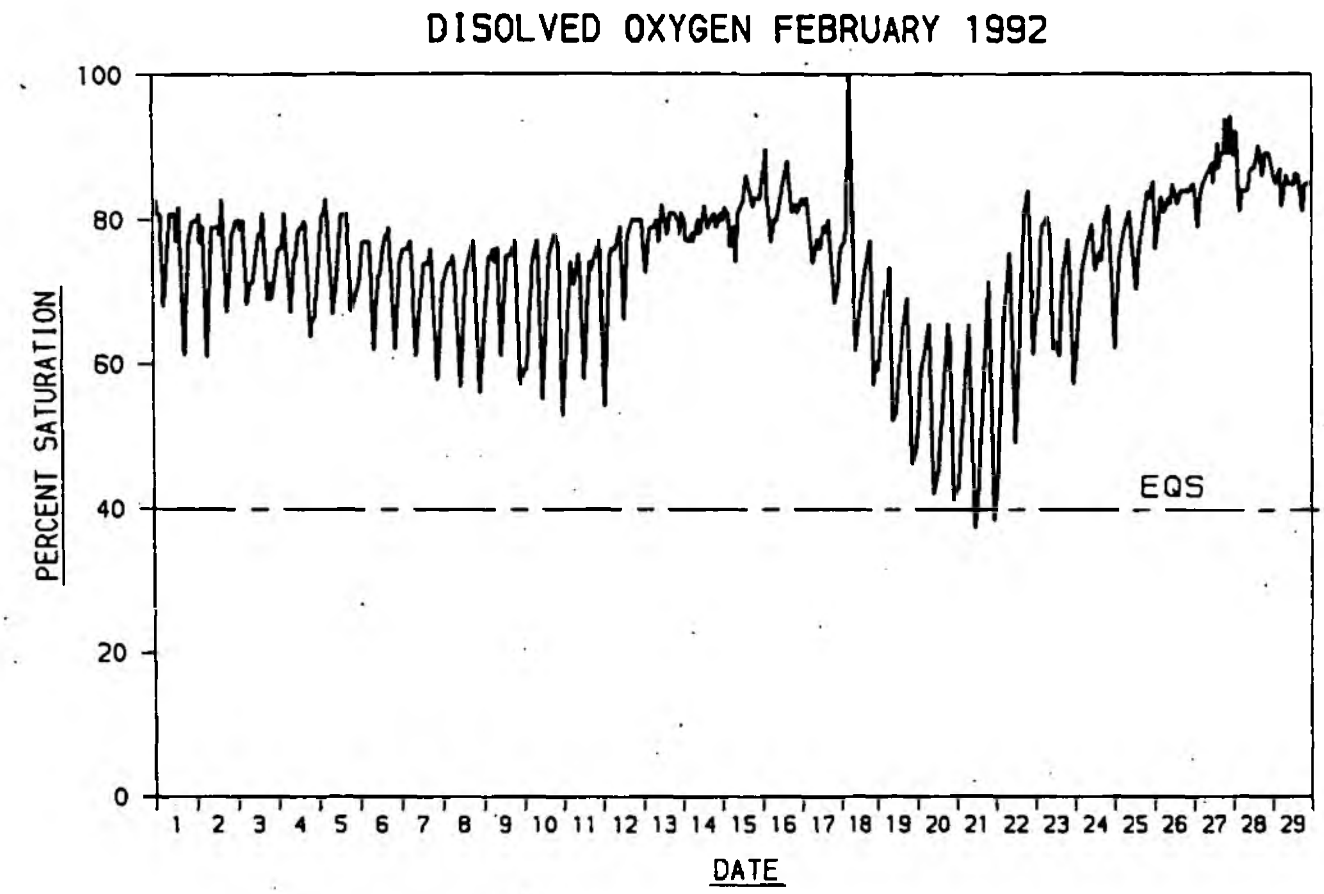

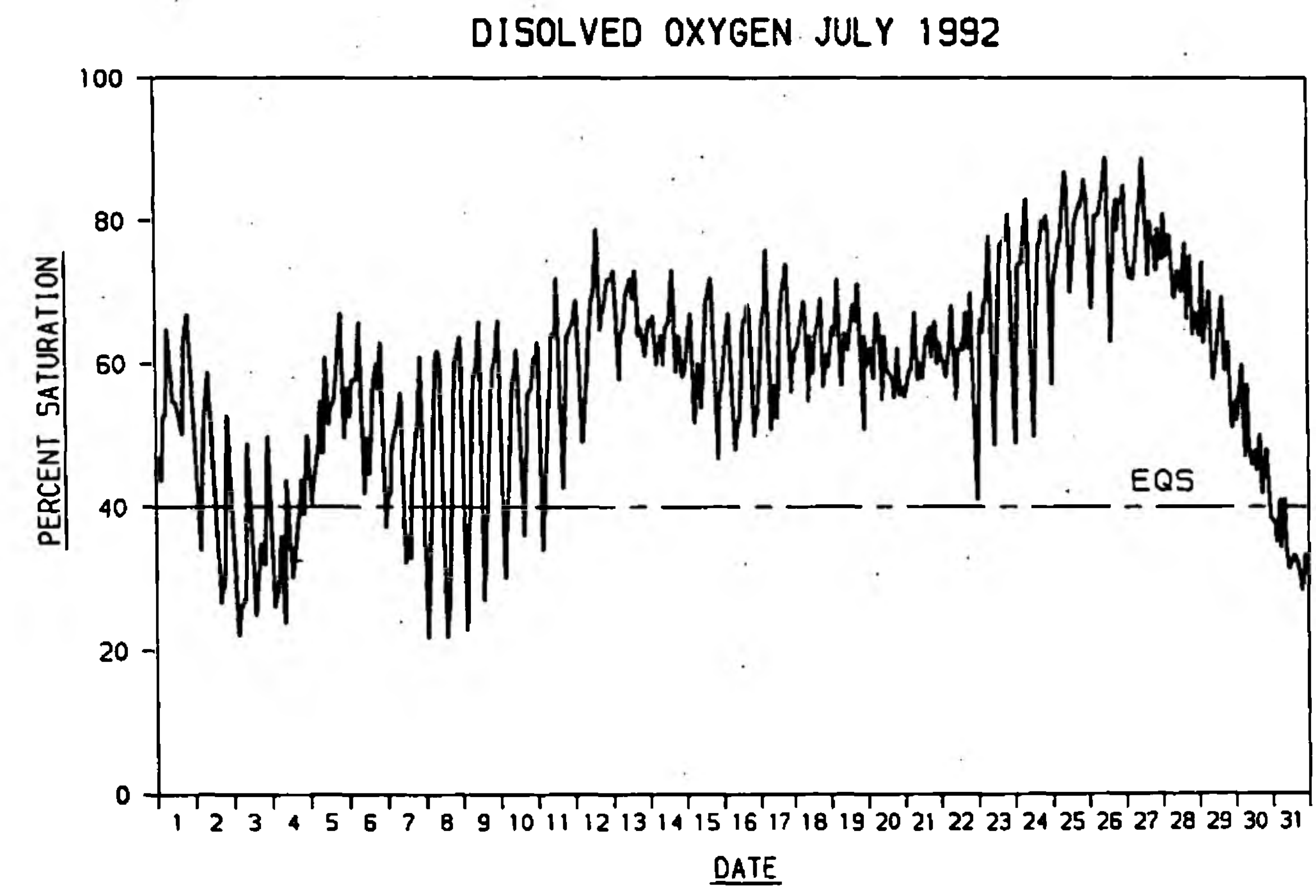

FIGURE 4:11 RIVER TRENT AT FLIXBOROUGH
DISSOLVED OXYGEN

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SECTION 5
BIOLOGICAL QUALITY

5.1 INTRODUCTION

Monitoring the number and variety of invertebrate animals and fish living in the tidal rivers and Humber plays an important part in assessing the health of the estuary. Many invertebrates live on or in the mud bottom and are exposed to any contaminants present in the sediment and water throughout their lives, so that successfully breeding populations are an indicator of satisfactory water and sediment quality. The tidal rivers and estuary are very harsh environments for invertebrates, which must be able to withstand changes in salinity and periodic drying out of the intertidal areas. This means that the numbers of species in these areas is often small compared to a freshwater environment, but the species which can tolerate the varying conditions of the estuary are often present in large numbers. These invertebrates are the food of the large numbers of wading birds which over-winter on the Humber every year and so play a vital role in the food chain of the estuary.

5.2 DATA ANALYSIS

The statistical analysis of biological data has always been problematical because of the inherent 'variability' of species and populations, due to natural fluctuations, population peaks at slightly different times of the year, and the mobility of some species, such as fish and shrimps.

To test for trends and similarities in the data produced by the surveys, statistical techniques such as cluster analysis, which groups sites together according to their similarity in species composition, and ordination, which looks at the distribution of sites or species along an environmental gradient, such as salinity or sediment type, have been used. To reduce the effects of very abundant or rare species or unusual sites on such analyses, the data are often 'transformed', that is, each result is converted by a fixed method such as by taking the square root of the number of individuals present, or the log of this number.

Extensive use has been made in this report of a computer package called PRIMER, which was developed by Plymouth Marine Laboratory. This package can be used to perform cluster analysis (most commonly using the Bray-Curtis similarity index), and produce ordination 'maps' based on multidimensional scaling (MDS), where sites or samples are plotted according to their similarity. These ordination maps can also be used to relate the biological data to environmental gradients.

5.3 TIDAL RIVERS

5.3.1 METHODS

Routine bankside biological surveys of the tidal rivers using airlift, sweep-net and kick-sample methods where appropriate, were carried out on the rivers Aire, Don, Wharfe, Ouse and Hull between September and December 1992, and on the Trent in June 1992. Methods used at specific sites are shown in Table 5:1.

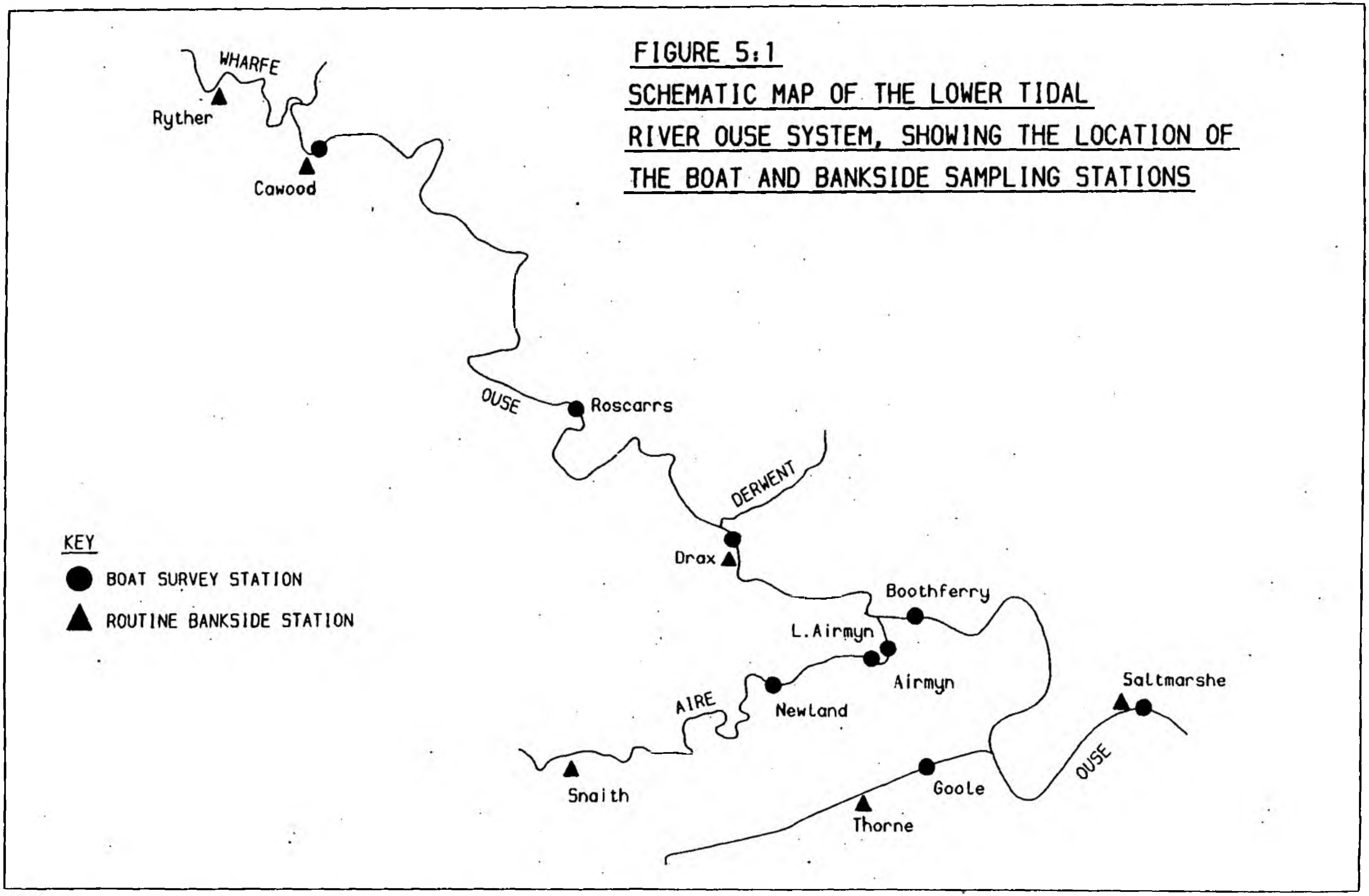
FIGURE 5:1
SCHEMATIC MAP OF THE LOWER TIDAL
RIVER OUSE SYSTEM, SHOWING THE LOCATION OF
THE BOAT AND BANKSIDE SAMPLING STATIONS
WHARFE
Ryther
Cawood
OUSE
Roscarrs
DERWENT
Drax
Boothferry
L.Airmyn
Airmyn
Newland
AIRE
Snaith
Goole
Thorne
Saltmarshe
OUSE
KEY
BOAT SURVEY STATION
ROUTINE BANKSIDE STATION

STAT128

TABLE 5:1			
Method of Sampling at Bankside and Boat Sampling Sites			
RIVER	SITE	BANKSIDE METHOD	BOAT METHOD
AIRE	Snaith	Airlift from Bridge	-
	Newland	-	0.1 square metre Day Grab
	Airmyn	-	0.1 square metre Day Grab
	Little Airmyn	-	0.1 square metre Day Grab
OUSE	Saltmarsh	Sweep sample at LW	0.1 square metre Day Grab
	Boothferry	-	0.1 square metre Day Grab
	Drax	Sweep sample at LW	0.1 square metre Day Grab
	Selby	-	0.1 square metre Day Grab
	Cawood	Sweep sample at LW	0.1 square metre Day Grab
DON	Thorne Bridge	Airlift from Bridge	
	Goole	-	0.1 square metre Day Grab
	Sutton Road Bridge	3 min kick sample at LW	
WHARFE	Ryther	3 min kick sample at LW	
TRENT	Dunham	Airlift from Bridge	
For a description of kick, sweep and airlift samples see HEC The Water Quality of the Humber Estuary 1991			

In addition to the bankside surveys, a set of mid-channel Day-Grab samples were taken using the Anglian Region boat, the Sea Vigil, during June and July. This survey was undertaken to compare the results of the bankside surveys with the boat surveys, where a standard size grab was used and replicate samples could be taken. The bankside surveys are often criticised because a variety of methods are used (for practical and safety reasons) and no replicate samples are taken. The locations of the bankside and boat survey sites are shown in Figure 5:1. and Appendix D shows the families and numbers of animals found at each sites.

5.3.2 RESULTS

5.3.2.1 Summary

The fauna of most of the tidal river sites was dominated by oligochaete worms and gammarid shrimps, and there was little difference between the 1991 and 1992 results for the Aire, Don, Ouse, Wharfe and Hull. (It is not possible to compare the tidal Trent as no samples were taken in 1991). Table 5:2 gives the results of PRIMER cluster analysis showing which pairs of sites grouped together. It can be seen that the Aire, Don, Wharfe and Hull sites were grouped together by year, while the Ouse was separated by year. This was the result, however, of a large catch of *Gammarus zaddachi* at Cawood in 1992, and a low catch of this mobile species in 1991. There was no significant difference between 1991 and 1992 data.

5.3.2.2 Ouse

The tidal Ouse sites in 1992 supported a very poor fauna, with only tubificid worms recorded at Drax, only 4 families at Cawood, and 2 at Saltmarshe. There were large numbers of the estuarine shrimp *Gammarus zaddachi* collected at Cawood, and these numerically dominated the site, which also supported oligochaete worms and fly larvae (blackfly and chironomid midges).

FIGURE 5:2A DENDROGRAM OF THE FAUNAS FROM THE 1992 BOAT & ROUTINE SURVEYS: PRESENCE/ABSENCE DATA

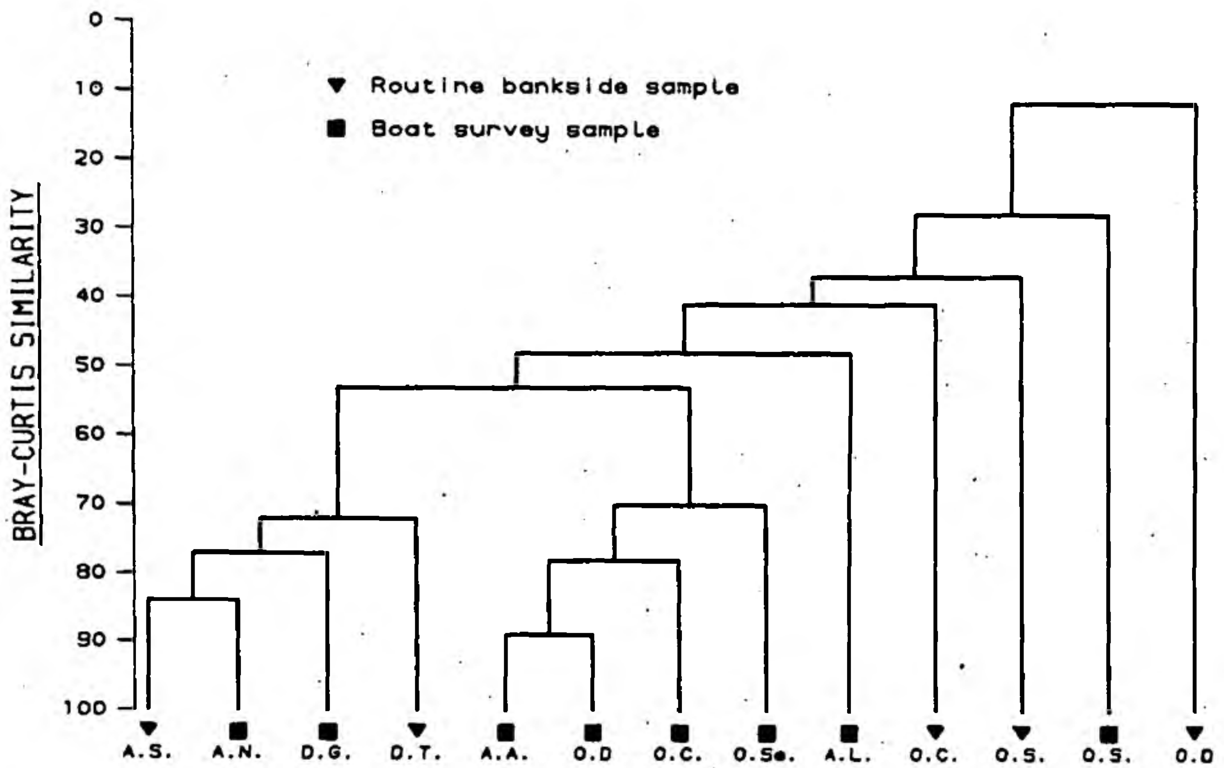

FIGURE 5:2B MDS MAP OF THE FAUNAS FROM THE 1992 BOAT & ROUTINE SURVEYS: PRESENCE/ABSENCE DATA

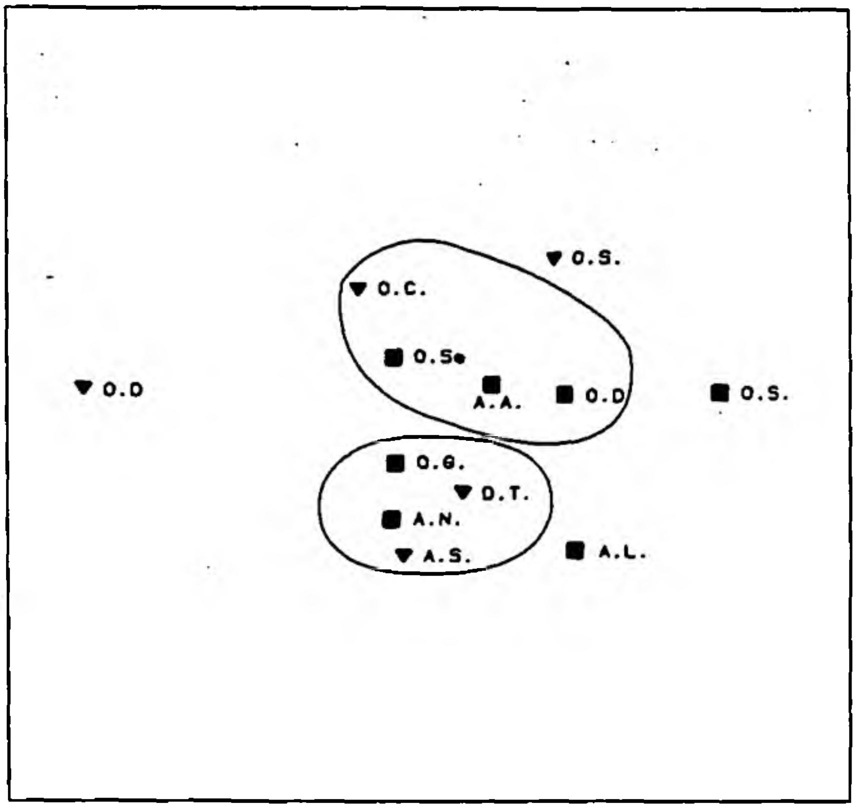

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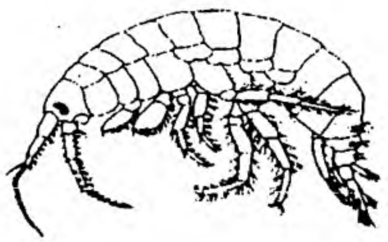
TABLE 5: 2							
NON-TIDAL RIVER SITE GROUPINGS WHERE THE FAUNA ARE MORE THAN 50% SIMILAR							
USING THE BRAY-CURTIS SIMILARITY INDEX							
GROUP 1		GROUP 2		GROUP 3		GROUP 4	
SITE	YEAR	SITE	YEAR	SITE	YEAR	SITE	YEAR
OUSE at Cawood	1991	WHARFE at Tadcaster	1991	HULL at Sutton Road Bridge	1991	AIRE at Snaith	1991
OUSE at Drax	1992	WHARFE at Tadcaster	1992	HULL at Sutton Road Bridge	1992	AIRE at Snaith	1992
						DON at Thorne	1991
						DON at Thorne	1992
						HULL at Beverley	1991
						HULL at Beverley	1992
						OUSE at Cawood	1991

