

'Sea Vigil' Water Quality Monitoring

Lincolnshire Coast Report



© AMS Graphics (1994)

National Rivers Authority
Anglian Region - Marine Section
Peterborough

February, 1994



Contents

EXECUTIVE SUMMARY	3
BACKGROUND.....	5
SURVEY AREA.....	5
OBJECTIVES.....	6
WORK PROGRAMME.....	7
RESULTS.....	7
COMMENTS.....	8
Ammonia:.....	8
Phosphate:.....	9
Silicate:.....	10
Nitrate (TON):.....	11
Nitrite:.....	12
Chlorophyll.....	12
Temperature.....	13
Salinity.....	13
DO data.....	13
Turbidity.....	13
ELECTRONIC DATA.....	13
CONCLUSIONS.....	13
RECOMMENDATIONS.....	14
FUTURE WATER COLUMN SURVEYS.....	14
TABLES	
FIGURES	



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 the surveys along the Lincolnshire Coast are reported here. Their purpose was to gain information on the nutrient levels in the coastal waters of the Anglian Region and to investigate some potentially "sensitive areas".

The Lincolnshire Coast between the Wash and the Humber is a 60 km stretch of relatively featureless sandy coastline with occasional mudflats. The sea is relatively shallow, being charted at less than 10 metres throughout the survey area.

Approximately every 2 months, surface water samples were collected from 11 sites along the Lincolnshire Coast and analysed on-board 'Sea Vigil' for nitrate, ammonia, phosphate, silicate and nitrite. Field data was also collected.

Although the Lincolnshire Coast has only minor freshwater inputs along its length, the data from these surveys does exhibit an unexpectedly varied concentration profile for each nutrient. This suggests that there are significant inputs, if only residual Humber Estuary water.

The coastal water between Huttoft and Ingoldmells frequently shows enhanced nutrient levels.

Phosphate reached very low concentrations in early summer, which appeared to lead to phosphate-limiting conditions near the Humber.

In late summer, nitrate-limiting conditions appeared to occur near the Wash.

Algal blooms were evident in both June 1992 and June 1993. Secondary blooms appeared to have occurred in September along the middle to northern part of the coastline.

The data so far is not sufficient to determine the status of these coastal waters. It will be necessary to determine appropriate background levels, possibly from measurements along the Yorkshire Coast to the north of the Humber Estuary.

It is recommended that a similar sampling programme is carried out along the coast, with much more chlorophyll data being collected, along with turbidity, dissolved oxygen and salinity. Knowledge of the phytoplankton and zooplankton would be an added benefit.

LINCOLNSHIRE COAST

WATER COLUMN SURVEYS

'SEA VIGIL', 1992 - 1993.

BACKGROUND.

Since 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 offshore coastal water sites between the Humber and the Thames, the area covered by the Anglian Region of the NRA.

During August, 1991, the Anglian Region of the NRA took delivery of its first coastal survey vessel. It started its work programme with an extensive benthic survey of the Wash, something not previously done by the NRA. In order to follow up with chemical surveys, analytical techniques were developed during the following months to analyse water samples for the low levels of nutrients encountered in outer estuaries and coastal waters. As a consequence, 'Sea Vigil' has been collecting nutrient information from a set of offshore sample points along the East Anglian coastline since April 1992, using an on-board auto-analyser, permitting immediate analysis. The data from those surveys along the Lincolnshire Coast are presented here. Separate reports will cover the Wash, The Humber Estuary and the East Coast (outer Wash to outer Thames).

Since there is a lack of historical data, it is difficult to make comparisons and provide explanations. A continuing programme of nutrient monitoring is planned for the coastal zones of Anglian Region, in order to overcome these deficiencies.

SURVEY AREA.

The Lincolnshire Coast is relatively featureless, stretching approximately 60 km from the Humber at Cleethorpes to the Wash at Gibraltar Point, near Skegness. It is a very open coast with few havens, dominated by a wall of steep sand dunes, beaches and flood defences, which protect a large area of low-lying coastal plain with predominantly arable agricultural interests.

The Louth Coastal Catchment area, which drains to this coastline via a number of minor rivers (e.g. Great Eau, Steeping, Louth Canal), covers an area of 1,040 km² and supports a rural population of 88,000, over 40,000 of which is centred on Louth, Skegness, Mablethorpe and Sutton-on-Sea. Industry is limited with only three major industrial discharges in the catchment. There are no industrial outfalls along the coast, although there are a large number of offshore oil and gas installations. There are 22 sewage

treatment works within the catchment, with only one discharging direct to sea via a sea outfall, at Ingoldmells. Bathing waters in the vicinity of this outfall have complied with EC Bathing Water Directives from 1988 to 1993. It can be concluded that the main pollution risks arise from agricultural and sewage outputs.

This coastline is of regional importance as a holiday destination for many people living in the East Midlands and South Yorkshire. The population of the catchment can increase by 150,000 during the peak summer holiday season, with an additional 33,000 day visitors. The Lincolnshire Coast is also of conservation importance due to its proximity to the Humber and the Wash, both of which are recognized important wildfowl and wader wintering sites. Actually located on this coast is a National Nature Reserve at Saltfleet and an RSPB reserve at Tetney.

Due to the bleakness and relative isolation of the coast in this part of the country, there are a number of military aircraft bombing ranges, used by British, American and European Air Forces on a virtually daily basis. There is one on the extensive mud flats of Donna Nook and another at Wainfleet Sands, just inside the Wash southwest of Skegness. These ranges necessarily place constraints on vessel movements, preventing 'Sea Vigil' sampling as close inshore as would be desirable.

The sea is relatively shallow along the coast, the area enclosed by the 3-mile limit being charted at less than 10 metres, with occasional overfalls (caused by tidal streams over shallow banks in the sea) further offshore. At the northern end near Donna Nook, it was too shallow for 'Sea Vigil' to sample safely within the 3-mile limit.

OBJECTIVES.

The initial purpose of these surveys was to gain information on nutrient levels in the coastal waters of the Anglian Region, particularly on a seasonal basis. Subsequently, the coming into effect of the Urban Waste Water Treatment Directive (UWWTD) has required the investigation of potentially "sensitive areas" which includes the Anglian coastal zone and the Wash estuaries.

The UWWTD sets standards for Phosphorus and Nitrogen sewage discharges in areas designated as "Sensitive Areas (Eutrophic)". In effect the saline sites (estuarine or coastal) would only have Nitrogen limits, since that is the limiting nutrient in these areas. The values are:

Phosphorus	2 mg.l ⁻¹ for works with 10,000 to 100,000 population
	1 mg.l ⁻¹ for works with > 100,000 population
Nitrogen	15 mg.l ⁻¹ for works with 10,000 to 100,000 population
	10 mg.l ⁻¹ for works with > 100,000 population

The original DoE guidance for classification states that Estuaries and Coastal Areas can be considered **Eutrophic** if:

Algae densities	> 5 x 10 ⁵
Chlorophyll A	around 10 mg.m ⁻³
Nitrate	Significantly enhanced relative to a background level.

