Sea Vigil Water Quality Monitoring

The Humber Estuary : 1994

National Rivers Authority
Anglian Region - Marine Section
Peterborough

NRA
Anglian Region

February, 1996

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ACKNOWLEDGEMENTS.

Thanks are due to the crew of *Sea Vigil*, for their efforts in carrying out the survey work:
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Contents

EXECUTIVE SUMMARY

The NRA has an obligation to monitor and safeguard the coastal waters of England and Wales out to a designated 3 nautical mile limit. To meet this obligation, Anglian Region uses a purpose-designed coastal survey vessel, *Sea Vigil*, purchased in 1991.

Data from surveys carried out within the Humber Estuary during 1994 are reported here. Their purpose was to gain information on the nutrient levels within one of the major estuaries in the U.K.

During 1992 and 1993, *Sea Vigil* was involved in sampling for the MAFF/DoE JoNuS Project. From 1994, the NERC-funded LOIS Project was the major focus in the Humber Estuary with *Sea Vigil* involved in the sampling programme but not collecting independent nutrient data. With *Sea Vigil* being based at Hull Marina during Humber Estuary survey programmes, the opportunity was taken to collect nutrient samples on other occasions, usually collecting surface samples at 11 sites between Hull and Haile Sand at the Estuary mouth.

Samples were analysed on-board *Sea Vigil* for nitrate, ammonia, phosphate, silicate and nitrite, although the closure of the Anglian Region laboratory at the end of 1993 caused a disruption in operations. Field data were also collected.

The Humber is a very turbid estuary with a strong tidal action, making it most unlikely that high levels of planktonic activity could occur and lead to events such as algal blooms. The main concern is likely to be how much nutrient load is exported to the North Sea, with the possible consequence of affecting the Lincolnshire Coast and the Wash.

Nitrate and Phosphate concentrations only decreased slightly between Winter and Summer, whilst Silicate levels dropped by around 60% in the summer, suggesting that the only significant algal activity in the Humber Estuary is consistent with diatoms.

There are five High Natural Dispersion Areas in the Humber Estuary, four of them within Anglian Region. Most of the data collected was within the associated 10 km zones.

A limited monitoring programme continued until 1995. A review of all Regional coastal nutrient data would then be carried out, in order to define an appropriate monitoring programme, in line with the NRA's newly issued National Marine Monitoring Strategy.

HUMBER ESTUARY

WATER COLUMN SURVEYS

SEA VIGIL, 1994.

BACKGROUND.

Following its formation in September, 1989, the National Rivers Authority has had an obligation to monitor and safeguard the coastal waters of England and Wales out to a designated 3 nautical mile limit. This responsibility was defined differently for the previous Water Authorities. Consequently, there was very little data collected for coastal water sites between the Humber and the Thames, the area covered by the Anglian Region of the NRA.

The Coastal Survey Vessel of the Anglian Region of the NRA, *Sea Vigil*, has been collecting nutrient information from along the Anglian Coast since March 1992, using an on-board autoanalyser, permitting immediate analysis. Analytical techniques have been developed to measure the low levels of nutrients encountered in outer estuaries and coastal waters. This report is a summary of sampling carried out within the Humber Estuary during 1994. The data from surveys during 1992-1993 were reported previously. Separate reports over the *Wash*, the *Lincolnshire Coast* and the *East Coast* (outer Wash to outer Thames).

Geographically, all of the Humber Estuary is within the defined 3-mile limit. However, it is clear from a number of sources that the influence of the Humber extends well outside the 3-mile limit. In the future, it may be necessary to sample further offshore, since there is evidence that the Humber plume returns inshore, hitting the south Lincolnshire Coast around the Skegness area.

The Humber Estuary Committee (HEC) has a substantial programme of monitoring throughout the Humber Estuary and produces an annual report on the data. There have also been two long term reviews produced (1961-1980 and 1981-1990). However, the majority of the water column monitoring is shoreline based. Within the Anglian part of the Estuary, no routine monitoring is carried out for all nutrients at these sites.

The JoNuS Project (Joint Nutrient Study) focused on the Humber in 1992 and 1993. The NRA provided *Sea Vigil* to assist MAFF with extensive nutrient data collection within the Estuary. This JoNuS data was reported in the 1992-1993 report. The LOIS Project (Land Ocean Interaction Study) has since targeted the Humber Estuary, again with assistance from the NRA. The Project commenced in 1993 and uses airborne surveillance in addition to water sampling. During LOIS surveys, however, the NRA did not collect or measure its own nutrient data, although data collected by LOIS scientists is available to the NRA. As a consequence, the only data collected by *Sea Vigil* from the Humber Estuary is of an opportunistic nature.

As there is a lack of historical nutrient data, it is not yet possible to make comparisons and provide explanations. A continuing programme of nutrient monitoring was planned until 1995, in order to overcome these deficiencies. An overall report will be produced early in 1996, with the aim of putting the 1992-1995 data into geographic and historical perspective.

Description of the Humber Estuary Area.

The Humber is an estuary extending for 62 km from the confluence of the Yorkshire Ouse and Trent river systems at Trent Falls to its mouth between Spurn Head on the North Bank and Donna Nook on the South Bank. It possesses the largest catchment of any UK estuary, covering an area of 24,240 km^2, a fifth of the area of England.

As the largest contributor of freshwater from the UK to the North Sea, the Humber has a special importance with regard to its quality. Much of the county's coal output, electricity generating capacity and manufacturing industry is concentrated within this catchment. Some 11 million people live within the catchment and on the banks of the Humber. Unlike many other UK estuaries, most of the population lives in inland cities, such as Birmingham, Leeds, Sheffield, Bradford, Leicester and Nottingham, and not in its immediate vicinity.

The Humber is a valuable resource for the community in terms of fisheries and wildlife. Its immediate environs are predominantly rural with localised industrial areas. Two oil refineries, several chemical manufacturers and the ports of Grimsby, Hull and Immingham are all located along its banks. The Estuary is one of the UK's largest shipping complexes, handling both cargo and passengers. Additionally, there are vast areas of intertidal mudflats and sandbanks within the estuary, supporting large populations of overwintering wildfowl and waders, and are of international importance to eight bird species. As a consequence, a large majority of these areas have been designated as Sites of Special Scientific Interest (SSSI's) and Nature Reserves. The recreational use of the Humber is underdeveloped in comparison to other British estuaries. Sea angling, wildfowling and other forms of outdoor recreation have been inhibited by problems of access and restricted provision of basic facilities, such as car parking. Cleethorpes is the only traditional seaside holiday resort within the Humber area, with a sandy bathing beach and associated tourist amenities. It has a designated EC Bathing Water. Some sailing also occurs on the estuary, although conditions are not ideal. The outer Humber supports a fin fishery and a shell fishery, although the fishing industry located in this area has declined during the second half of this century. The estuary remains important to North Sea fisheries because it is a nursery ground for flatfish.

Under the DoE's revised definition of coastal waters, as applied for the Urban Waste Water Treatment Directive (UWWTD), the Humber Estuary downstream of the Humber Bridge was classified as coastal water, as opposed to estuary. This meant that 4 Anglian Region sewage discharges in the Humber Estuary were made candidate HNDA discharges, in addition to Hull, which is controlled by the adjacent Yorkshire Region. These discharges are Winteringham, Barton on Humber, Immingham and Pyewipe (Grimsby) and are marked in Figure 1a.

The Humber is a highly energetic estuary with a characteristic turbid, swirling appearance and a tidal range only exceeded in Britain by the west coasts of England. The tidal excursion of the Humber is several times greater than the displacement of seawater by freshwater input during the tidal cycle. This asymmetric tidal flow results in an extended residence period of effluents discharged to the estuary whilst they are progressively diluted and edged towards the North Sea. The main inputs of polluting load to the Humber are from the freshwater rivers, which carry high effluent loads from Yorkshire and the industrial Midlands, as well as the direct discharges of sewage, particularly from Hull and Grimsby, and industrial effluents. There is a high level of nutrients within the Humber system, derived from these sewage and industrial sources. In 1993, the Humber was responsible for around one fifth of the UK's nitrogen and phosphorus inputs to the North Sea. However, there are currently no EQS values (Environmental Quality Standard) stipulated for nutrients within the Estuary.

Bathymetry

The Humber Estuary is of classic shape, being about 8km wide at its mouth, narrowing to less than 500 metres in the Ouse and Trent. The maximum tidal range is 7m, which is only exceeded by the Bristol Channel within Britain. Current velocities can reach 11 km/hour (6.8 knots) at Spring tides.

Whilst the sea is relatively shallow at the mouth along the southern side, there is a clearly defined deep water channel throughout the Estuary, although it does require dredging. The maximum charted depth is around 25m at the mouth, with the channel depth being less than 10m up as far as Hull and less than 5m above Hull. The channel shape changes regularly, especially above the Humber Bridge.

It is the combination of these particular features that gives rise to complex tidal patterns and mixing of river water with estuary water. This is apparent from the results of these nutrient surveys.

Objectives.

The purpose of the 1994 surveys was to extend knowledge on nutrient levels and their variation throughout the coastal waters of the Anglia Region, particularly on a seasonal basis, building on the 1992-1993 data set. The EC Urban Waste Water Treatment and Nitrate Directives require information on nutrients, chlorophyll and water quality.

Although Anglian Region currently does not have any coastal areas designated as "Sensitive Areas [Eutrophic]" under the UWWTD, this work will provide data for any necessary reassessment.

Following on from the JoNuS Project, valuable information could be collected on nutrient loads being discharged to the North Sea from the UK's largest contributor. The data can also help to assess the relevance of PARCOM load calculations, which by necessity, are measured well upstream at the freshwater limits of the tributary estuaries.

Whilst no samples were collected during LOIS surveys, "opportunistic" sampling was undertaken at appropriate times when *Sea Vigil* was travelling to its Humber Estuary base at Hull Marina.

The intention has been to collect data from all the coastal waters of the Anglian Region and produce a series of reports.

Work Programme Details.

The intention of nutrient sampling in the Humber Estuary was to collect data that would produce a regression profile against salinity. There were 11 sites sampled between Hull Marina and Haile Sand at the mouth, with sites above Hull occasionally sampled. There were a few more extensive surveys undertaken, with additional sites. It is more effective for *Sea Vigil* to travel with the tide than against it and so surveys usually took place under a similar tidal state for a particular direction.

The sample sites were defined at regular intervals on either side of the main channel, pilotage buoys being used as site markers. Some surveys were more intensive than others and different surveys would use a different set of sample points.

Previous data collected during 1992-1993 for the JoNuS Project demonstrated the complexity of the unmixed water masses in the Humber Estuary. Experiments were therefore made in carrying out transects across the Humber at a number of locations, in order to provide a clearer picture.

Water was collected from the surface layer of the sea, at pre-defined sites, shown in Figure 1a, with site details in Table 1. Not all sites were sampled on each survey. Transects are shown in Figure 1b. Field data was collected at the same time, including temperature, salinity and dissolved oxygen. Samples were immediately filtered and then put through the autoanalyser. The methods employed contained built-in Analytical Quality Control procedures and have satisfactorily passed special marine AQC exercises, particularly the stringent ones prepared for International Council for the Exploration of the Seas (ICES) exercises. Results were then sent to Peterborough for entering onto the laboratory database.

During 1992 and 1993, the Anglian Region operated its own analytical laboratory. This was closed at the end of 1993. During 1994, there was no Marine Chemist available within the Region to control the nutrient analysis on-board *Sea Vigil*. Sometimes it was possible to borrow or hire a chemist from other NRA laboratories. Otherwise, samples had to be frozen and sent to an NRA laboratory (Fobney Mead, Llanelli or Nottingham).

Due to the high turbidity of the Humber Estuary, it was not felt necessary to sample for chlorophyll.

Presentation of Results.

The nutrient data reported here are from water column samples, filtered after collection through 0.45µm membrane filters and are therefore termed "dissolved nutrients". The nutrients are: nitrate, reactive phosphate, silicate, ammonia and nitrite. All results are

in microgrammes per litre ($\mu g.l^{-1}$) and are given, by site, in Tables 4 to 13. Available field data are also given.

In this summary, the term nitrate is used in preference to Total Oxidised Nitrogen (TON). There is an analytical distinction, TON being the summation of nitrate and nitrite results. Since the levels of nitrate are generally vastly higher than those of nitrite, the distinction does not significantly influence the data interpretation.

The data is presented as a series of graphs, by survey (i.e. date). Table 3 lists the figure and table numbers. For each survey there is:

- Table of Data;
- Chart of Nutrient data against Salinity;
- Chart of Dissolved Oxygen data against Salinity.

It is traditional to represent estuary data as a regression against salinity for two reasons. Firstly, it will clearly show the pattern of dilution of river water with sea water, which, in a simple estuary with the river at the head (and no other inputs) would show a straight line of negative gradient for conservative parameters. A complex estuary like the Humber will have additional peaks and troughs due to other inputs or changes in parameter behaviour, e.g. remobilisation of phosphate from sediments. The second reason is that by definition, the water in an estuary moves upstream as well as downstream. If the variability of any parameter is known in relation to salinity throughout the estuary, then a knowledge of the salinity regime at any point will be enough to deduce the necessary parameter values.

To date, no allowance has been made for the variability in tidal state, nor an estimate of how critical it is to the interpretation of the data. This will require tidal cycle studies, at a variety of sites throughout the Estuary.

General Comments.

Nutrient, plankton and chlorophyll concentrations follow a seasonal pattern. During winter, there is negligible planktonic activity due to low light irradiance, with the majority of old biomass being regenerated into dissolved nutrients. Hence maximum nutrient concentrations are found in late Winter (January-February)

Spring is the period for fastest planktonic growth and nutrient uptake. Consequently, chlorophyll concentrations are expected to be at their highest concentrations within the water column. This usually commences in Anglian Region in early March, through to May.

Mid-summer is the period when dissolved nutrients first reach minimum concentrations within the water column, having been consumed by the phytoplankton. The reason this does not coincide with high chlorophyll concentrations is because of grazing of phytoplankton by zooplankton.

The nutrient levels are relatively high within the Humber Estuary, partly because it is an estuary as opposed to coastal water and also because of significant effluent inputs in the lower estuary.

Nitrate is normally the most abundant of the nutrients. Nitrite is at low concentrations and rapidly oxidised to nitrate but can provide valuable information for nutrient processes.

The surveys provide information in two forms:

1) Variations in spatial distribution of nutrient concentrations;

2) Variations in seasonal distribution of nutrient concentrations.

There are a number of factors to be borne in mind when considering the data:

- there are major fresh water nutrient inputs to the Humber Estuary, via the Trent and Ouse river systems;
- there are other less significant fresh water inputs via the Hull and Ancholme rivers;
- there are large sewage outfalls discharging to the Estuary at Hull, Immingham, Grimsby and Cleethorpes; Grimsby has a long outfall reaching to the deep water channel;
- there are designated HNDA's at Hull, Winteringham, Barton, Hull, Immingham and Grimsby (Pyewipe);
- there are numerous industrial discharges to the Estuary, particularly from the South Bank between Immingham and Grimsby; of these, Hydro Fertilisers, SCM Chemicals and Tioxide UK have locally significant nutrient loads;
- the fast tidal currents and large tidal range should ensure good mixing;
- high turbidity and strong tides usually inhibit photosynthetic activity, although the strong tides may create enough water turnover for sufficient light energy to be absorbed to facilitate a normal level of photosynthetic activity;
- the deposition and resuspension of sedimentary material will influence the budgets of the dissolved nutrients;
- in the middle estuary, the salinity range is great; at Blacktoft the extremes can vary between 0 and 20‰ during the year;
- the variable salinities will lead to a biological species diversity throughout the estuary;
- soluble nutrients are part of a very complex chemical equilibrium, involving phytoplankton, zooplankton and sediments.
- the salinity of an estuary would be expected to range from less than 1‰ at low water at the freshwater end to close to 35‰ at high water at the seaward end;

Further information is available from the annual HEC reports and the recent report 'The Quality of the Humber Estuary, 1980-1990' (NRA Water Quality Series No. 12).

JANUARY, 1994 SURVEYS.

There were 2 surveys carried out, one of the Middle Estuary between Lower Burcom and Chowder Ness, with results for 16 sites given in Table 4 and data presented in Figures 2 and 2a. The other was of the Lower Estuary from Hull Marina to Haile Sand with results for 11 sites given in Table 5 and data presented in Figures 3 and 3a.

FEBRUARY, 1994 SURVEY.

Results are given in Table 6 with nutrient data presented in Figure 4, with 11 sites sampled from Haile Sand to Hull Marina. No dissolved oxygen data were collected.

MARCH, 1994 SURVEYS.

There were 2 surveys carried out, one of the full Estuary between Blacktoft and Spurn, with results for 33 sites given in Table 7 and data presented in Figures 5 and 5a. The other was of the Lower Estuary from Hull Marina to Haile Sand with results for 11 sites given in Table 8 and data presented in Figures 6 and 6a.

APRIL, 1994 SURVEY.

Results are given in Table 9 with data presented in Figure 7 and 7a, with 11 sites sampled from Haile Sand to Hull Marina.

MAY, 1994 SURVEY.

Results are given in Table 10 with data presented in Figure 8 and 8a, with 33 sites sampled from Blacktoft to Spurn.

AUGUST, 1994 SURVEYS.

There were 2 surveys carried out, one of the full Estuary between Blacktoft and Spurn, with results for 33 sites given in Table 11 and data presented in Figures 9 and 9a. The other was of the Lower Estuary from Hull Marina to Haile Sand with results for 11 sites given in Table 12 and data presented in Figures 10 and 10a.

DECEMBER, 1994 SURVEY.

Results are given in Table 13 with data presented in Figure 11 and 11a, with 28 sites on 14 transects sampled from Barrow Haven to Haile Sand. A map of sample locations is given in Figure 1b.

Electronic Data Collection.

On-board electronic sensors and towed arrays have been used to measure temperature, dissolved oxygen, salinity, turbidity, pH and chlorophyll in the Humber estuary, either on longitudinal profiles or cross-estuary transects. The longitudinal profiles, taking recordings every 10 seconds, collected data at about 40m intervals, whilst the transects had intervals of 2 seconds and about 5m respectively. Examples of these data are presented in Figures 12a to 12d for salinity, dissolved oxygen, temperature and turbidity.

However, additional work is still required to confirm the values of this data as well as the validity of the techniques.

Data show trends rather than absolute values.

Conclusions.

- It is clear that on a local basis, the Humber is not well mixed horizontally, across the Estuary. This is accentuated in the sampling programme which, by design, does not consistently sample from the main deep water channel. To do so, would lose data on this important aspect. In order to obtain a fuller picture of nutrient behaviour within the Humber system, horizontal profiles across the estuary are required.
- The data presented reflects the known inputs of nutrients throughout the Estuary, which include riverine, industrial and sewage effluents.
- Ammonia concentrations occasionally rose at the seaward end, whilst other nutrients decreased; this was less emphasized than for data collected during 1992-93.
- Unlike data for 1992-93, profiles did not contain spikes of increased phosphate concentration.
- The maximum salinity of the Estuary as measured was always less than that of full seawater (nominally 35‰). At Spurn Head, maximum measured salinity was mostly in the range of 27‰ to 30‰, reaching 33‰ in August.
- Surveys that only went upstream as far as Hull (the NRA "opportunistic" surveys) measured the salinity minimum about 8‰ in winter, rising to around 16‰ in Spring and 23‰ in August.
- Surveys that covered the anticipated full length of the estuary up to Trent Falls at Apex or the Ouse at Blacktoft, did not reach freshwater salinities in the summer months, the minimum exceeding 5‰.
- The tidal state did not affect the nutrient-salinity profiles, although the minimum and maximum salinities were not always sampled. The largest changes were either seasonal or as a result of possible inputs.

- Whilst there was only a small drop in Phosphate and Nitrate concentrations between Winter and Summer, Silicate concentrations fell by about 60% for the same period, suggesting that the only significant algal activity in the Humber Estuary is consistent with diatoms.
- There are a number of NRA sampling sites within each of the HNDA's. This should be helpful when the NRA has to make any judgements.

Future Years.

The programme of monthly surveys in the Humber for LOIS is planned to continue but with no NRA nutrient sampling taking place. Opportunistic sampling will also continue during the Regional Work Programme, although the number of sites and their location will be reviewed.

There is a large amount of data collected electronically, only some of which has been worked up. These will be reported on in due course. They consist of profiles of the Humber Estuary from minimum to maximum salinity as well as transects across the Humber at a number of locations. This includes the fluorescence determination of chlorophyll and turbidity.

It may be necessary to sample further out than Spurn Head, even outside the three mile limit, in order to gain full information on the influence of the Humber Estuary on the coastal zone and the waters of the Lincolnshire Coast.

It is also hoped to investigate further the levels of phytoplankton, zooplankton, chlorophyll and turbidity.

Future work should lead to an assessment of the influence of the Humber Estuary on the localised coastal waters.

This report is one of a series covering the coastal waters of the Anglian Region of the NRA. The other reports are for the *Lincolnshire Coast*, the *Wash* and the *East Coast* (Norfolk, Suffolk & Essex). Further reports on Humber Estuary water quality data will be produced on an annual basis.

An overall report will be produced early in 1996, with the aim of putting the 1992-1995 data into geographical and historical perspective and comparing the Humber Estuary with results from other estuaries. It will also permit a reassessment of the Coastal Monitoring Programme, in line with the NRA's National Marine Monitoring Strategy.