5.3.2.3 Aire

Gammarus zaddachi



The Aire at Snaith supported a fauna containing very high numbers (6128 individuals per sample) of oligochaete worms, particularly Tubificidae. The only other species present were the hog-louse, *Asellus aquaticus*, and a saline and organic pollution tolerant midge larva, *Procladius* sp. The Aire was affected by a serious pollution incident in 1992, when a fire at a chemical works caused toxic chemicals to be released into Spen Beck, a tributary of the River Calder, and from there into the River Aire. There were mortalities of fish and invertebrates in the River Aire downstream of the River Calder immediately after the incident, but later in the year the fauna had recovered. The effects of the spillage could not be detected at Snaith, and as the slight depression in the number of families collected at Snaith was also seen at Thorne on the River Don, this is not likely to be due to this incident.

5.3.2.4 Don

The Don at Thorne Bridge supported quite high numbers of tubificid worms (338 per sample). These included 15 specimens of an interesting 'variant' of a common species, *Limnodrilus hoffmeisteri*, which differed from the normal *Limnodrilus hoffmeisteri* in the shape of its chaetae and penis sheath.

5.3.2.5 Wharfe

The Wharfe at Ryther supported the most diverse and also the most 'freshwater' fauna, with 12 families including mayflies (*Caenis luctuosa*), leeches, caddis larvae (*Brachycentrus subnubilis*) and crustaceans. There were very high numbers (>1000) of the estuarine shrimp *Gammarus zaddachi*.

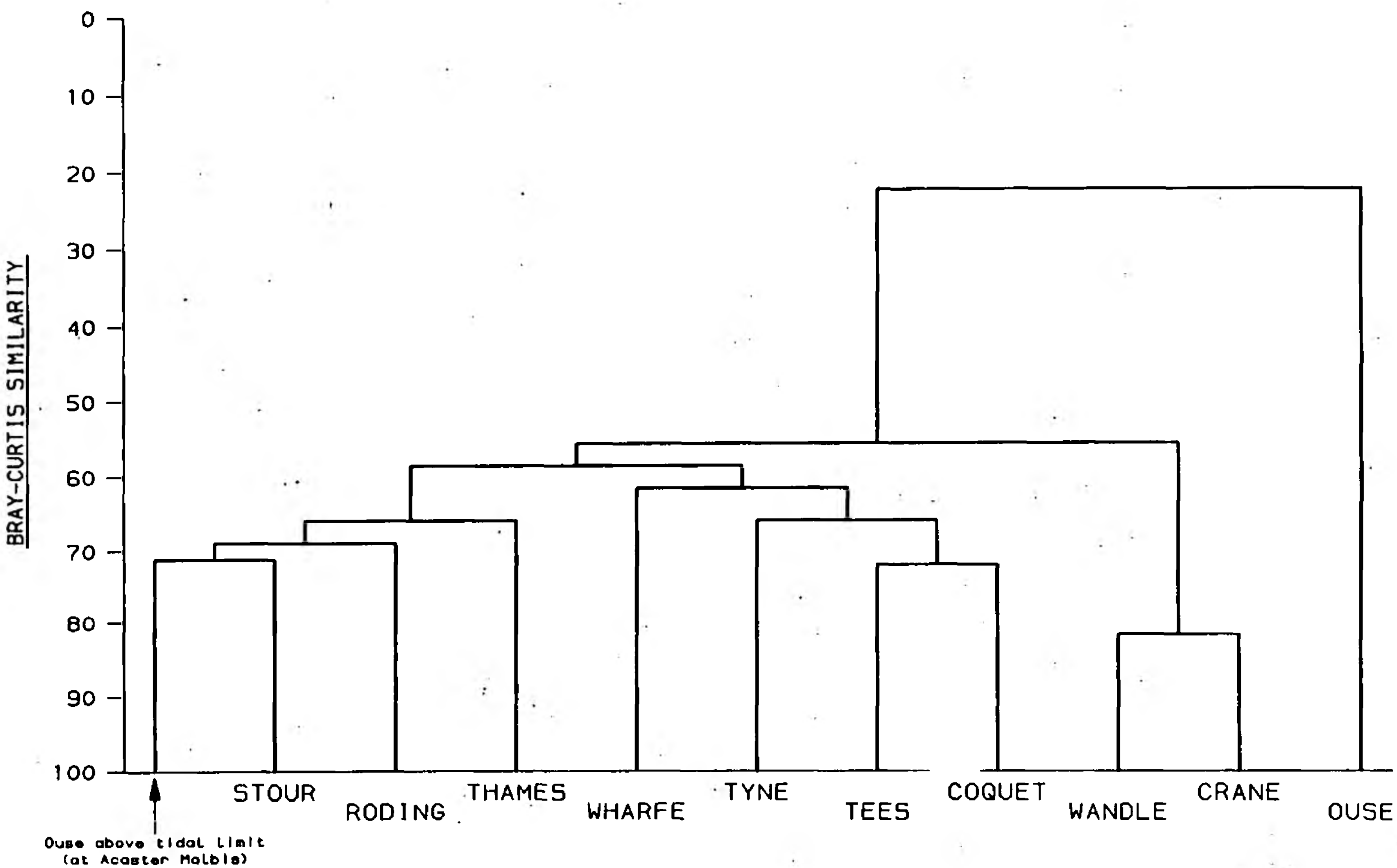


FIGURE 5:3 COMPARISON OF TIDAL RIVER FAUNAS IN EASTERN ENGLAND WITH THE OUSE & WHARFE

STAT89

5.3.2.6 Hull

The fauna of the Hull at Sutton Road Bridge was moderately diverse, with six families including leeches, midge larvae, pea-mussels, and crustaceans. The fauna was the most 'saline' of the tidal river sites, with four species of estuarine crustacea (*Jaera ischiosetosa*, *Sphaeroma rugicaudata*, *Corophium volutator* and *Gammarus zaddachi*). The Hull at Beverley also supported a 'saline' fauna, with the polychaete worm *Nereis diversicolor* present as well as *Gammarus zaddachi*. The increasingly 'saline' composition of the Hull is most likely due to the low freshwater flows over the last three years, when the eastern side of the county has suffered considerable drought. It will be interesting to study the change in fauna when river flows improve.

5.3.2.7 Trent

The Trent at Dunham supported a fauna similar but slightly less diverse than that found in the Wharfe, with the presence of snail taxa such as Viviparidae and Planorbidae indicating a firmer substrate than that found in the Don and Aire. There were abundant tubificid worms and *Gammarus zaddachi*.

5.3.3 COMPARISON OF BANKSIDE AND BOAT SAMPLES

When the data from the two 1992 tidal river surveys are compared there is a very close similarity between samples at coincident or nearby sites (Figure 5:2A). Figure 5:2B shows the PRIMER similarity dendrogram between the bank and boat samples. This shows the Aire and Don boat and bank surveys clustering together, and the Ouse sites, with very few taxa, forming a loose 'chain' group. It is evident from these results that the bankside samples, despite their differences in sampling methods, are giving a representative picture of the fauna of the Tidal Rivers.

5.3.4 COMPARISON OF THE BIOLOGICAL QUALITY OF THE TIDAL RIVERS OUSE AND WHARFE WITH 'CLEAN' FRESHWATER TIDAL RIVERS ELSEWHERE IN EASTERN ENGLAND.

In order to compare the tidal rivers feeding the Humber with tidal rivers in other areas, biological data was obtained from the NRA's former Northumbria region, and from the Southern and Thames Regions. The data came from rivers which were believed to be relatively unpolluted and above any substantial saline influence (salinity less than 2°/oo). A presence/absence matrix was compiled from the data. The sites used were from the rivers Thames, Crane, Wandle, Roding, Great Stour, Coquet, Tees and Tyne. From the Humber catchment, data from the Ouse as a polluted river and the Wharfe as a clean river, were analysed.

Figure 5:3 shows the PRIMER Cluster analysis for this data. It is clear that the River Ouse is impoverished when compared with the other river sites. Several invertebrate taxa which are very frequently found in other rivers are missing from the Ouse, for example, Erpobdellidae and Glossiphonidae (leeches), Ancylidae, Sphaeriidae, Hydrobiidae (Snails), Asellidae (Hog-Louse), Hydracarina (mites) and Caenidae (mayflies). These groups are also absent from the Aire and Don, and to a lesser extent from the Trent.

Asellus aquaticus (one of the most common freshwater and tidal water species) was recorded in the Ouse at Cawood and Drax up to 1988 but has not been found since then. With the exception of the snails, the missing taxa are soft-sediment types, so the substrate of the Ouse is not the reason for their absence. The freshwater Ouse above Naburn Lock has supported a diverse fauna over the last four years, with at least 33 taxa present, and this is most similar to the South-Eastern rivers Great Stour, Thames and Roding. The Wharfe is more similar to the North-Eastern tidal rivers Tyne, Tees and Coquet.

5.4 INTERTIDAL BIOLOGY

5.4.1 INTRODUCTION

The routine survey of the intertidal fauna of the North and South Banks of the Humber Estuary was carried out in August 1992. The sites surveyed in 1991 were re-sampled in 1992 with the exception of Broomfleet (North Bank) which was omitted for safety reasons. Sampling of this site will be resumed in 1993, when appropriate safety equipment will have been obtained.

5.4.2 METHODS

Five 10 cm diameter cores were taken at high, mid and low shore at each station where possible, and the samples washed fresh through a 0.5 mm sieve then preserved for identification of invertebrates and analysis at a later date. Sediment analysis for each site was carried out by the Institute of Estuarine and Coastal Studies, University of Hull. This included particle size analysis using a dry sieving technique; organic carbon content determined by using potassium dichromate wet digestion; and the loss on ignition at 400°C and 480°C.

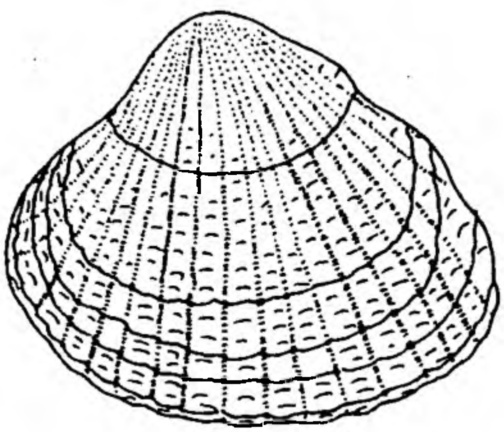
5.4.3 NORTH BANK

5.4.3.1 Summary

No new taxa were added to the North Shore species list this year although the syllid polychaetes recorded in both 1991 and 1992 were identified as *Streptosyllis websteri*.

There was a large recruitment of young (less than 1 cm long) individuals to the middle and outer estuary populations of the catworm *Nephtys*, and these juvenile animals were probably all *Nephtys hombergi*. Post-recruitment events such as winter die-off or losses due to predation may, however, mean that the increase in the abundance of *Nephtys sp.* is short lived.

Cerastoderma



Faunal abundance was lower than 1991 in the upper estuary due to the apparent lack of small naidid oligochaete worms. It is possible that, due to the short life span of these worms, the main peak in population abundance was missed in this year's survey. There were generally low numbers of oligochaete worms at all sites on the estuary, particularly the small naidid species *Paranais litoralis* and *Amphichaeta sannio*. In fact only a single specimen of the latter was recorded in the 1992 survey - from East Clough. These short lived species undergo rapid population changes and it is probable that the 1992 survey missed the peak in population density, although *Paranais frici* was found to be abundant at Cherry Cob. A general trend of declining oligochaete numbers over the whole estuary in the last five years suggests that there may have been

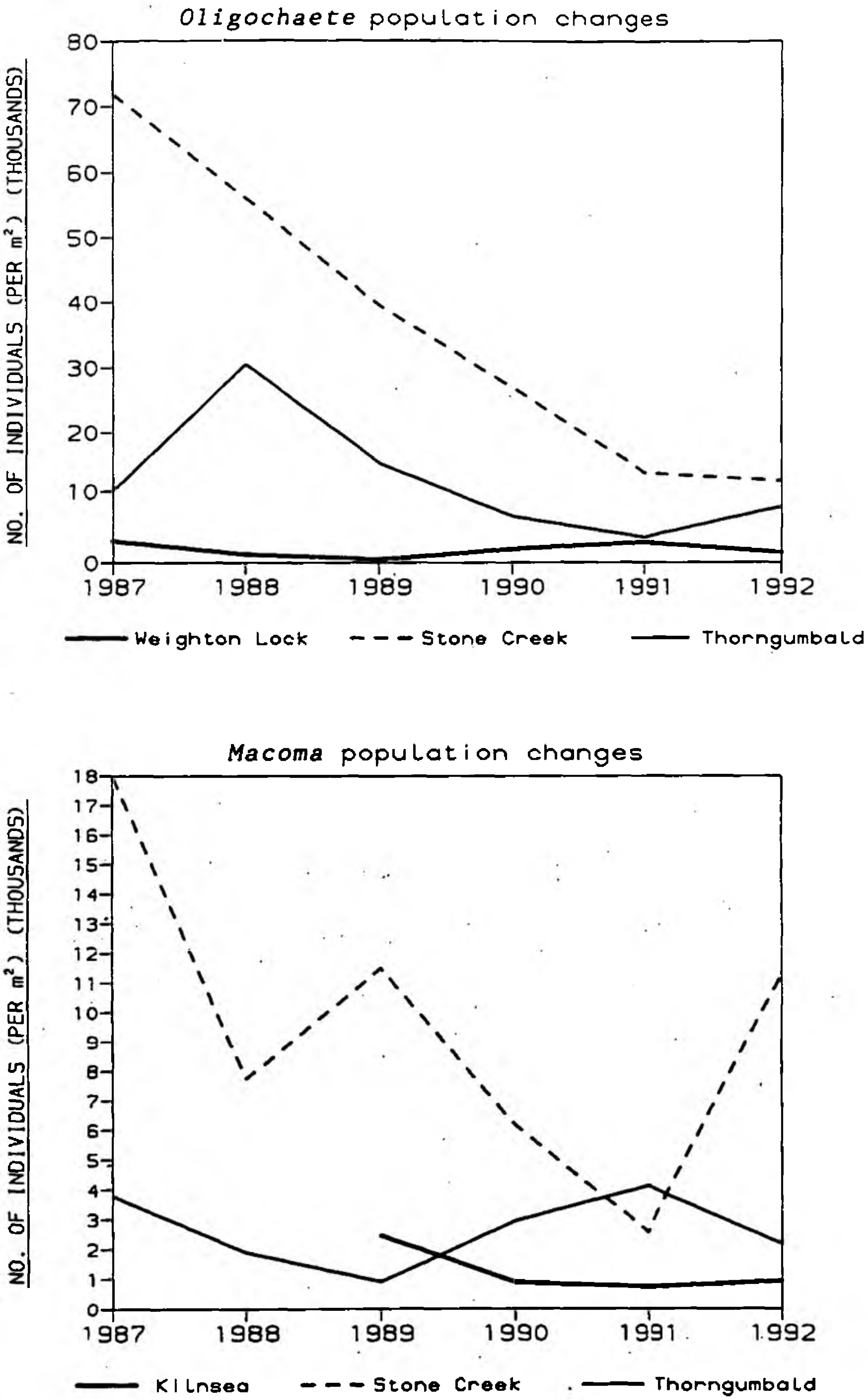


FIGURE 5:4 HUMBER INTERTIDAL FAUNA NORTH SHORE

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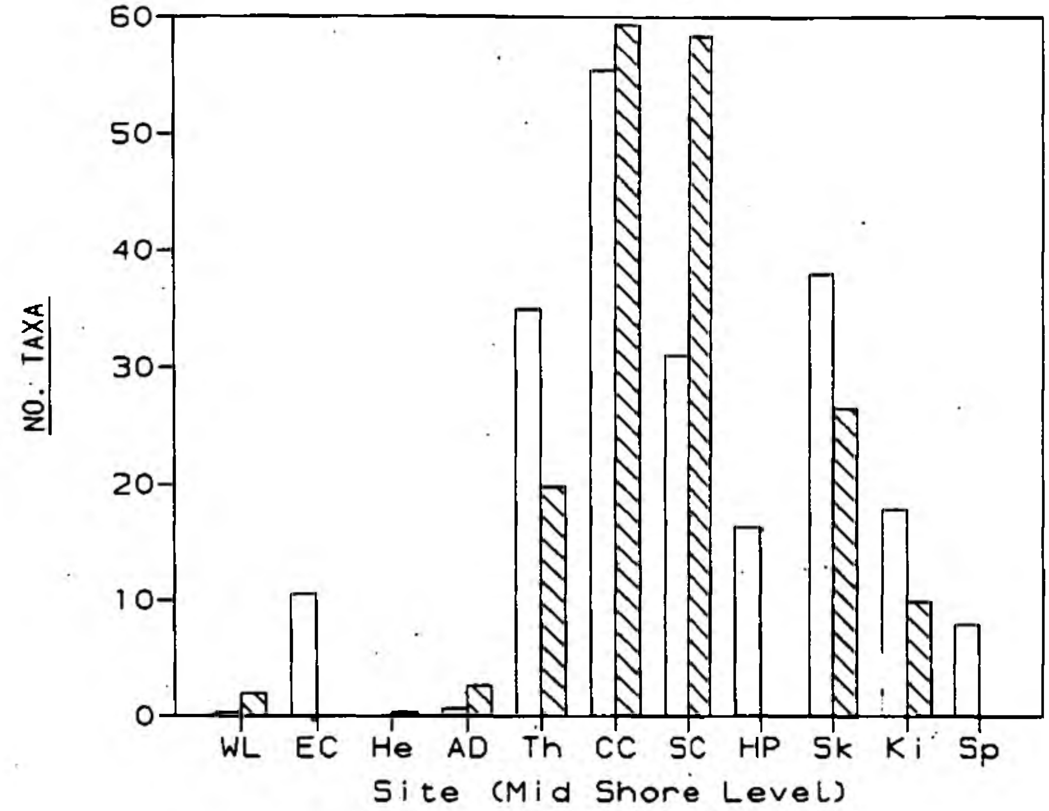