These are only guidelines and even if an area met all of the criteria it may not have been considered in the first phase of designations in 1993. New guidelines are being considered for the next phase of designations in 1997.

Anglian Region has no designated coastal Nitrogen limited Sensitive Areas (Eutrophic).

WORK PROGRAMME.

For operational reasons, surveys of the Lincolnshire Coast were usually part of a three day coastal run covering the coast from Hull in the Humber Estuary to Shoeburyness in the outer Thames Estuary (or vice versa, since the survey may be in either direction).

Tidal constraints mean that it is more effective for 'Sea Vigil' to travel with the tide than against it. As a consequence, surveys usually take place under a similar tidal state for a particular direction, although the implications of this are not yet known.

In the absence of other data, the sample sites were initially defined at approximately 5 km intervals, halfway out to the 3 mile limit, assuming that this coastal zone was well mixed, i.e. the midpoint was representative of the coastal zone. The northernmost sites had to be relocated further offshore because of the bombing ranges at Donna Nook, as well as the extensive shallows in those areas.

Water was collected from the surface layer of the sea, at a standard set of 11 sites, shown in Figure 1, with site details in Table 1. Field data was collected at the same time, including temperature, salinity and dissolved oxygen. Samples were immediately filtered and then put through the auto-analyser. The methods employed contained built-in Analytical Quality Control procedures and have satisfactorily passed special marine AQC exercises, particularly the stringent ones prepared for ICES (International Council for the Exploration of the Seas). Results were then sent to Peterborough for entering onto the laboratory database.

RESULTS.

The nutrient data reported here is from water column samples, filtered after collection through 0.45µm membrane filters and is therefore termed "dissolved nutrients". All results are in microgrammes per litre ($\mu\text{g.l}^{-1}$) and are given, by site, in Tables 2 to 12. There is some chlorophyll data. Field data are also given.

In this summary, the term nitrate is used in preference to T.O.N. (Total Oxidised Nitrogen). There is an analytical distinction, caused by nitrite. 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 graphs, as follows.

- | | |
|------------------------|--|
| Figure 2 (a, b): | Nutrients versus Date, by Site; |
| Figure 3 (a, b, c, d): | Nutrients versus Location by Date; |
| Figure 4: | Nutrients on transect at Chapel-St-Leonards (23/9/93);
Nutrients on transect at Skegness (23/9/93); |

Figure 5a:	Ammonia Seasonal Changes (All Sites);
Figure 5b:	Phosphate Seasonal Changes (All Sites);
Figure 5c:	Silicate Seasonal Changes (All Sites);
Figure 5d:	T.O.N. Seasonal Changes (All Sites);
Figure 5e:	Nitrite Seasonal Changes (All Sites);
Figure 5f:	Chlorophyll Seasonal Changes (All Sites);
Figure 5g:	Temperature Seasonal Changes (All Sites);
Figure 5h:	Salinity Seasonal Changes (All Sites);
Figure 5i:	Dissolved Oxygen Seasonal Changes (All Sites);

Salinity variations were considered to be too small to be significant, especially as the salinometer used was not to oceanographic specification. To date, it has not been possible to make allowance for the variations in tidal state, nor to estimate how critical it is to the interpretation of the data.

COMMENTS.

The survey should provide information in two forms:

- 1) Variations in spatial distribution of nutrient concentrations;
- 2) Seasonal variations in nutrient concentrations.

There are a number of factors pertinent to the explanation of the data:

- there are no major fresh water inputs to this coastal zone;
- there is a sewage sea outfall near site LC 04, off Ingoldmells;
- the shallow waters should ensure good mixing;
- a thermocline is unlikely to develop in summer and nutrient stripping is therefore unlikely;
- the strong tides in the area should create enough water turnover for sufficient light energy to facilitate a normal level of photosynthetic activity;
- the deposition and resuspension of sedimentary material will influence the budgets of the dissolved nutrients;
- the consistent high salinity level should enable a stable species diversity in the water column;
- soluble nutrients are part of a very complex chemical equilibrium, involving phytoplankton, zooplankton and sediments.

Ammonia:

Although most phytoplankton species preferentially use ammonia as their nitrogen source, ammonia is expected to be low in well oxygenated waters such as the Lincoln-

shire Coast. However, the organic nitrogen compounds produced by excretion or death of organisms are rapidly broken down to ammonia by bacteria in the water. These competing processes can be difficult to recognise from ammonia data.

From the data of Figure 2, it is clear that ammonia levels rise and fall more frequently than the levels of the other nutrients.

From the site off Ingoldmells northwards to Saltfleet, the ammonia concentrations rose sharply around May 1993, after the sharp decline in silicate concentrations but coincided with plummeting nitrate levels. This reflects the anticipated rise in excretion products associated with a phytoplankton bloom and possibly a consequential zooplankton bloom. At each site, there was an observable fall in ammonia about two months later, followed by a second peak in ammonia concentrations around September 1993. Except at Ingoldmells, the second peak was lower and similarly appears to represent an Autumn bloom. The three sites at the Wash end only seem to have a significant bloom in the second period.

These phenomena are not so clearly identified during 1992.

Ammonia concentrations are at their lowest between October and April, in contrast to the other nutrients.

There is no consistent geographical trend in ammonia concentrations along the coast although there are some significant events.

Firstly, there were a number of surveys where ammonia levels increased in a southerly direction, in contrast to nitrate and silicate levels, particularly in November 1992 and October and November 1993.

Secondly, there were a number of surveys when a significant peak in ammonia concentration was observed in the middle of the coast in the Chapel St. Leonards/Ingoldmells area, particularly August 1992 and August 1993. It is possible that this reflects the additional sewage effluent, as a result of the increased seasonal holiday population in this area. In comparison, ammonia levels in the outer Wash in August 1992 (Wash Survey) were similar to the coastal data except for the above sites, which matched ammonia levels off the mouth of the Nene estuary.

The transect carried out from Chapel St. Leonards in September 1993 (Figure 4) showed ammonia levels to rise by about 20% between the shore zone and the normal sample point 3 km offshore, with only a gradual decline over the next four kilometres. This would appear to be evidence of the sea outfall at Ingoldmells but is not conclusive, although the other nutrients do not show the same trend. Neither does the data from the other transect off Skegness (Figure 4).

Phosphate:

As a guide, phytoplankton contains roughly eight times more nitrogen than phosphorus, on a dry weight basis. This suggests that phytoplankton need to absorb around ten to fifteen times more dissolved nitrate/ammonia than phosphate, allowing for their differing atomic weights.

It is well established that for phosphate concentrations greater than about $10 \mu\text{g-P.l}^{-1}$, the rate of growth of many species of phytoplankton is independent of phosphate concen-

trations and it is doubtful if phosphorus is ever growth limiting in the sea.