NRA - Anglian Region

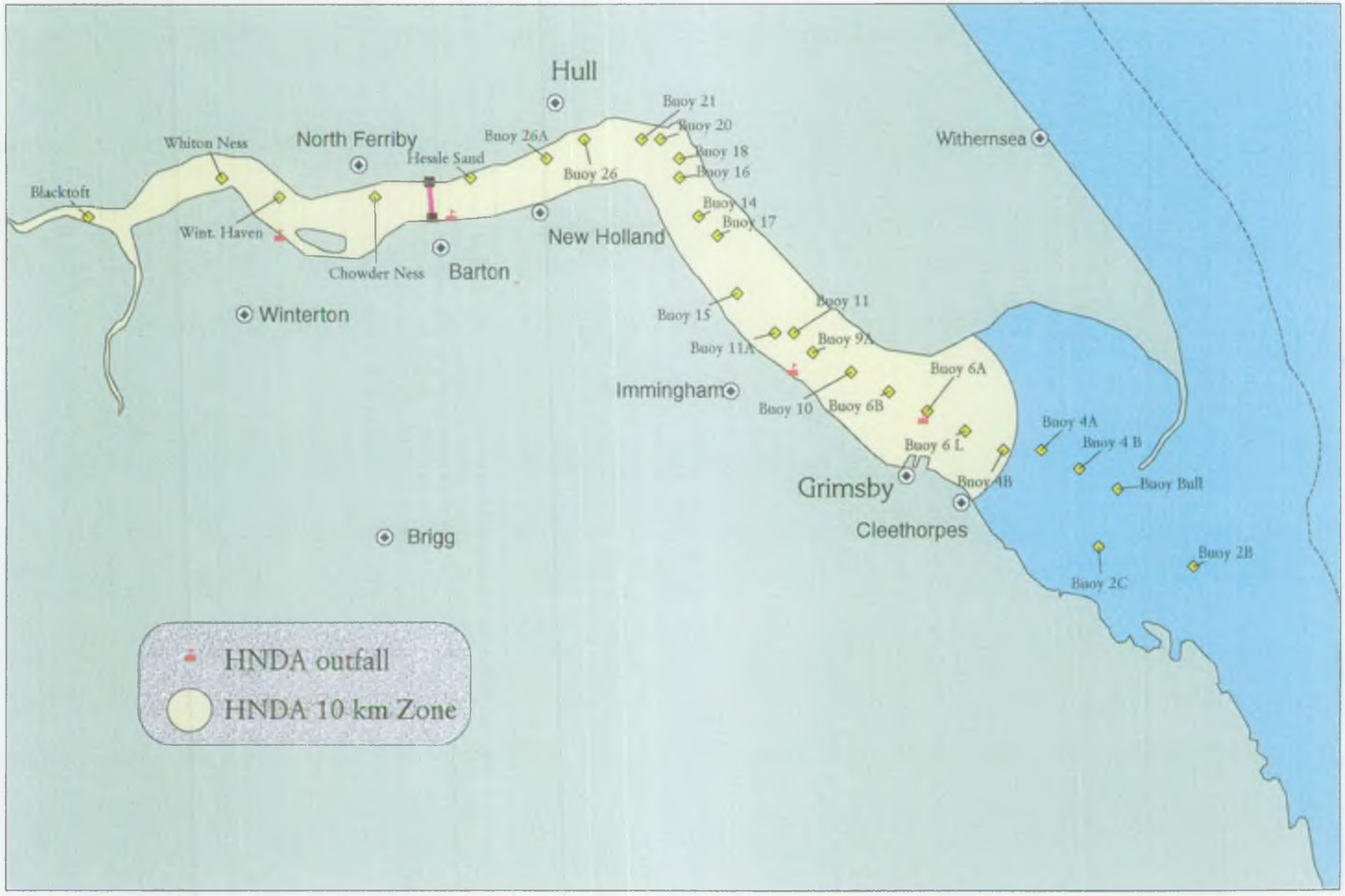
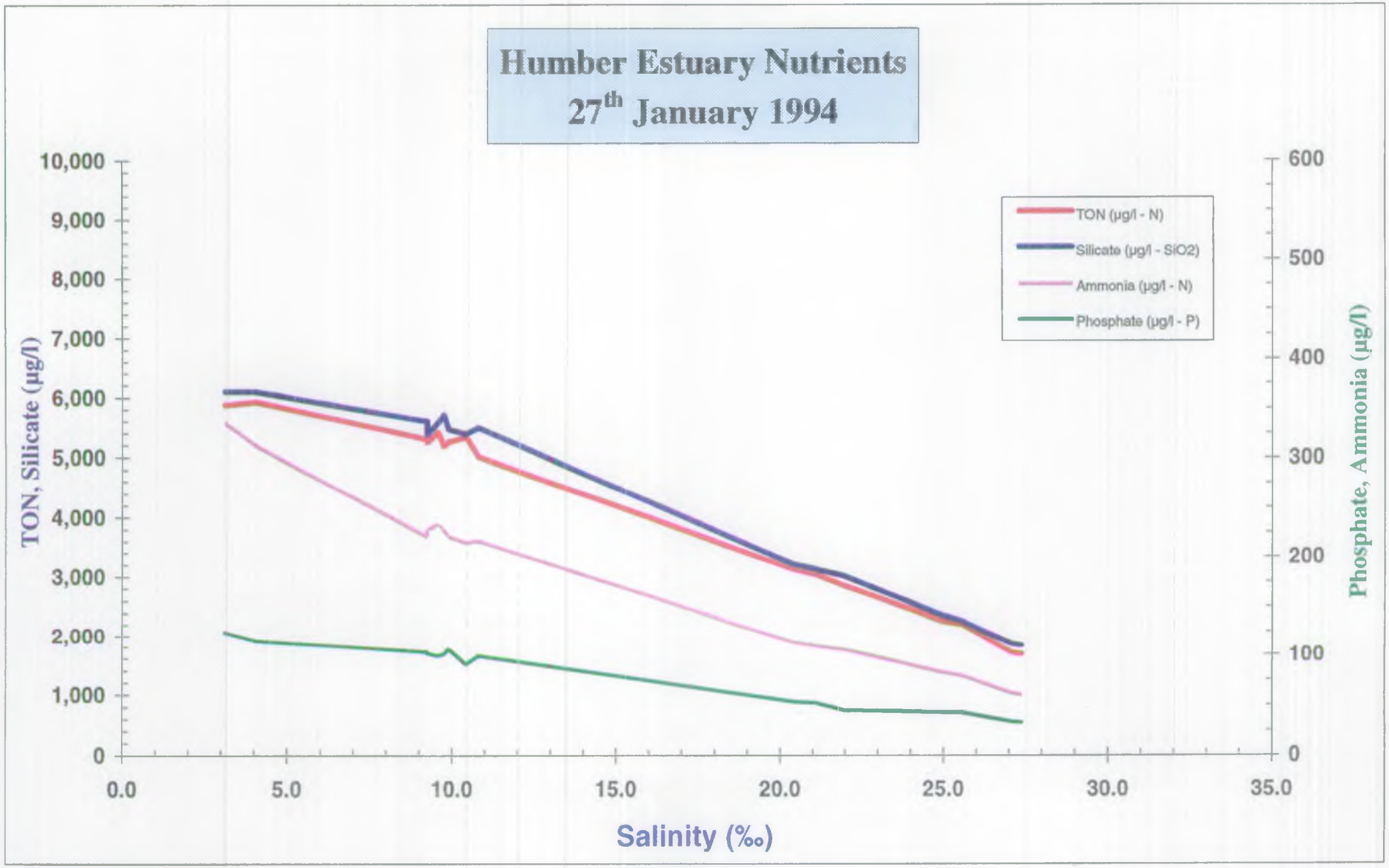


Figure 1a : Humber Estuary - 'Sea Vigil' Nutrient Sample Points

NRA - Anglian Region

Figure 1b : Humber Estuary - 'Sea Vigil' Transect Lines



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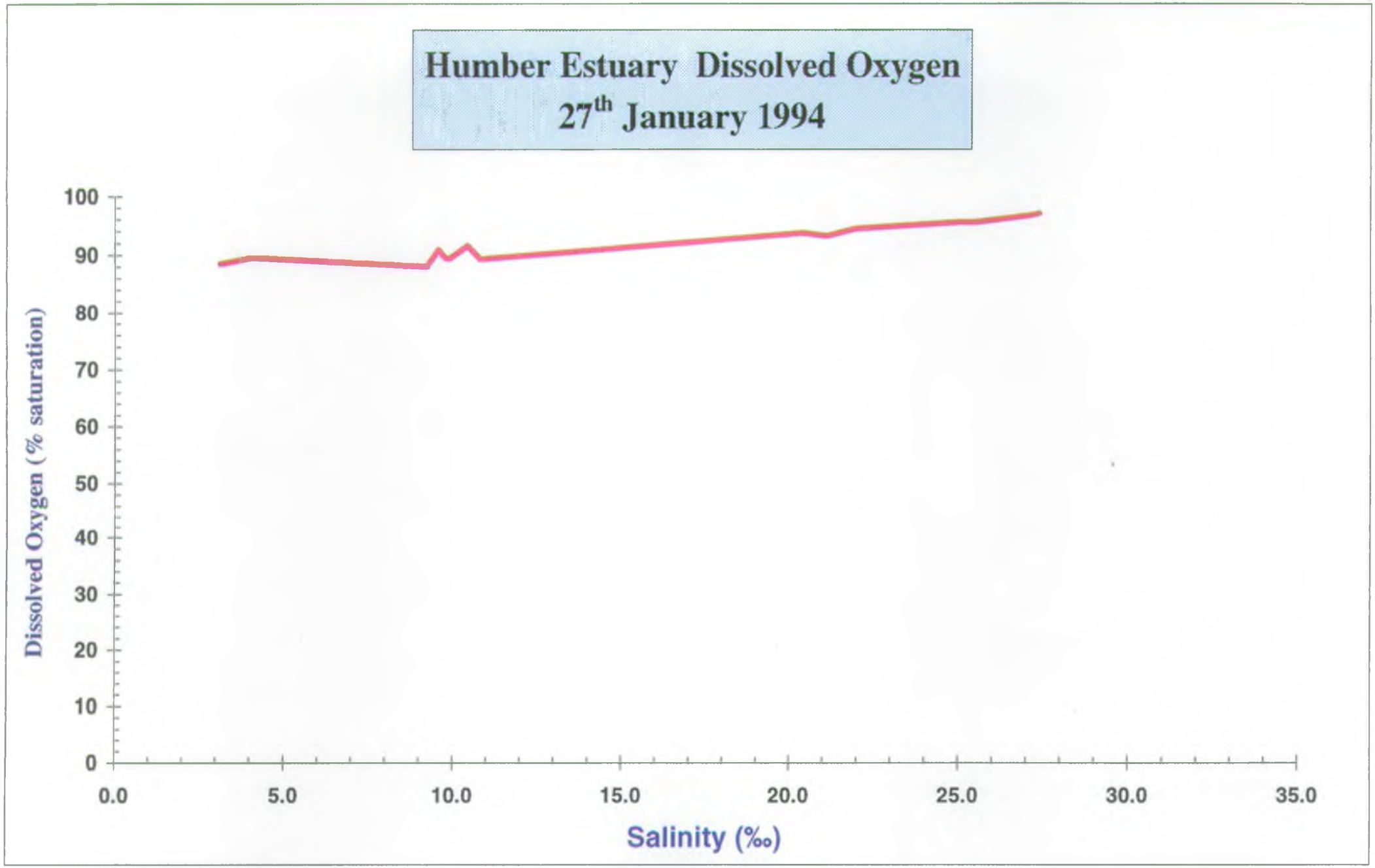

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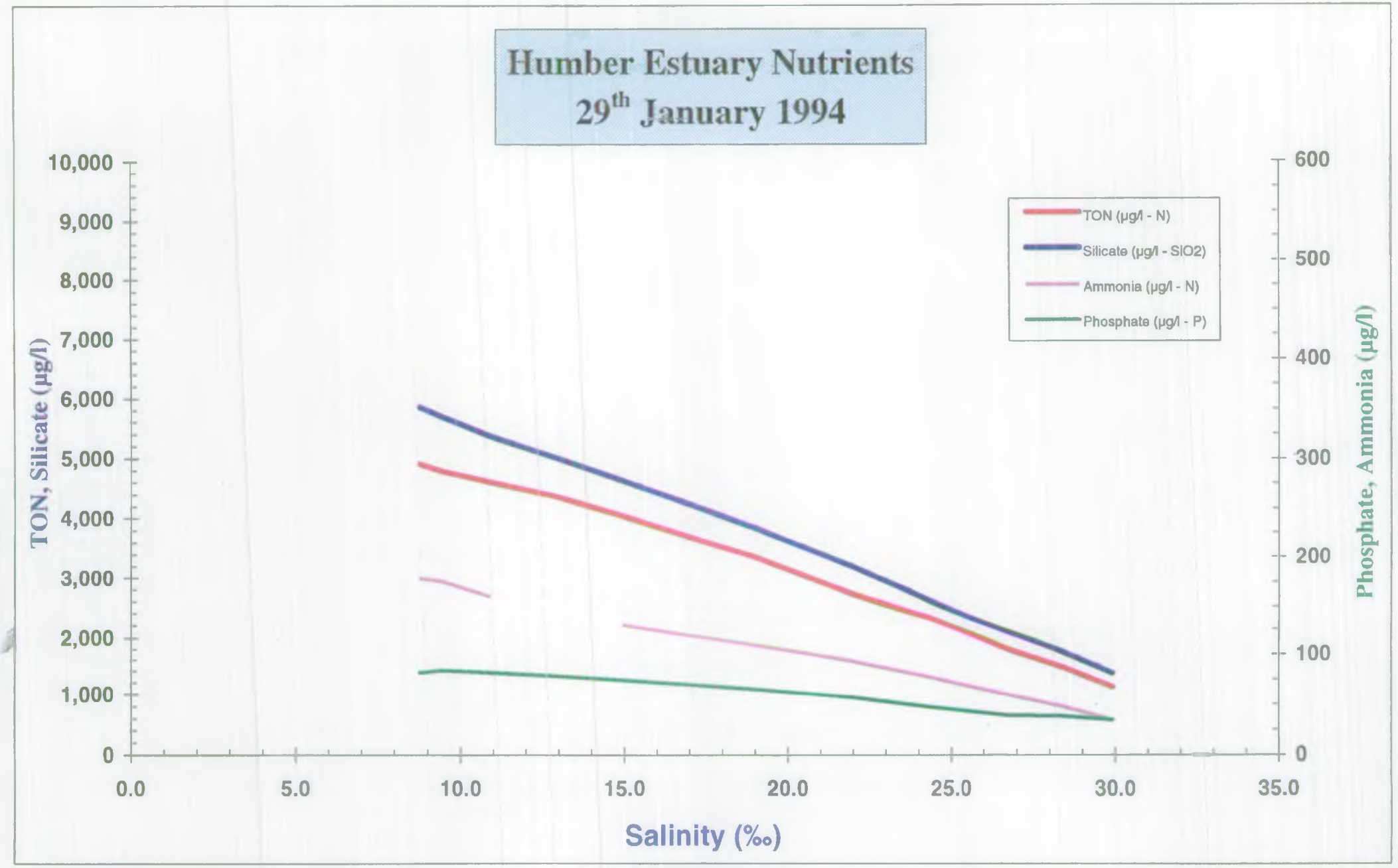

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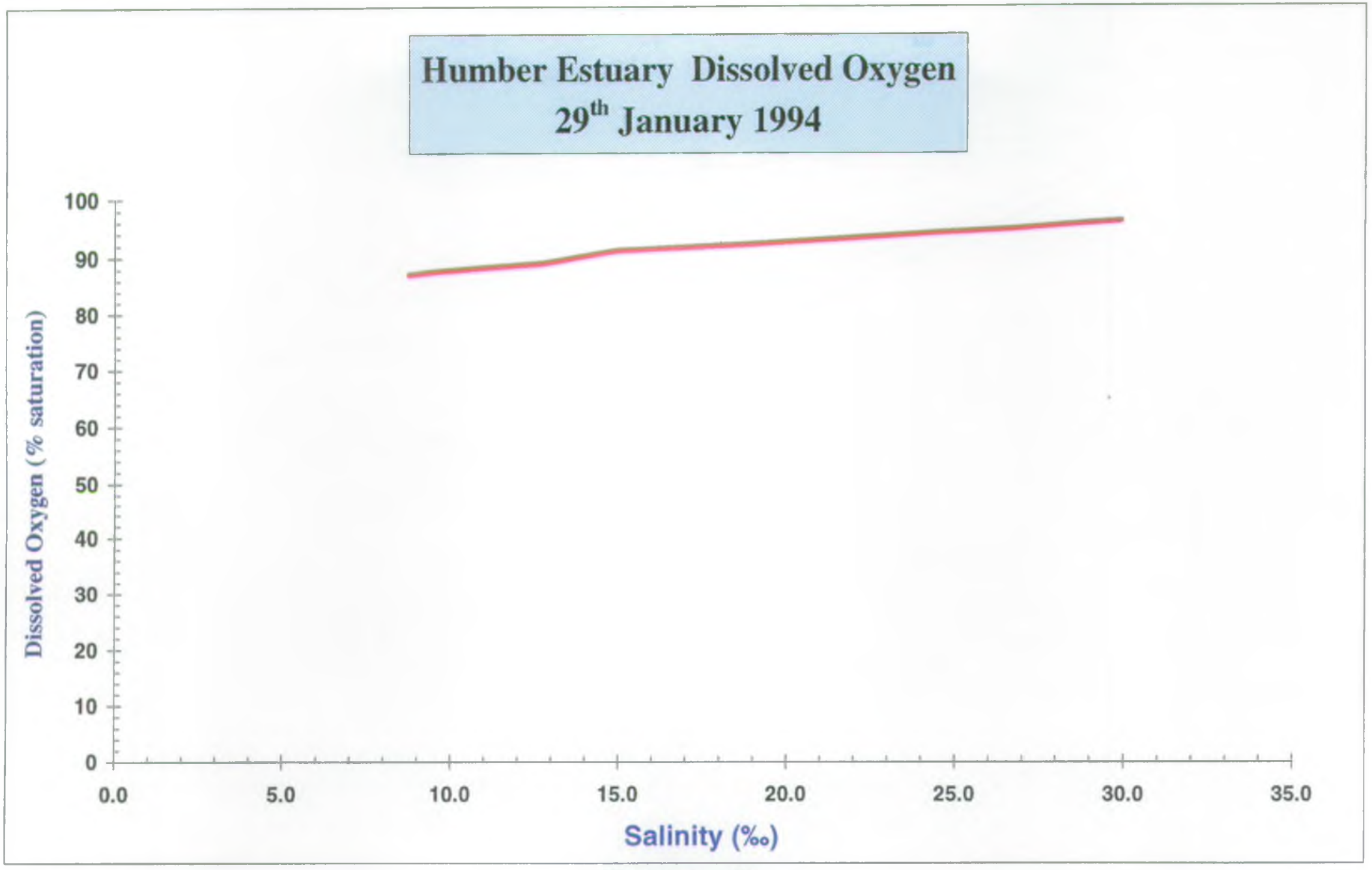

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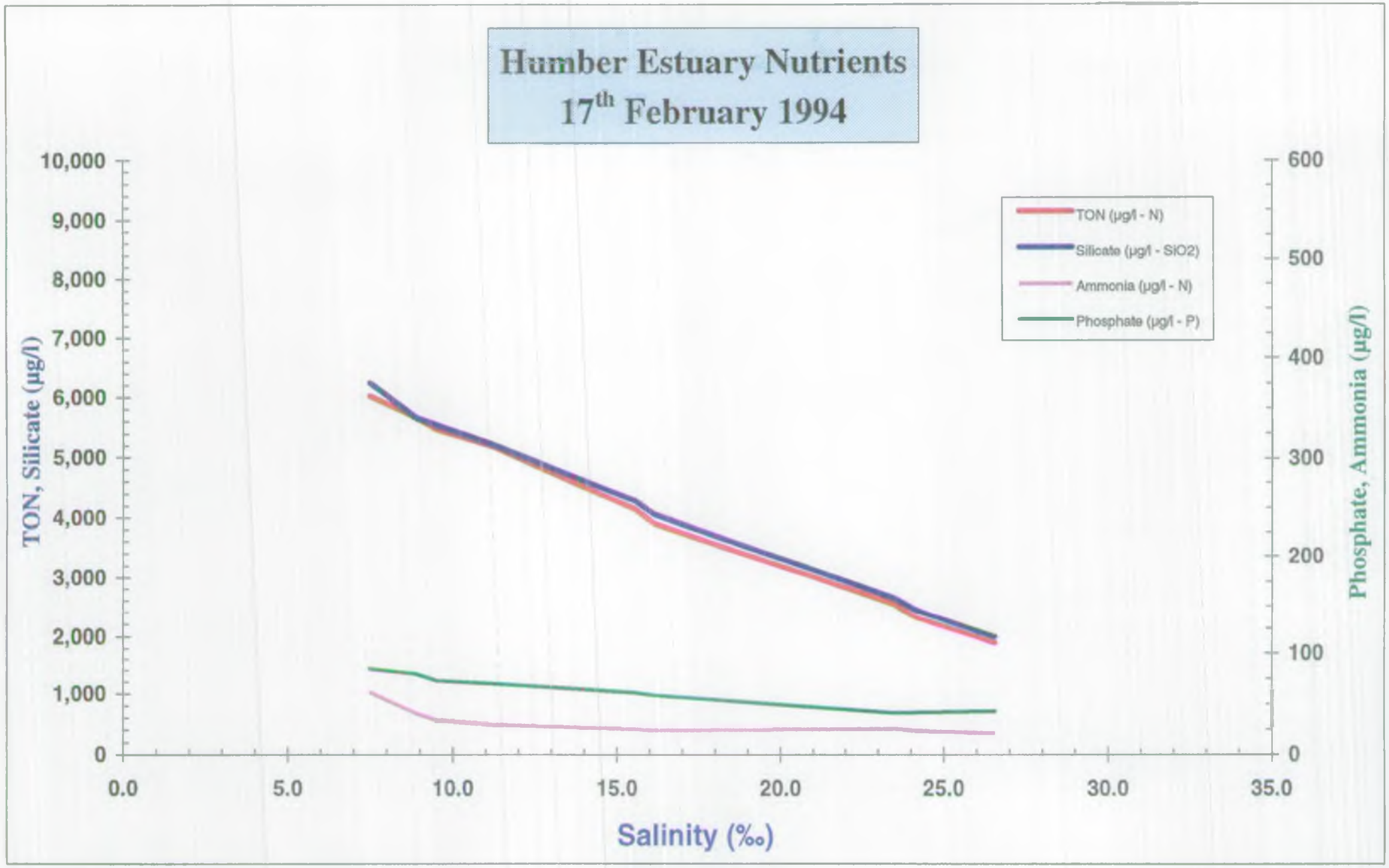