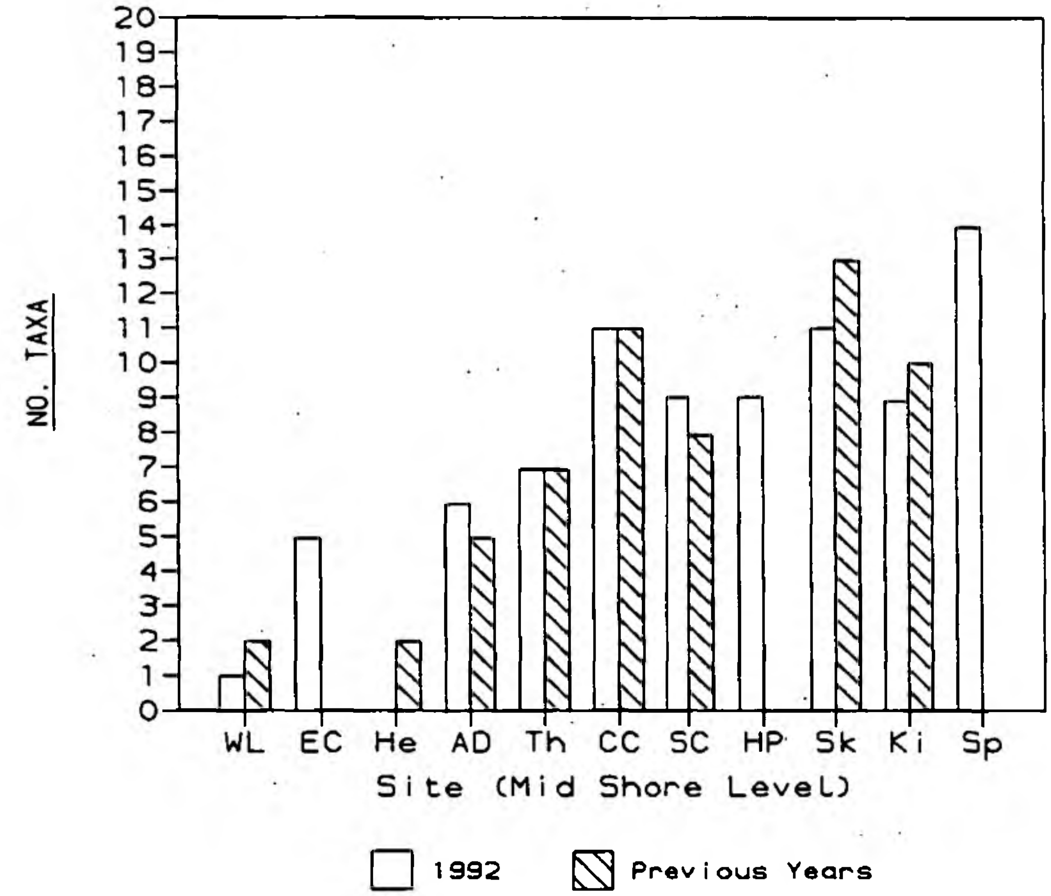

FIGURE 5:5 HUMBER INTERTIDAL FAUNA - MID SHORE NORTH SHORE AUGUST 1992

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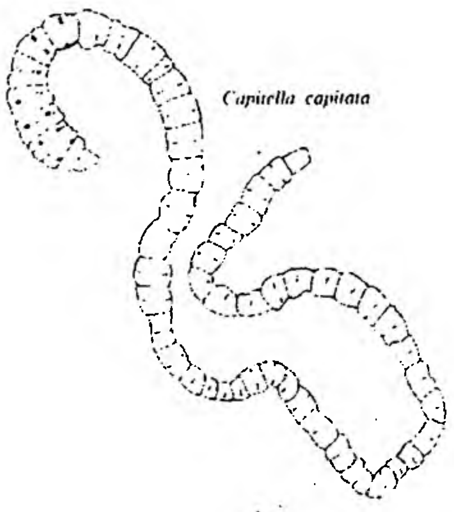

an overall reduction in organic matter available to the oligochaetes as a food source. Fig 5:4 shows the trend of falling abundance in the oligochaete populations although it does appear that the decline in density has levelled off in the last couple of years. The exception to this was the increase in the abundance of the opportunistic and pollution tolerant oligochaete *Tubificoides benedeni* at Alexandra Dock which may be a chance occurrence. The apparent decline in the amount of organic material available in the intertidal area is surprising as there is as yet no reduction in the organic loadings from Hull East and West STW, the major organic inputs to the North Shore of the Humber. It is possible that the low freshwater flows over the last three years have allowed the Hull sewage to be distributed further inland than is normal, reducing the effects in the Hull area.

No animals were recorded from the mid and low water stations at Hessle and there was a marked reduction in the numbers recorded from the high water station. This follows the same pattern as previous years, when faunal abundance at this site was very low. This is due to the extreme instability of the sediments in this area, rather than any high levels of pollutants in the sediments (levels of metals are no higher in this area than elsewhere on the estuary, and levels of arsenic have declined markedly in the last few years). An examination of the stony substrate in the area revealed a reasonably productive fauna which suggests that in a more stable sediment a more typical faunal community would develop. The site is retained in the monitoring programme, however, as it is typical of the unstable conditions which can be found in a large estuary.

The organic pollution indicator worm species *Capitella capitata* was not recorded from the North Bank of the Humber this year.

The stations on the outer estuary (Spurn Bight) had increased in faunal abundance compared to 1989/90 levels, which was partly due to an increase in numbers of the small spire shell *Hydrobia ulvae*.

5.4.3.2 North Bank Mid Shore

As with the 1991 results, both diversity and abundance of animals were found to be highest at Cherry Cob (see Fig 5:5).

Comparison of the 1992 survey results with long term averages (Fig 5:5) suggest that there has been little change in the number of taxa recorded at each site on the North Bank. In previous years, however, faunal identification had been to a lower taxonomic level and so in order to make a valid comparison; the 1992 data was combined into groups where necessary.

A comparison of faunal abundance with the long term averages (Fig 5:5B) show that there had been an increase in numbers at Thorngumbald, Skeffling and Kilnsea and a reduction in abundance at Stone Creek and Cherry Cob.

The ragworm (*Nereis diversicolor*) population appears to be remaining fairly constant after the large recruitment boom of 1988.

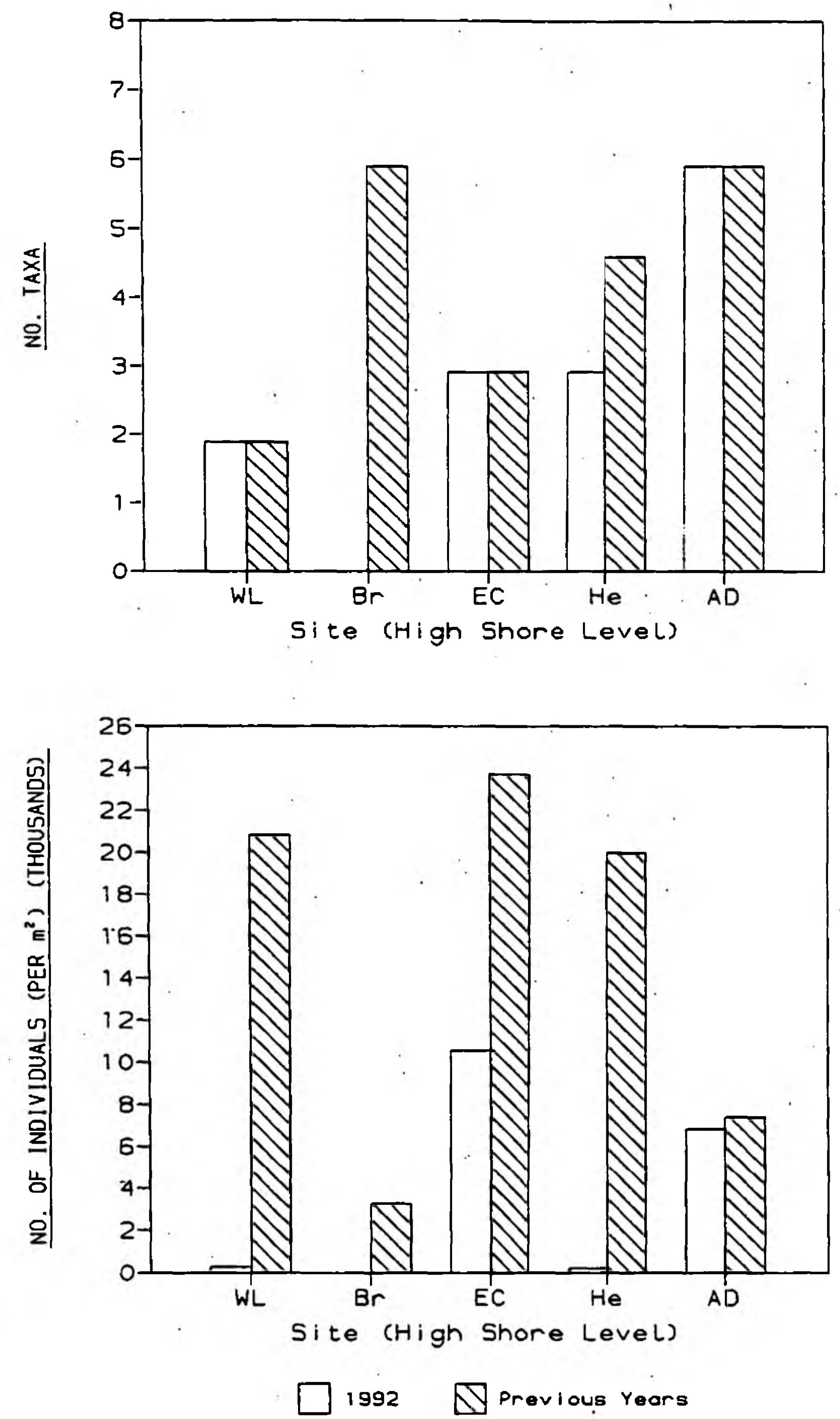

FIGURE 5:6 HUMBER INTERTIDAL FAUNA NORTH SHORE AUGUST 1992

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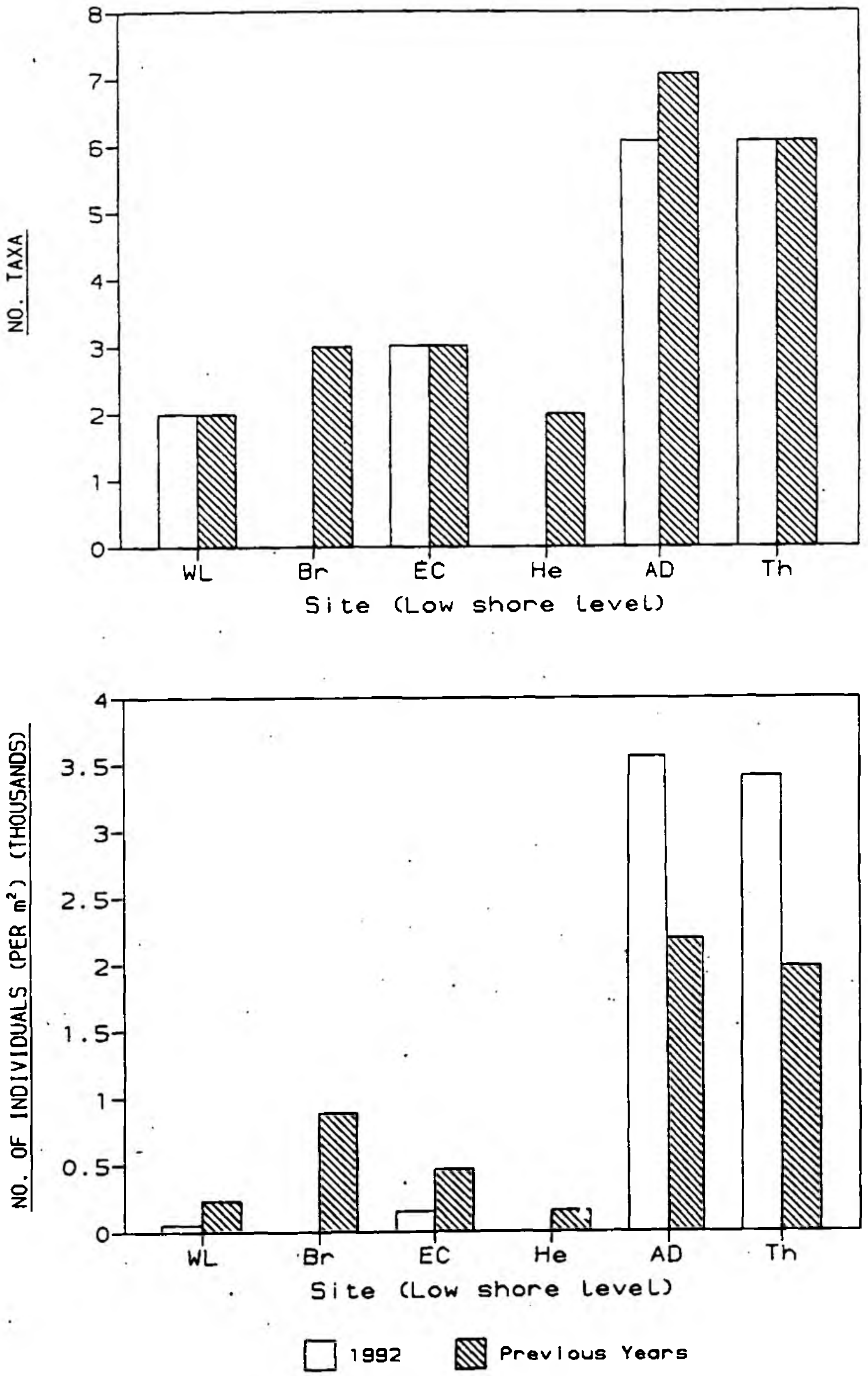

FIGURE 5:7 HUMBER INTERTIDAL FAUNA - LOW SHORE NORTH SHORE AUGUST 1992

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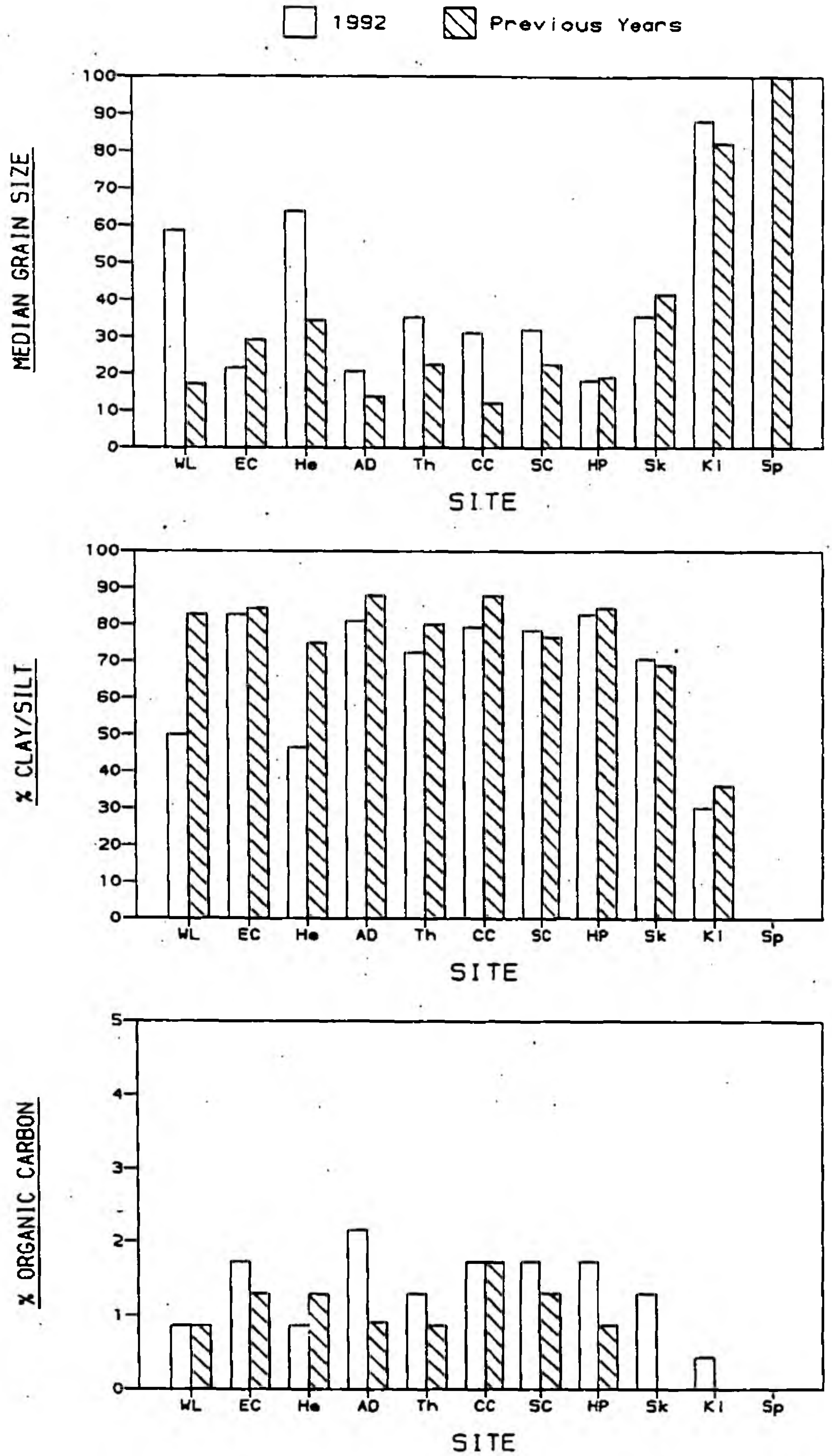

FIGURE 5:8 HUMBER NORTH SHORE SEDIMENT ANALYSIS AUGUST 1992

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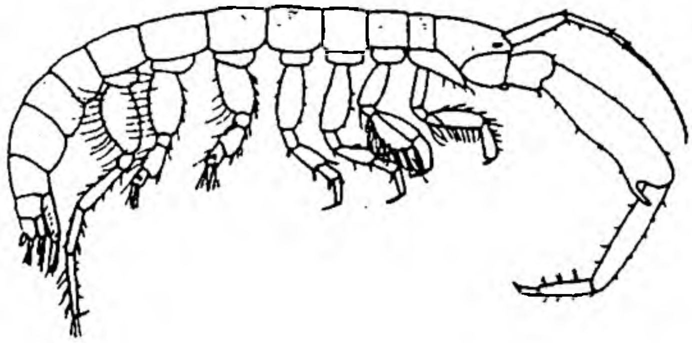
Corophium volutator



The bivalve mollusc *Macoma balthica* was again generally well represented in the estuary with the population at Stone Creek appearing to be the most changeable (Fig 5:4). A large number of the Macoma recorded were less that 2mm long and so were probably first winter animals recruited in May and June, (N. Jones and C. Park 1991).

The majority of sites remain numerically dominated by one species. The crustacean *Corophium volutator* now tends to be a numerically dominant member of the faunal community in the middle estuary following its return to the estuarine fauna first observed in 1989. The numbers of this species declined throughout the country during the 1980's, and have only recently begun to recover. It is not known if this change was due to disease or climate changes.

At Kilnsea the spire shell Hydrobia ulvae has replaced the cockle *Cerastoderma edule* as the most numerically dominant species. Hydrobia was also found to be very numerous at the outer estuary sand habitat of Spurn. The majority of these animals were small (1-2mm) individuals, many of them apparently without calcified shells, which indicated that they were juveniles.

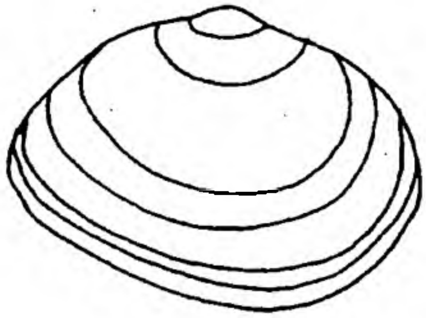
The lower overall abundance of the fauna at Hawkins Point when compared to 1991 can mainly be accounted for by the reduction in numbers of the spionid polychaete worm *Pygospio elegans*. Conversely an increase in the faunal density at Skeffling in comparison to the 1991 data was, in part, due to a return of *Pygospio elegans* to the 1990 abundance level. It is possible that the observed changes are due to the patchy distribution of these polychaete worms. It has been shown that *Pygospio* has a tendency to form dense aggregations that result from asexual reproduction which are easy to miss when sampling.

The reduction in overall density at both Skeffling and Kilnsea reported in 1991 has not continued into 1992. Overall abundance has returned to 1990/89 levels respectively with increases in the densities of *Nephtys* sp., *Cerastoderma edule* at both sites and *Hydrobia ulvae* at Kilnsea. The increase in the abundance of these classic estuarine mollusc species may be a result of a greater stability of the outer estuary sediment or an improvement in the water quality of this area.