In waters significantly affected by sewage discharges, effluents containing detergents or runoff water from farm land (to which excessive amounts of fertiliser have been applied), can result in conditions leading to very rapid proliferation of phytoplankton. When they die, they soon strip the water of its dissolved oxygen, causing eutrophication in severe cases. It seems probable that phosphorus is the main cause of such eutrophication.

In general, the phosphate profile of waters along the Lincolnshire Coast was as expected; a steady rise in concentration between July and November, a slight decline until April (possible loss to sediments), followed by a dramatic fall around May to a seasonal minimum until July (plankton bloom). The profile was slightly different close to the Humber (Saltfleet northwards) when there was a temporary break in the phosphate regeneration in early September, suggesting an autumn bloom.

Throughout the period November to April, there was very little change in the phosphate concentrations along the whole coast (about $30 \mu\text{g-P.l}^{-1}$ in 1992/93). This plateau was the most distinctive feature of the phosphate profile and did not happen with the other nutrients (except possibly Nitrite, which was too low to be certain). At that time, when nutrients were being released back into the water column and there was a major decline in phytoplankton populations, the N:P ratio along the coast was about thirty-five. Only if there were sufficient algal growth to consume the phosphate would it become a limiting nutrient, which was obviously not the case since phosphate levels actually increased at that time of year.

However, in May/June time, major growth did take place, causing rapid uptake of available nutrients. Since more nitrogen is required than phosphorus, the N:P ratio soon fell. In June 1993 (Figure 3c), nitrate concentrations fell below phosphate levels along the middle of the coast, leading to possible nitrogen-limiting growth, although the very high ammonia levels appear to have compensated. At the northern sites near the Humber, there was a different picture. Phosphate levels had fallen almost to zero ($< 2 \mu\text{g-P.l}^{-1}$), whilst nitrate levels were very much higher, probably leading to phosphate-limiting growth, which would sustain the higher nitrate levels. A similar picture was observed in July 1992, although ammonia levels were much lower.

By August (1992) the N:P ratio ranged from 1 at the Wash end to 10 at the Humber end, suggesting nitrogen-limiting conditions had been re-established.

Silicate:

Usually, dissolved silicate is comparatively high in coastal waters because of freshwater runoff. However, with no significant freshwater inputs this should not apply. In fact, the silicate levels were very similar to the nitrate levels at all sites during all surveys. This is in distinct contrast to the Wash where in August 1992, silicate was around fifteen times the nitrate level, although the Witham showed a ratio of about three times, presumably because of significant nitrate inputs.

At most sites, the silicate bloom period coincided with the phosphate bloom period but preceded the nitrate bloom period, as would be expected. However, significant silicate regeneration appeared to commence a little later in the summer than would be anticipated. Also, south of Chapel St. Leonards, the silicate minimum was reached

earlier and was over later than for the sites north of there. This suggests influence by high silicate levels from the Humber.

Silicate levels reached their peak around November, generally dropping off slightly until April, followed by a dramatic decrease to minimum levels in May. This late Winter decline in concentration could reflect the incorporation of silicate into the sediment, either chemically or by sinking.

In the Spring, silicate levels always dropped away before nitrate suggesting a significant diatom population.

Silicate levels were nearly always highest at the northern end of the coast, reflecting the inputs to the North Sea from the Humber. Sometimes, the site off Donna Nook was slightly depressed in relation to adjacent sites. This probably reflects the fact that it is further offshore than the other sites, whilst the direction of sampling (and hence tidal state) does not appear to be related.

There is evidence from a transect off Chapel St. Leonards (Figure 4) that silicate concentrations decline away from the coast.

Data from the survey of 23rd November 1993 do not fit this established pattern. After the first two sites near the Humber, silicate levels showed an upward trend to a maximum at the edge of the Wash. Normally, this is the time of year when dissolved silicate is rapidly regenerated, so this phenomena may reflect unusually good mixing along the coast caused by high freshwater flows from the Humber and the Wash estuaries. The unusual extended peak in silicate concentration south of the Humber on the 7th October 1993 may have been the start of this phenomena.

The silicate concentrations in November 1993 were of the order of 50% higher than the previous November at the southern end near the Wash and also at the Haile Sand Flat site at the mouth of the Humber, with the sites in between having lower values in 1993. This could be an indication of significant fresh water flows in the late autumn of 1993.

Only on one other survey, 17th August 1992, did the silicate concentration rise in a southerly direction, this time at the site off Huttoft. This rise was reflected by ammonia and phosphate levels but not by nitrate levels. It is possible that the nitrate had reached such low levels that it had become nitrate limiting and the rise in the other nutrients was due to release from dead organisms.

Nitrate (TON):

In general, the nitrate profile of waters along the Lincolnshire Coast was as expected; a steady rise in concentration from August to a December peak, a significant decline until April (probable loss to sediments), an unusual, but significant rise until May, followed by a dramatic fall (plankton bloom) to a seasonal minimum from June to August. There was evidence of a secondary bloom in September. The profile was slightly different at the southern end, near the Wash (Ingoldmells southwards) when there did not appear to be either an unusual rise in April/May or a secondary bloom in September.

As already mentioned, the decline and rise of nitrate concentrations occurred a little later than for silicate and phosphate.

Also, in June 1993 nitrate concentrations fell below phosphate levels along the middle

of the coast, leading to possible nitrogen-limiting growth, although the very high ammonia levels may have compensated. At the northern sites near the Humber, phosphate levels had fallen almost to zero, whilst nitrate levels were very much higher, probably leading to phosphate-limiting growth, which would sustain the higher nitrate levels. A similar picture was observed in July 1992, although ammonia levels were much lower.

Unlike phosphate, there were very distinct trends in winter nitrate concentrations along the coast. Only for a short period around March/April time was the nitrate concentration relatively constant between the Humber and the Wash. Even then, there was a small downward trend in concentration from the Humber to the Wash, reflecting its high input. Throughout the remainder of the year, there was always a distinct downward trend in nitrate concentration southward from the Humber, although the location of the steepest decline varied: Ingoldmells (June '92); Theddlethorpe (August '92); Trusthorpe (September '92); Chapel St. Leonards (January '93, May '93, October '93).

In January '93 there was a rise between the Humber and Saltfleet and a fall again towards Ingoldmells to a steady level.

Similarly, in October '93, nitrate levels rose between the Humber and Trusthorpe but fell again towards Ingoldmells to a steady level, although the values were much lower than in January.

In November '93, nitrate levels actually rose after the Humber towards the Wash, reaching a level almost the same as the Humber end.

Between July and August ('92 and '93) there was very little nitrate along the entire coast. The highest levels were at the Humber end with concentrations falling below those of phosphate at the Wash end, i.e. phosphate levels recovering before nitrate levels.

Nitrite:

Nitrite occurs at very low levels and is rapidly oxidised to nitrate, although it can provide meaningful information on nutrient processes.

The nitrite data was not as comprehensive as for the other nutrients. However, it would appear to have started regeneration before nitrate in October '92.