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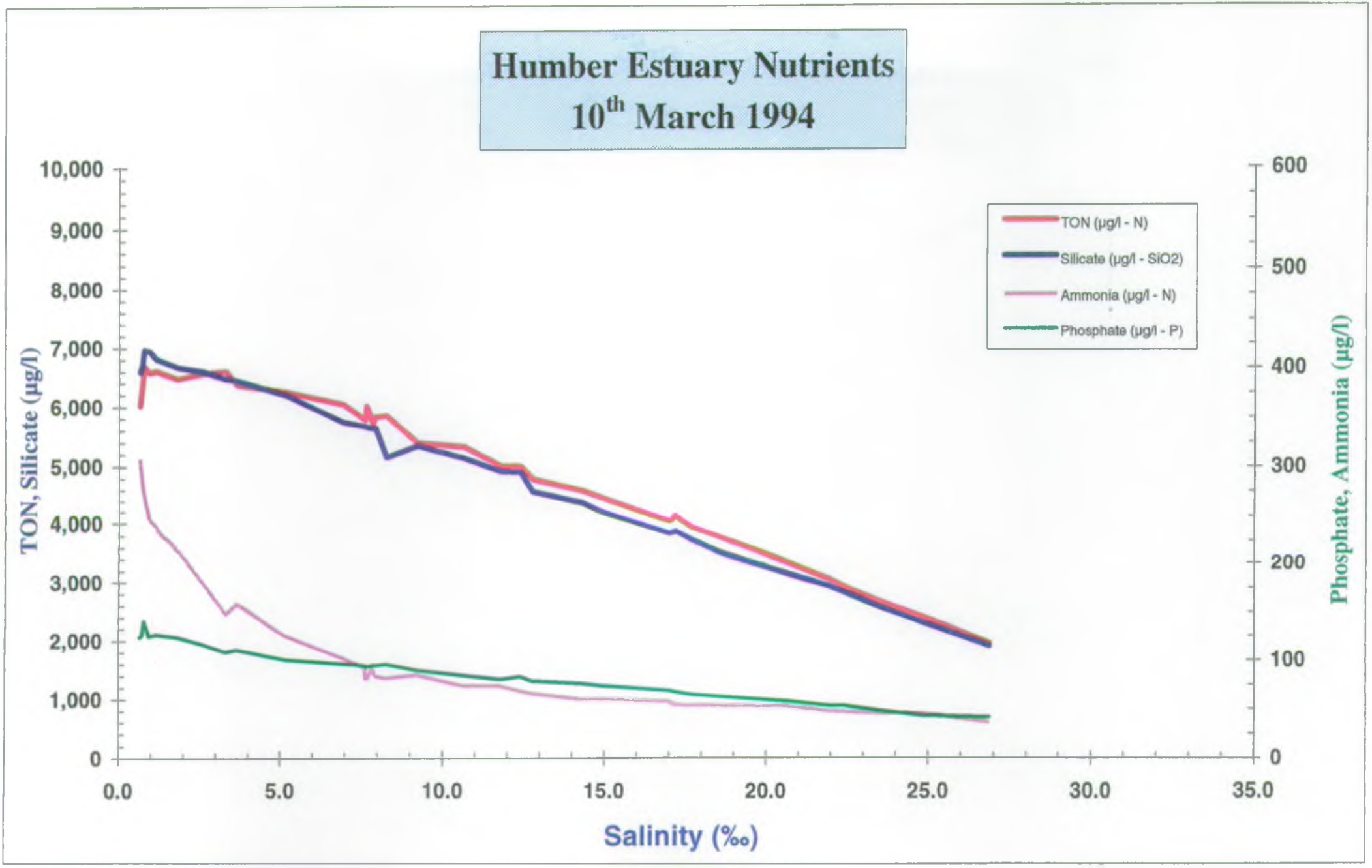

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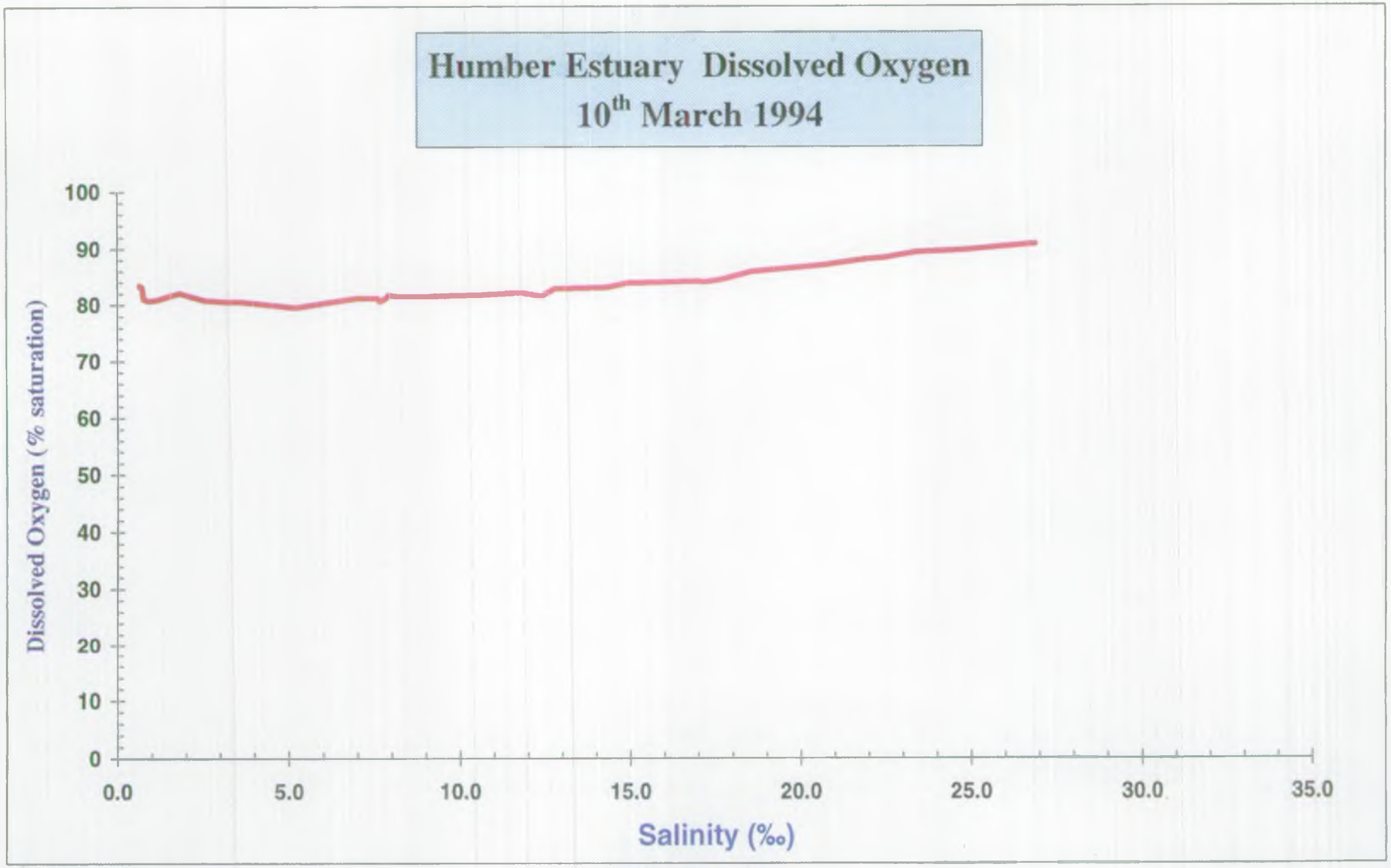

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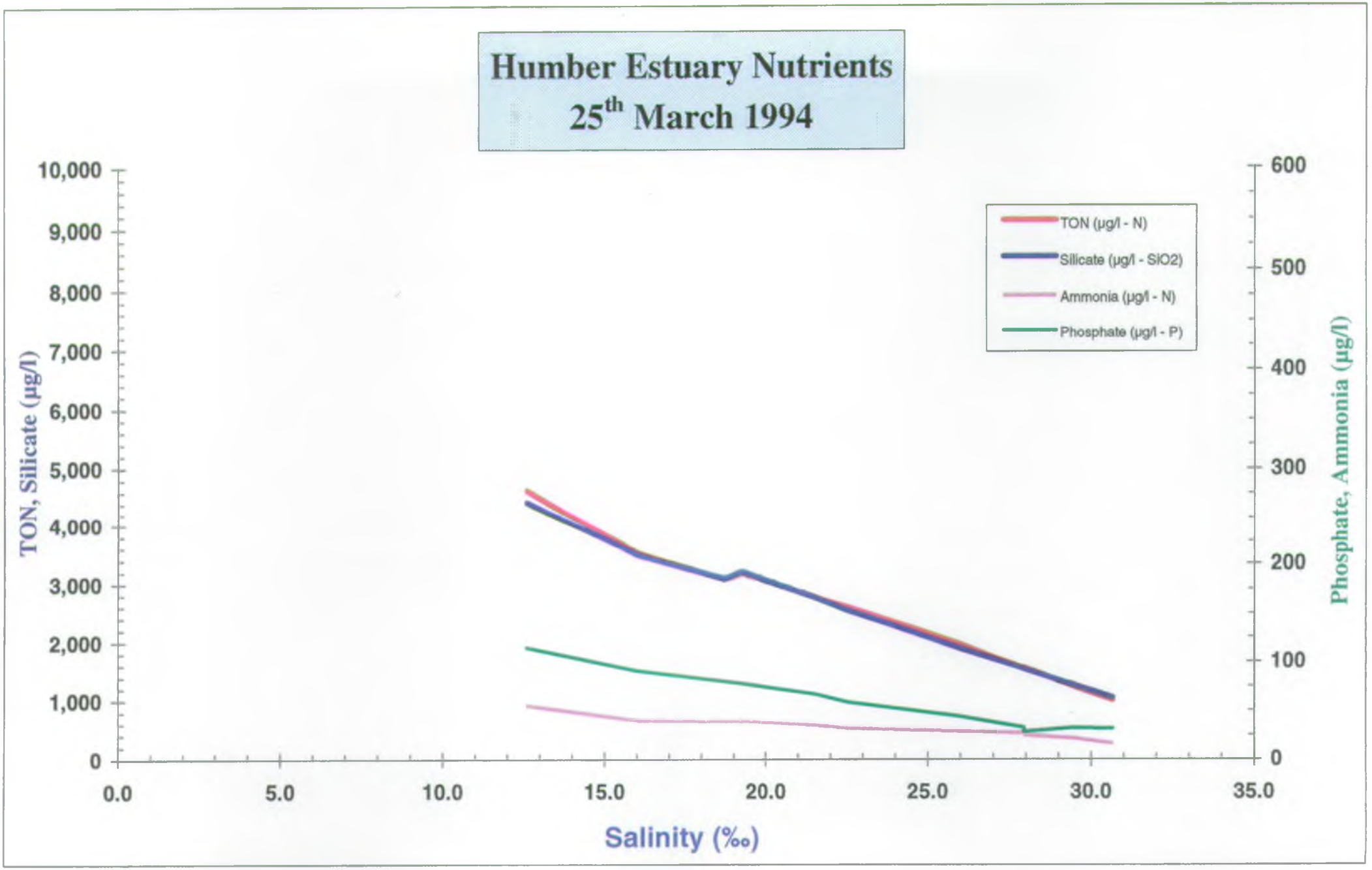

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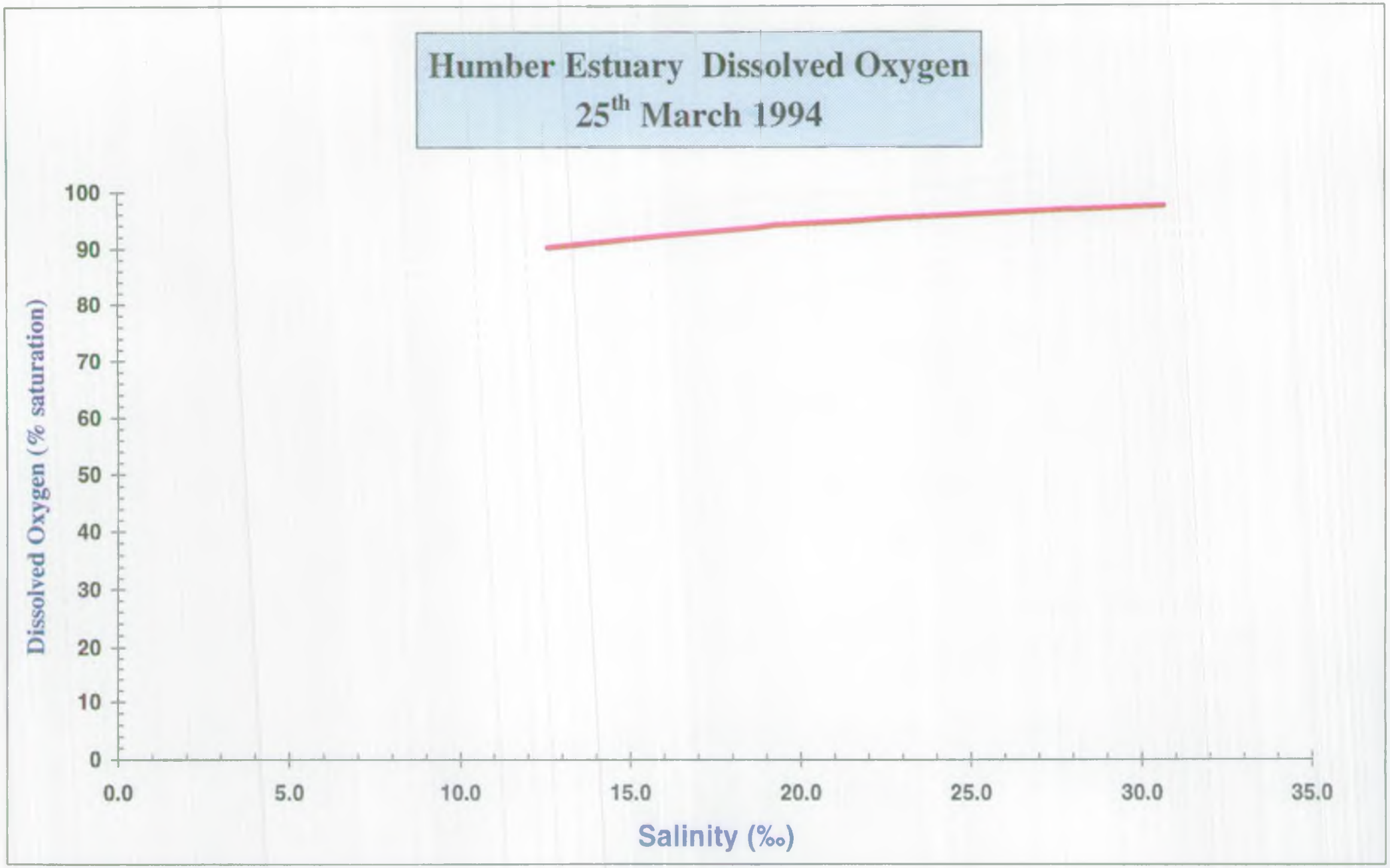

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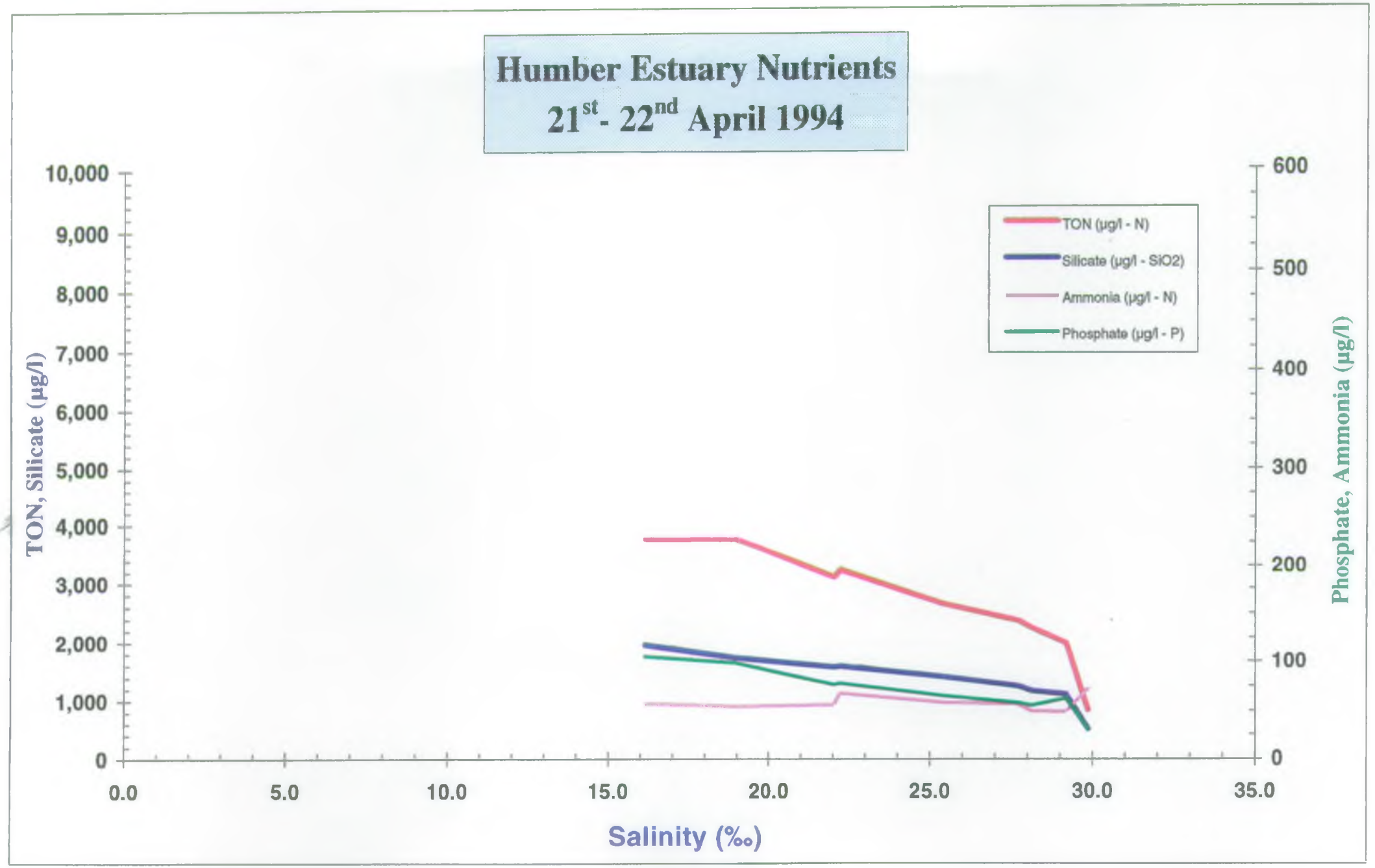