5.4.3.3 North Bank High Shore

In general the faunal abundance and taxon richness was comparable with the mid shore level. Comparison of the 1992 data with long term averages showed that there was little difference in the number of taxa recorded (see Fig 5:6). Again, due to the fact that identification has been to different taxonomic levels in previous years the 1992 data has been grouped together where necessary. Weighton Lock, East Clough and Hessle all show a reduction in faunal density in the 1992 survey. At Weighton Lock and Hessle this can again be attributed to fewer oligochaete worm numbers. At East Clough there appeared to be a drop in the abundance of *Corophium*, but as the density had increased at the mid shore level, it was probably the result of a redistribution of the population on the shore.

5.4.3.4 North Bank Low Shore



Macoma balthica

In general both faunal density and taxon richness were lower than at the mid and high shore levels (Figure 5:7), with the exception of Alexandra Dock where faunal abundance was actually greater at the low shore level. This can be ascribed to the comparatively high numbers of the pollution tolerant oligochaete worm, *Tubificoides benedeni* and the mollusc *Macoma balthica*.

Comparison of the 1992 data with long term averages indicates that there was little difference in the number of taxa that have been recorded. The faunal density had dropped where, in previous years, the oligochaete worms were a dominant member of the community ie. Weighton Lock, East Clough and Hessle.

Total faunal abundance at Alexandra Dock returned to 1990 levels although the community structure was slightly different in 1992. The spionid worms that had apparently disappeared from this station in 1991 were present again in the 1992 survey at a density of 195m-2. The oligochaete worms had increased in density once more as had the molluscs *Macoma balthica* and *Hydrobia ulvae*.

The observed increase in faunal abundance at Thorngumbald can also be attributed, in part, to an increase in the numbers of *Macoma* as well as *Nephtys* and *Corophium volutator*.

5.4.3.5 Comparison of Sediment Particle Size with Faunal Distribution

In general there appeared to be a reduction in the percentage of organic carbon over the whole intertidal area (Fig 5:8), although these results were reasonably low in both 1991 and 1992. At certain sites, particularly in the upper estuary, there appeared to be a tendency for the median grain size to decrease and the silt / clay fraction of the sediment to increase. The most significant difference was between Kilnsea and Spurn and the other sites.

A PRIMER program called BIOENV was used to consider which of the sediment parameters, or combination of parameters, was the most important in determining the distribution of the invertebrate communities. At the mid water stations this showed that median grain size was the single most important parameter in determining species distribution, although the amount of explained variation rank correlation was small.

5.4.4 SOUTH BANK

5.4.4.1 Summary

All South Bank sites except Cleethorpes showed an increase in both abundance and diversity when compared to 5-year average values.

The increase in diversity was greatest at Grimsby. This was likely to be due to the recovery of the site following the diversion in 1987 of a major sewage outfall in the area. The fauna has been poor since 1987, due to the reduction in numbers of organic tolerant species, but there are now increasing numbers of 'clean water' taxa indicating that new colonisation is taking place.

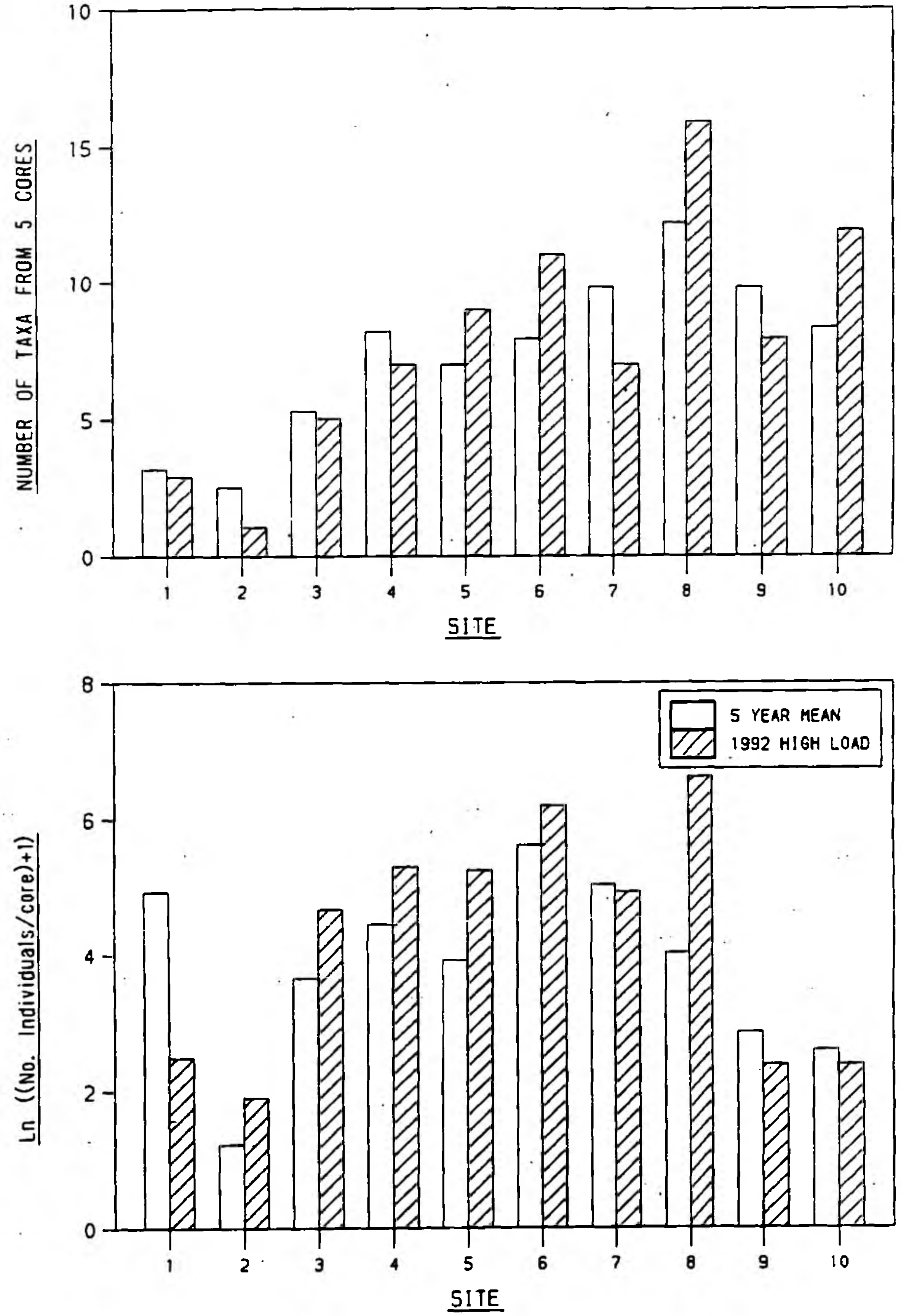


FIGURE 5:9 HUMBER INTERTIDAL FAUNA - MID SHORE SOUTH SHORE 1992

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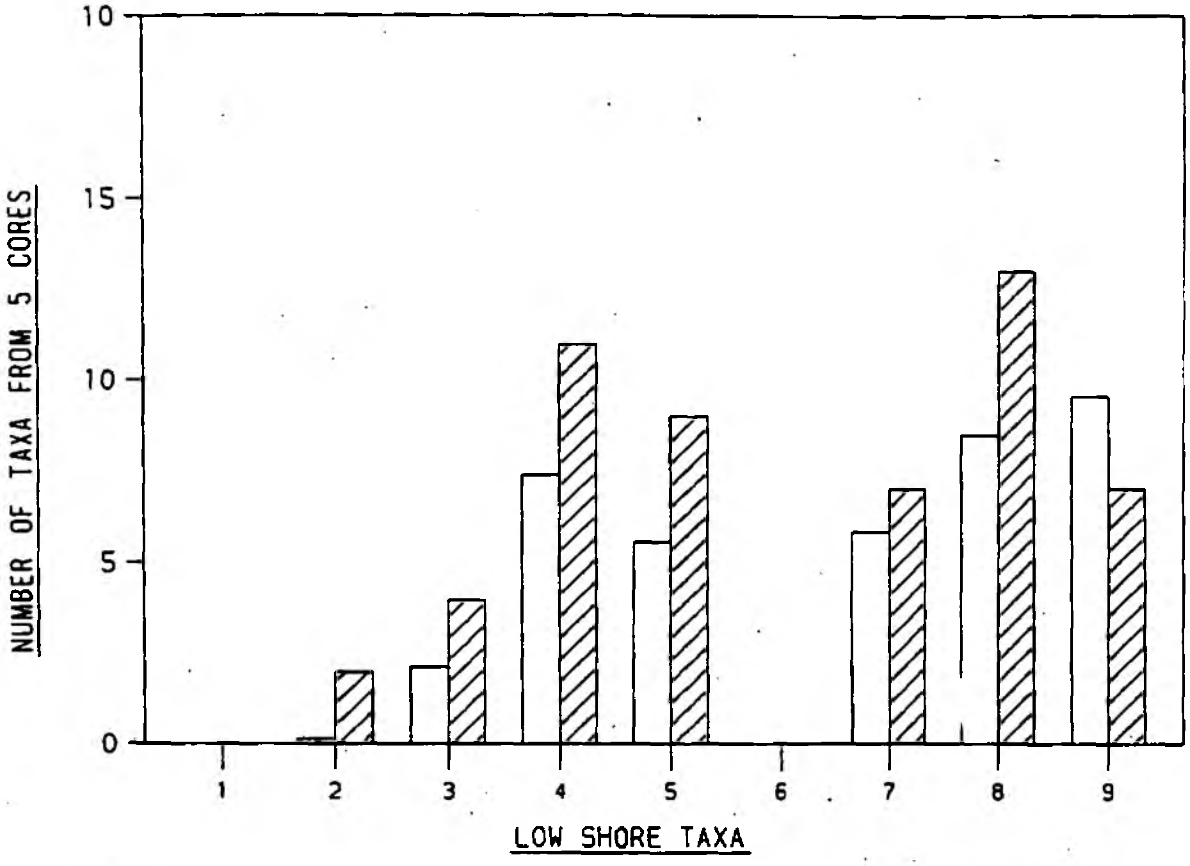

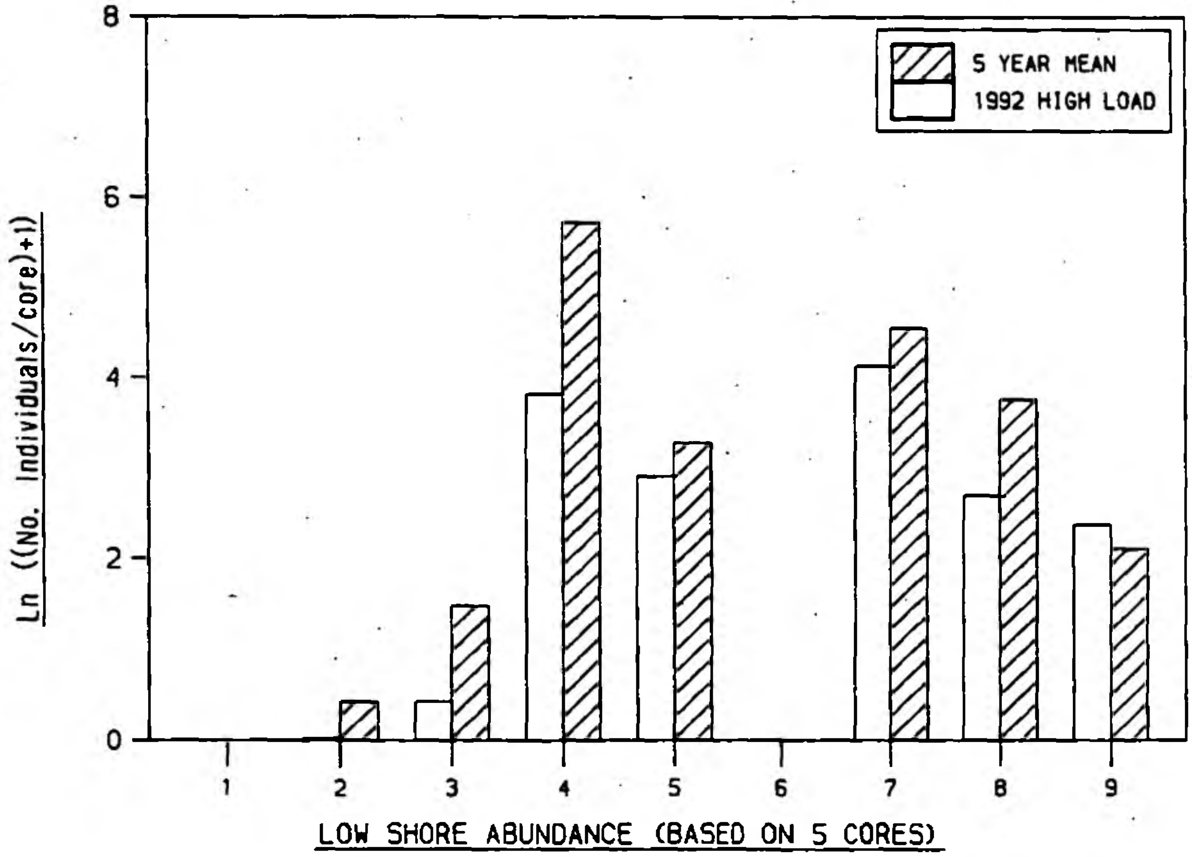

FIGURE 5:10 HUMBER INTERTIDAL FAUNA - LOW SHORE SOUTH SHORE 1992

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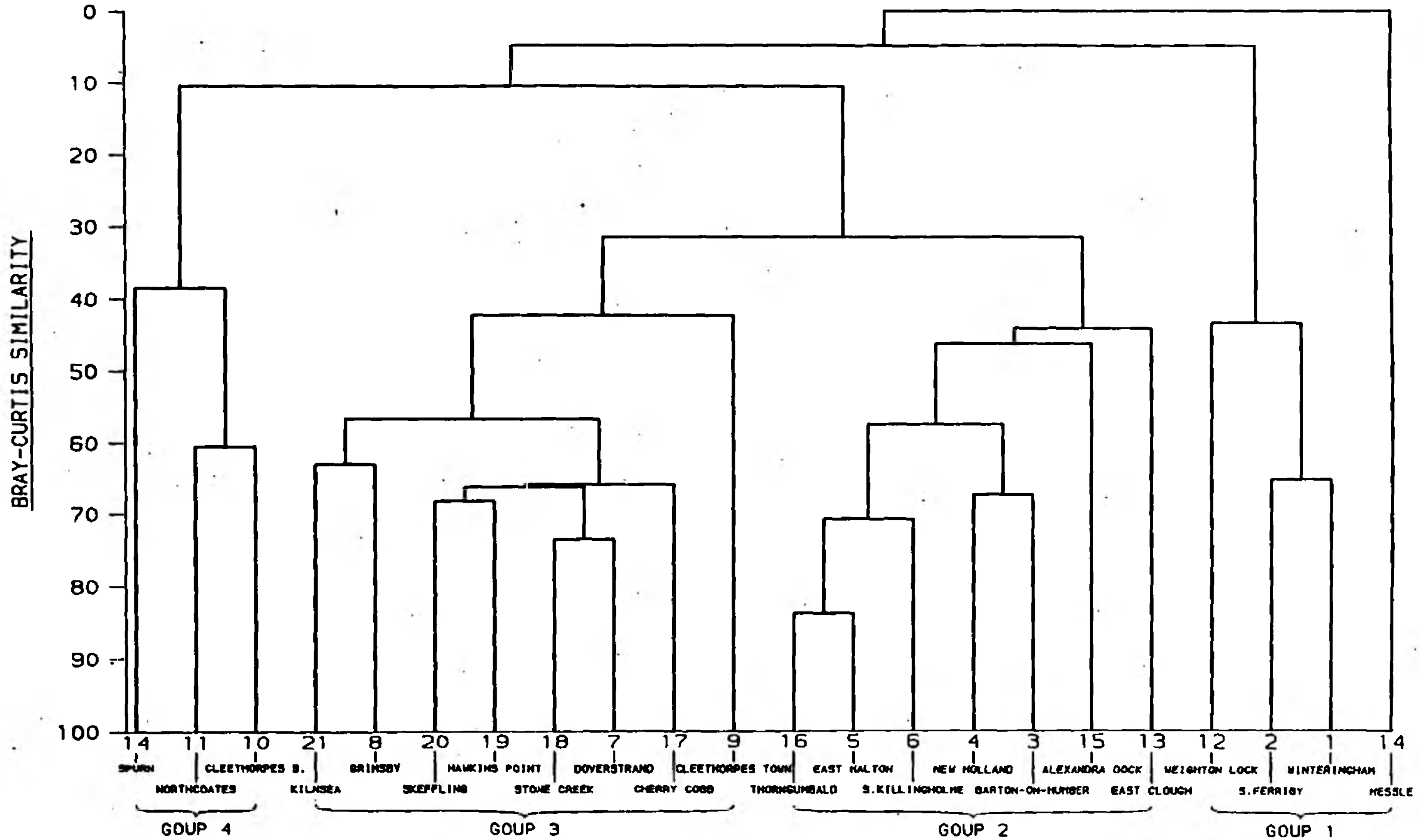
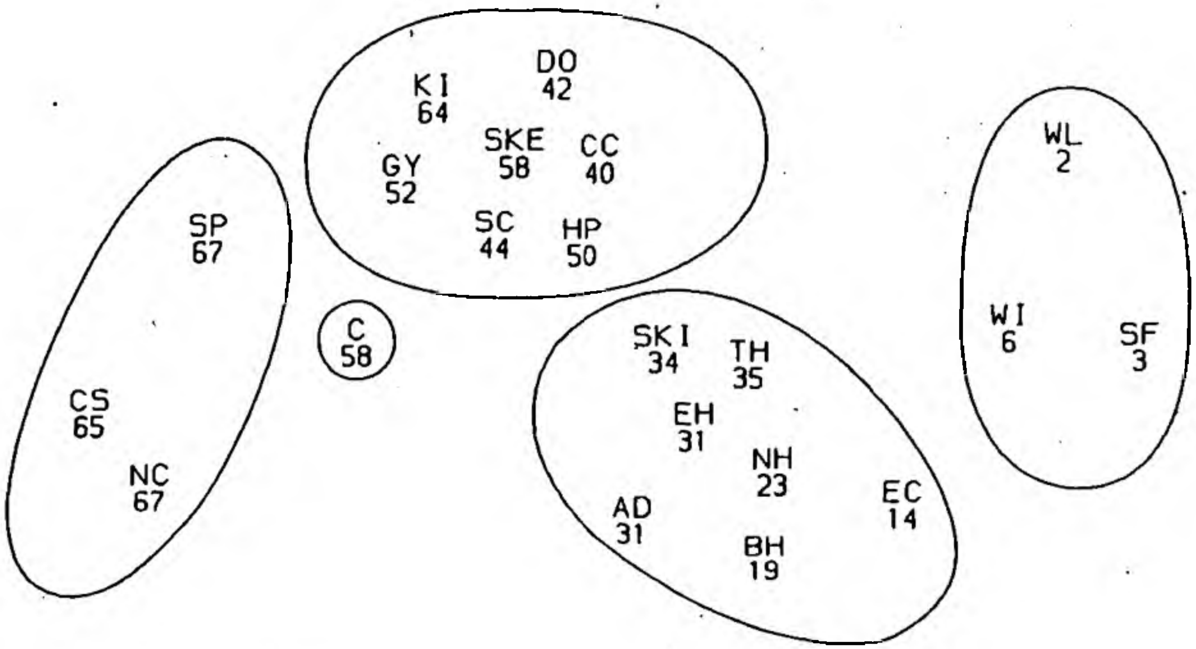


FIGURE 5:11 INTERTIDAL INVERTEBRATE GROUPS FROM HUMBER NORTH & SOUTH SHORES

STAT92



SITE NAMES

SOUTH BANK

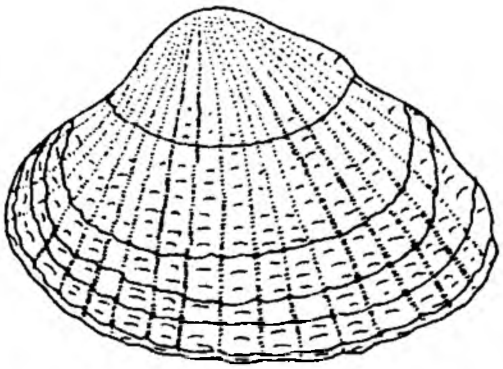
WI	WINTERINGHAM
SF	SOUTH FERRIBY
BH	BARTON-ON-HUMBER
NH	NEW HOLLAND
EH	EAST HALTON
SKI	SOUTH KILLINGHOLME
DO	DOVERSTRAND
GY	GRIMSBY
CS	CLEETHORPES
NC	NORTHCOATES

NORTH BANK

WL	WEIGHTON LOCK
EC	EAST CLOUGH
HE	HESSLE
AD	ALEXANDRA DOCK
TH	THORNGUMBOLD
CC	CHERRY COBB
SC	STONE CREEK
HP	HAWKINS POINT
SKE	SKEFFLING
KI	KILNSEA
SP	SPURN

FIGURE 5:12 HUMBER 1992 NORTH & SOUTH SHORES INTERTIDAL SITES
PRIMER MAP OF SITES WITH APPROX. DISTANCE FROM TRENT FALLS (km)

STAT91



There was an increase in the numbers of cockles (*Cerastoderma spp*) at Grimsby, which may also indicate an increase in the stability of the sediment, and also good numbers of *Corophium* species in the middle part of the estuary, indicating that the recovery in population size of this species is continuing.
There were lower numbers of naididae (small worms) at South Killingholme, as also seen on the North Bank at Cherry Cobb.