From the evidence, it would appear to have similar profiles to phosphate but at a much lower concentration. The minimum values appeared to occur in August '92.

As mentioned under nitrate, the November '93 survey produced anomalous results. Nitrite levels rose significantly southwards of Huttoft, reaching a maximum at the Wash, as did ammonia, nitrate and silicate (excluding the site nearest the Humber).

Chlorophyll.

There is only limited chlorophyll data available, for the period May to October, 1993 (Figure 5f). It is hoped to provide electronic chlorophyll data in the next report. This has been measured by a fluorescence technique, still undergoing trials.

From May to August, chlorophyll values for the two sites closest to the Humber seemed to follow an inverse pattern to most of the other sites, which showed a minimum in June

and a maximum in May.

Temperature.

All sites showed virtually identical temperature profiles (Figure 5g) with a minimum in January/February and a maximum in early August. There was over a degree difference between August '92 and August '93.

Salinity.

Except for the late 1992 data, the salinity along the Lincolnshire Coast seemed to be steady around 32 ‰ (Figure 5h).

DO data.

The mean level of dissolved oxygen along the Lincolnshire Coast was consistently around 96% saturation (Figure 5i).

There were significant deviations from this around both June '92 and June '93, reaching levels of nearly 130% saturation. This phenomena is usually associated with a plankton bloom and ties in with the blooms suggested by the nitrate and phosphate data.

Turbidity.

There is currently no processed turbidity data, since this has been recorded electronically.

ELECTRONIC DATA.

No electronic data has been processed to date. This will be presented in a future report.

CONCLUSIONS.

- It is not possible to say whether any of the nitrate levels along the Lincolnshire Coast are significantly enhanced relative to a background level, until it is clear what such a background level is. It may be possible to use the nitrate levels off the Yorkshire coast between the Humber and Flamborough Head as a background, since this area appears to maintain a steady level of nutrient and does not appear to be influenced by the Humber Estuary, although the coastal water is deeper than that along the Lincolnshire Coast (charted over 10 metres).
- Although the Lincolnshire Coast has no major inputs along its length, the coastal water does exhibit a varied concentration profile for each nutrient. This suggests that there are significant inputs,

either direct discharges or else a complex combination of discharges and residual Humber Estuary water.

- The coastal water between Huttoft and Ingoldmells frequently shows enhanced nutrient levels.
 - Phosphate levels can reach very low concentrations in early summer, after the first bloom. This has little effect at the southern end of the coast, where nitrate levels are also low. However, at the northern end, near the Humber, it appears to lead to phosphate-limiting conditions.
 - In late summer, the nitrate levels fall below the phosphate levels at the southern end of the coast, leading to nitrate-limiting conditions.
 - Algal blooms can be identified from the data as having occurred in June 1992 and June 1993.
 - Whilst it is not possible to be certain how the direction of sampling affects the value of the data, it is unlikely to be very significant, since the most important changes are seasonal.
-

RECOMMENDATIONS.

- It would be necessary to determine background levels of nutrients before the data could be used to assist with designation under the UWWTD.
 - The Lincolnshire Coast data needs to be tied in with data for both the Humber and the Wash and compared with data for other East Coast waters.
 - It would be of benefit to confirm that the direction of sampling does not put any undue bias on the results.
 - Whilst monitoring the water along the Lincolnshire Coast, it would be of benefit to assess the offshore nutrient gradient.
 - It is necessary to monitor the chlorophyll a concentrations as well as the nutrients.
 - It would be of benefit to acquire some information on the phytoplankton and zooplankton along the Lincolnshire Coast.
-

FUTURE WATER COLUMN SURVEYS.

During 1994, there is a planned programme of monthly surveys along the Anglian coastline, collecting nutrient samples at similar sites, including offshore transects, as well as electronic data collection at variable depths. It is hoped to modify, change or add to existing sites in order to provide better coverage of the coastal zone. It may be necessary to sample outside the three mile limit, in order to gain information on the influence of the Humber on the waters of the Lincolnshire Coast, as well as determining

whether nutrient levels decrease away from the coast.

It is likely that a minimum of monthly monitoring will be necessary in order to provide adequate data for UWWTD designation.

There may well be opportunities to process data from fixed sites for evidence of a thermocline, which could lead to eutrophication.

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

Anglian Site Name	Easting	Northing	Sample Point Name	Sample Point Code
LC 01	560500	347500	WASH - LYNN DEEPS	R05BJWA560347
LC 02	560500	357500	LINCS COAST OUTER DOGS HEAD 4.5 KM O/S	R03BJLC560357
LC 03	561500	363500	LINCS COAST SKEGNESS 3.9 KM O/S	R03BJLC561363
LC 04	560500	369500	LINCS COAST INGOLDMELLS 3.4 KM O/S	R03BJLC560363
LC 05	558500	374500	LINCS COAST CHAPEL-ST-LEONARD 3.0 KM O/S	R03BJLC558374
LC 06	556500	379500	LINCS COAST HUTTOFT 3.3 KM O/S	R03BJLC556379
LC 07	554500	384500	LINCS COAST TRUSTHORPE 3.3 KM O/S	R03BJLC554384
LC 08	552500	390500	LINCS COAST THEDDLETHORPE 3.6 KM O/S	R03BJLC552390
LC 09	551500	395500	LINCS COAST SALTFLEET 5.7 KM O/S	R03BJLC551395
LC 10	551500	402500	LINCS COAST DONNA NOOK 9.0 KM O/S	R03BJLC551402
LC 11	547500	405500	LINCS COAST HAILE SAND FLAT 7.5 KM O/S	R03BJLC547405

Table 1 : Lincolnshire Coast 'Sea Vigil' Sample Sites

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug/l)	Time After HW Dover
05 April '92	15	218	307	14.9	1.2		-02:39
28 April '92	19	353	432	28.0	5.4		04:08
10 June '92	21	<2.3	33	<1.15	<0.3		07:13
27 July '92	16	3	20	4.4			
05 August '92	23	<2.33	45	6.0	0.4		-03:00
25 August '92	32	20	92	9.3			-02:49
15 December '92	64	725	666	28.2			10:34
05 May '93	14	688	7	10.2	11.0	15.0	04:21
15 June '93	42	13	24	<1.15		2.1	-02:00
07 August '93	28	7	24	5.2		6.2	04:31
31 August '93	32	20	79	7.4	1.7	6.2	05:51
23 September '93	89	85	265	22.3	3.5		04:47
07 October '93	76	182	373	26.0		2.6	-02:00
23 November '93	43	957	1,075	35.0	12.4		