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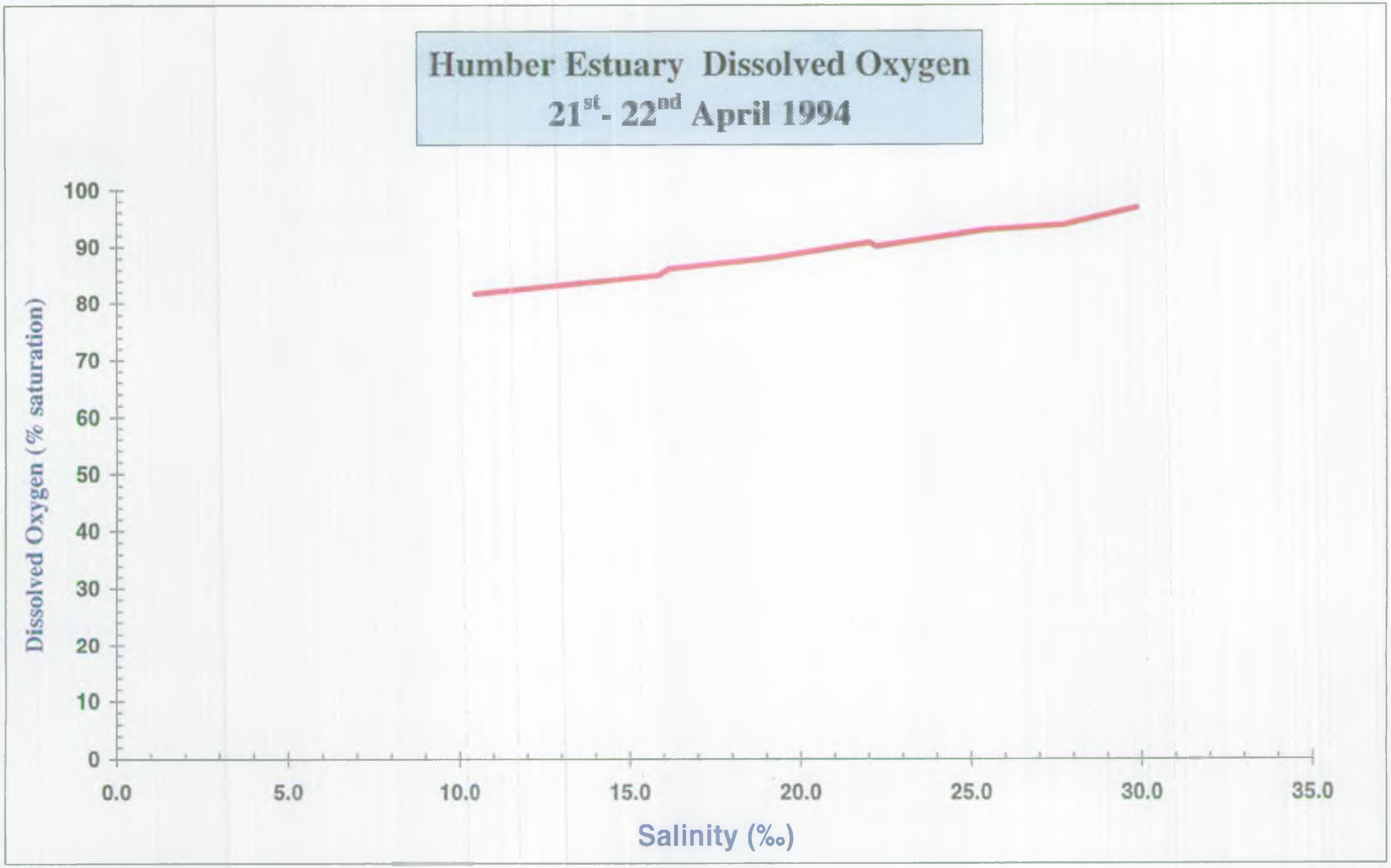

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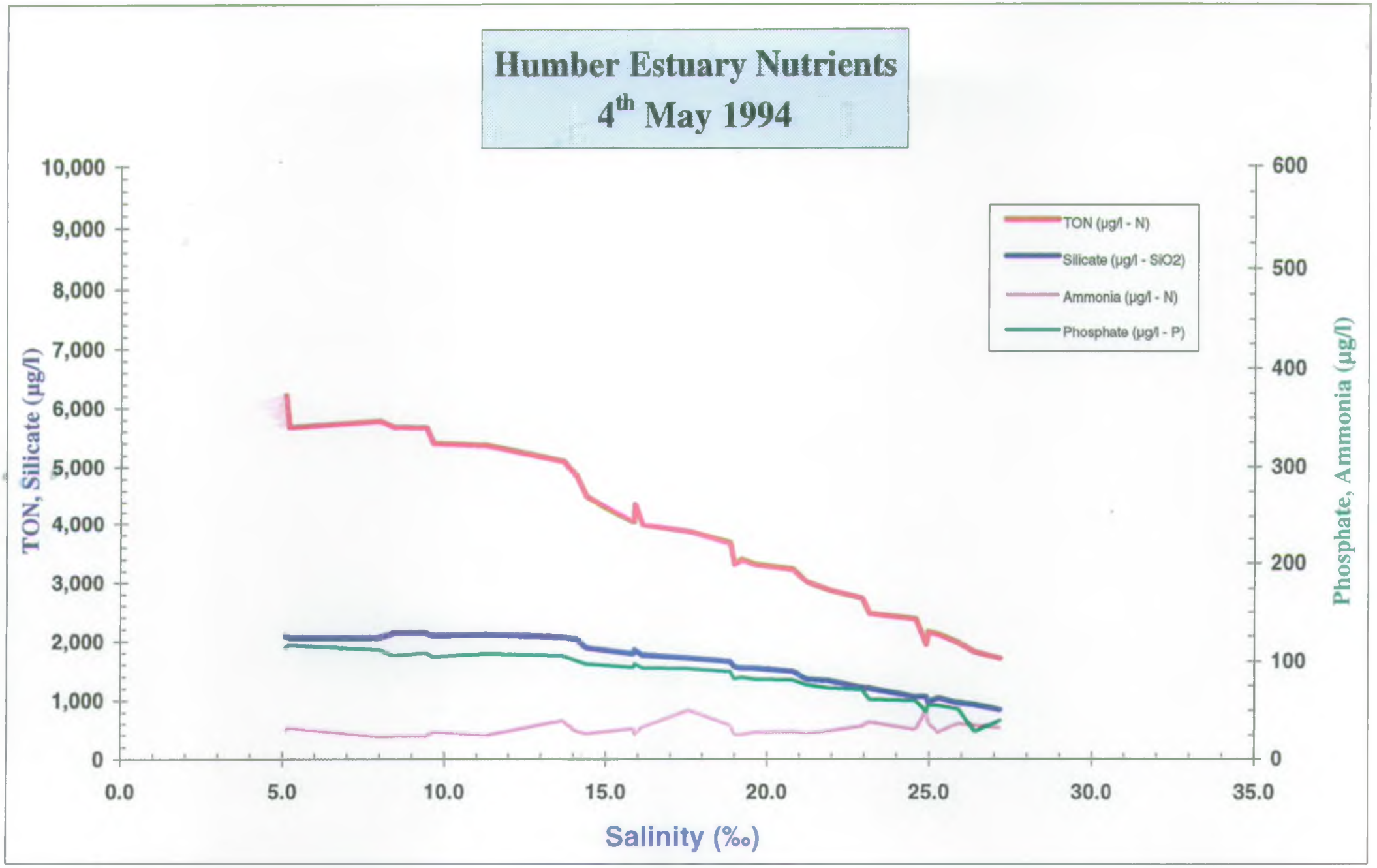

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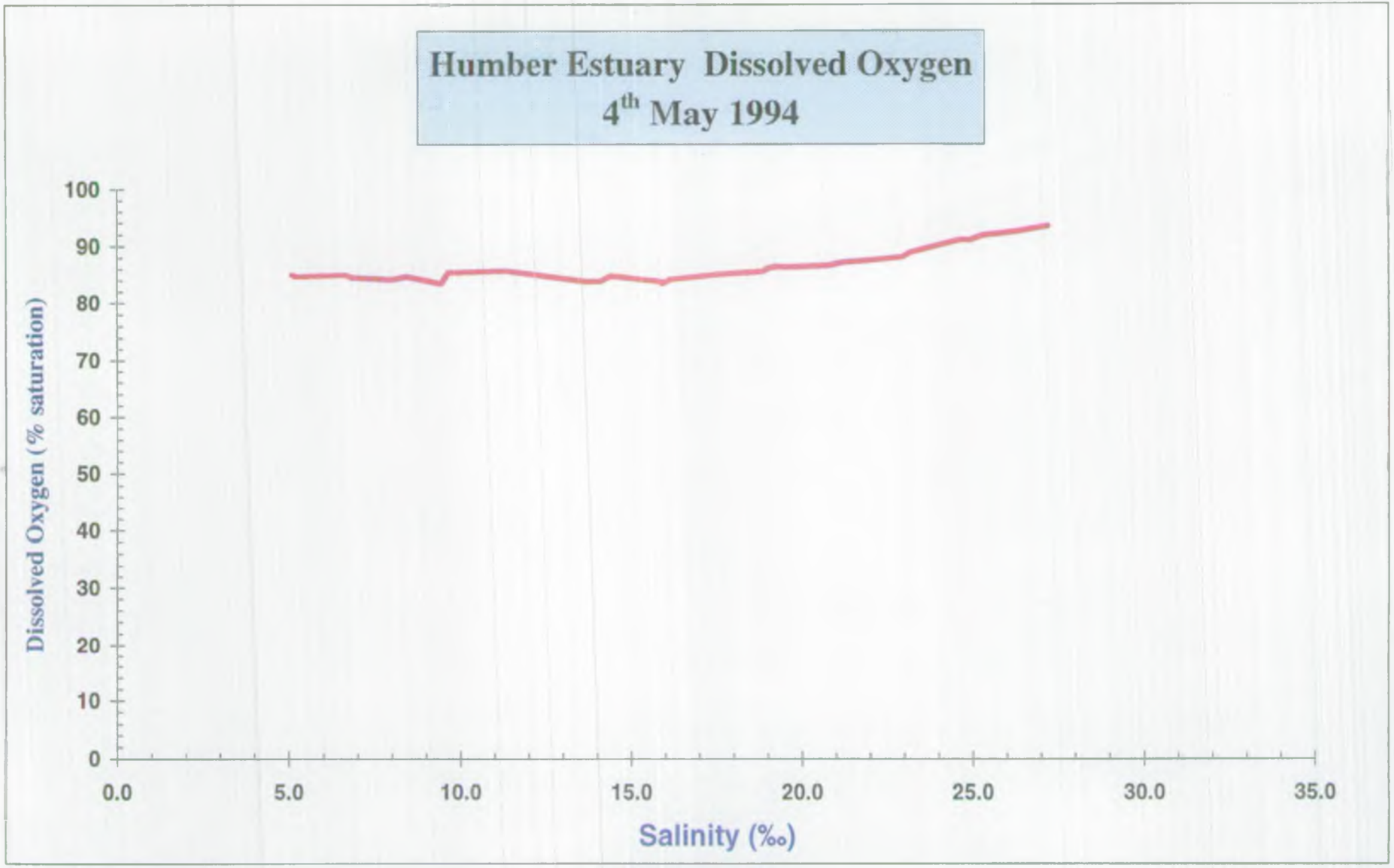

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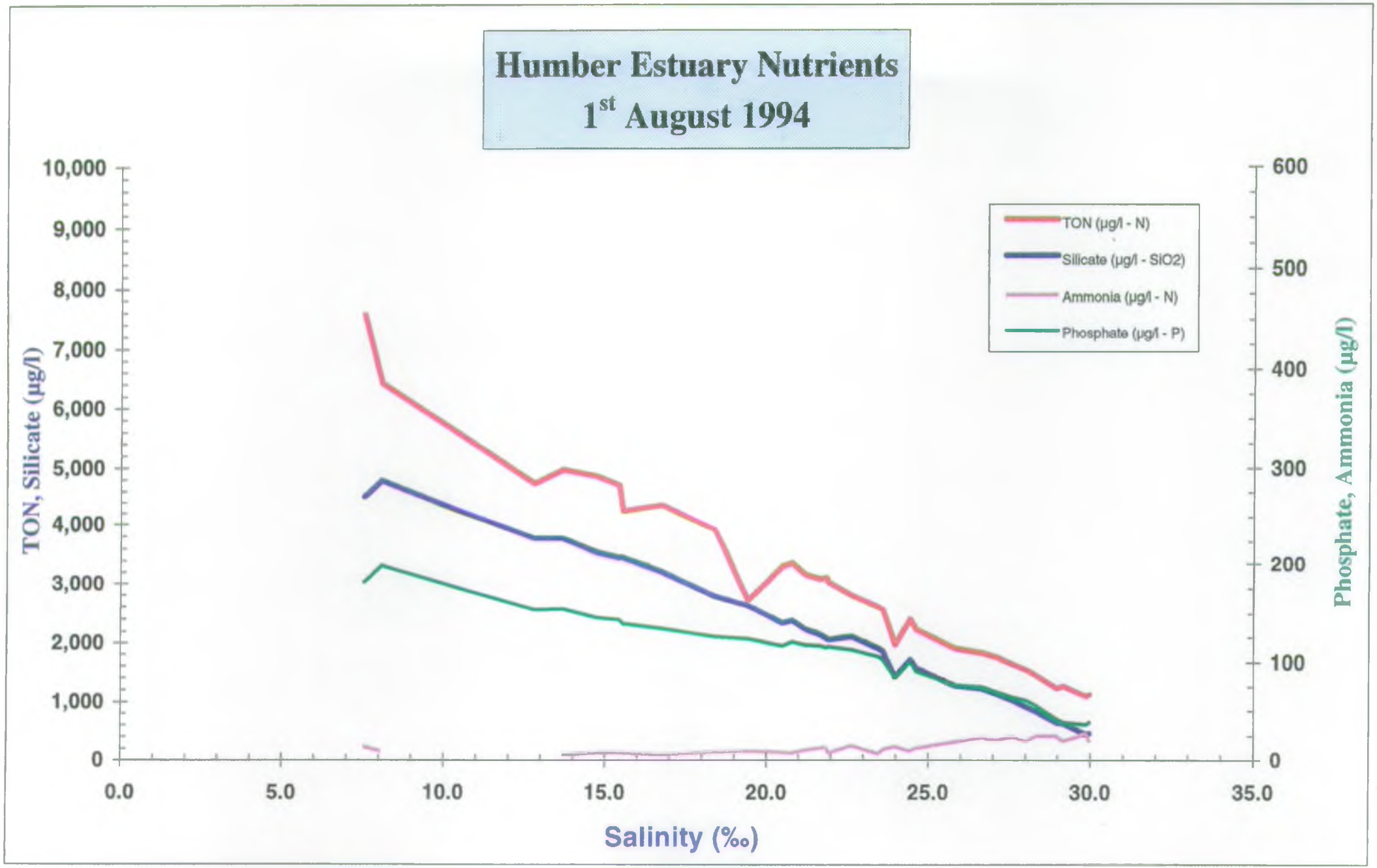

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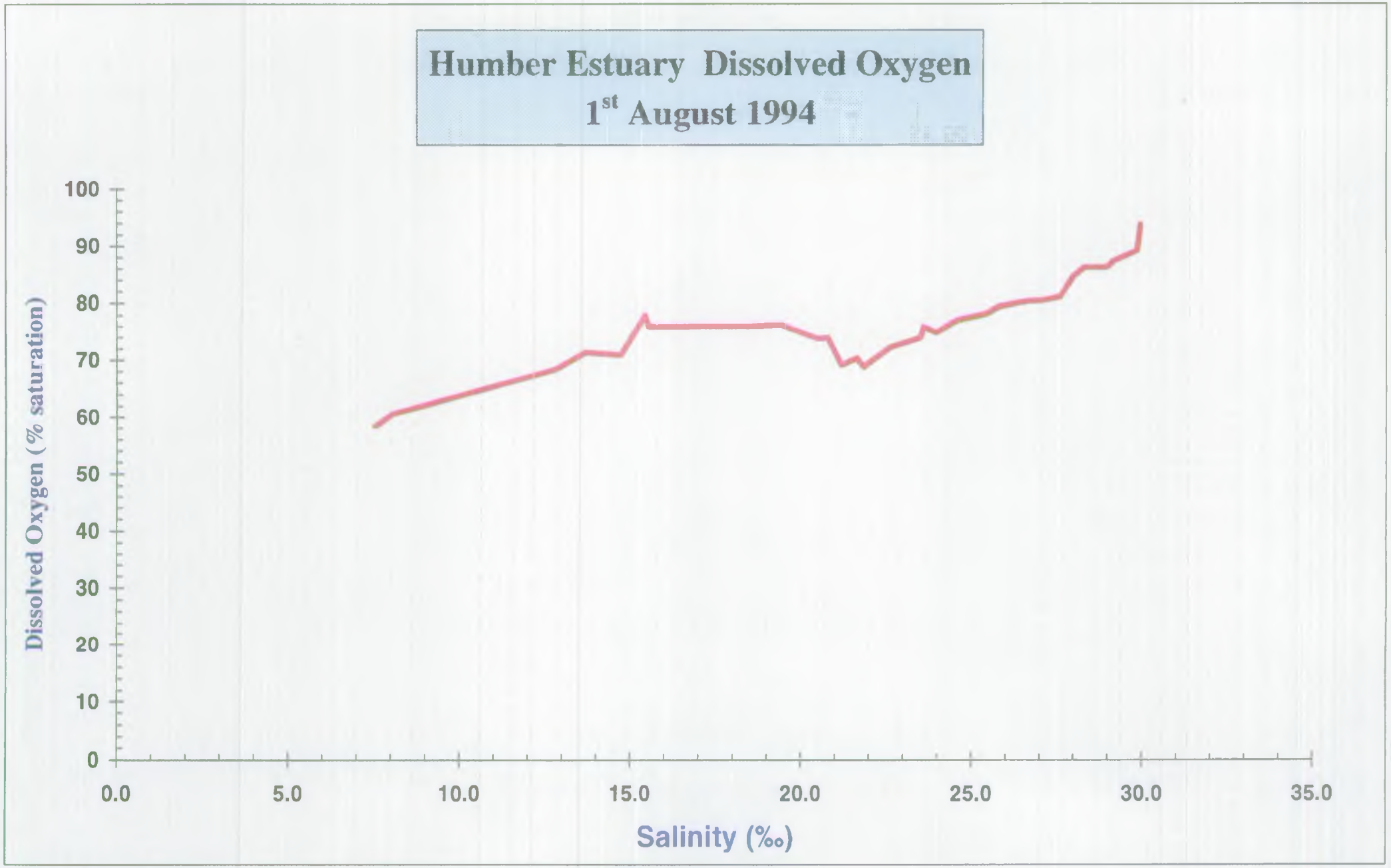