The very low numbers of taxa at Barton on Humber (0 in 1991, 3 in 1992) were also seen on the North bank, directly opposite at Hessle. This was due to the extreme instability of the area, where mud banks can appear and disappear rapidly.

Figures 5:9 and 5:10 show the abundance and numbers of taxa at South Bank sites compared to the long-term average for mid and low-shore levels.

5.3.5.2 COMPARISON OF NORTH BANK AND SOUTH BANK

The fauna of the North and South Bank sites was compared using the PRIMER computer package to discover whether position on the estuary was more important than local environmental variables in determining the species present at a site. Figure 5:11 shows the similarity dendrogram for the 1992 data. These diagrams group together the most similar sites (based on the numbers and variety of species present) and join the sites together with lines at the level of similarity. The higher the Bray-Curtis similarity index, the more alike are the two sites. For example, from Figure 5:11 it can be seen that Thorngumbald and East Halton are the two most similar sites, with a similarity of 85%, but Hessle (a site with no animals present) was least like any other site, with a similarity index of only 5%.

Five groupings of sites can be identified from the similarity dendrogram, and these are drawn on Figure 5:12. It is clearly seen that the North and South Bank sites group together according to their position in the estuary rather than by local environmental factors such as a high pollution load from a particular source. This confirms the finding that the levels of contaminants in sediments do not differ significantly between the North and South Banks of the Estuary. Figure 5:12 shows the sites 'mapped' according to their similarity and distance from Trent Falls. Hessle was not included in this map, as it is so different from the other sites that if it is included it causes the remaining sites to group very closely together.

Group 1:- species-poor inner estuary sites up to approximately 10 km from Trent Falls.
Group 2:-Mid estuary sites between approximately 10 and 40km for Trent Falls.
Group 3:-Muddy outer estuary sites between approximately 40 and 65km from Trent Falls.
Group 4:-Sandy outer estuary sites between 60 and 70km from Trent Falls.
Group 2 could be subdivided at New Holland with increasing distance from Trent Falls.
It is clear from these groupings that the overriding factor in deciding the composition of the fauna is the position of a site on the estuary, ie its salinity regime, rather than any pollutant or other factor.

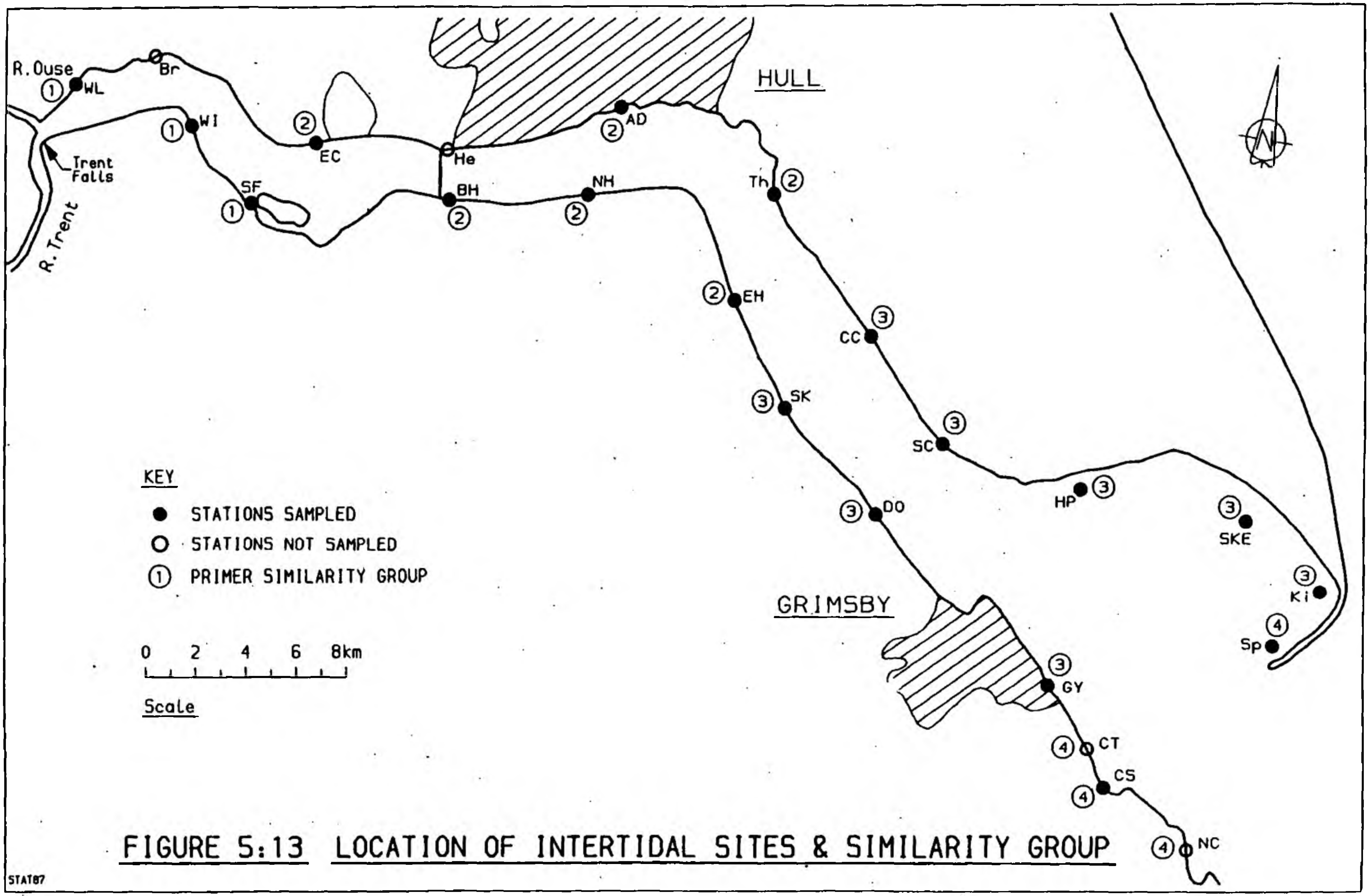


FIGURE 5:13 LOCATION OF INTERTIDAL SITES & SIMILARITY GROUP

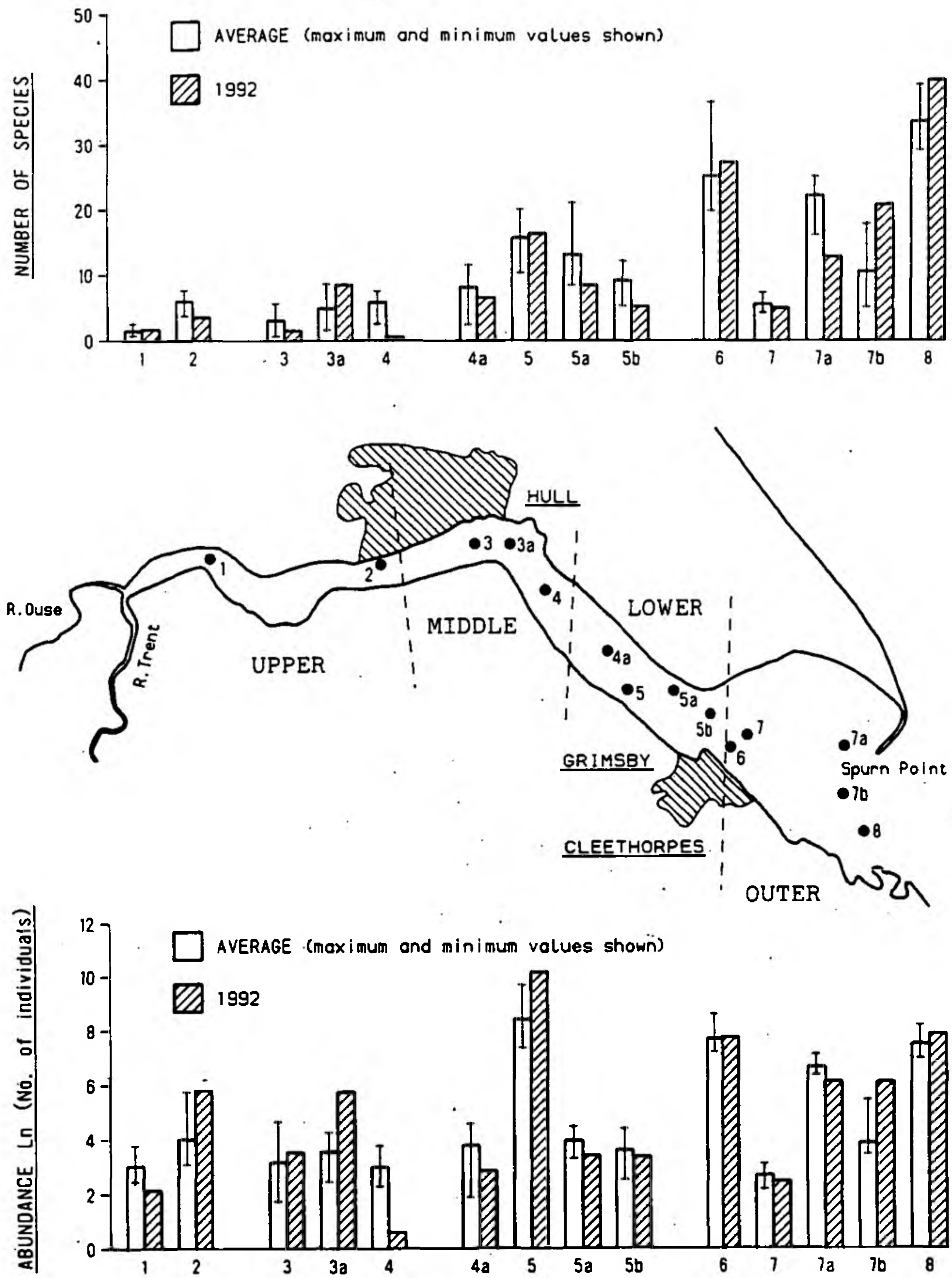


FIGURE 5:14 SUB-TIDAL SPECIES VARIETY AND ABUNDANCE IN 1992 COMPARED TO LONG TERM AVERAGE VALUES

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FIGURE 5:15 CLUSTER ANALYSIS OF ROUTINE DATA FROM SITE 8 (7728)

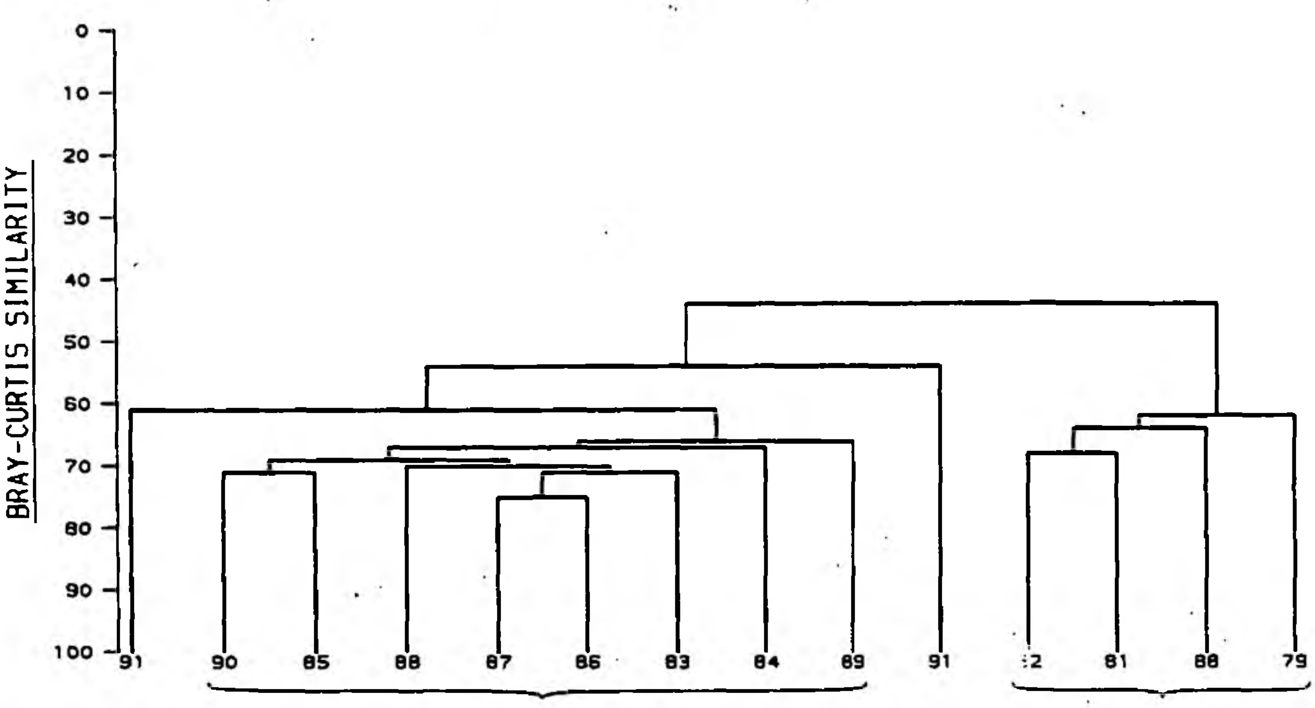


FIGURE 5:16 MDS PLOT OF ROUTINE DATA FROM SITE 8 (7728)

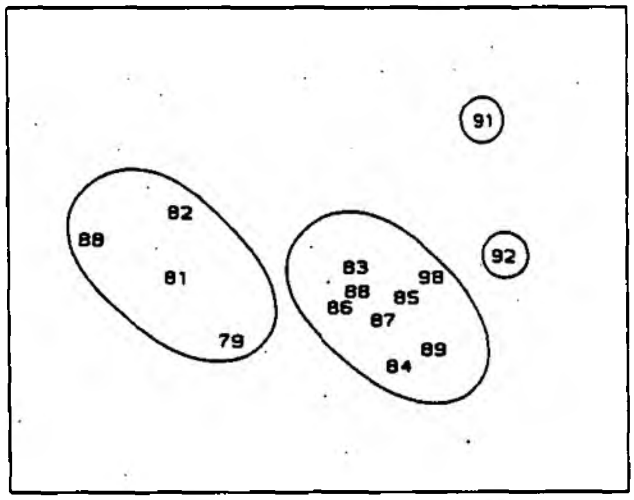
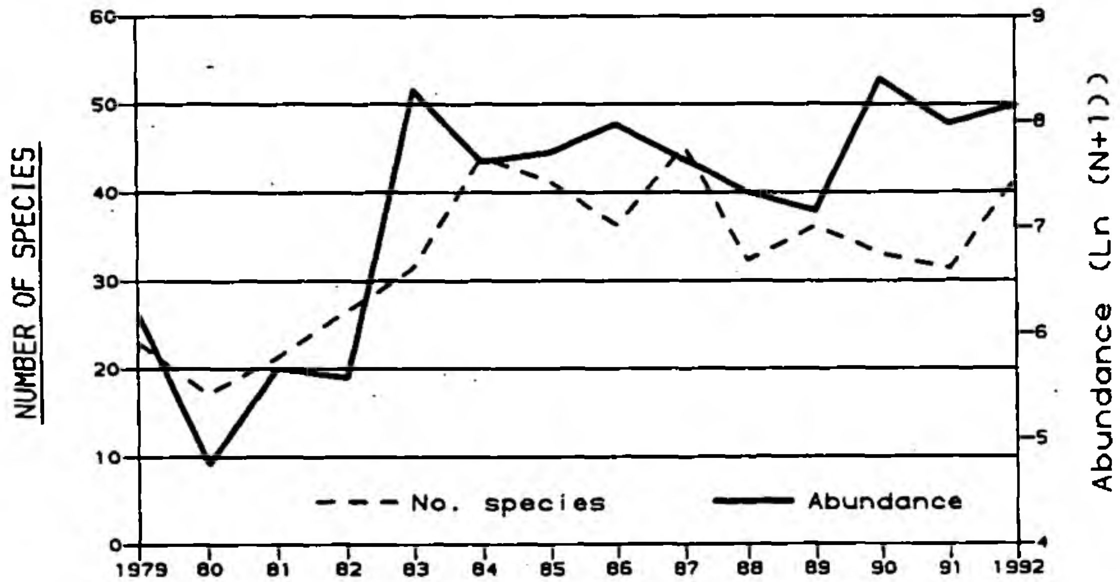


FIGURE 5:17 CHANGES IN SPECIES VARIETY & ABUNDANCE AT SITE 8 1979 TO 1992



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5.5 SUBTIDAL SURVEY

5.5.1 INTRODUCTION

Standard sampling methods were followed for this survey as described by Barr (1987). The estuary has been arbitrarily divided into four sectors for reference purposes, upper, middle, lower and outer, which are shown in Figure 5:14

5.5.2 SPECIES VARIETY AND ABUNDANCE.

Species variety and abundance at each site in 1992 were generally comparable with the five year average values as shown in Figure 5:14.

5.5.3 UPPER AND MIDDLE ESTUARY

At Site 2 in the upper estuary and 3 and 3a in the middle estuary abundances were higher in 1992 than the average values, although species variety was comparatively low (Figure 5:12). The polychaete worm *Capitella capitata* was the dominant faunal component in the middle estuary and site 2 in the upper estuary and densities have increased during the period 1990 to 1992, indicating continued and perhaps increased state of organic enrichment, perhaps due to the effects of the newer long sewage outfalls redistributing sewage from the intertidal zone to the subtidal zone.

At site 4 the fauna in 1992 was reduced to a single specimen, whilst during the previous five years an average of 20 individuals of 6 species were recorded. This reduction is possibly a result of sediment disturbances caused by tidal currents. A similar reduction in fauna was recorded in 1987 at the middle estuary sites and was also tentatively attributed to tidal scouring phenomena (Barr 1988).

5.5.4 LOWER ESTUARY

At sites 4a, 5a and 5b in the lower estuary species variety and abundance in 1992 were lower than the five year average (Figure 5:14). Lower than average values were also recorded at these sites in 1990 and 1991. These results indicate a long term, gradual impoverishment of the fauna in this sector of the estuary, although there is no evidence of related deterioration of physical or quality conditions.

At site 5 in the lower estuary appreciably higher than average abundance was recorded in 1992. This reflects unusually high densities of the polychaete worm *Polydora* spp. in 1992. In previous years population densities of *Polydora* have varied considerably, reaching levels of over 40,000 per 0.3m2 in some years and little more than 1,000 in others.

5.5.5 OUTER ESTUARY

At site 7a in the outer estuary there were marked reductions in species variety and abundance in 1992 and in 1991. At site 7b in the outer estuary there were increases in species variety and abundance both in 1992 and 1991. These faunal changes were not matched by changes in sediment structure, but are likely to be a result of a period of stable sediment conditions.

5.5.6 DATA ANALYSIS

The results of cluster analysis and ordination of the historical data from site 8, using the PRIMER package are presented here as an example, shown in Figure 5:15. Four cluster groups are recognised at about 65% similarity level (Bray Curtis Similarity index): 1979-1982, 1983-1990, 1991 and 1992. Multidimensional scaling (Figure 5:16) of the same data further separates the four cluster groups and places them on a gradient according to affinity towards each other. The results indicate that the faunal composition has changed in stages over the 14 year monitoring period. The cluster groups correspond, to some extent, to different levels of species variety and abundance, with the addition of separating years 1991 and 1992 from other years of relatively high species variety and abundance, thus indicating differences in species composition between these years (Figure 5:17).

5.5.7 SUMMARY

The results of the 1992 routine survey provide evidence for a more marked organic enrichment in the middle and upper sectors of the estuary than in previous years. Environmental conditions have not changed appreciably throughout the lower and outer estuary. At one monitoring site in the middle estuary and one in the outer estuary there is an indication of some deterioration in conditions, whilst at one site in the outer estuary there is indication of improved environmental conditions.

5.6 FISH POPULATION SURVEY

5.6.1 INTRODUCTION

The annual fish distribution survey was carried out in conjunction with MAFF (Ministry of Agriculture, Fisheries and Food) in September 1992 and standard methods employed by MAFF were used throughout the survey. A total of 14 sites were sampled by towing a 2 m beam trawl fitted with distance measuring wheel, for 10 minutes. Replicate samples were taken at 6 sites. Fish were identified and measured on board. Samples were also collected at each site to determine salinity, dissolved oxygen and bottom sediment types.