Field Data

Date	Temp (deg C)	Saln. Field (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH Field	DO Field (% Satn)	DO Field (mg)
05 April '92	7.1	32.5		33.5			
28 April '92	9.2	32.1		35.2		96	
10 June '92	14.9	31.4		38.7		119	
27 July '92	18.4	32.3		35.0		107	
05 August '92	18.0	29.1		36.5		100	
25 August '92	16.0	28.8		36.5	8.1	98	
15 December '92	6.7	30.6		50.0		99	9.9
05 May '93	11.4	30.5	1.0	34.7	8.5	123	11.1
15 June '93	15.2	33.1	1.0	35.0		92	7.5
07 August '93	17.0	34.1	1.0	34.9	8.2	100	9.7
31 August '93	15.9	33.8	1.0	37.0	8.2	101	8.2
23 September '93	14.7	33.2	1.0	36.0	8.3	92	7.6
07 October '93	13.5	33.2	1.0	36.0	8.2	100	8.6
23 November '93	6.7	31.5	1.0	36.0		96	9.4

Table 2 : Lincolnshire Coast at Wash Lynn Deeps (LC01)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug/l)	Time After HW Dover
05 April '92	25	296	405	19.3	3.1		-02:03
28 April '92	25	417	420	26.7	6.2		03:33
10 June '92	20	<2.3	53	<1.15	<0.3		08:06
29 July '92	17	<2.33	29	1.2			04:16
05 August '92	25	<2.33	69	8.7	<0.3		-02:22
17 August '92	32	12	146	10.1	1.2		03:53
25 August '92	27	12	76	8.8			-02:16
28 September '92	50	55	140	16.0	3.6		04:22
10 November '92	55	380	502	28.3	15.6	3.1	03:14
15 December '92	41	752	679	28.1			11:04
29 January '93	23	535	549	27.6	3.6	0.9	03:52
15 March '93	30	518	529	25.6	4.6		03:53
07 April '93	40	436	391	24.5	4.4		06:58
05 May '93	12	463	21	12.9	6.7	11.3	03:49
07 June '93	34	8	48	2.5		<1	
15 June '93	23	4	73	<1.15		3.7	-01:29
07 August '93	25	7	23	4.1		8.6	03:58
18 August '93	35	19	45	7.0	2.0	5.2	
31 August '93	28	10	88	7.5	0.7	3.5	06:39
23 September '93	48	67	177	14.6	2.2		04:09
29 September '93	94	120	296	21.7	5.8		
07 October '93	66	160	331	24.0		1.3	-01:24
23 November '93	43	957	1,075	35.0	12.4		

Field Data

Date	Temp (deg C)	Salinity (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH	DO (% Satn)	DO (mg/l)
05 April '92	6.9	32.7		12.5			
28 April '92	9.7	32.6		12.0		96	
10 June '92	15.6	31.6		13.8		108	
29 July '92	18.0	32.2		11.0		104	
05 August '92	17.8	32.2		12.1		100	
17 August '92	17.5	31.6		10.7		95	
25 August '92	16.7	29.3		12.1	8.1	99	
28 September '92	14.7	29.0		10.9	8.2	98	8.3
10 November '92	9.1	31.5	0.5	11.6	8.4	98	9.1
15 December '92	6.7	31.8		12.5	7.9	97	9.6
29 January '93	5.2	33.3	1.0	12.1	8.2		10.0
15 March '93	5.4	32.9	0.5	12.6	8.1	100	10.1
07 April '93	7.0	33.2	1.0	16.7	8.3	100	9.7
05 May '93	10.5	31.7	1.0	12.0	8.4	114	10.3
07 June '93	14.6	33.4	1.0	10.3		105	8.6
15 June '93	14.6	33.1	1.0	13.1	8.4	99	8.2
07 August '93	16.9	34.8	1.0	12.1	8.2	104	10.1
18 August '93	17.0	33.6	1.0	10.1	8.2	104	8.2
31 August '93	16.2	33.7	1.0	15.3	8.2	101	8.1
23 September '93	14.8	33.7	1.0	13.1	8.3	95	7.8
29 September '93			7.0	12.0		98	
07 October '93	13.4	33.4	1.0	12.6	8.3	102	8.5
23 November '93	6.6	31.5	1.0	36.0		96	9.4

Table 3 : Lincolnshire Coast at Outer Dogshead (LC02)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug/l)	Time after HW Dover
05 April '92	22	270	366	17.7	3.3		-01:40
28 April '92	27	423	415	26.7	6.5		03:11
10 June '92	21	14	70	1.3	0.6		08:36
29 July '92	15	<2.33	24	<1.15	<0.3		03:55
05 August '92	22	<2.33	94	10.5	<0.3		-01:57
17 August '92	38	12	157	11.3	1.3		03:33
25 August '92	23	6	72	9.3			-01:54
28 September '92	52	56	145	16.6	3.6		04:05
10 November '92	53	354	488	27.9	15.2		02:51
15 December '92	33	672	617	25.9			11:27
29 January '93	22	549	556	26.0	3.8	1.4	03:32
15 March '93	30	526	542	25.6	4.3		03:29
07 April '93	35	458	396	25.0	4.5		07:22
05 May '93	13	434	16	12.4	6.5	12.6	03:23
15 June '93	30	5	19	2.7			-01:10
07 August '93	20	5	21	4.0		6.6	03:38
31 August '93	42	43	135	16.7	2.5	2.9	07:07
23 September '93	65	82	222	14.8	2.1		03:06
07 October '93	63	152	320	24.0		2.6	-01:02
23 November '93	22	671	798	31.1	6.8		

Field Data

Date	Temp (deg C)	Saln. Field (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH Field	DO Field (% Satn)	DO Field (mg/l)
05 April '92	6.9	32.8		8.5			
28 April '92	9.9	32.7		8.5		96.8	
10 June '92	15.8	31.4		10.2		106.0	
29 July '92	18.1	31.3		7.5		104.0	
05 August '92	18.0	32.2		9.2		97.2	
17 August '92	17.1	30.9		7.2		98.1	
25 August '92	16.7	28.9		7.9	8.1	99.5	
28 September '92	14.8	29.0		7.5	8.2	98.4	8.3
10 November '92	9.0	31.9	0.5	8.9	8.4	98.2	9.1
15 December '92	6.5	31.6		9.1	7.9	97.6	9.7
29 January '93	5.2	33.3		7.9	8.2		
15 March '93	5.5	33.2	0.5	9.0	8.1	99.3	10.0
07 April '93	7.5	32.8	1.0	13.1	8.3	98.8	9.5
05 May '93	10.4	32.3	1.0	8.1	8.4	114.0	10.3
15 June '93	15.2	33.1	1.0	9.2	8.4	92.7	7.6
07 August '93	16.8	34.6	1.0	8.4	8.2	104.0	10.1
31 August '93	16.1	33.5	1.0	12.4	8.2	99.2	8.0
23 September '93	14.8	33.5	1.0	8.4	8.3	93.8	7.7
07 October '93	13.4	33.5	1.0	8.6	8.3	101.0	8.5
23 November '93	6.9	32.4	1.0	9.0		95.9	9.4