Figure : 9a

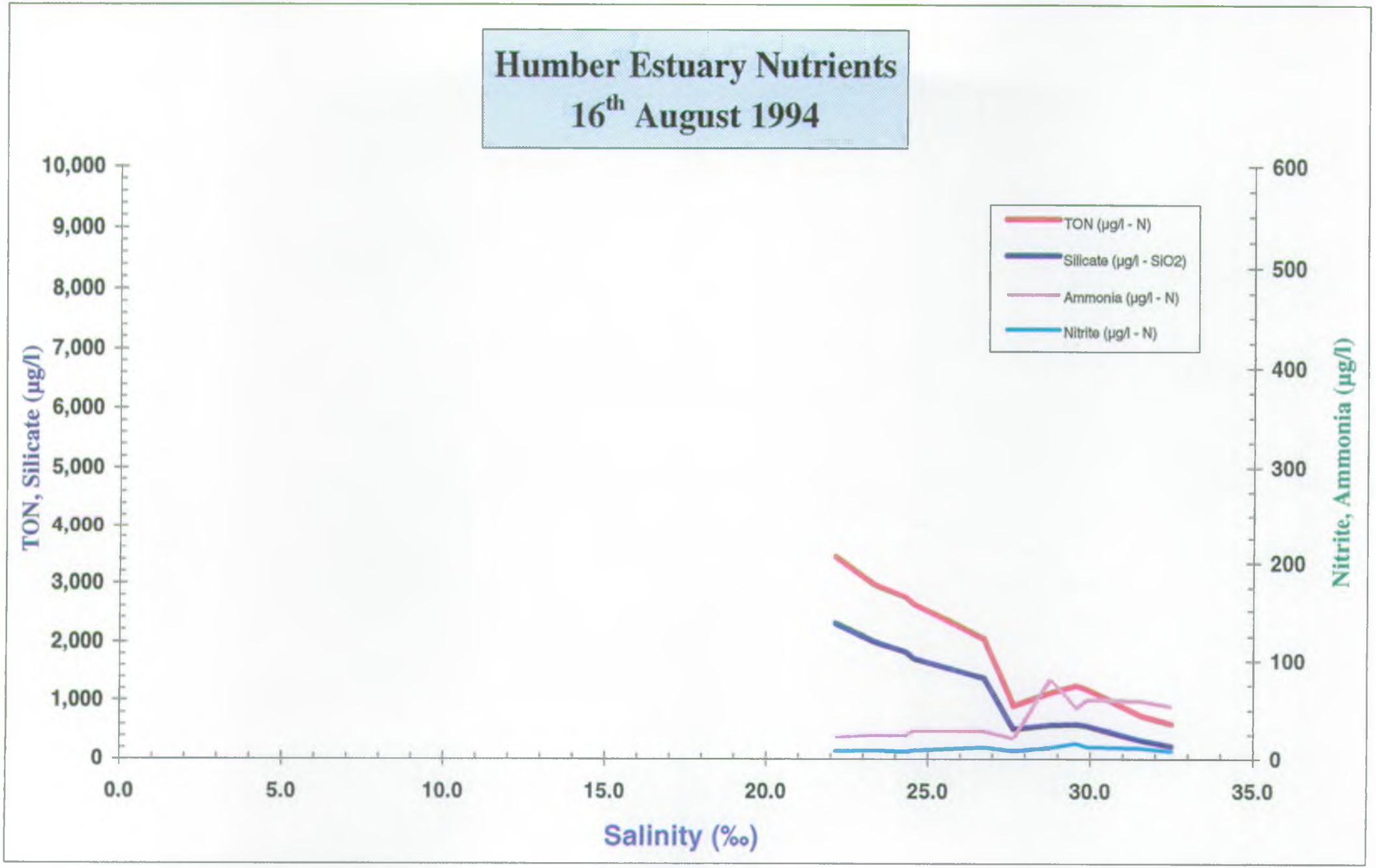


Figure : 10

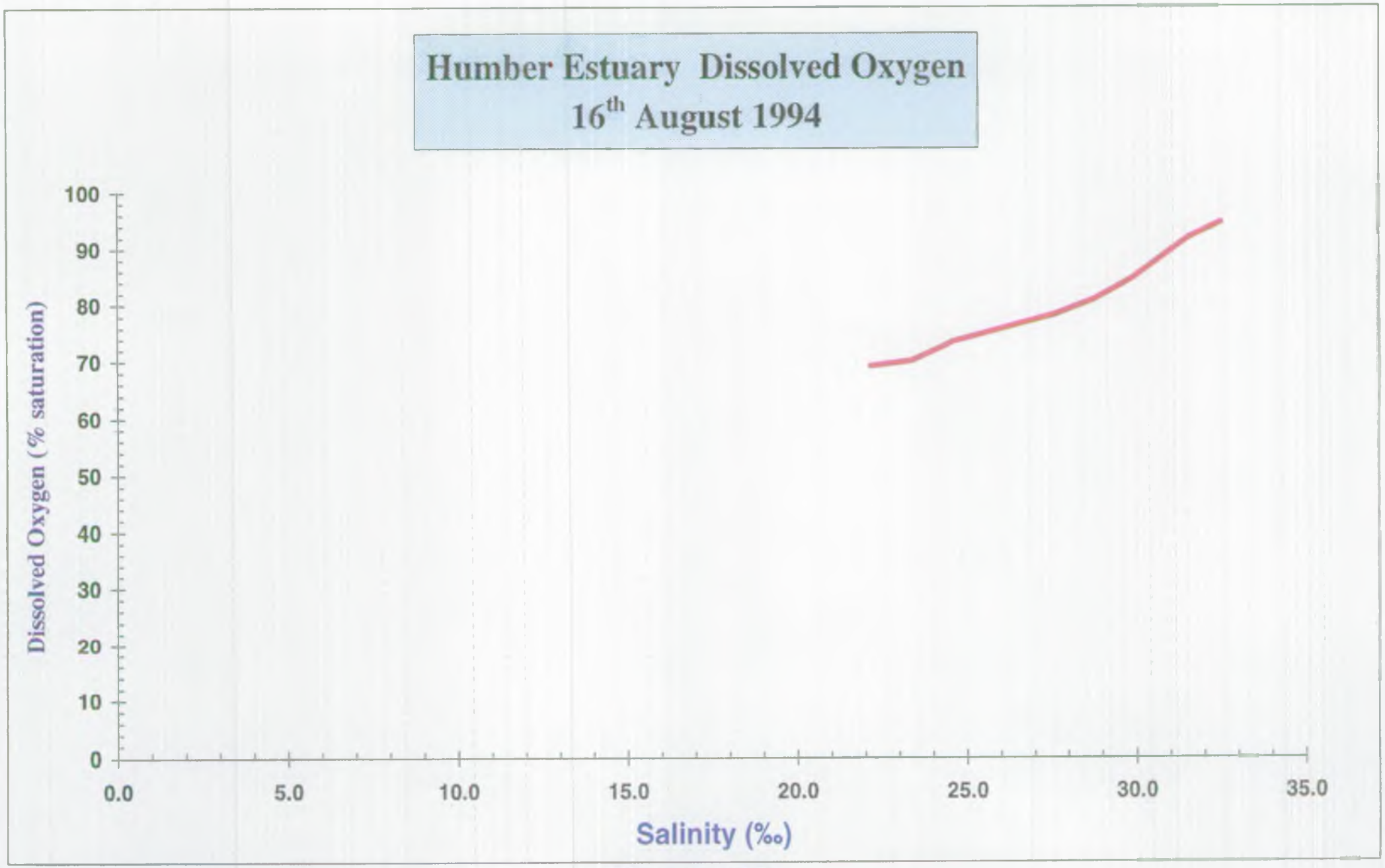
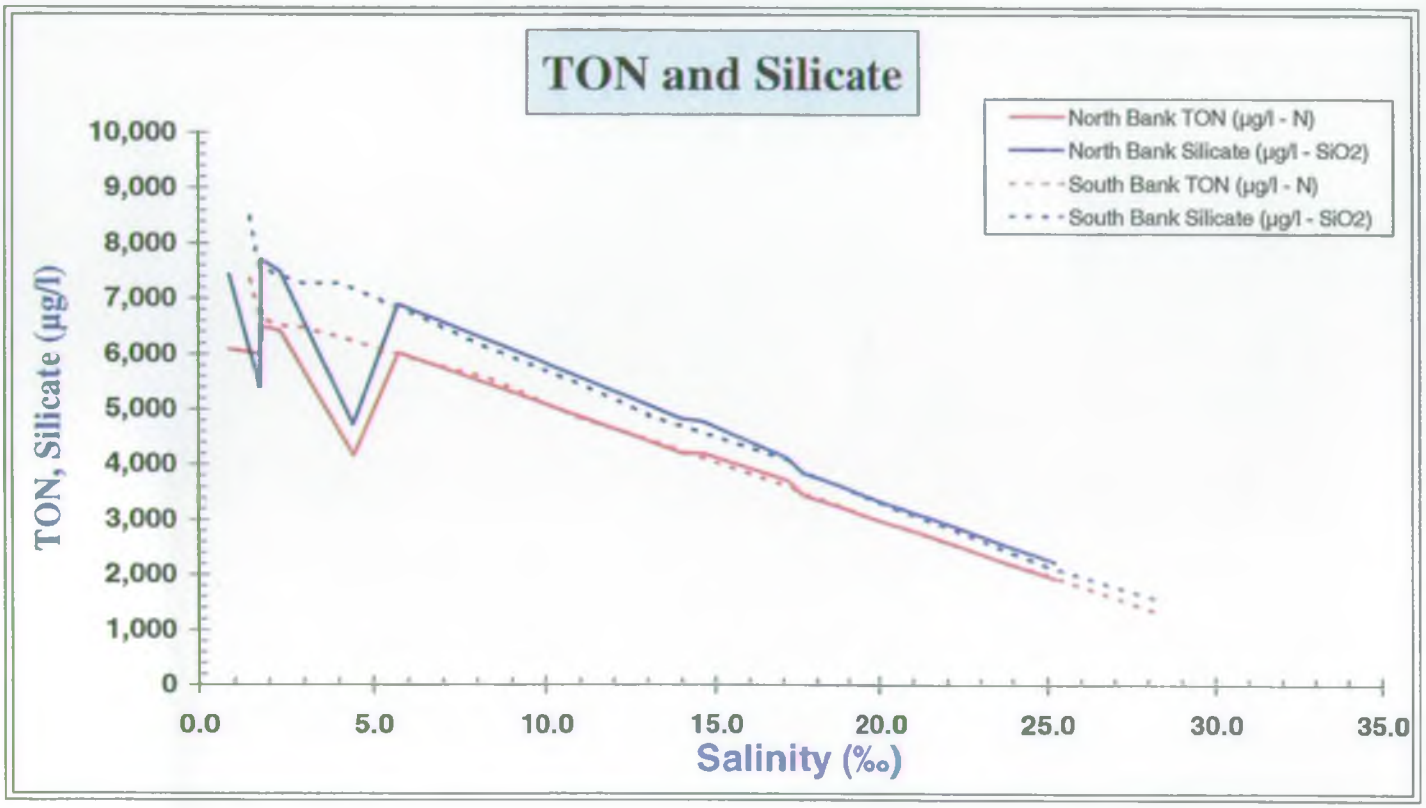


Figure : 10a

Humber Estuary
North and South Bank Nutrients
9th December 1994



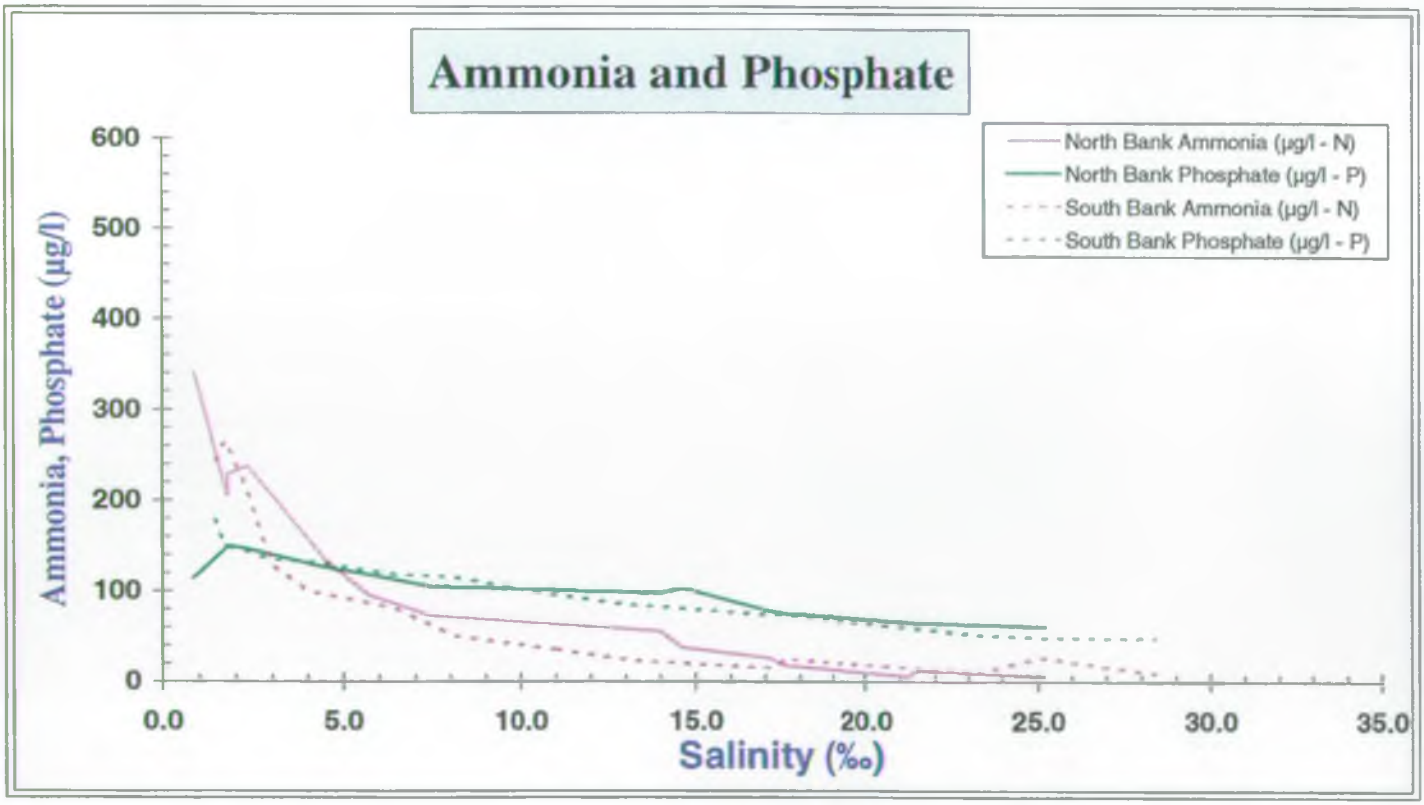


Figure : 11

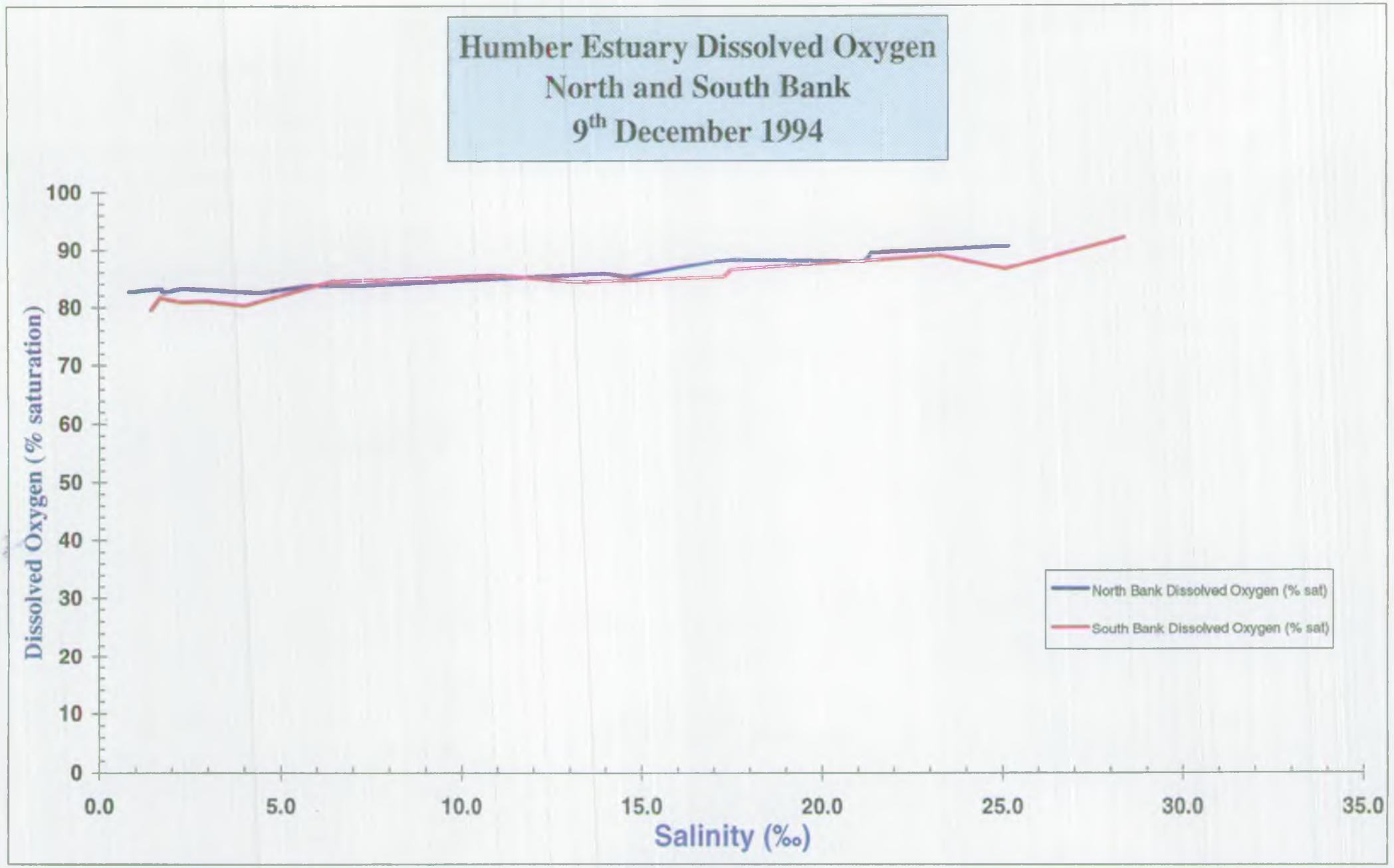


Figure : 11a

NRA - Anglian Region

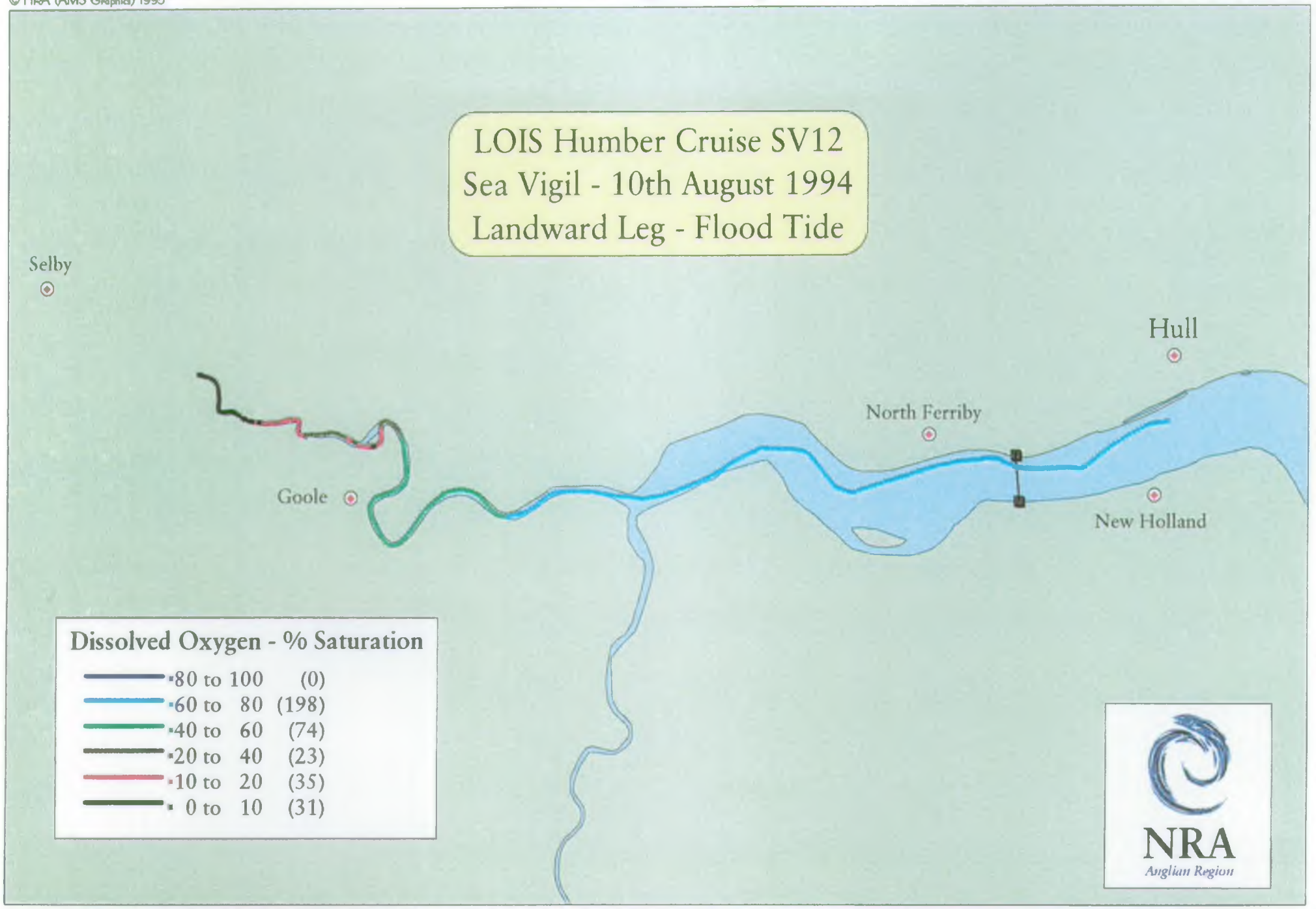


Figure 12a : Humber Estuary, 10th August, 1994 - Dissolved Oxygen on Flood Tide.