5.6.2 RESULTS

The results of the fish survey are shown in Appendix E and Figure 5:18. The abundance of fish species are shown per 1000 m2 based on the area of estuary bed covered by the trawl.

A total of 13 species were caught in the 1992 survey, which is comparable with the results of previous years. In general the fish distribution patterns were similar to previous surveys, with both species variety and abundance increasing towards the mouth of the estuary.

Largest catches were made at Haile Sand and Clee Ness, where substantial numbers of plaice and dover sole were recorded. Catches were generally larger in 1992 than in 1991, both in terms of total number of fish and number of species caught at each site. In 1991 relatively poor catches were recorded at sites upstream from Burcom Shoal. Species variety and abundance at these sites were appreciably higher in 1992 and were comparable with results of the 1989 and 1990 surveys (Barr 1990, 1991, Gudmunsson 1992).

5.6.3 OCCURRENCE OF JUVENILE FISH IN 1992

Whiting was abundant throughout the estuary in 1992, whilst it was absent from the upper- and middle estuary in 1991.
Plaice was abundant at Haile Sand and Clee Ness, and was present at three other lower and outer estuary sites.

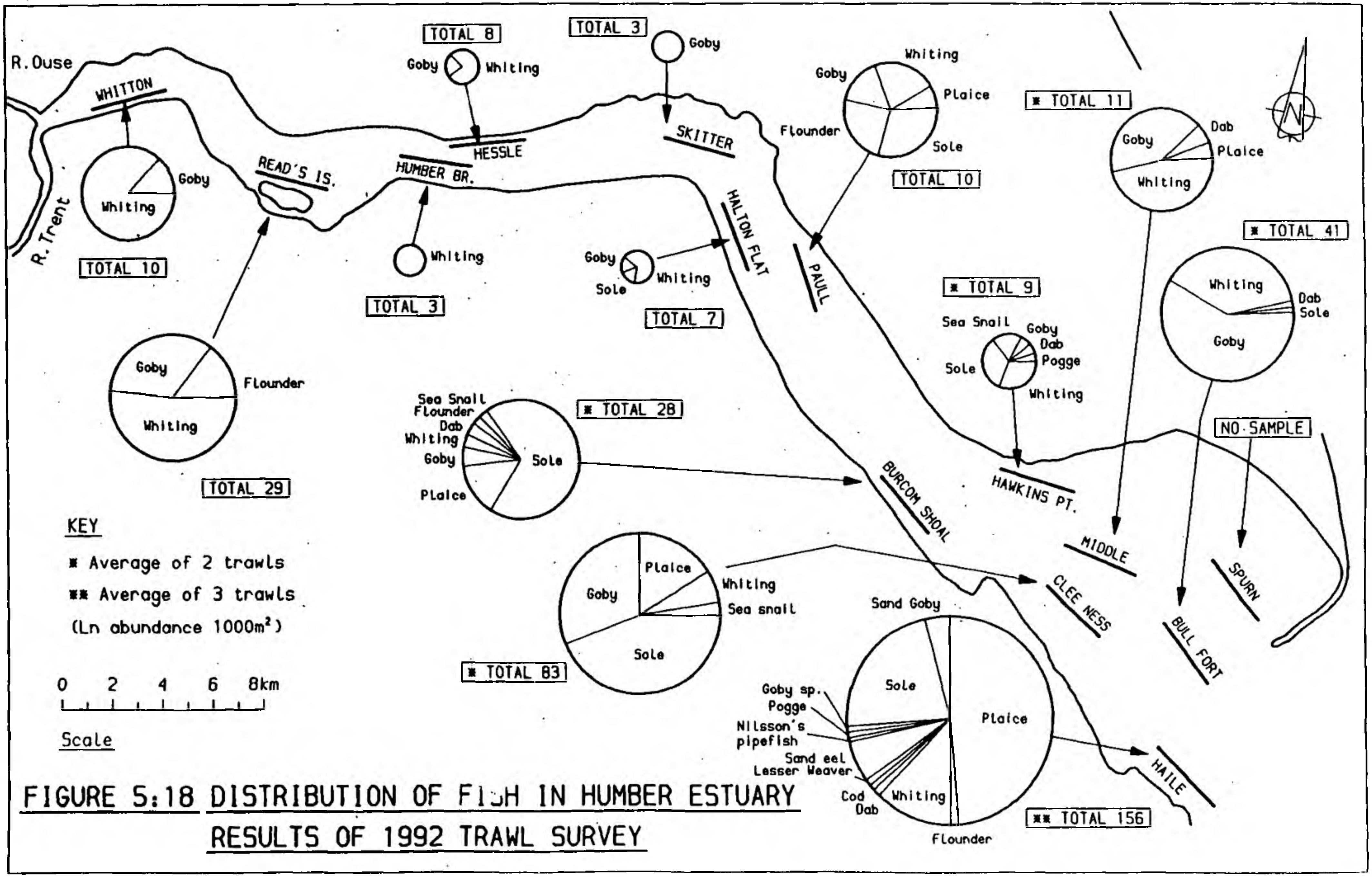

FIGURE 5:18 DISTRIBUTION OF FISH IN HUMBER ESTUARY
RESULTS OF 1992 TRAWL SURVEY

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Dover sole was abundant at Burcom Shoal, Clee Ness and Haile Sand, and occurred at 4 other middle- to outer estuary sites.

Dab occurred in low numbers at 5 sites in lower and outer sectors of the estuary. It was abundant at Haile Sand in 1989, but has made up a decreasing proportion of the catches since then (Barr 1990, 1991, Gudmunsson 1992).

Flounder was present in small numbers at 5 sites in the estuary, similar to previous years.

5.6.4 PUSH-NET RESULTS

In addition to the trawl survey, two sites; Spurn and Cleethorpes, are sampled annually by a Riley push-net (described by Holmes 1971). A 1.5 m wide push-net is pushed for 20 min in 0 to 1 m deep water at low tide. The resulting catches are calculated per 1000 m2. The results of the surveys 1989-1992 are shown in Appendix D.

Species composition was generally comparable with that of the trawl surveys. Brill and Turbot were caught in the push net but were absent in the trawl surveys. This is consistent with their established distribution patterns, juveniles being common on sandy shores and in marine rather than estuarine environment (see Wheeler 1969). Whiting was absent from the push-net surveys whilst abundant in the trawl surveys. Plaice was abundant at both push-net sites with good catches in the 1992 survey. Gobies made up an appreciable proportion of the push-net catches at Cleethorpes

The results of the 1992 push-net survey appear to be somewhat better than previous years with the highest species variety for all years and second highest combined abundance

5.7 SUMMARY

The Humber Estuary supports healthy populations of both invertebrates and fish in the intertidal and subtidal zones. Intertidal surveys have shown a general decline in the numbers of organic pollution tolerant species over the past few years, while the subtidal area has shown an increase in these species. This could be due to several factors; firstly lower freshwater river flows allowing cleaner sea water further up the estuary and secondly the effects of new long-sea outfalls on the South Bank. There has been no significant decline in direct organic loading to the North Bank from Hull, as these outfalls are as yet untreated. It will be of interest to see if this pattern is maintained over the next few years.

SECTION 6
SEAL STOCKS IN GREAT BRITAIN INCLUDING THE HUMBER

During 1991, a survey of the seal populations in Britain was carried out by the Sea Mammal Research Unit (SMRU) (Hiby, Duck and Thompson 1993). Ariel surveys were carried out in the Scottish Isles, mainland Scotland, Humber and Southwest Britain.

Table 6:1 shows the calculated numbers of pups produced in each area, and the estimated population in each area. Counts have been made since the 1970's in some areas of Britain, and the estimates of population numbers is especially important to estimate the effects of the epidemic of phocid distemper in 1988, which reduced the East Coast seal population by up to 50%.

Scottish seal populations were not so badly affected by the disease,but some European populations, for example in the Wadden Sea, were reduced by 60%. Britain now supports about 5% of the world population of the common seal, and nearly 40% of the population of the European subspecies *Phoca*

TABLE 6:1

ESTIMATED GREY SEAL POPULATIONS IN THE UNITED KINGDOM IN 1991

LOCATION	PUP PRODUCTION	TOTAL POPULATION (TO NEAREST 100)
Inner Hebrides	2500	8700
Outer Hebrides	10782	37500
Orkney	8358	29000
Isle of May	1218	4200
Farne Islands	927	3200
Mainland Scotland	1021	3500
Shetland	1000	3500
HUMBER ESTUARY	223	800
Southwest Britain	900	3100

Data from 'Seal Stocks in Great Britain: surveys conducted in 1991' in NERC News January 1993 *vitulina vitulina*. There is no evidence at present that numbers on the East Coast of Britain are recovering significantly from the epidemic, but populations in the Scottish Isles show a slow increase. The Humber supports a small but important seal population, mainly on the South side at Donna Nook, which is maintaining its numbers following the epidemic of 1988.

SECTION 7
NATIONAL AND INTERNATIONAL MONITORING PROGRAMMES INCLUDING THE HUMBER

7.1 INTRODUCTION

There are several international chemical monitoring programmes which cover the Humber. These include EC (European Community) Directives and Paris Commission (PARCOM) Surveys. All the regions of the NRA collect data for these surveys and the results are collated by the DOE/MAFF before returns are made to the EC.

7.1.1 EC DIRECTIVES

At present there are three EC Directives which apply to the Humber:-

1. THE DANGEROUS SUBSTANCES DIRECTIVE

2. THE BATHING WATERS DIRECTIVE

3. THE TITANIUM DIOXIDE DIRECTIVE

Two more Directives will be implemented within the next few years. The *Nitrate Directive* will not directly concern the Humber, but will be applied to areas within the catchment. The *Urban Waste Water Treatment Directive*, however, includes a requirement that all sewage from areas of population over 2000 people is treated by the early years of next century. This includes discharges to estuarine waters, and has considerable implications for the Humber, as the sewage discharges from Hull are at present untreated. New sewage works for Hull and other major centres such as Grimsby will need to be built, and discussions concerning these works are already in progress.

7.1.2. THE DANGEROUS SUBSTANCES DIRECTIVE

Levels of substances which need to be reported to the EC in accordance with the Dangerous Substances Directive are listed in Appendix 2. Most of these are included in the routine Humber survey at all sites, and others are monitored downstream of discharges containing these substances. They are also measured at 'Harmonised Monitoring Points', which are situated at the tidal limits of major river systems. The data from the Harmonised Monitoring Points is reported to HMIP (Her Majesty's Inspectorate of Pollution) every six months. Table 7:1 shows the means, maximum and minimum for the List I and List II substances not included in the routine Humber Survey at these sites.

7.1.3 BATHING WATERS DIRECTIVE

The only designated Bathing Water within the Humber Estuary is at Cleethorpes, on the South Bank. For this Directive, levels of bacteria in the seawater close to the beach are reported weekly (20 times) throughout the bathing season. The sample is considered to have failed the Directive if there are more

TABLE 7:1

MEAN, MAXIMUM AND MINIMUM LEVELS OF LIST II SUBSTANCES AT HARMONISED MONITORING POINTS IN YORKSHIRE

SUBSTANCE	OUSE AT NABURN			WHARFE AT TADCASTER			AIRE AT BEAL			DON AT NORTH BRIDGE			DERWENT AT LOFTSOME BRIDGE		
	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX
PERMETHRIN	0.0155	<0.01	<0.1	0.0092	<0.01	<0.03	0.0455	<0.03	0.01	0.0108	<0.01	<0.04	0.0085	<0.01	<0.03
HCB	0.0005	<0.001	<0.001	0.0005	<0.001	<0.002	0.0005	<0.001	<0.001	0.0005	<0.001	<0.001	0.0005	<0.001	<0.001
CYFLUTHRIN	0.015	<0.01	<0.1	0.0091	<0.01	<0.03	0.0145	<0.02	<0.03	0.0108	<0.01	<0.01	0.0085	<0.01	<0.03
EULAN	0.0175	<0.02	<0.1	0.0093	<0.01	<0.03	0.1125	<0.02	0.31	0.0143	<0.01	<0.6	0.0087	<0.01	<0.03
ORGANO-TIN	0.0139	<0.02	<0.04	0.0122	<0.02	<0.03	0.0121	0.02	<0.03	0.0147	<0.02	<0.6	0.0117	<0.02	<0.03
TRI-CB	0.05	<0.01	<0.1	0.05	<0.01	<0.1	0.05	<0.01	<0.1				0.05	<0.01	<0.1
TETRA-CB	0.05	<0.01	<0.1	0.05	<0.01	<0.1	0.125	<0.1	0.2				0.05	<0.01	<0.01
pp-TDE	0.001	<0.001	<0.002	0.001	<0.001	<0.002	0.001	<0.002	<0.002	0.001	<0.001	,0.002	0.001	<0.002	<0.002

ALL FIGURES IN ug/l MEANS ARE CALCULATED WITH < VALUES AT HALF THE LIMIT OF DETECTION than 2000 faecal E. coli (bacteria) or more than 1000 total coliforms in 100ml of sample on more than one occasion during the season. The Bathing Beach at Cleethorpes did not reach the required standard in 1991 (NRA 1992) or 1992 (NRA 1993), and major improvements are now under way to ensure that the beach will comply with the terms of the Directive. A new STW to treat the sewage from Cleethorpes will be built at Newton Marsh, discharging to Louth Canal instead of directly to the beach. The existing storm overflows which carry water away from Cleethorpes in times of heavy rain also discharge to the beach and these will be removed. These improvements are due to be finished in 1995.

7.1.3 TITANIUM DIOXIDE DIRECTIVE

The Titanium Dioxide Directive applies to the discharges from Tioxide Europe Ltd. and SCM Chemicals Ltd. on the South Bank. The discharges from these factories meets the requirements of the Directive.

7.2 *PARIS COMMISSION*

Countries bordering the North Sea are required to report to the Paris Commision for the Prevention of Marine Pollution on the loading of certain contaminants and nutrients released to the North sea each year. The data for 1990 has now been analysed and reported, and can be used to compare the loads of different substances discharged to the North Sea by different estuaries. Fig 7:1A & B shows the loads of copper, mercury, cadmium, zinc and lead from the major United Kingdom Estuaries compared to the River Rhine. The loading of all metals from UK estuaries is very much lower than the load contributed by the Rhine, and in the case of copper and zinc, the output from the Rhine is greater than the output from the whole of the UK. The highest UK loading of mercury is from the Mersey Estuary, and of cadmium from the Severn. The Humber has the highest UK output of zinc.

7.3 *NUTRIENT SURVEYS FROM 'SEA VIGIL'*

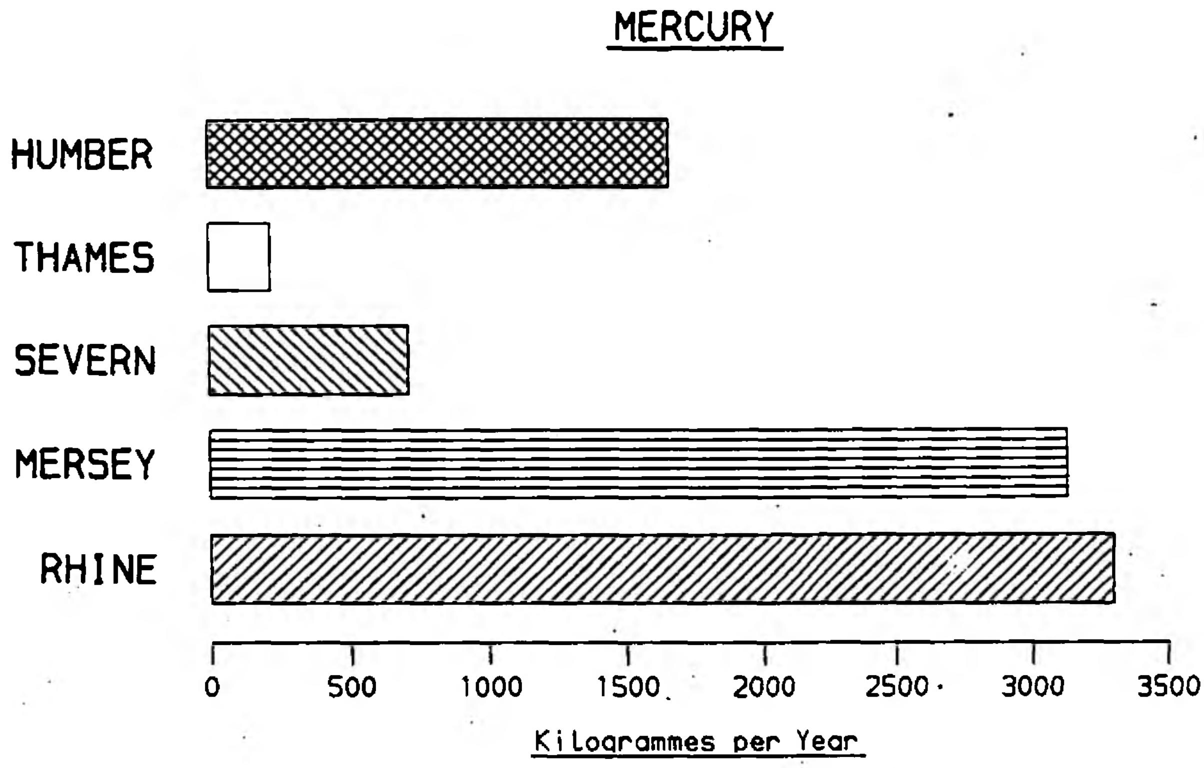
The Anglian Region Boat, Sea Vigil, is equipped for the sampling and on-board chemical analysis of nutrients in sea water, and two surveys were completed in 1992 in conjunction with MAFF.

7.3.1 TON SURVEY IN COASTAL WATERS

This survey took samples of sea water 20km out to sea from Kings Lynn (about 3km offshore) and continued up the coast to Bridlington, past the mouth of the Humber. Levels of TON (Total Oxidised Nitrogen) were measured every 5km, and are shown in Figure 7.2. The effects of the 'plume' from the Wash can be seen (20-65 km from Kings Lynn). The plume of water containing higher levels of TON discharging from the Humber can be seen between 77km and 97km from Kings Lynn, although there are two stations in the middle of this section with lower readings (perhaps areas of seawater which are not affected by the plume).

7.3.2 NUTRIENT SURVEY IN THE HUMBER MID-ESTUARY

This survey was carried out in August 1992, and was conducted in mid-estuary between Trent Falls and Spurn Head (Figure 7:3). Silicate, total ammonia, TON and orthophosphate were measured. It should be noted that on the graph the results for ammonia and orthophosphate have been multiplied by 50. Orthophosphate, TON and ammonia are all measures of the nutrient status of the water. Silicate is measured as this is an important factor in the formation of some algal 'blooms', when the algae which are multiplying are diatoms, which have a silica shell.