Table 4 : Lincolnshire Coast at at Skegness (LC03)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug/l)	Time After HW Dover
05 April '92	22	295	370	17.3	2.3		-01:17
28 April '92	33	439	407	27.8	6.9		02:46
10 June '92	22	418	26	13.6	5.4		09:19
29 July '92	13	<2.33	18	1.5	<0.3		03:34
05 August '92	29	2	132	18.9	0.8		-01:32
17 August '92	40	15	164	12.3	1.6		03:13
25 August '92	62	24	142	17.6			-01:24
28 September '92	57	53	149	17.3	3.5		03:45
10 November '92	52	348	476	27.6	14.5		02:27
15 December '92	39	746	686	29.2			11:55
29 January '93	25	589	578	27.0	3.7	1.4	03:11
15 March '93	31	553	552	26.6	4.5		03:07
07 April '93	32	543	586	28.9	3.8		07:47
05 May '93	12	467	12	11.8	7.1	9.0	03:03
15 June '93	65	27	54	5.8		1.4	-00:50
07 August '93	24	18	50	7.3		1.6	03:18
31 August '93	77	142	84	23.4	7.5	2.1	07:34
23 September '93	70	80	235	19.7	3.2		02:39
07 October '93	70	163	344	26.0		2.4	-00:39
23 November '93	28	774	873	31.7	7.5		

Field Data

Date	Temp (deg C)	Saln. Field (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH Field	DO Field (% Satn)	DO Field (mg/l)
05 April '92	7.1	32.4		8.0			
28 April '92	10.1	32.7		8.2		96	
10 June '92	16.0	30.8		9.6		102	
29 July '92	18.3	31.7		7.1		104	
05 August '92	18.2	32.5		8.0		96	
17 August '92	17.2	31.9		6.7		98	
25 August '92	17.0	29.3		7.9	8.1	99	
28 September '92	14.8	29.1		6.9	8.1	99	8.4
10 November '92	9.0	31.9	0.5	8.0	8.4	99	9.2
15 December '92	6.5	31.5		8.1	8.0	98	9.8
29 January '93	5.0	33.2		7.8	8.2		
15 March '93	5.4	33.1	0.5	8.7	8.1	99	10.0
07 April '93	7.0	32.6	1.0	13.1	8.2	99	9.6
05 May '93	10.6	32.8	1.0	7.5	8.1	115	10.4
15 June '93			1.0	8.7	8.4	87	7.0
07 August '93	16.9	36.0	1.0	8.1	8.2	96	9.3
31 August '93	16.1	33.1	1.0	11.9	8.1	95	7.7
23 September '93	14.9	33.5	1.0	8.4	8.3	93	7.6
07 October '93	13.4	33.4	1.0	8.2	8.3	101	8.5
23 November '93	6.2	32.0	1.0	8.6		97	9.7

Table 5 : Lincolnshire Coast at Ingoldmells (LC04)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (mg/l)	Time After HW Dover
05 April '92	20	266	564	22.1	1.7		-01:06
28 April '92	31	589	593	29.9	7.4		02:21
10 June '92	19	285	9	2.2	2.8		09:54
29 July '92	19	3	58	6.3	0.5		03:14
05 August '92	37	17	88	14.5	3.3		-01:06
17 August '92	58	19	256	22.8	2.0		02:53
25 August '92	71	56	141	21.7			-00:53
28 September '92	64	47	161	19.5	3.5		03:27
10 November '92	62	450	540	29.9	14.3	3.4	02:05
15 December '92	31	954	898	29.7			12:17
29 January '93	43	1,010	896	32.0	3.4	1.6	02:48
15 March '93	43	616	602	26.7	4.9		02:46
07 April '93	24	559	605	29.1	3.7		08:08
05 May '93	19	631	27	21.5	6.2	4.7	02:27
15 June '93	109	32	29	11.1		<1	-00:30
07 August '93	25	7	21	9.0		2.3	02:57
31 August '93	28	108	66	13.9	4.3	9.4	07:59
23 September '93	77	315	462	34.7	7.1		01:43
07 October '93	52	442	611	36.0		1.8	-00:18
23 November '93	24	818	917	32.8	5.1		

Field Data

Date	Saln. Field (p.p.t.)	DO Field (% Satn)	DO Field (mg/l)	Temp (deg C)	Sample Depth (m)	Water Depth (m)	pH Field
05 April '92	31.8			7.1		8.0	
28 April '92	32.7	96		9.8		8.0	
10 June '92	30.8	119		15.9		9.4	
29 July '92	31.9	97		18.4		7.5	
05 August '92	31.9	95		17.9		8.5	
17 August '92	31.7	94		17.0		7.0	
25 August '92	28.7	100		16.9		8.2	8.1
28 September '92	29.3	98	8.2	15.0		7.2	8.1
10 November '92	31.8	99	9.2	9.2	0.5	8.3	8.4
15 December '92	30.2	99	9.9	6.2		8.7	7.9
29 January '93	31.9			4.6	1.0	8.0	8.2
15 March '93	31.4	98	9.9	5.9	0.5	9.2	8.1
07 April '93	32.6	99	9.6	6.9	1.0	13.0	8.2
05 May '93	32.8	108	9.6	11.0	1.0	7.9	7.9
15 June '93	32.8	88	7.2	15.4	1.0	9.2	8.5
07 August '93	33.4	94	9.0	17.3	1.0	8.3	8.2
31 August '93	33.1	109	8.8	16.1	1.0	12.3	8.2
23 September '93		97	8.0		1.0	6.9	
07 October '93	32.3	100	8.6	13.1	1.0	8.4	8.3
23 November '93	31.8	96	9.7	5.8	1.0	9.6	

Table 6 : Lincolnshire Coast at Chapel-St-Leonards (LC05)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug/l)	Time After HW Dover
05 April '92	18	279	538	22.2	1.6		-00:30
28 April '92	25	566	583	29.3	6.9		01:56
10 June '92	18	224	11	<1.15	2.5		10:23
29 July '92	33	39	73	10.4	3.1		02:52
05 August '92	37	9	107	13.3	1.9		-00:36
17 August '92	43	47	82	17.8	4.5		02:28
25 August '92	24	13	48	12.8			-00:28
28 September '92	73	104	216	28.7	6.6		03:06
10 November '92	44	551	696	34.8	9.0		01:42
15 December '92	23	997	982	30.7			00:20
29 January '93	29	1,090	986	32.9	4.9	1.5	02:29
15 March '93	32	695	758	27.7	3.1		02:23
07 April '93	27	584	638	30.4	3.8		08:29
05 May '93	18	977	545	31.7	5.9	3.1	02:05
15 June '93	97	65	24	11.7		<1	-00:11
07 August '93	40	52	59	8.7		<1	02:36
31 August '93	45	255	145	20.4	4.9	3.3	08:25
23 September '93	89	252	444	37.4	7.1		01:15
07 October '93	33	568	701	42.0		2.3	00:05
23 November '93	0	763	890	34.6	0.7		