NRA - Anglian Region

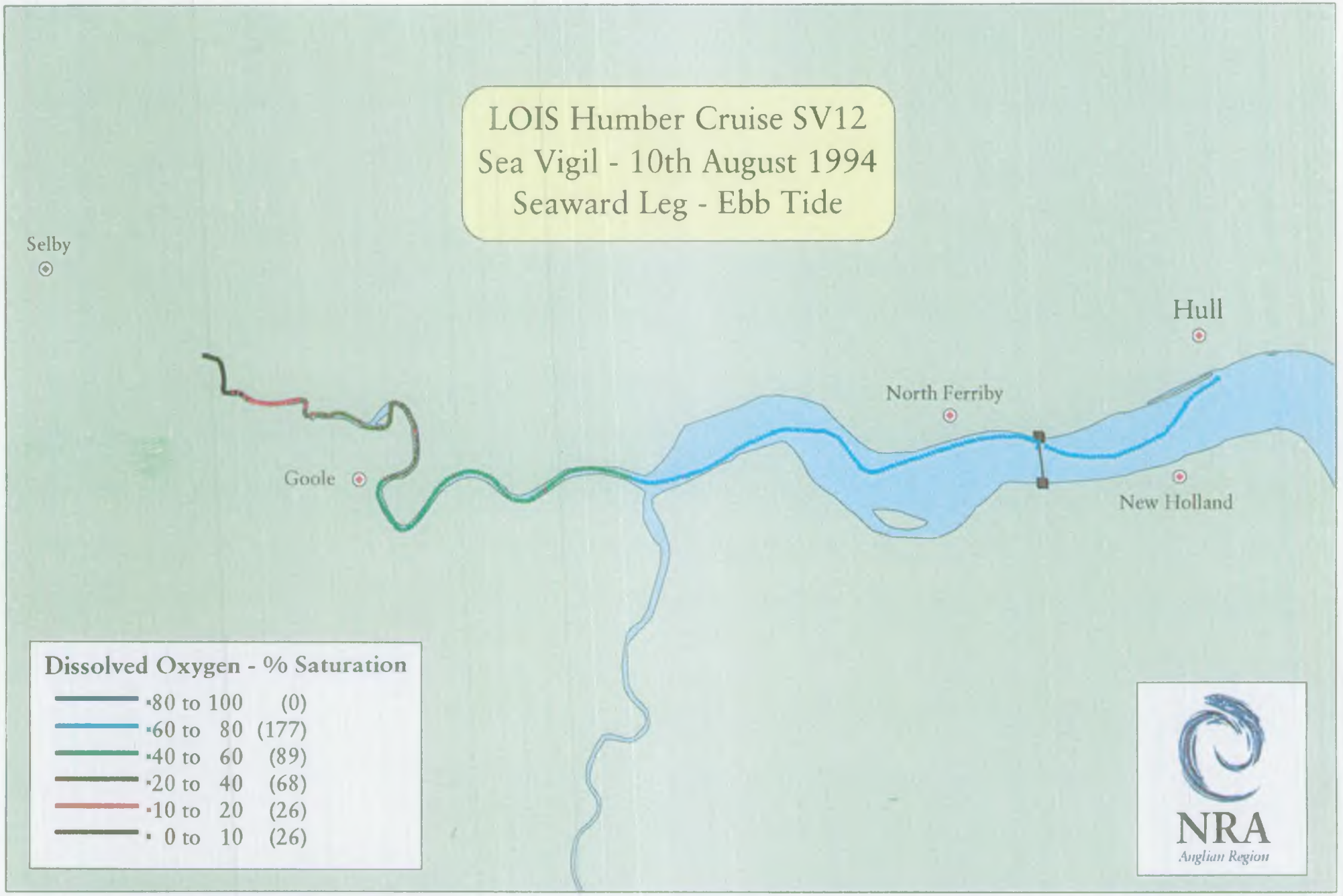
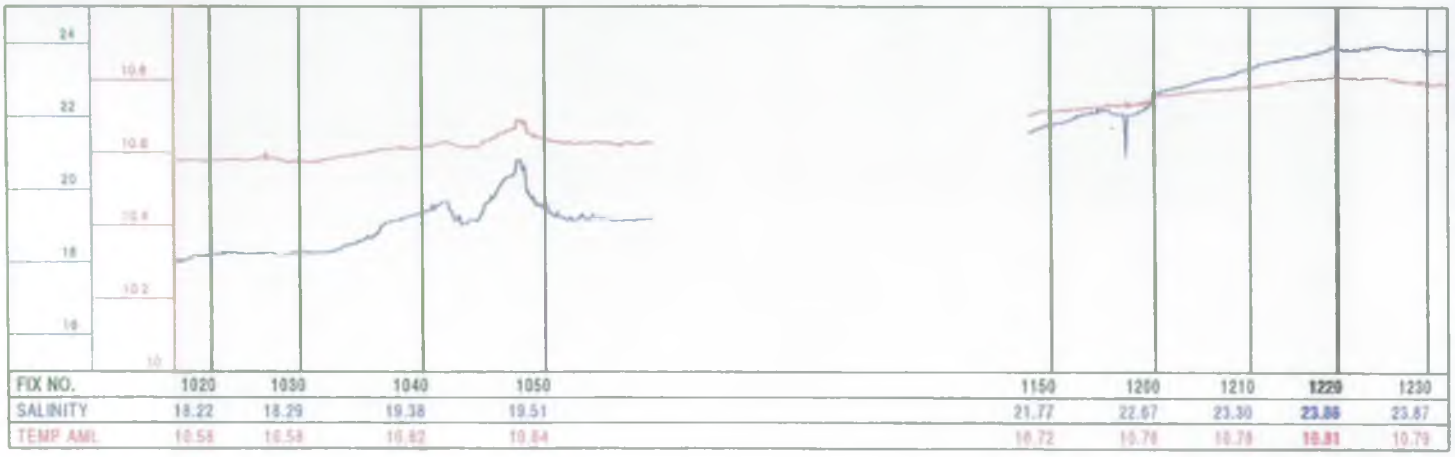
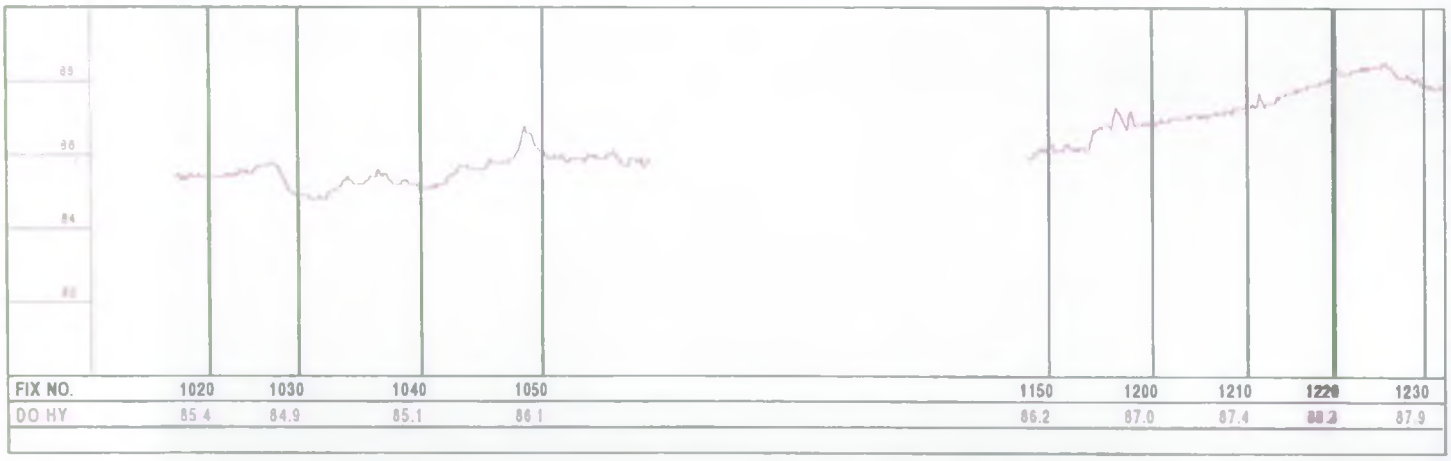


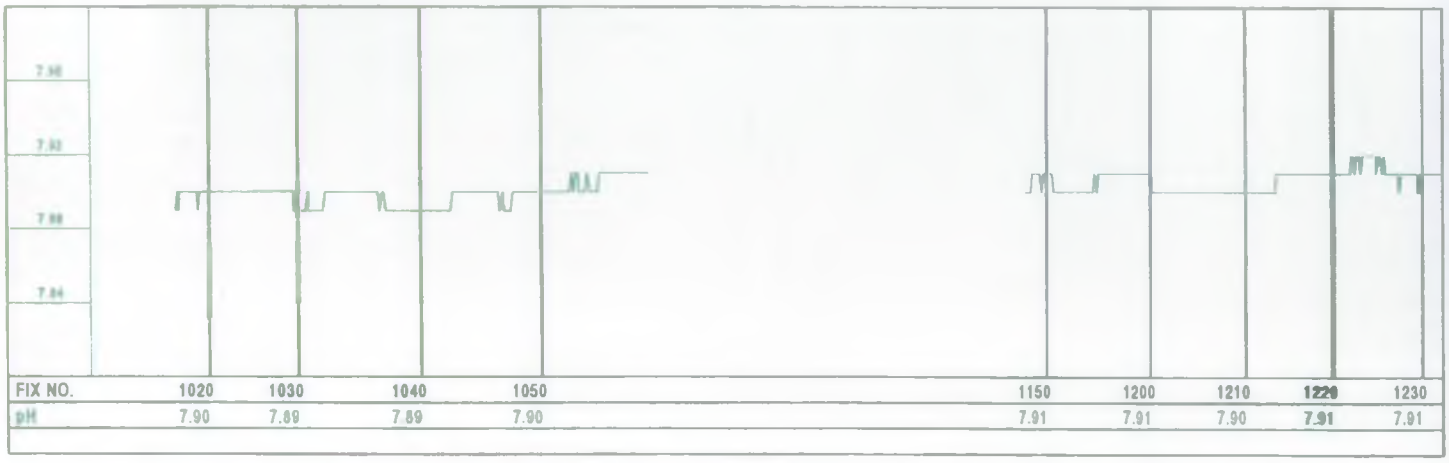
Figure 12b : Humber Estuary, 10th August, 1994 - Dissolved Oxygen on Ebb Tide.



FIX NO.	1020	1030	1040	1050	1150	1200	1210	1220	1230
SALINITY	18.22	18.29	19.38	19.51	21.77	22.67	23.30	23.86	23.87
TEMP AMI.	10.58	10.58	10.82	10.84	10.72	10.79	10.79	10.81	10.79



FIX NO.	1020	1030	1040	1050	1150	1200	1210	1220	1230
DO HY	85.4	84.9	85.1	86.1	86.2	87.0	87.4	88.2	87.9



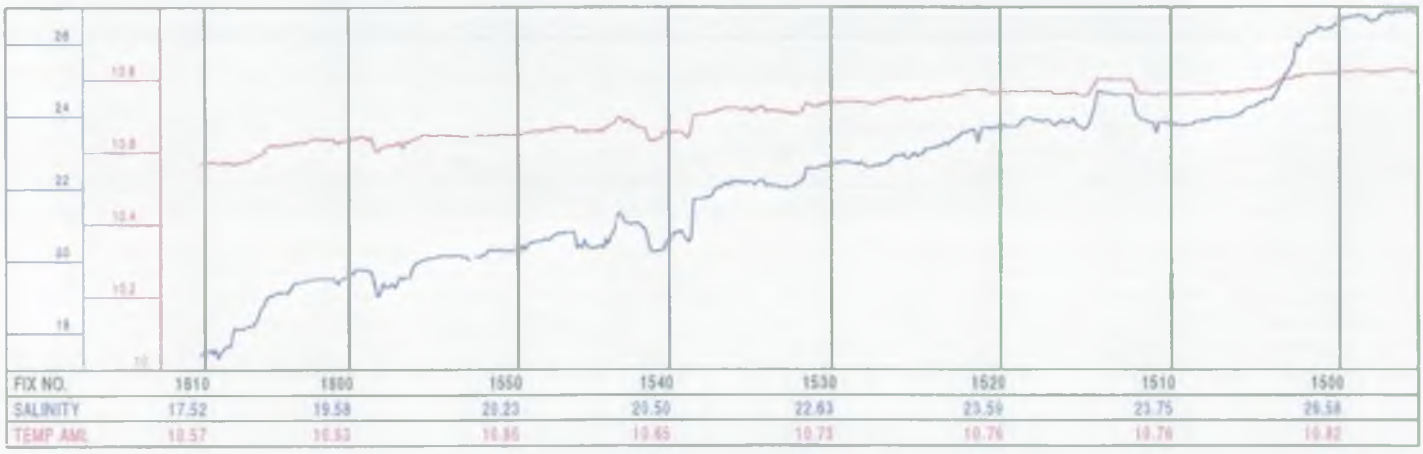
FIX NO.	1020	1030	1040	1050	1150	1200	1210	1220	1230
pH	7.90	7.89	7.89	7.90	7.91	7.91	7.90	7.91	7.91

Figure 13a : LOIS HUMBER CRUISE SV14

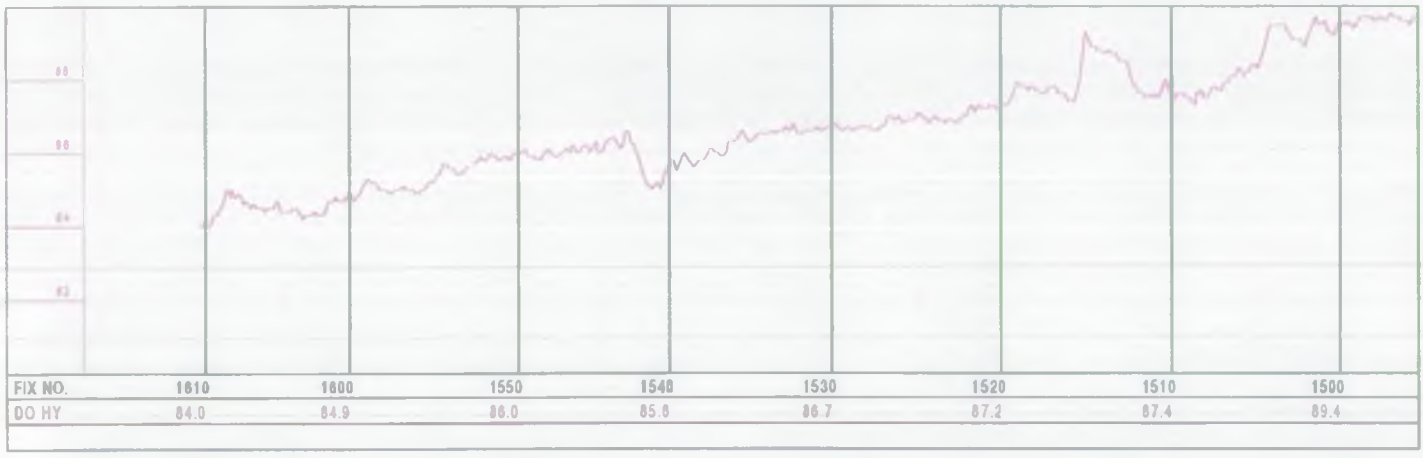
SEA VIGIL - 20th October 1994

Hull to Hawkin's Point - Ebb Tide

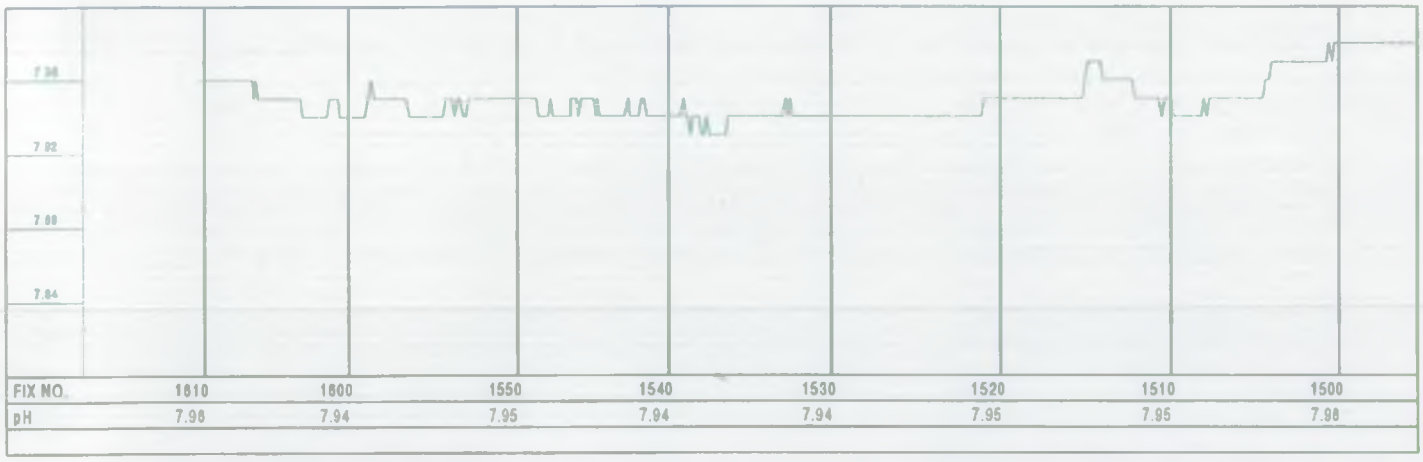
Data logged to Qubit TRAC V



FIX NO.	1610	1600	1550	1540	1530	1520	1510	1500
SALINITY	17.52	19.58	20.23	20.50	22.63	23.59	23.75	26.58
TEMP AMB	10.57	10.53	10.66	10.65	10.73	10.76	10.76	10.82



FIX NO.	1610	1600	1550	1540	1530	1520	1510	1500
DO HY	84.0	84.9	86.0	85.6	86.7	87.2	87.4	89.4



FIX NO.	1610	1600	1550	1540	1530	1520	1510	1500
pH	7.98	7.94	7.95	7.94	7.94	7.95	7.95	7.98

Figure 13b : LOIS HUMBER CRUISE SV14

SEA VIGIL - 20th October 1994

Hawkin's Point to Hull - Flood Tide

Data logged to Qubit TRAC V

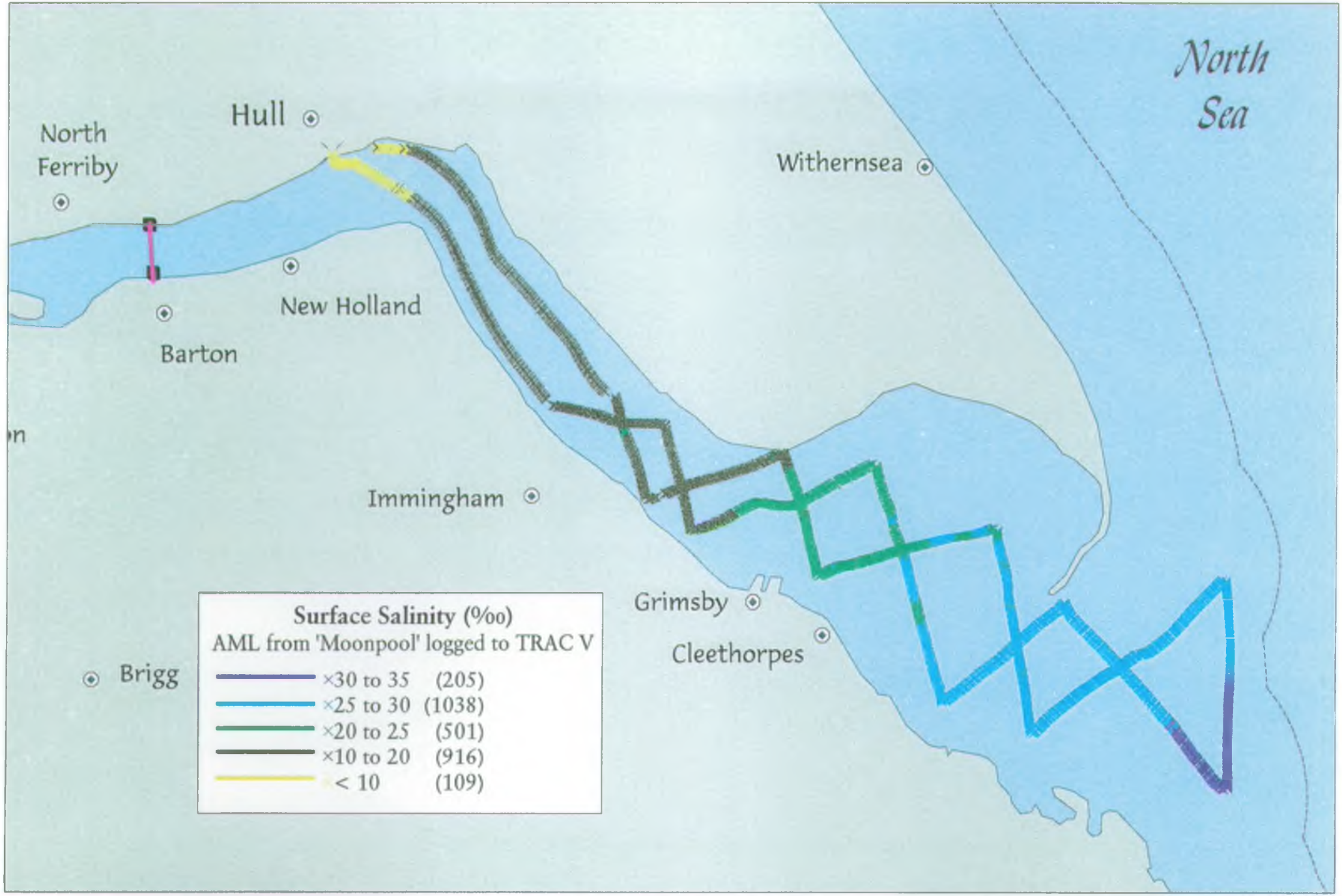


Figure 14a : Lower Humber Estuary. 20th December. 1994 - Salinity.

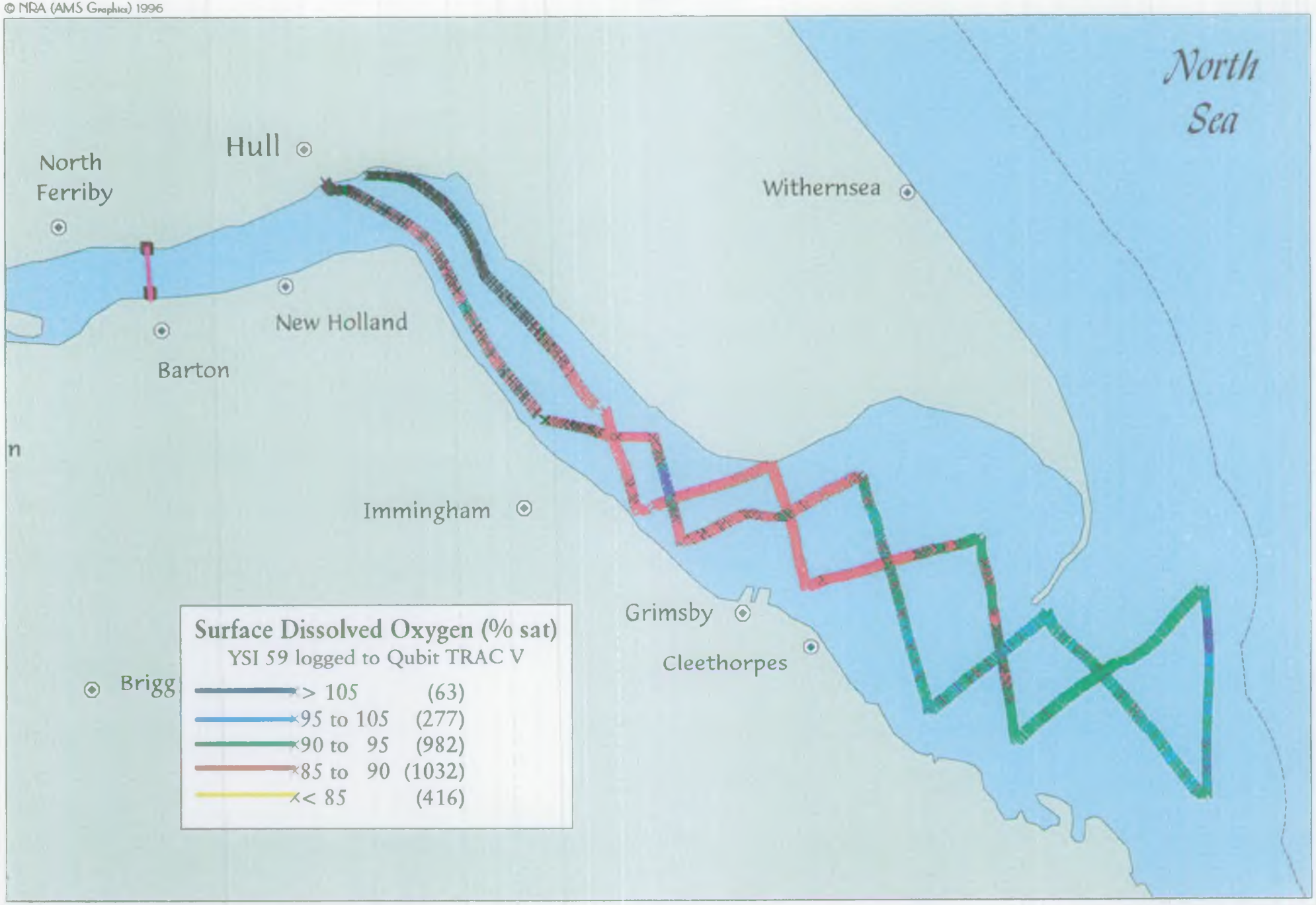


Figure 14b : Lower Humber Estuary. 20th December. 1994 - Dissolved Oxygen.