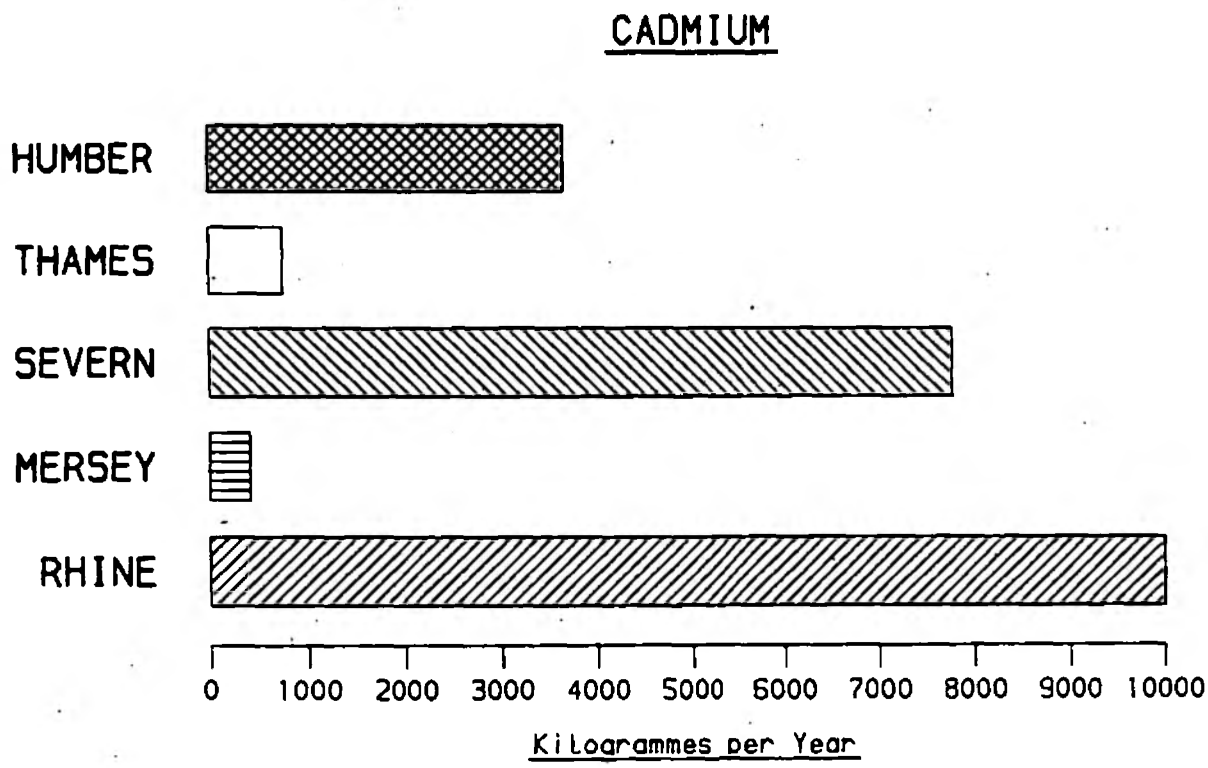


FIGURE 7:1A PARIS COMMISSION LOADS FROM NORTH SEA ESTUARIES IN 1990

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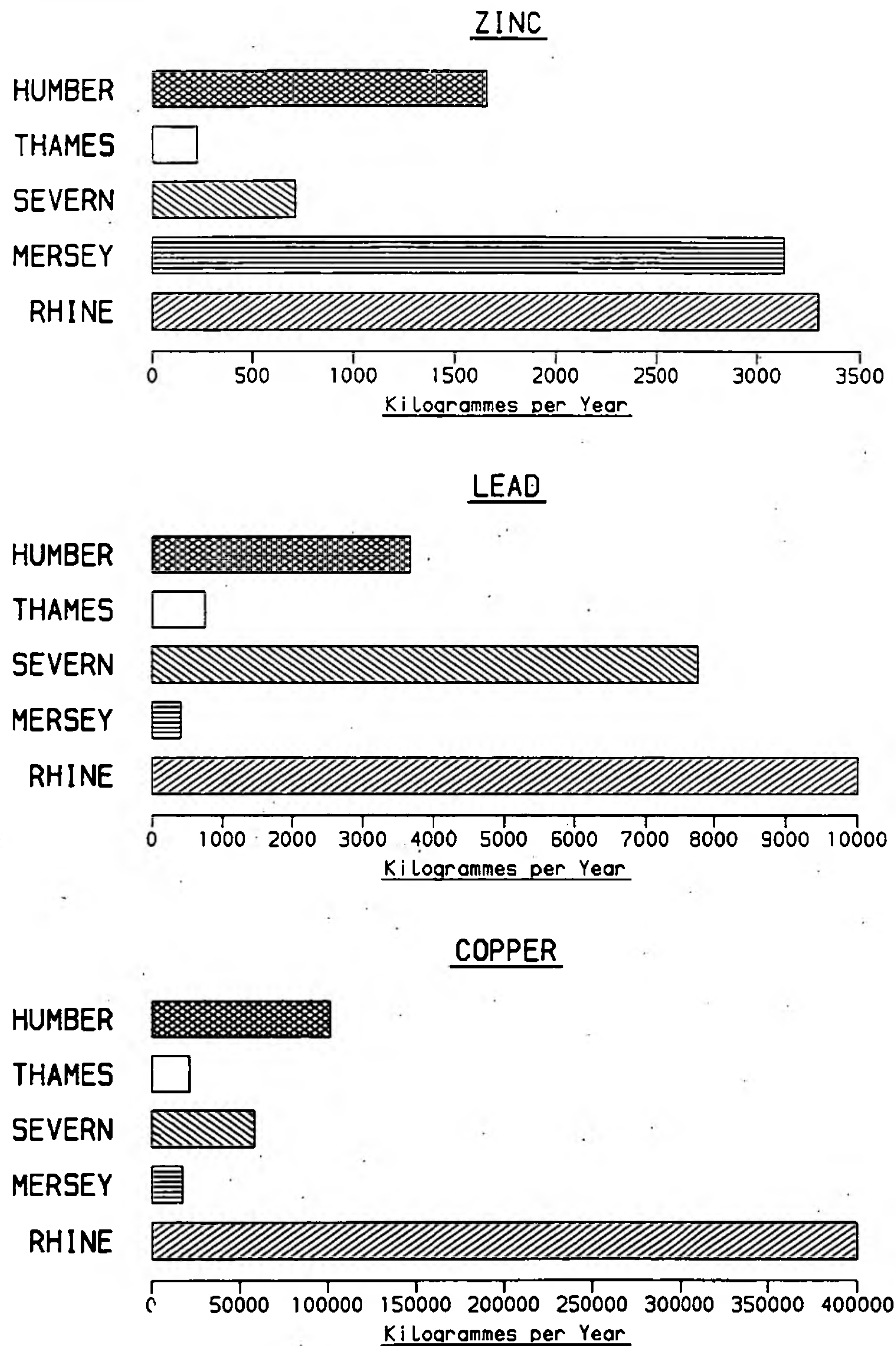

FIGURE 7:1B PARIS COMMISSION LOADS FROM NORTH SEA ESTUARIES IN 1990

STAT109

The levels of silicate and TON declined through the estuary towards Spurn Head (30o/oo salinity), as the estuary water mixed with sea water. Orthophosphate levels declined from Trent Falls (14o/oo salinity) until close to Spurn, when there was an erratic increase, with some sites showing a further decline, and others an increase. Ammonia levels were stable through the estuary, but apparently increased towards the sea.

There is little data from previous years for nutrients in the mid-estuary, and it is difficult to interpret these results without some reference values. There is information, however, from MAFF surveys in 1991 (MAFF 1991), when samples were taken in mid-estuary and nutrient levels measured before assessing the amount of algal growth could be supported by the water sample. The results of these surveys for 1990 and 1992 are shown in Figure 7:4A & B, together with the amount of algal growth for each sample. The MAFF samples were taken from the outer Estuary, and so can be compared to the outer estuary samples taken during the NRA cruise. The levels of nutrients recorded in the MAFF surveys were similar to the NRA surveys, and the Humber water samples supported algal growth at a similar level to the Tyne, Wear and Tees, although one sample from the Humber in 1990 was considered to possibly depress algal growth.

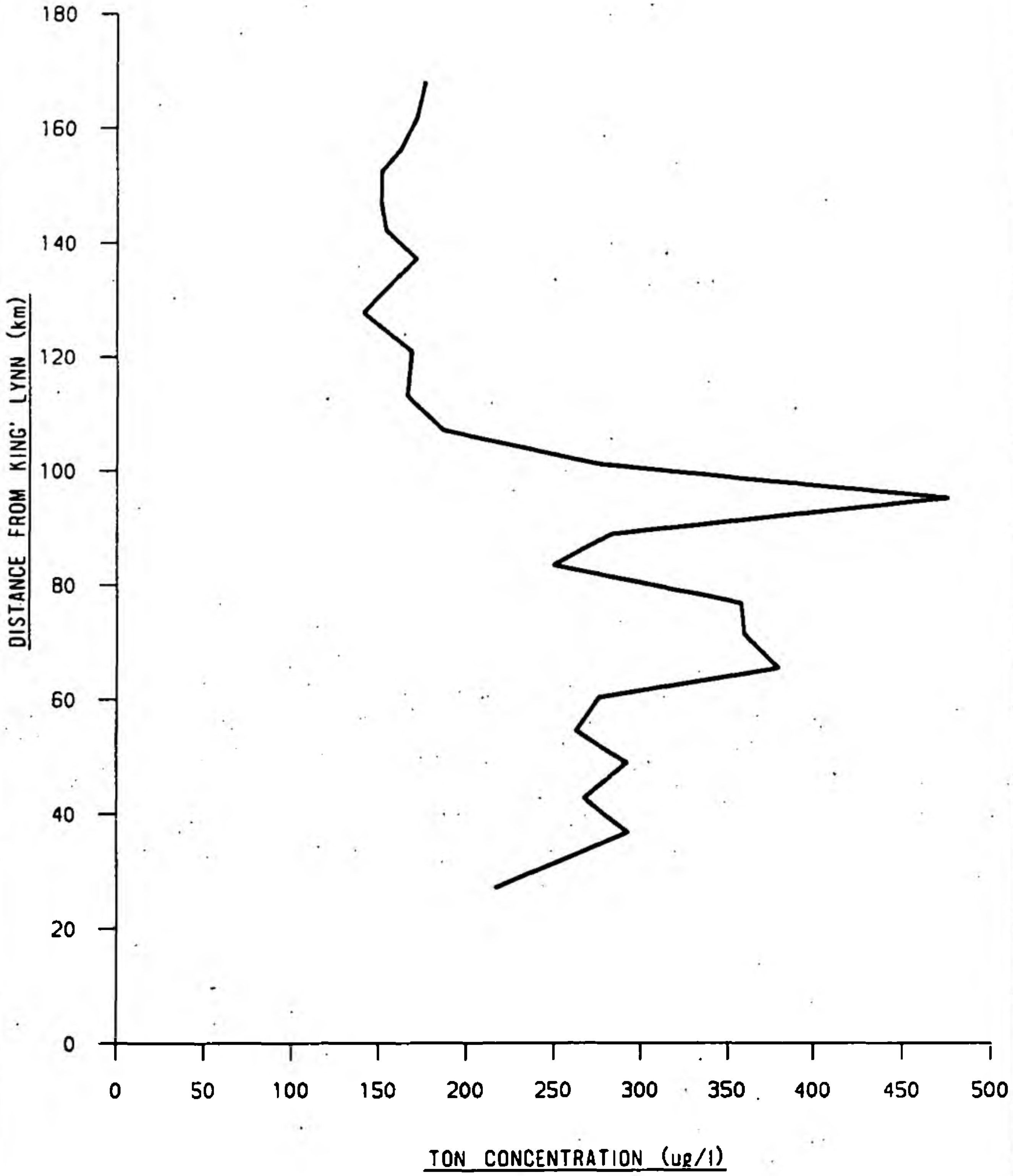

FIGURE 7:2 COASTAL NUTRIENTS SURVEY -
- WASH TO BRIDLINGTON 8th APRIL 1992

STAT127

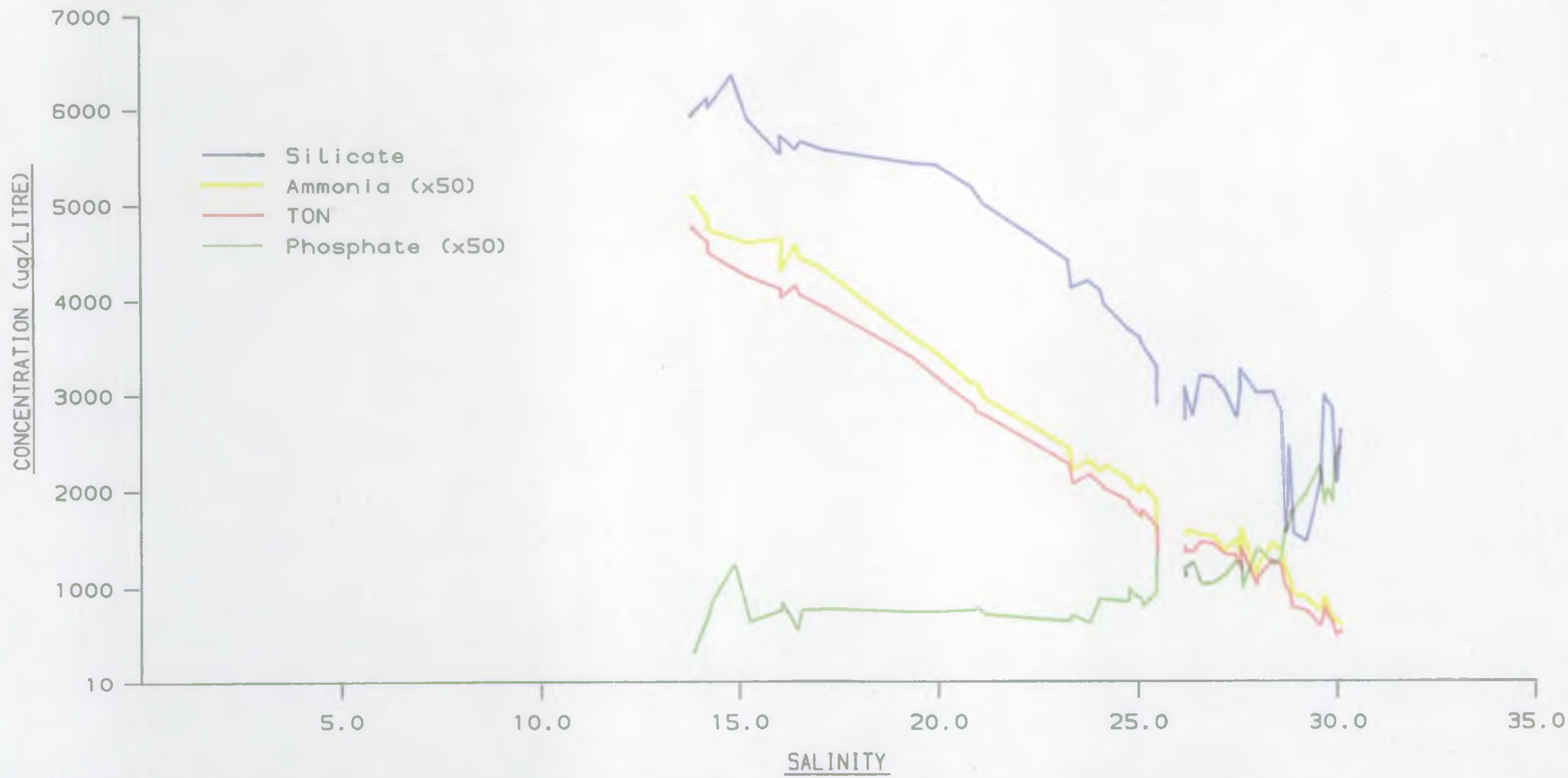

FIGURE 7.3 NUTRIENT ANALYSIS ON BOARD "SEA VIGIL"

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DATA REPRODUCED FROM :- AQUATIC ENVIRONMENT MONITORING REPORT NO. 36 MAFF

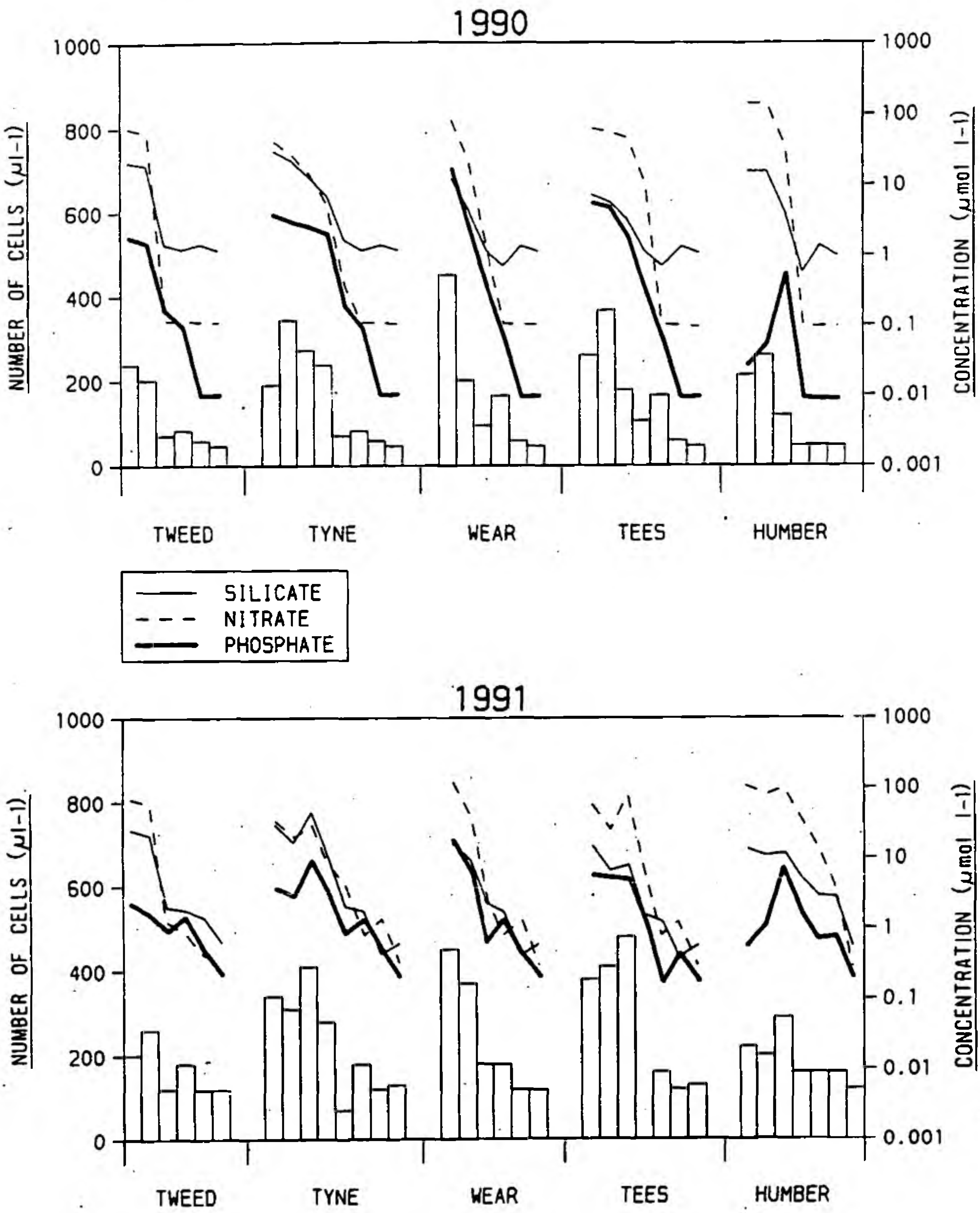

FIGURE 7:4A GROWTH OF *TETRASELMIS SUEICA* IN WATER SAMPLES TAKEN FROM FIVE ESTUARIES ON THE NORTH EAST COAST OF ENGLAND

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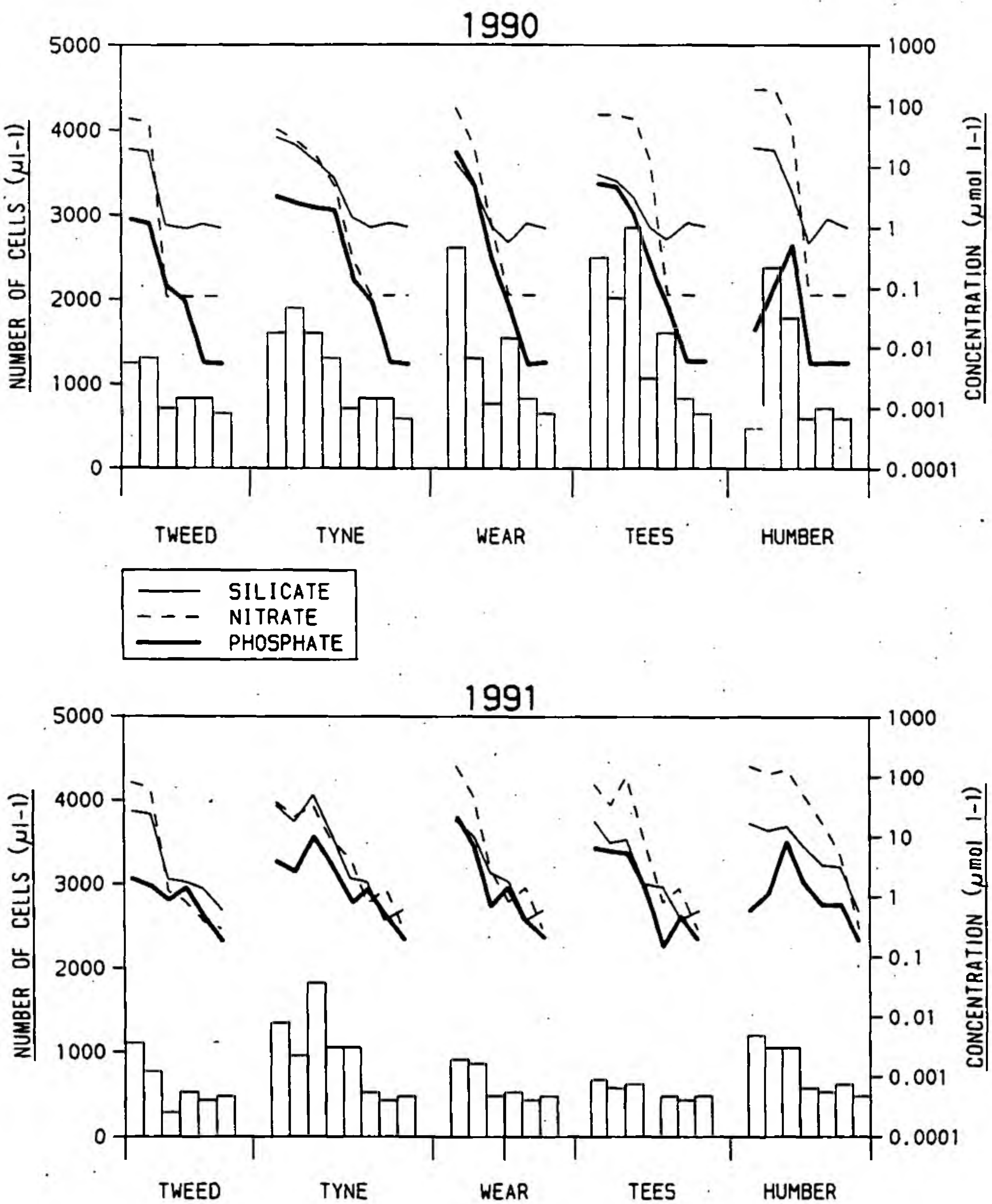

FIGURE 7:4B GROWTH OF *THALOSSIOSIRA PSEUDONANA* IN WATER SAMPLES TAKEN FROM FIVE ESTUARIES ON THE N.E. COAST OF ENGLAND

STAT124

SECTION 8
MATHEMATICAL MODELLING IN THE HUMBER ESTUARY

In order to improve conditions in the Estuary system, the results of changes in flow regime and discharge consents needs to be modelled, to ensure that any suggested changes are beneficial. Mathematical models can be used to predict the effect of such changes, and these are widely used by the NRA in setting discharge consents for factories and sewage works, and for assessing the impact of changes in flow.