Field Data

Date	Temp (deg C)	Saln. Field (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH Field	DO Field (% Satn)	DO Field (mg/l)
05 April '92	7.0	32.0		9.0			
28 April '92	9.6	32.1		9.2		96.2	
10 June '92	15.7	31.0		10.5		128.0	
29 July '92	18.5	31.0		7.6		95.0	
05 August '92	18.1	31.6		8.2		95.1	
17 August '92	17.2	31.1		8.0		102.0	
25 August '92	17.0	28.8		8.0	8.2	105.0	
28 September '92	14.8	28.8		7.7	8.1	97.0	8.2
10 November '92	8.5	30.9	0.5	9.8	8.4	98.6	9.4
15 December '92	6.3	29.7		9.3	7.9	98.7	10.0
29 January '93	4.7	31.4		10.1	8.1		
15 March '93	5.4	32.3	0.5	9.8	8.1	98.4	9.8
07 April '93	7.0	32.4	1.0	14.1	8.2	98.4	9.6
05 May '93	11.1	31.9	1.0	8.8	7.9	96.4	8.7
15 June '93	15.2	32.9	1.0	10.0	8.5	91.0	7.4
07 August '93	17.2	31.9	1.0	9.4	8.2	90.7	8.7
31 August '93	15.7	32.8	1.0	13.2	8.1	102.0	8.3
23 September '93	14.6	32.8	1.0	9.7	8.2	96.4	8.0
07 October '93	13.1	31.8	1.0	9.1	8.3	101.0	8.6
23 November '93	6.2	31.8	1.0	10.2		96.5	9.7

Table 7 : Lincolnshire Coast at Huttoft (LC06)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug/l)	Time After HW Dover
05 April '92	20	383	457	20.1	1.6		-00:07
28 April '92	15	599	617	28.2	5.7		01:29
10 June '92	19	264	23	<1.15	2.8		10:44
29 July '92	19	25	33	4.8	2.0		02:30
05 August '92	49	20	145	13.9	1.9		-00:15
17 August '92	24	76	32	13.6	3.3		02:08
25 August '92	23	10	20	11.3			-00:01
28 September '92	75	371	435	39.4	8.8		02:46
10 November '92	33	531	633	33.7	10.4		01:17
15 December '92	21	911	928	27.1			00:42
29 January '93	33	1,160	1,060	32.0	4.9	1.3	02:03
15 March '93	21	661	719	27.5	2.2		02:03
07 April '93	28	680	646	26.6	2.6		08:46
05 May '93	13	828	491	29.0	4.3	3.3	01:43
15 June '93	97	116	21	9.6		<1	00:07
07 August '93	44	87	63	11.3		1.2	02:13
31 August '93	55	299	205	27.1	5.2	2.8	08:44
23 September '93	71	378	473	39.3	6.6		00:47
07 October '93	30	649	765	45.0		<1	00:26
23 November '93	2	771	900	35.7	0.1		

Field Data

Date	Temp (deg C)	Saln. Field (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH Field	DO Field (% Satn)	DO Field (mg/l)
05 April '92	7.1	32.2		8.5			
28 April '92	9.5	31.0		9.0		96	
10 June '92	15.5	31.0		9.8		124	
29 July '92	18.3	1.0		7.5		97	
05 August '92	18.1	31.5		8.7		94	
17 August '92	17.1	31.1		7.6		110	
25 August '92	17.3	28.5		7.5	8.2	115	
28 September '92	14.6	28.9		7.0	8.0	99	8.4
10 November '92	8.4	31.9	0.5	9.0	8.4	99	9.4
15 December '92	6.3	29.6		9.6	7.9	99	10.1
29 January '93	4.7	31.0		9.6	8.1		
15 March '93	5.5	32.5	0.5	9.2	8.1	98	9.7
07 April '93	7.1	32.1	1.0	13.5	8.2	99	9.6
05 May '93	10.5	32.3	1.0	8.4	8.2	97	8.8
15 June '93	15.1	32.7	1.0	10.2	8.5	95	7.8
07 August '93	17.2	31.9	1.0	7.3	8.2	92	8.9
31 August '93	15.5	32.6	1.0	12.5	8.1	99	8.1
23 September '93	14.5	32.5	1.0	10.1	8.2	100	8.3
07 October '93	13.1	31.5	1.0	10.8	8.3	101	8.6
23 November '93	6.3	31.7	1.0	10.1		47	9.7

Table 8 : Lincolnshire Coast at Trusthorpe (LC07)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug/l)	Time After HW Dover
05 April '92	18	363	437	17.2	1.2		00:18
28 April '92	11	636	639	27.5	5.0		01:02
10 June '92	43	499	137	19.1	4.5		11:06
29 July '92	16	<2.33	51	1.2	<0.3		02:05
05 August '92	40	217	72	17.3	5.1		00:09
17 August '92	35	217	107	24.7	5.0		01:40
25 August '92	26	57	13	11.8			00:25
28 September '92	46	377	433	35.3	7.1		02:23
10 November '92	26	673	756	31.5	12.2	2.1	00:47
15 December '92	29	1,030	1,020	27.7			01:05
29 January '93	30	1,170	1,100	30.7	5.0	0.9	01:41
15 March '93	27	595	703	25.3	2.6		01:39
07 April '93	33	686	681	28.9	2.6		09:10
05 May '93	15	914	522	28.8	4.1	11.2	01:19
15 June '93	100	161	13	4.3		1.4	00:27
07 August '93	48	130	75	16.4		<1	01:48
31 August '93	31	252	227	23.4	4.5	4.0	09:08
23 September '93	57	562	634	42.7	7.0		00:15
07 October '93	29	625	743	43.0		<1	00:49
23 November '93	2	771	895	35.4	1.0		

Field Data

Date	Temp (Deg C)	Saln. Field (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH Field	DO Field (% Satn)	DO Field (mg/l)
05 April '92	7.0	32.4		8.7			
28 April '92	9.4	31.4		10.0		96	
10 June '92	15.1	30.5		9.4		96	
29 July '92	18.2	30.9		9.0		102	
05 August '92	17.5	31.0		8.4		96	
17 August '92	16.6	31.1		8.4		101	
25 August '92	16.9	28.7		8.5	8.3	118	
28 September '92	14.3	28.2		7.7	8.0	98	
10 November '92	8.6	30.5	0.5	9.6	8.4	99	
15 December '92	6.4	29.2		10.3	9.9	100	10.1
29 January '93	4.8	30.7	1.0	10.0	8.1		
15 March '93	5.6	33.0	0.5	10.3	8.0	98	9.8
07 April '93	7.1	32.0	1.0	14.5	8.2	98	9.6
05 May '93	10.3	32.0	1.0	8.9	8.2	98	8.9
15 June '93	14.8	32.4	1.0	12.0	8.5	100	8.2
07 August '93	16.7	32.0	1.0	9.5	8.1	91	8.9
31 August '93	15.3	33.1	1.0	12.1	8.1	104	8.5
23 September '93	14.2	31.8	1.0	10.5	8.2	100	8.4
07 October '93	13.1	31.6	1.0	10.1	8.3	101	8.7
23 November '93	6.4	31.7	1.0	10.1	96.9	10	