NRA - Anglian Region

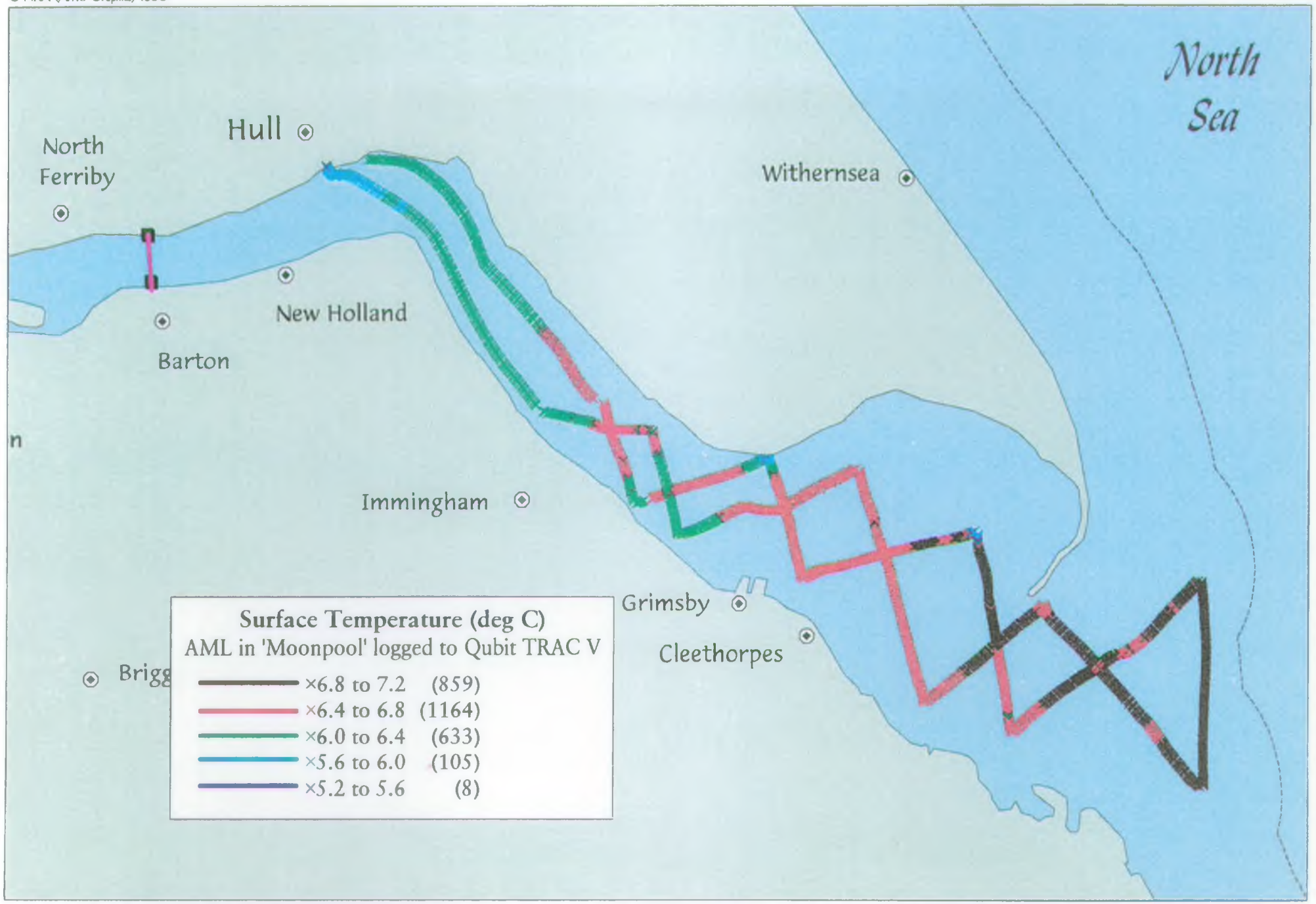


Figure 14c : Lower Humber Estuary, 20th December, 1994 - Temperature.

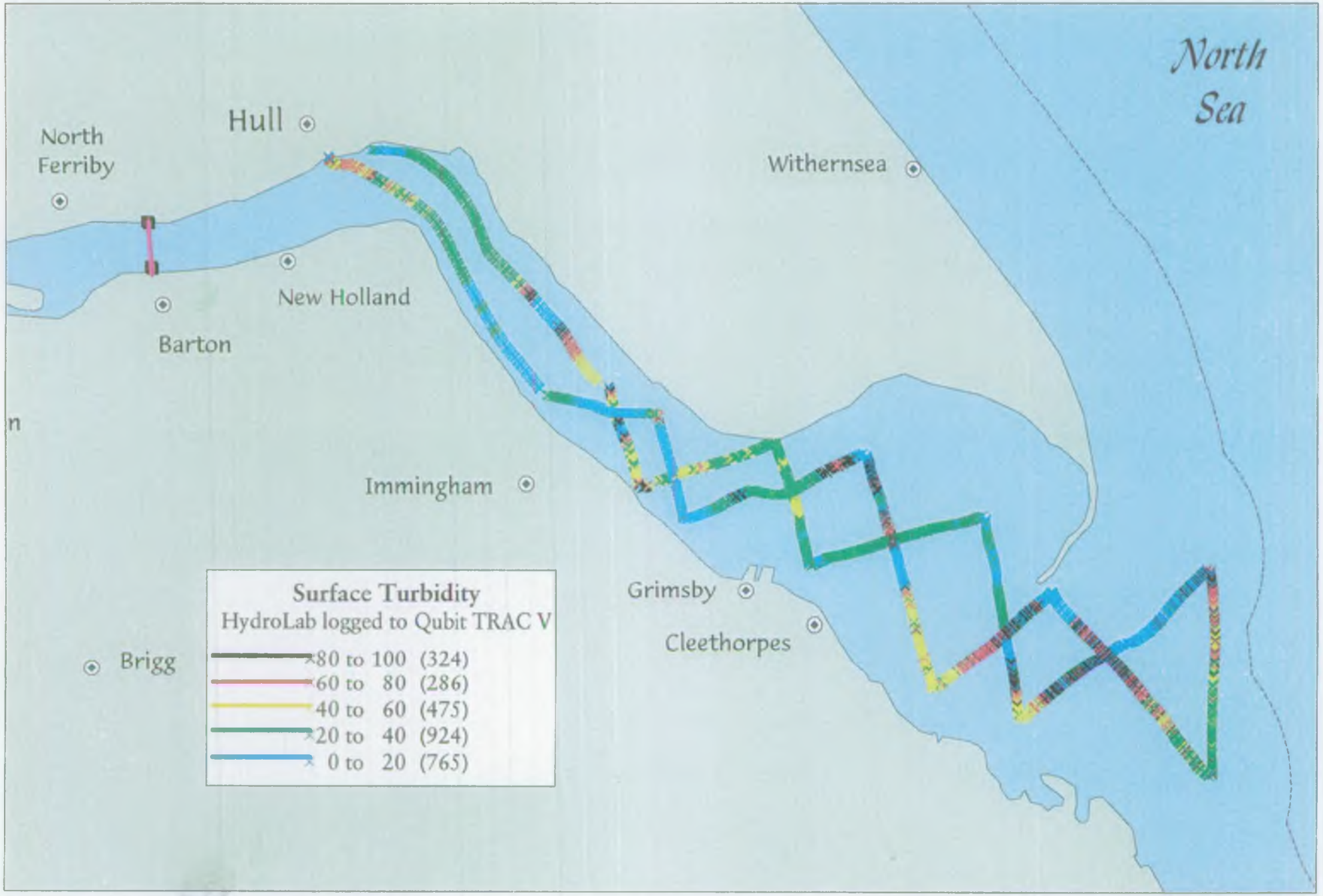


Figure 14d : Lower Humber Estuary, 20th December, 1994 - Turbidity (uncalibrated).

Anglian Site Name	Easting	Northing	Sample Point Name	Sample Point Code
H 2	484500	423500	HUMBER 0.1 KM O/S BLACKTOFT	R03BIHU484423
	485500	423500	HUMBER E.OUSE BEACON OFF FAXFLEET NESS	R03BIHU485423
	487500	423500	HUMBER W WALKER DYKE BEACON 1.3KM E APEX BUOY	R03BIHU487423
	489500	424500	HUMBER WHITTON CHANNEL OFF WHITTON	R03BIHU489424
H 4	491500	425500	HUMBER 0.5 KM O/S WHITTON NESS	R03BIHU491425
	493500	425500	HUMBER BROUGH SAND OPPOSITE TIDE GAUGE	R03BIHU493425
H 104	494500	424500	HUMBER 1.5 KM O/S WINTERINGHAM HAVEN	R03BIHU494424
	496500	424500	HUMBER CAPPER CHANNEL	R03BIHU496424
	498500	424500	HUMBER 0.8KM NE READS ISLAND	R03BIHU498424
H 106	499500	424500	HUMBER 1.1 KM O/S CHOWDER NESS	R03BIHU499424
	499500	425500	HUMBER 0.8KM SW OF CHOWDER NESS	R03BIHU499425
	502500	424500	HUMBER NO.23 FLOAT 0.3KM E OF HUMBER BRIDGE	R03BIHU502424
H 5	504500	425500	HUMBER NEAR HESSLE SAND 0.5 KM O/S	R03BIHU504425
	506500	426500	HUMBER NO.28 BUOY 2.6KM NE HESSLE SAND	R03BIHU506426
H 107	508500	426500	HUMBER BUOY 26A 0.5 KM O/S WEST HULL	R03BIHU508426
H 26 / H 108	510500	427500	HUMBER BUOY 26 0.5 KM O/S HULL MARINA	R03BIHU510427
	511500	428500	HUMBER NO.24 BUOY HULL ROAD	R03BIHU511428
H 21 / H 110	513500	427500	HUMBER BUOY 21 HEBBLES 0.4 KM O/S HULL	R03BIHU513427
H 20	514500	427500	HUMBER BUOY 20 0.3 KM EAST OF BUOY 21	R03BIHU514427
H 7 / H 16	515500	425500	HUMBER BUOY 16 SAND END 2.1 KM O/S	R03BIHU515425
H 112	515500	426500	HUMBER BUOY 18 ELBOW 1.1 KM O/S	R03BIHU515426

Table 1 : Humber Estuary - *Sea Vigil* Sample Sites

Anglian Site Name	Easting	Northing	Sample Point Name	Sample Point Code
H 113	516500	423500	HUMBER BUOY 14 SKITTER HAVEN 1.7 KM O/S	R03BIHU516423
	516500	425500	HUMBER BUOY 16 SAND END 2.1KM O/S	R03BIHU516425
H 17	517500	422500	HUMBER BUOY 17 NORTH HOLME 2.0 KM O/S	R03BIHU517422
H 115	518500	419500	HUMBER BUOY 15 HOLME NOOK 1.2 KM O/S	R03BIHU518419
H 11a	520500	417500	HUMBER BUOY 11A 1.3 KM O/S IMMINGHAM	R03BIHU520417
H 116	521500	417500	HUMBER BUOY 11 HOLME 1.2 KM O/S IMMING.	R03BIHU521417
H 10a	522500	415500	HUMBER BUOY 10A 1.1 KM O/S STALLINGBORO	R03BIHU522415
H 117	522500	416500	HUMBER BUOY 9A 1.5 KM O/S IMMINGHAM	R03BIHU522416
H 119	524500	415500	HUMBER BUOY 10 UPPER BURCOM 1.7 KM O/S	R03BIHU524415
H 6b / H 120	526500	414500	HUMBER BUOY 6B 3.0 KM O/S PYEWIPE	R03BIHU526414
H 136	528500	413500	HUMBER BUOY 6A 2.1 KM O/S GRIMSBY	R03BIHU528413
H 6 / H 121	530500	412500	HUMBER BUOY 6 LOWER BURCOM 2.2 KM O/S	R03BIHU530412
H 122	532500	411500	HUMBER BUOY 4B 3.1 KM O/S CLEETHORPES	R03BIHU532411
H 4a / H 123	534500	411500	HUMBER BUOY 4A CLEE NESS 4.4 KM O/S	R03BIHU534411
H 13	536500	410500	HUMBER BUOY 4 BULL CHANNEL 5.3 KM O/S	R03BIHU536410
H 2c	537500	406500	HUMBER BUOY 2C HAILE ANCHOR. 3.5 KM O/S	R03BIHU537406
H 124	538500	409500	HUMBER BUOY BULL 1.4 KM O/S SPURN	R03BIHU538409
H 2b	542500	405500	HUMBER BUOY 2B 6.8 KM O/S HAILE SAND	R03BIHU542405

Table 1 : Humber Estuary - *Sea Vigil* Sample Sites

Survey Date	Survey Area	Direction of Run	No. of Samples
27-January-94	Humber Profile	Up-stream	16
29-January-94	Humber Estuary	Down-stream	11
17-February-94	Humber Estuary	Up-stream	11
10-March-94	Humber Profile	Down-stream	33
25-March-94	Humber Estuary	Down-stream	11
21-April-94	Humber Estuary	Up-stream	3
22-April-94			8
04-May-94	Humber Profile	Down-stream	33
01-August-94	Humber Profile	Down-stream	33
16-August-94	Humber Estuary	Down-stream	11
09-December-94	Humber Transects	Down-stream	28

Table 2 : Humber Nutrient Surveys from *Sea Vigil* Sample Sites

Survey Date	Survey Area	Data Table	Nutrients Profile	Dissolved Oxygen Profile
27-January-94	Humber Profile	Table 4	Figure 2	Figure 2a
29-January-94	Humber Estuary	Table 5	Figure 3	Figure 3a
17-February-94	Humber Estuary	Table 6	Figure 4	No Data
10-March-94	Humber Profile	Table 7	Figure 5	Figure 5a
25-March-94	Humber Estuary	Table 8	Figure 6	Figure 6a
21-April-94 22-April-94	Humber Estuary	Table 9	Figure 7	Figure 7a
04-May-94	Humber Profile	Table 10	Figure 8	Figure 8a
01-August-94	Humber Profile	Table 11	Figure 9	Figure 9a
16-August-94	Humber Estuary	Table 12	Figure 10	Figure 10a
09-December-94	Humber - 14 Transects	Table 13	Figure 11	Figure 11a

Survey Date	Survey Area	Tidal State	Parameter Profiled	Figure No.
10-August-94	Upper Humber Estuary	Flood Tide	Dissolved Oxygen	Figure 12a
		Ebb Tide	Dissolved Oxygen	Figure 12b
20-October-94	Middle & Lower	Ebb Tide	Salinity, Temperature,	Figure 13a
	Humber Estuary	Flood Tide	DO & pH	Figure 13b
20-December-94	Middle, Lower	Ebb & Flood Tide	Salinity	Figure 14a
	& Outer	Ebb & Flood Tide	Dissolved Oxygen	Figure 14b
	Humber Estuary	Ebb & Flood Tide	Temperature	Figure 14c
		Ebb & Flood Tide	Turbidity	Figure 14d

Table 3 : Humber Surveys
Summary of Data Tables and Figures

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
27-January 04:14	H 6 / 121	Lower Burcom	27.39	4.92	13.2		97.0		59.6	1690	1840	33.1		
27-January 04:33	H 6b / 120	Pyewipe	27.08	4.92	15.8		96.6		62.0	1720	1870	34.0		
27-January 04:50	H 117	1.5km Immingham	25.59	4.86			95.6		78.5	2210	2260	42.6		
27-January 05:08	H 11a	1.3km Immingham	24.94	4.84			95.5		83.1	2270	2360	43.1		
27-January 05:20	H 115	Holme Nook	21.96	4.80	13.0		94.4		106.0	2860	3020	45.4		
27-January 05:33	H17	North Holme	21.12	4.79	10.0		93.2		110.0	3040	3130	52.4		
27-January 05:42	H 113	Skitter Haven	20.42	4.77	11.0		93.7		114.0	3130	3220	53.7		
27-January 05:54	H 112	Elbow	10.43	4.88	13.5		91.6		215.0	5340	5400	91.0		
27-January 06:06	H 21 / 110	Hebbles	9.58	4.90	11.0		90.9		233.0	5420	5590	99.2		
27-January 06:17		Hull Road	9.76	4.88	12.5		89.5		227.0	5190	5720	101.0		
27-January 06:27	H 26 / 108	Hull Marina	9.90	4.86	12.0		89.4		221.0	5260	5470	106.0		
27-January 06:40	H 107	West Hull	9.25	4.86	13.0		88.0		221.0	5300	5610	103.0		
27-January 06:51		Buoy 28	10.81	4.84	10.3		89.3		217.0	5020	5500	99.1		
27-January 07:06	H 5	Hessle Sand	9.25	4.88	6.0		88.2		228.0	5250	5390	102.0		
27-January 07:20		No 23 Float	4.07	5.17	10.4		89.6		312.0	5930	6100	115.0		
27-January 07:30	H 106	Chowder Ness	3.13	5.34	10.0		88.5		335.0	5880	6100	124.0		

Table 4 : Humber Profile Survey, 27th January 1994

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
29-January 08:53	H 26 / 108	Hull Marina	8.77	4.28	11.2	8.52	87.1	11.10	180.0	4910	5860	82.7		
29-January 09:05	H 21 / 110	Hebbles	9.43	4.31	9.9	8.48	87.5	11.13	177.0	4790	5700	84.7		
29-January 09:16	H 7 / 16	Sand End	10.91	4.31	11.0	8.46	88.2	11.23	161.0	4610	5380	82.4		
29-January 09:27	H17	North Holme	12.79	4.33	11.1	8.50	89.0	10.61		4380	5040	79.5		
29-January 09:40	H 11a	1.3km Immingham	14.95	4.33	10.7	8.53	91.1	10.86	133.0	4040	4640	74.9		
29-January 09:49	H 10a	Stallingborough	18.99	4.35	17.0	8.54	92.2	10.81	110.0	3350	3850	65.7		
29-January 10:00	H 6b / 120	Pyewipe	21.96	4.37	13.3	8.54	93.2	10.92	94.0	2720	3190	57.6		
29-January 10:12	H 6 / 121	Lower Burcom	24.35	4.38	9.0	8.55	94.0	11.01	77.7	2320	2610	47.8		
29-January 10:22	H 4a / 123	Clee Ness	26.71	4.44	11.0	8.53	94.7	11.08	60.3	1760	2060	39.5		
29-January 10:41	H 2c	Haile Anchor	28.38	4.36	10.7	8.50	95.5	10.22	48.1	1460	1720	38.5		
29-January 10:58	H 2b	Haile Sand	29.93	4.46	9.0	8.45	96.1	10.15	34.4	1130	1360	35.0		

Table 5 : Humber Estuary Survey, 29th January 1994

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
17-February 16:14	H 2b	Haile Sand	26.56	3.19	9.4				21.2	1850	1950	43.6		
17-February 16:33	H 2c	Haile Anchor	24.14	3.06	9.8				23.5	2320	2450	42.1		
17-February 16:54	H 4a / 123	Clee Ness	23.50	3.04	8.3				26.0	2540	2640	41.5		
17-February 17:09	H 6 / 121	Lower Burcom		2.90	7.5				22.9	3520	3600	53.7		
17-February 17:55	H 6b / 120	Pyewipe		2.92	14.1				23.7	3940	4050	58.1		
17-February 18:10	H 10a	Stallingborough	16.13	2.91	17.3				24.1	3900	4060	59.4		
17-February 18:22	H 11a	1.3km Immingham	15.55	2.97	9.4				25.4	4140	4290	62.0		
17-February 18:38	H17	North Holme	11.24	2.82	10.6				29.8	5190	5220	70.5		
17-February 18:50	H 7 / 16	Sand End	9.53	2.77	9.0				34.4	5470	5550	73.9		
17-February 19:01	H 20	Buoy 20	8.88	2.77	7.6				41.2	5680	5680	80.5		
17-February 19:14	H 26 / 108	Hull Marina	7.49	2.76	10.1				61.7	6020	6250	85.6		