The need for modelling of the Humber Estuary is particularly great due to the complex effects of tides on the dispersion of effluent plumes. The first mathematical model of the Humber was commissioned in the late 1970's by the Humber Estuary Committee, and has been in use since then. It is a one-dimensional model of the whole estuary and has been used mainly to model the effects of low dissolved oxygen levels in the Humber particularly around the Trent Falls area.

Modelling techniques have, however, advanced considerably since the first Humber Model, and the HEC decided in 1992 to commission a new mathematical model of the Humber system. The new model will be able to produce statistical outputs which can be compared to EQS standards, and also to take into account the effects of suspended solids on the oxygen concentration of the water, an important factor in the very silty Humber. The model will take two years to develop.

The model will be developed in two phases, a 'one-dimensional' model of the whole tidal river and estuary system, and a 'two dimensional' model of the estuary from Trent Falls. A one-dimensional model assumes that the river water and effluent are uniformly mixed across the whole width of the river, whereas a two-dimensional model can predict the differences in concentration of substances across the width of a river. The two-dimensional model is therefore important in the wide estuary, where an effluent plume from one bank may not spread across the estuary, and may be moved landward and seaward by the tide.

The first phase of the model will be completed in the summer of 1993, and the second phase in the spring of 1994.

SECTION 9
HUMBER CONFERENCE

In November 1992, the NRA and Humberside County Council sponsored a one-day conference in Hull, the aim of which was to bring together people interested in the Humber and its immediate environment.

There were presentations on many aspects of the management of the Humber, including Planning, Economic Development, Water Quality, Nature Conservation and future developments. Speakers were invited from a range of interested bodies, including the NRA, Humberside County Council, English Nature, the Marine Conservation Society, BP Chemicals and Anglian Water.

The Conference was well attended, with approximately 200 people present. It is hoped to have further short conferences in the future, covering varying aspects of the Humber Environment. The Proceedings of the Conference are available from NRA Northumbria and Yorkshire Region (The Humber Estuary:Conference Proceedings 5th November 1992)

SECTION 10
CONCLUSIONS

The most serious water quality issue for the Humber Estuary remains the low levels of dissolved oxygen in the upper Estuary and tidal Ouse in summer. A strategy is being implemented to reduce the input of organic pollution from the Aire and Don catchments, and from direct discharges to tidal waters, but it will be several years before these improvements are completed.

The first phase of works at Blackburn Meadows STW near Sheffield has produced an improvement in the quality of the River Don below Sheffield, and this will be further improved when the next phase is completed in 1995.

The environmental standards for trace metals and organic chemicals are generally met in the Humber and tidal rivers, and new pollution control measures will reduce levels further. There was a decrease in the amount of arsenic released to the estuary due to the closure of Capper Pass.

The Humber estuary continues to support a substantial invertebrate fauna and consequently a variety of fish species, and is of international importance for migratory birds. There is also a small but important breeding colony of seals at Donna Nook.

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GLOSSARY

Abstraction	Removal of water from surface water or groundwater, usually by pumping.
Abstraction Licence	Licence issued by the NRA under s.38 of the Water Resources Act 1991 to permit water to be abstracted.
Adsorption	The process by which one substance is taken up and held on the surface of a material, for example, metals in seaweeds.
Ammonia	A chemical found in water often as the result of 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.
Aquifer	A layer of underground porous rock which contains water and allows water to flow through it.
Asexual Reproduction	Breeding without mating, for example, by dividing into two or laying unfertilized eggs.
Benthic	Referring to life in or on the sea-floor.
Bioaccumulation	Mechanism whereby organisms concentrate substances, in their body tissues, which are present in dilute concentration in sea or freshwater.
Biochemical Oxygen Demand (BOD)	A standard test measuring the uptake of dissolved oxygen in water by the microbial decomposition of organic matter.
Bio-degradable	Capable of being broken down by bacteria into harmless substances such as carbon dioxide and water.
Catchment	The area of land that drains into a particular river system.
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.

Controlled Waters	Defined by the Water Resources Act 1991, Part III, Section 104. They include groundwaters, inland waters and estuaries.
Cumecs	Cubic Metres per Second. (1 cumec = 1000 litres per second.)
Culvert	For the purposes of this document a culvert is an enclosed watercourse.
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.
Deoxygenation	The removal of dissolved oxygen from water, often by the bacterial oxidation of organic matter such as sewage.
Dissolved Oxygen	The amount of oxygen dissolved in water, which is an indication of the 'health' of the water and its ability to support a balanced aquatic system. It is part of the system used to classify water quality.
Drins	Collective term to include the insecticides Dieldrin, Endrin, Aldrin and Isodrin, previously used in the textile industry. Total Drins are controlled under the List I Dangerous Substances Directive.
Environmental Quality Standard (EQS)	A specific concentration limit for a particular substance which affects a particular water use or objective.
Epibenthic	Referring to life living on or near the sea bottom.
Eutrophication	The increase in nutrients in a body of water, which may lead to extensive algal and weed growth, with undesirable consequences.
Faecal Bacteria	A group of bacteria found in faeces. (i.e. human body waste.)
High Shore	Shoreline nearest to land, covered only at high tide.
HMIP	Her Majesties Inspectorate of Pollution. The Government body responsible for pollution control.
Hydrocarbons	Compounds of carbon and hydrogen found in petroleum products. (Oil, for example)
Inter-tidal	Refers to the region of the shore that lies between the highest and lowest tides.
Invertebrate	Animal without a backbone.
Lindane	A form of the chemical 'hexachlorohexane' (HCH) used as a wood preservative and previously used in sheep dip. HCH is controlled under the List I Dangerous Substances Directive.

Low Shore Shoreline only uncovered at very low tides.

MAFF Ministry of Agriculture, Fisheries and Food.

Mathematical Water Quality Model
The representation, by equations, of the physical, chemical; and sometimes,biological; processes influencing water quality. When solved by computer these enable simulations to be made of the level of a particular quality parameter within the estuary; for example, dissolved oxygen; in response to relevant variables such as river flow, tidal state, effluent input and temperature.

mg/l Milligrams per Litre. (1\1000th of a gram per litre.)

Mid Shore Shoreline uncovered at low tide for short periods.

NRA National Rivers Authority.

NWC National Water Council.

Oligochaete Segmented worms related to the common earthworm.

Organic Complex A compound formed between, for example, a metal ion and an organic substance such as protein.

Plankton Microscopic drifting organisms in water, which can include the egg and larval stages of some species of fish.

Polychaete Segmented bristle worms of the class Polychaeta.

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

River Quality Objectives (RQO)
The level of water quality that a river should achieve in order to be suitable for its agreed uses. Salinity The extent to which salts are dissolved in water.

Shoal Shallow stretch of water.

Site of Special Scientific Interest. (SSSI)
A site given a statutory designation by English Nature or the Countryside Council for Wales because it is particularly important, as a result of its conservation value.

Statutory Water Quality Objectives. (SWQO)
Water quality objectives set by the Secretaries of State in relation to controlled waters.

STW Sewage Treatment Works.

Sub-tidal	The area which lies below the low water mark which is continuously covered by water.
Supersaturated	The situation when the apparent concentration of oxygen dissolved in water exceeds the saturation value, due to the evolution of oxygen within the water by photosynthesis.
Suspended Solids	Solid matter in a water sample which is retained by filtration under specified conditions.
Tidal Range	The difference between high and low water levels.
ug/l	Microgrammes per litre. (One millionth of a gram per litre.)

APPENDIX A
TERMS OF REFERENCE AND OBJECTIVES OF THE HUMBER ESTUARY COMMITTEE

Humber Committee terms of reference

To advise the constituent National Rivers Authority Regions and other bodies on matters appertaining to their functions relating to the restoration and maintenance of the wholesomeness of the rivers and other waters in the Humber Estuary, and to act as a co-ordinating link between constituent Regions on matters relating to the management of the estuary with particular reference to the objectives laid down for the committee.

Humber Committee objectives

To consider matters concerned with the control, management and use of the Humber estuary of relevance to the constituent National Rivers Authority Regions, and in particular:-

(1) to restore and maintain the wholesomeness of water in the estuary and to reduce pollution. In particular to restore the wholesomeness of all tributaries and their tidal reaches and to control areas of local pollution east of the Humber Bridge;

(2) to consider the quality and quantity of the residual flows to the estuary which it is desirable to maintain at the various tidal limits under varying conditions and at different times of the year;

(3) to undertake a programme to survey and monitor flows and quality conditions in the estuary;

(4) to monitor and assess the effects of toxic materials carried from the Humber Estuary to the North Sea;

(5) to maintain, improve and develop the indigenous fisheries in the estuary and to allow the passage of migratory fish by improving the quality conditions in the estuary;

(6) to initiate, co-ordinate and undertake appropriate research on the Humber Tidal System;

(7) to further conservation, in accordance with section 8 of the Water Act 1989, of the flora and fauna, and the geographical physiographical and archaeological features of special interest in, and adjacent to, the estuary;

(8) to advise on matters in and adjacent to the estuary, such as flood defence, amenity and future development, where these impact on water quality management.

APPENDIX B

Environmental Quality Standards

(Annual average in ug/l except where stated)

DETERMINAND	TIDAL RIVERS	ESTUARY	COMMENT
Temperature	25°C	25°C	95 percentile
Dissolved oxygen	40% saturation	55% saturation	5 percentile
pH	5.5 - 9.0	6.0 - 8.5	95 percentile
Ammonia	0.021 (mg/l)	0.021 (mg/l)	Unionised 95%ile
Mercury	1 total	0.3 dissolved	(1)
Cadmium	5 total	2.5 dissolved	(1)
Arsenic	50 dissolved	25 dissolved	(3)
Chromium (III+VI)	250 dissolved	15 dissolved	(3)
Copper (II)	28 dissolved	5.0 dissolved	(2)(3)
Lead	250 dissolved	25 dissolved	(3)
Nickel	200 dissolved	30 dissolved	(3)
Zinc	500 total	40 dissolved	(3)
Iron	1000 dissolved	1000 dissolved	(3)
HCH	0.1 total	0.02 total	(1)
DDT (all isomers)	0.025 total	0.025 total	(1)
DDT (pp isomer)	0.01 total	0.01 total	(1)
CCl_4	12 total	12 total	(1)
PCP	2 total	2 total	(1)
TOTAL DRINS	0.03	0.03	Annual means of all Drins added together (max 0.005 endrin)

(1) Mandatory - Statutory Quality Objective laid down in the 1989 regulations (SI 2286)

(2) Higher values acceptable where acclimation expected or substance present in organic complexes.

(3) National List II Environmental Quality Standard

Notes:

(a) Standards for most of the metals in freshwater vary according to the water hardness. However, since the average hardness of the tidal rivers varies only between 290 and 350 mg/l, standards have been defined in relation to a hardness of 300mg/l.

(b) No standard has been set for suspended solids in the water column. Local control may be necessary to avoid excessive accumulation of sediment or the deposition of sewage solids.

EC DANGEROUS SUBSTANCES DIRECTIVE LIST 1 AND LIST 2

LIST 1 (BLACK LIST)

Mercury
Cadmium
Hexachlorocyclohexane (HCH)
DDT
Pentachlorophenol (PCP)
Carbon Tetrachloride
Aldrin
Dieldrin
Endrin
Isodrin
Hexachlorobenzene (HCB)
Chloroform
Trichloroethylene (TRI)
Tetrachloroethylene (PER)
Trichlorobenzene (TCB)

LIST 2 (GREY LIST)

1,2-Dichloroethane (EDC)
Lead
Chromium
Zinc
Copper
Nickel
Arsenic
Boron
Iron
pH
Vanadium
Tributyltin
Triphenyltin
PCSDs
Cyfluthrin
Sulcofuron
Flucofuron
Permethrin

APPENDIX C
NWC 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 relevant species of migratory fish, when this is not prevented by physical barriers.	2
b)	Supports a residential 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 which receive inputs which cause a certain amount of pollution but do not seriously interfere with estuary usage.	6
c)	Estuaries or zones of estuaries which receive inputs which result in aesthetic pollution sufficiently serious to affect estuary usage.	3
d)	Estuaries or zones of estuaries which receive inputs which cause widespread public nuisance.	0
Water Quality (Score according to quality)		
Dissolved Oxygen exceeds the following saturation values:		
	60%	10
	40%	6
	30%	5
	20%	4
	10%	3
	below 10%	0

The points awarded under each of the headings of biological, aesthetic and water quality are summed. Waters are classified on the following scales.

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

APPENDIX C

NWC RIVER QUALITY CLASSIFICATION SCHEME

RIVER CLASS	QUALITY CRITERIA	REMARKS	CURRENT POTENTIAL USES
1a Good Quality	1. 5 percentile Dissolved Oxygen Saturation greater than 80%. 2. 95 percentile Biochemical Oxygen Demand not greater than 3 mg/l. 3. 95 percentile Ammonia not greater than 0.4 mg/l. 4. Where the water is abstracted for drinking water, it complies with requirements for A2*. 5. Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures are unavailable).	1. Mean Biochemical Oxygen Demand probably not greater than 1.5 mg/l No visible evidence of pollution.	1. Water of high quality suitable for potable supply abstractions. 2. Game or other high quality fisheries. 3. High amenity value.
1b Good Quality	1. 5 percentile Dissolved Oxygen Saturation greater than 60%. 2. 95 percentile Biochemical Oxygen Demand not greater than 5 mg/l. 3. 95 percentile Ammonia not greater than 0.9 mg/l. 4. Where water is abstracted for drinking water it complies with the requirements for A2*. 5. Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures are unavailable).	1. Mean Biochemical Oxygen Demand probably not greater than 2 mg/l. 2. Mean Ammonia probably not greater than 0.5mg/l. 3. No visible evidence of pollution. 4. Water of high quality which cannot be placed in Class 1a because of the effect of physical factors such as canalisation, low gradient or eutrophication.	Water of less high quality than Class 1a but usable for substantially the same purposes.
2 Fair Quality	1. 5 percentile Dissolved Oxygen Saturation greater than 40%. 2. 95 percentile Biochemical Oxygen Demand not greater than 9 mg/l. 3. Where water is abstracted for drinking water it complies with the requirements for A3*. 4. Non toxic to fish in EIFAC terms (or best estimates if EIFAC figures are unavailable).	1. Mean Biochemical Oxygen Demand probably not greater than 5 mg/l. 2. Water showing no physical signs of pollution other than humic colouration and a little foaming below weirs.	1. Waters suitable for potable supply after advanced treatment. 2. Supporting reasonably good coarse fisheries. 3. Moderate amenity value.
3 Poor Quality	1. 5 percentile Dissolved Oxygen Saturation greater than 10%. 2. 95 percentile Biochemical Oxygen Demand not greater than 17 mg/l. This may not apply if there is a high degree of re-aeration.		Waters which are polluted to an extent that fish are absent or only sporadically present. May be used for a low grade abstraction for industry. Considerable potential for further use if cleaned up.
4 Bad Quality	Waters which are inferior to Class 3 in terms of Dissolved Oxygen and likely to be anaerobic at times.		Waters which are grossly polluted and are likely to cause nuisance.
X	DO greater than 10% saturation.		Insignificant watercourses and ditches which are not usable, where the object is simply to prevent nuisance.

APPENDIX D

NUMBERS PER SAMPLE OF INVERTEBRATE GROUPS FOUND IN TIDAL RIVERS IN 1992

GROUP	AIRE	DON	WHARFE	HULL	HULL	OUSE	OUSE	OUSE	TRENT
	Snaith	Thorne Bridge	Ryther	Beverley	Sutton Road Bridge	Cawood	Drax	Saltmarshe	Gainsboro'
MOLLUSCS			46	10					
OLIGOCHAETE WORMS	6128	345	15	602	2122	10	1	4	
POLYCHAETE WORMS				8					
LEECHES		2	11	2					
CRUSTACEA	9	67	>1012	239	374	153		6	
MAYFLIES			1						
BEETLES			3	2					
CADDIS FLIES			1						
TRUE FLIES						4			
MIDGES	2	1	35	34	2				
NUMBER OF B M W P FAMILIES	3	4	12	6	3	4	1	2	
BMWP SCORE	6	13	52	18	9	14	1	7	
ASPT	2.00	3.25	4.33	3.00	3.00	3.50	1.00	3.50	
BIOLOGICAL CLASS	B 3	B 3	B 2	B 3	B 3	B 3	B 4	B 3	

APPENDIX E

RESULTS OF HUMBER FISH SURVEY 1992 (BOAT SURVEY) (Numbers/1000m)

SPECIES	SITE AND NUMBERS PER 1000m																				
	WHITTO	READS ISLAND	HUMBER BRIDGE	HESSLE	SKITTER	PAULL	HALTON FLAT	BURCOM SHOAL A	BURCOM SHOAL B	HAWKIN POINT A	HAWKIN POINT B	MIDDLE A	MIDDLE B	CLEES NESS A	CLEE NESS B	BULL FORT A	BULL FORT B	SPURN	HAILE SAND A	HAILE SAND B	HAILE SAND C
Pogge											1.1									1	
Sand Eel																			25.2	1	
Lesser Weevil																			3.9		
Cod																					0.9
Dab									2.2	1.1		1.2					1.3			4.1	1.8
Sea Snail									1.11		3.3			3.7	1.1						
Whiting	9.2	16	3.5	6.7		1.9	5.7		2.2	6.4		7.2	3.3	9.2	4.6	25.2	5			38	31.1
Flounder		5.3				2.9			1.1											3.1	
Plaice						1		1.8	6.6				1.1	14.7	10.2				10.7	222.8	
Sand Goby.	1.3	9.6		2	3.3	1.9	1.1		3.3	1.1		4.8	4.4	45.8	4.5	26.3	23.8		14.5	3.1	1.8
Dover Sole						2.9	1.1		37.6	5.4				60.4	13.5	1.1			1	89.3	6.4
Nilson's Pipefish																			3.9	2.1	
Gobies Unknown																				2.1	
NUMBER OF SPECIES	2	3	1	2	1	5	3	1	7	4	2	3	3	5	5	3	3	0	6	10	5
ABUNDANCE	10.5	29.9	3.5	8.7	3.3	10.6	7.9	1.8	54.1	14	4.4	13.2	8.8	133.8	33.8	52.6	30.1	0	59.2	366.6	42

APPENDIX E											
RESULTS OF HUMBER FISH SURVEY 1992 (PUSH NET) (Numbers/1000m)											
		SITE AND NUMBERS PER 1000m									
		CLEETHORPES						SPURN POINT			
SPECIES		1989	1990	1991	1992			1989	1990	1991	1992
Sand Eel				1	1.1					1.9	5.7
Herring				2.9	1				1	1	
Lesser Weever					1.9						2.9
Dab					1				1		
Whiting					1						
Flounder					1						
Plaice		111	250	33.3	99			22	41	34.3	46.7
Sand Goby		8	168	82.9	108.6				3	2.9	4.8
Common Goby			5	1	48.6						
Painted Goby		1									
Turbot			1	2.9				9	18	11.4	3.8
Brill					1.9					3.8	1
Dover Sole											1.9
Sprat				1.9							
Nilson's Pipefish		2	4	1	10.5						
Weaver				1.9						1.9	
NUMBER OF SPECIES		4	5	8	11			2	6	7	7
ABUNDANCE		122	428	129	276			31	65	57	66