Table 6 : Humber Estuary Survey, 17th February 1994

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
10-March 06:52	H 2	Blacktoft	0.65	7.31	5.6		83.4	9.98	308.0	6030	6600	124.0		2.0
10-March 06:59		Faxfleet Ness	0.72	7.33	7.4		83.2	9.94	287.0	6340	6710	126.0		4.3
10-March 07:07		Walker Dyke	0.78	7.44	6.6		81.0	9.66	271.0	6690	6970	141.0		4.7
10-March 07:15		Whitton Channel	0.94	7.40	6.4		80.7	9.61	245.0	6590	6950	125.0		2.7
10-March 07:22	H 4	Whitton Ness	1.15	7.35	5.9		80.9	9.65	236.0	6620	6820	127.0		3.7
10-March 07:29		Brough Island	1.81	7.15	5.9		82.1	9.79	215.0	6490	6680	124.0		3.5
10-March 07:35	H 104	Winteringham Haven	2.56	7.14	5.2		80.8	9.60	182.0	6580	6610	117.0		2.8
10-March 07:44		Capper Channel	3.30	7.04	9.3		80.5	9.54	148.0	6610	6480	109.0		6.9
10-March 07:51		Reads Island	3.65	7.00	6.1		80.5	9.52	159.0	6380	6450	111.0		6.0
10-March 07:59	H 106	Chowder Ness	5.18	6.86	6.8		79.5	9.34	126.0	6260	6200	101.0		3.7
10-March 08:11		No 23 Float	6.93	6.60	8.3		81.1	9.46	103.0	6060	5740	96.4		5.0
10-March 08:19	H 5	Hessle Sand	7.65	6.54	4.3		80.5	9.38	80.4	6020	5660	93.5		5.8
10-March 08:27		Buoy 28	8.26	6.47	7.5		81.4	9.47	82.6	5860	5160	96.0		10.8
10-March 08:33	H 107	West Hull	7.92	6.48	9.0		81.6	9.46	84.6	5840	5650	94.7		8.7
10-March 08:42	H 26 / 108	Hull Marina	7.84	6.53	9.1		81.2	9.47	92.5	5730	5640	94.7		11.2
10-March 08:49		Hull Road	7.60	6.57	10.3		81.1	9.39	92.8	5790	5680	95.0		5.4
10-March 08:56	H 21 / 110	Hebbles	9.22	6.46	13.7		81.5	9.40	85.8	5400	5350	90.0		3.3
10-March 09:04	H 112	Elbow	10.66	6.34	10.7		81.7	9.37	74.2	5330	5140	84.7		4.0
10-March 09:09		Sand End	12.39	6.21	10.2		81.5	9.27	68.9	5010	4910	83.2		5.1
10-March 09:14	H 113	Skitter Haven	12.77	6.15	10.1		82.8	9.37	66.2	4800	4590	78.9		6.0
10-March 09:21	H 17	North Holme	11.78	6.25	8.8		82.1	9.27	74.3	5020	4920	80.9		6.2
10-March 09:30	H 115	Holme Nook	14.31	6.07	8.6		83.0	9.41	60.4	4610	4400	76.4		6.1
10-March 09:40	H 11a	1.3km Immingham	14.91	6.06	10.6		83.8	9.38	61.0	4490	4240	74.2		6.6
10-March 09:46	H 116	1.2km Immingham	17.01	5.91	19.6		84.1	9.36	58.4	4080	3850	69.4		9.3
10-March 09:55	H 117	1.5km Immingham	17.18	5.90	16.9		83.9	9.34	55.3	4180	3890	67.9		5.2
10-March 10:02	H 119	Upper Burcom	17.68	5.87	15.6		84.4	9.36	54.6	3970	3740	65.5		8.5
10-March 10:13	H 6b / 120	Pyewipe	18.55	5.81	11.7		85.8	9.48	54.3	3790	3520	63.2		7.5
10-March 10:24	H 136	Grimsby	20.68	5.74	10.5		86.9	9.51	53.4	3350	3160	58.2		4.5
10-March 10:33	H 6 / 121	Lower Burcom	21.91	5.73	8.8		88.0	9.51	48.8	3090	2960	54.0		2.9
10-March 10:42	H 122	Cleethorpes	22.45	5.71	10.3		88.2	9.47	47.8	2940	2840	53.6		4.5
10-March 10:50	H 4a / 123	Clee Ness	23.39	5.69	10.1		89.2	9.55	46.7	2720	2620	49.2		6.8
10-March 11:00	H 13	Bull Channel	24.81	5.69	13.5		89.6	9.50	45.8	2430	2320	43.6		4.9
10-March 11:10	H 124	Spurn	26.88	5.65	13.7		90.7	9.53	37.1	1960	1910	41.8		4.1

Table 7 : Humber Profile Survey, 10th March 1994

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
25-March 06:53	H 26 / 108	Hull Marina	12.60	6.76	10.1	7.64	90.1		55.6	4640	4430	115.0		4.3
25-March 07:04	H 20	Buoy 20	16.02	6.58	9.7	7.66	92.2		40.9	3530	3500	91.4		4.3
25-March 07:14	H 7 / 16	Sand End	18.71	6.45	10.2	7.70	93.6		39.6	3090	3100	80.2		3.3
25-March 07:23	H17	North Holme	19.25	6.44	10.1	7.63	94.0		39.9	3200	3220	78.2		184.8
25-March 07:36	H 11a	1.3km Immingham	21.52	6.38	8.5	7.61	94.7		36.2	2790	2780	67.0		6.8
25-March 07:45	H 10a	Stallingborough	22.50	6.34	13.8	7.72	95.2		32.9	2620	2550	58.8		4.5
25-March 07:57	H 6b / 120	Pyewipe	25.92	6.23	11.0	7.66	96.2		30.0	1980	1910	44.3		4.0
25-March 08:10	H 6 / 121	Lower Burcom	27.94	6.19	9.0	7.68	96.8		27.8	1560	1550	32.7		4.3
25-March 08:21	H 4a / 123	Clee Ness	27.95	6.15	9.1	7.70	96.7		25.4	1570	1540	28.4		6.4
25-March 08:41	H 2c	Haile Anchor	29.47	6.22	9.9	7.73	97.1		22.2	1240	1270	32.4		2.4
25-March 09:00	H 2b	Haile Sand	30.67	6.03	10.4	7.80	97.4		17.1	1010	1060	31.6		1.8

Table 8 : Humber Estuary Survey, 25th March 1994

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
21-April 23:19	H 2b	Haile Sand	29.87	7.42	12.0	7.97	96.7		73.4	839	513	29.5		
21-April 23:37	H 2c	Haile Anchor	29.18	7.27	11.5	7.95	95.8		48.9	1990	1120	62.9		
21-April 23:59	H 4a / 123	Clee Ness	28.13	7.31	9.5	7.89	94.3		49.5	2254	1180	55.5		
22-April 00:15	H 6 / 121	Lower Burcom	27.73	7.43	8.0	7.87	93.7		56.6	2380	1260	58.0		
22-April 00:32	H 6b / 120	Pyewipe	25.40	7.36	15.3	7.87	92.8		58.2	2670	1420	65.3		
22-April 00:47	H 10a	Stallingborough	22.02	7.44	16.3	7.84	90.7		56.3	3120	1590	77.3		
22-April 00:59	H 11a	1.3km Immingham	22.22	7.53	10.1	7.83	90.0		68.1	3250	1600	78.4		
22-April 01:15	H17	North Holme	18.95	7.65	11.1	7.81	87.8		54.3	3780	1750	99.5		
22-April 01:28	H 7 / 16	Sand End	16.15	7.72	9.2	7.81	86.1		57.7	3770	1960	106.0		
22-April 01:38	H 20	Buoy 20	15.84	7.78	6.2	7.79	84.9							
22-April 01:52	H 26 / 108	Hull Marina	10.45	8.08	10.6	7.80	81.6							

Table 9 : Humber Estuary Survey, 21st- 22nd April 1994

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
04-May 15:08	H 2	Blacktoft	5.20	13.08	5.4	7.93	84.6		32.9	5680	2080	117.0		
04-May 15:17		Faxfleet Ness	5.10	13.08	6.8	7.93	84.9		30.7	6220	2100	114.0		8.0
04-May 15:26		Walker Dyke	6.63	12.98	7.1	7.89	84.9							6.8
04-May 15:34		Whitton Channel	6.82	12.93	6.4	7.89	84.5							5.6
04-May 15:43	H 4	Whitton Ness	8.00	12.81	5.5	7.86	84.1		23.6	5790	2070	112.0		4.6
04-May 15:51		Brough Island	8.41	12.84	5.4	7.86	84.6		24.3	5690	2150	106.0		6.3
04-May 15:58	H 104	Winteringham Haven	9.43	12.75	4.6	7.83	83.4		24.3	5670	2150	109.0		1.1
04-May 16:07		Capper Channel	9.64	12.86	8.6	7.85	85.3		29.2	5410	2110	105.0		
04-May 16:14		Reads Island	11.31	12.74	6.7	7.84	85.6		25.3	5370	2130	108.0		
04-May 16:22	H 106	Chowder Ness	13.68	12.43	6.3	7.78	83.7		40.7	5110	2080	106.0		
04-May 16:34		No 23 Float	14.08	12.49	8.6	7.79	83.8		30.1	4870	2060	101.0		0.9
04-May 16:43	H 5	Hessle Sand	14.39	12.41	5.1	7.80	84.7		27.2	4520	1900	97.3		1.5
04-May 16:53		Buoy 28	15.90	12.27	7.5	7.78	83.3		26.5	4380	1870	97.5		2.2
04-May 17:01	H 107	West Hull	.		9.3				33.7	4170	1810	94.6		1.5
04-May 17:10	H 26 / 108	Hull Marina	15.86	12.26	9.9	7.78	83.7		32.4	4050	1800	94.1		1.3
04-May 17:17		Hull Road	16.13	12.24	11.6	7.79	84.1		33.9	4000	1780	93.5		1.1
04-May 17:25	H 21 / 110	Hebbles	17.58	12.04	7.8	7.78	85.0		51.2	3880	1730	92.5		2.2
04-May 17:35	H 112	Elbow	18.85	11.86	10.1	7.76	85.5		36.4	3680	1670	89.5		1.4
04-May 17:41		Sand End	19.22	11.91	10.7	7.77	86.3		26.5	3413	1550	83.5		1.2
04-May 17:47	H 113	Skitter Haven	18.98	11.93	10.5	7.77	86.0		26.3	3330	1580	82.3		2.6
04-May 17:56	H 17	North Holme	19.60	11.86	9.6	7.77	86.2		28.5	3330	1550	81.6		1.4
04-May 18:07	H 115	Holme Nook	20.79	11.69	9.6	7.77	86.5		29.3	3250	1500	80.6		2.9
04-May 18:17	H 11a	1.3km Immingham	21.22	11.63	12.8	7.78	87.1		27.7	3040	1360	75.9		1.0
04-May 18:24	H 116	1.2km Immingham	21.89	11.55	20.1	7.78	87.4		30.0	2900	1340	72.8		
04-May 18:32	H 10a	Stallingborough	22.94	11.44	18.1	7.77	88.0		35.2	2750	1220	71.0		2.5
04-May 18:40	H 119	Upper Burcom	23.16	11.43	16.3	7.78	88.8		39.7	2480	1210	61.7		1.3
04-May 18:51	H 6b / 120	Pyewipe	24.59	11.34	12.1	7.81	91.0		31.5	2390	1070	60.3		0.6
04-May 19:03	H 136	Grimsby	24.97	11.27	11.1	7.82	91.1		38.4	2170	990	55.4		0.6
04-May 19:14	H 6 / 121	Lower Burcom	24.91	11.27	9.2	7.83	91.0		51.5	1960	1070	49.8		0.9
04-May 19:23	H 122	Cleethorpes	25.29	11.24	13.6	7.84	91.8		29.0	2130	1050	55.4		0.9
04-May 19:32	H 4a / 123	Clee Ness	25.90	11.14	9.8	7.83	92.2		37.9	1990	967	52.0		1.0
04-May 19:42	H 13	Bull Channel	26.40	11.11	13.5	7.85	92.6		36.2	1840	940	28.9		
04-May 19:55	H 124	Spurn	27.19	10.95	11.7	7.88	93.4		33.5	1730	846	40.6		

Table 10 : Humber Profile Survey, 4th May 1994

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
01-August 14:00	H 2	Blacktoft	7.54	21.14	5.5	7.63	58.4		15.0	7580	4513	182.0		5.4
01-August 14:15		Faxfleet Ness	8.07	21.00	7.1	7.63	60.6		10.0	6440	4791	199.0		4.3
01-August 14:28		Walker Dyke	12.80	20.79	6.8	7.61	68.4		<6	4750	3765	153.0		4.9
01-August 14:43		Whitton Channel	13.68	20.76	7.1	7.62	71.4		6.0	4980	3765	154.0		3.4
01-August 14:55	H 4	Whitton Ness	14.72	20.68	4.8	7.60	70.9		8.0	4870	3529	145.0		4.7
01-August 15:06		Brough Island	15.43	20.98	5.3	7.66	78.0		8.0	4720	3444	143.0		4.4
01-August 15:17	H 104	Winteringham Haven	15.54	20.87	4.5	7.64	75.9		8.0	4280	3444	139.0		4.0
01-August 15:28		Capper Channel	16.75	20.85	8.7	7.62	76.0		6.0	4380	3208	134.0		3.6
01-August 15:37		Reads Island	18.38	20.90	8.0	7.61	76.0		9.0	3950	2802	126.0		3.5
01-August 15:47	H 106	Chowder Ness	19.42	20.86	7.0	7.60	76.3		10.0	2730	2631	124.0		4.3
01-August 16:00		No 23 Float	20.79	20.65	8.2	7.58	74.0		8.0	3360	2374	121.0		3.7
01-August 16:09	H 5	Hessle Sand	20.49	20.66	4.6	7.58	73.8		9.0	3310	2331	117.0		4.3
01-August 16:21		Buoy 28	21.19	20.61	7.9	7.54	69.2		11.0	3170	2224	118.0		3.6
01-August 16:30	H 107	West Hull	21.64	20.64	9.2	7.55	70.4		13.0	3100	2139	117.0		3.5
01-August 16:40	H 26 / 108	Hull Marina	21.85	20.61	10.1	7.54	68.8		14.0	3110	2075	115.0		3.4
01-August 16:47		Hull Road	21.90	20.57	14.0	7.54	69.2		8.0	3050	2053	116.0		3.2
01-August 16:59	H 21 / 110	Hebbles	22.63	20.54	15.3	7.56	72.3		16.0	2820	2103	113.0		3.2
01-August 17:07	H 112	Elbow	23.50	20.33	11.4	7.57	74.0		7.0	2610	1899	106.0		3.0
01-August 17:16		Sand End	23.98	20.23	10.7	7.57	74.9		15.0	1970	1418	85.0		3.1
01-August 17:20	H 113	Skitter Haven	23.60	20.48	10.7	7.58	75.9		12.0	2570	1859	103.0		3.7
01-August 17:30	H 17	North Holme	24.44	20.33	9.4	7.58	76.6		10.0	2400	1722	101.0		3.3
01-August 18:00	H 115	Holme Nook	24.62	20.38	11.3	7.59	77.1		13.0	2230	1572	91.0		3.8
01-August 18:13	H 11a	1.3km Immingham	25.41	20.25	11.3	7.59	78.1							
01-August 18:24	H 116	1.2km Immingham	25.82	20.14	21.6	7.60	79.4		20.0	1910	1264	77.0		4.0
01-August 18:41	H 10a	Stallingborough	26.64	20.03	17.4	7.60	80.3		24.0	1840	1213	75.0		3.6
01-August 18:54	H 119	Upper Burcom	27.09	19.93	15.9	7.60	80.5		22.0	1770	1125	70.0		3.2
01-August 19:13	H 6b / 120	Pyewipe	27.59	19.84	12.0	7.60	81.1		25.0	1650	1020	64.0		3.0
01-August 19:30	H 136	Grimsby	28.01	19.91	10.7	7.64	84.7		21.0	1550	909	61.0		3.0
01-August 19:42	H 6 / 121	Lower Burcom	28.32	19.82	9.7	7.66	86.2		26.0	1460	838	56.0		3.2
01-August 19:55	H 122	Cleethorpes	28.98	19.71	14.0	7.65	86.2		26.0	1230	655	42.0		3.2
01-August 20:01	H 4a / 123	Clee Ness	29.18	19.65	16.5	7.66	87.4		21.0	1270	640	39.0		2.8
01-August 20:14	H 13	Bull Channel	29.87	19.51	13.9	7.71	89.2		28.0	1090	456	37.0		3.3
01-August 20:28	H 124	Spurn	29.97	19.67	12.5	7.76	93.7		20.0	1120	471	39.0		3.3

Table 11 : Humber Profile Survey, 1st August 1994

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
16-August 04:37	H 26 / 108	Hull Marina	22.15	17.70	9.0	7.61	69.1	5.33	23.7	3450	2299		8	1.9
16-August 04:49	H 20	Buoy 20	23.36	17.83	9.6	7.61	70.0	5.25	25.7	2977	2006		9	3.2
16-August 05:00	H 7 / 16	Sand End	24.32	17.79	10.0	7.63	72.6	5.39	25.4	2760	1835		8	3.4
16-August 05:12	H17	North Holme	24.56	17.74	9.0	7.63	73.4	5.45	30.3	2631	1724		9	3.1
16-August 05:28	H 11a	1.3km Immingham	26.73	17.73	7.6	7.66	76.9	5.73	29.8	2060	1373		12	4.7
16-August 05:39	H 10a	Stallingborough	27.64	17.58	12.5	7.69	78.3	5.81	22.2	913	524		9	5.1
16-August 05:54	H 6b / 120	Pyewipe	28.76	17.43	10.2	7.73	80.7	5.78	81.5	1131	592		12	4.2
16-August 06:11	H 6 / 121	Lower Burcom	29.57	17.25	10.1	7.75	83.3	5.91	52.5	1254	610		16	4.0
16-August 06:24	H 4a / 123	Clee Ness	29.91	17.27	10.1	7.76	84.5	5.94	61.0	1185	575		13	5.1
16-August 06:47	H 2c	Haile Anchor	31.55	16.84	10.2	7.93	91.7	6.48	59.9	757	329		11	2.3
16-August 07:06	H 2b	Haile Sand	32.50	16.64	10.6	8.00	94.4	6.68	54.5	614	229		8	3.5

Table 12 : Humber Estuary Survey, 16th August 1994

Date and Time	Site No.	Site Name	Field Salinity (‰)	Temp (°C)	Water Depth (m)	pH	DO (%sat)	DO (mg/l)	Ammonia (µg/l N)	TON (µg/l N)	Silicate (µg/l SiO_2)	Phosphate (µg/l P)	Nitrite (µg/l N)	Chloro phyll (µg/l)
09-December 08:42	XS 01 - south	Barrow Haven	8.14	6.20		7.67	84.7		50.0	5600	6150	115.0		
09-December 08:56	XS 01 - north	Barrow Haven	7.40	6.55		7.68	83.7		72.6	5650	6470	105.0		
09-December 09:26	XS 02 - south	W of Humber Bridge	6.42	6.19		7.71	84.4		80.3	5860	6660	118.0		
09-December 09:15	XS 02 - north	W of Humber Bridge	4.42	6.28		7.76	82.4		136.0	4170	4730	126.0		
09-December 09:52	XS 03 - south	E of Reeds Island	4.02	6.21		7.71	80.3		99.8	6310	7280	132.0		
09-December 10:11	XS 03 - north	E of Reeds Island	5.71	6.41		7.72	83.6		94.6	6020	6900	118.0		
09-December 10:43	XS 04 - south	Winteringham	2.96	6.18		7.74	81.0		129.0	6470	7280	135.0		
09-December 10:33	XS 04 - north	Winteringham	2.30	6.10		7.81	83.2		237.0	6420	7490	146.0		
09-December 12:19	XS 05 - south	Whitton Ness	2.27	6.09		7.73	80.9		213.0	6510	7440	144.0		
09-December 12:10	XS 05 - north	Whitton Ness	1.74	6.13		7.77	83.2		204.0	5990	5400	147.0		
09-December 11:27	XS 06 - south	East of Apex	1.44	6.11		7.74	79.5		242.0	7370	8490	179.0		
09-December 11:20	XS 06 - north	East of Apex	0.84	5.93		7.78	82.6		341.0	6090	7430	114.0		
09-December 11:45	XS 07 - south	Whitton Channel	1.69	6.01		7.76	81.6		265.0	6690	7580	149.0		
09-December 11:53	XS 07 - north	Whitton Channel	1.77	6.04		7.76	82.4		228.0	6500	7710	150.0		
09-December 14:23	XS 08 - south	Skitter Sand	11.00	6.69		7.69	85.4		34.9	4840	5460	95.2		
09-December 14:03	XS 08 - north	Skitter Sand	14.00	7.00		7.65	85.7		55.1	4200	4820	97.0		
09-December 14:57	XS 09 - south	North Holme	13.20	6.88		7.68	84.2		23.1	4420	4850	84.5		
09-December 15:13	XS 09 - north	North Holme	14.60	7.00		7.68	85.1		37.0	4200	4780	103.0		
09-December 15:56	XS 10 - south	u/s of SCM	17.30	7.20		7.66	85.1		14.1	3570	4050	72.5		
09-December 15:40	XS 10 - north	u/s of SCM	17.10	6.85		7.75	87.9		25.4	3710	4120	78.1		
09-December 16:01	XS 11 - south	d/s of SCM	17.50	7.17		7.67	86.3		24.1	3490	3880	73.6		
09-December 16:15	XS 11 - north	d/s of SCM	17.60	6.95		7.71	88.2		17.3	3430	3840	74.9		
09-December 18:15	XS 12 - south	u/s of Tioxide	25.10	7.38		7.71	86.5		26.5	1980	2130	48.2		
09-December 19:12	XS 12 - north	u/s of Tioxide	21.20	7.29		7.73	87.8		5.8	2750	3080	65.6		
09-December 19:41	XS 13 - south	d/s of Tioxide	23.30	7.30		7.71	88.9		9.7	2320	2570	51.1		
09-December 19:20	XS 13 - north	d/s of Tioxide	21.40	7.31		7.73	89.4		12.2	2710	3040	64.7		
09-December 17:55	XS 14 - south	Haile Sand / Spurn	28.40	7.36		7.82	91.9		8.7	1300	1540	48.1		
09-December 17:21	XS 14 - north	Haile Sand / Spurn	25.20	7.38		7.79	90.5		<5.4	1930	2240	60.8		

Table 13 : Humber Transect Survey, 9th December 1994