Table 9 : Lincolnshire Coast at Theddlethorpe (LC08)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug.l)	Time After HW Dover
05 April '92	15	362	428	14.9	1.2		00:40
28 April '92	19	595	591	27.4	4.9		00:34
10 June '92	43	444	163	20.8	4.2		11:27
29 July '92	17	<2.33	54	<1.15	<0.3		01:40
05 August '92	44	308	147	28.8	5.8		00:32
17 August '92	30	259	160	27.4	5.7		01:16
25 August '92	29	186	75	20.0			00:50
28 September '92	41	367	415	33.1	6.8		02:00
10 November '92	21	668	724	26.1	10.9		00:20
15 December '92	42	1,080	1,080	29.8			01:27
29 January '93	33	1,120	1,070	28.9	4.3	1.0	01:18
15 March '93	28	641	706	24.6	2.8		01:15
07 April '93	31	672	647	27.8	2.4		09:27
05 May '93	14	851	508	26.3	3.3	4.3	00:55
15 June '93	141	196	25	1.2		4.9	00:44
07 August '93	33	256	139	23.1		2.7	01:24
31 August '93	33	212	218	19.3	4.4	2.2	09:29
23 September '93	50	559	659	40.5	6.3		-00:16
07 October '93	35	468	593	35.0		4.3	01:10
23 November '93	<2.0	700	818	33.4	1.5		

Field Data

Date	Temp (deg C)	Saln. Field (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH Field	DO Field (% Satn)	DO Field (mg/l)
05 April '92	7.0	32.2		8.6			
28 April '92	9.6	31.7		9.0		96	
10 June '92	14.8	30.6		8.5		96	
29 July '92	18.0	30.5		7.6		100	
05 August '92	17.2	30.8		8.0		95	
17 August '92	16.3	31.1		8.5		100	
25 August '92	16.5	28.6		8.6	8.2	108	
28 September '92	14.2	27.9		8.0	8.0	98	
10 November '92	9.0		0.5	9.2	8.4	99	
15 December '92	6.6	29.1		9.5	9.9	99	10.0
29 January '93	4.9	30.8		9.0	8.1		10.4
15 March '93	5.9	32.6	0.5	10.1	8.0	96	9.6
07 April '93	7.0	32.1	1.0	12.4	8.2	98	9.6
05 May '93	9.9	32.2	1.0	8.7	8.2	98	9.0
15 June '93	14.4	32.2	1.0	10.6	8.5	99	8.2
07 August '93	16.0	31.4	1.0	9.5	8.1	93	9.2
31 August '93	14.7	33.4	1.0	11.1	8.1	100	8.3
23 September '93	14.0	31.8	1.0	10.5	8.2	101	8.5
07 October '93	13.0	32.1	1.0	10.3	8.3	101	8.7
23 November '93	6.6	32.1	1.0	9.9		97	9.6

Table 10 : Lincolnshire Coast at Saltfleet (LC09)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug/l)	Time After HW Dover
05 April '92	21	253	504	17.9	1.9		01:22
28 April '92	21	618	611	24.8	5.1		-00:09
10 June '92	26	284	112	13.0	3.4		12:07
29 July '92	29	93	31	<1.15	2.1		00:55
05 August '92	46	252	200	30.6	4.8		01:02
17 August '92	70	228	213	26.1	5.3		00:30
25 August '92	23	172	146	17.7			01:31
28 September '92	37	429	480	31.8	6.9		01:30
10 November '92	21	552	608	24.0	10.9		-00:33
15 December '92	48	905	948	27.1			01:55
29 January '93	24	691	722	24.9	2.6	0.6	00:46
15 March '93	25	494	598	24.6	2.5		00:46
07 April '93	41	322	357	22.4	1.8		09:46
05 May '93	14	603	423	23.1	2.6	2.7	00:09
15 June '93	61	150	44	<1.15		8.0	01:23
07 August '93	50	299	234	29.2		<1	00:51
31 August '93	30	114	139	12.8	3.7	3.1	09:52
23 September '93	41	485	588	35.7	5.6		-00:57
07 October '93	24	317	426	27.0		2.8	01:55
23 November '93	<2.0	602	711	40.6	1.8		

Field Data

Date	Temp (deg C)	Saln. Field (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH Field	DO Field (% Satn)	DO Field (mg/l)
05 April '92	7.3	32.3		8.2			
28 April '92	8.9	31.2		9.6		97	
10 June '92	14.1	31.1		6.7		101	
29 July '92	17.0	30.1		7.5		105	
05 August '92	16.9	30.8		7.0		94	
17 August '92	15.8	31.5		7.2		100	
25 August '92	16.0	28.9		8.5	8.1	107	
28 September '92	14.0	28.3			8.0	99	
10 November '92	8.8		0.5	9.7	8.4	97	
15 December '92	6.9	29.6		10.0	9.9	100	10.0
29 January '93	5.1	32.3		9.6	8.1		
15 March '93	5.9	33.1	0.5	9.9	8.0	96	9.8
07 April '93	6.8	32.2	1.0	11.7	8.2	99	9.7
05 May '93	9.4	33.0	1.0	8.3	8.2	99	9.2
15 June '93	14.0	32.3	1.0	10.2	8.6	116	9.7
07 August '93	15.6	32.1	1.0	9.4	8.1	91	9.1
31 August '93	14.5	33.8	1.0	11.4	8.1	100	8.3
23 September '93	14.1	32.0	1.0	10.5	8.1	94	7.8
07 October '93	13.0	32.9	1.0	9.8	8.4	102	8.6
23 November '93	6.9	32.6	1.0	9.8		96	9.8

Table 11 : Lincolnshire Coast at Donna Nook (LC10)

Nutrient Data

Date	Ammonia (ug/l N)	TON (ug/l N)	Silicate (ug/l Si)	Phosphate (ug/l P)	Nitrite (ug/l N)	Chlorophyll (ug/l)	Time After HW Dover
05 April '92	22	287	566	17.2	2.1		01:49
28 April '92	20	921	794	27.0	5.4		-00:39
10 June '92	22	286	128	11.0	3.3		12:28
29 July '92	16	127	9	<1.15	3.3		00:28
05 August '92	34	328	220	35.1	6.3		01:27
17 August '92	45	312	312	31.9	6.4		00:03
25 August '92	22	240	212	20.8			01:55
28 September '92	37	568	624	37.1	7.1		01:05
10 November '92	25	791	847	26.3	11.2	1.6	-01:02
15 December '92	48	920	962	26.7			01:55
29 January '93	28	939	932	26.0	3.3	0.8	00:20
15 March '93	28	592	670	25.2	2.2		00:20
07 April '93	41	670	625	28.9	2.2		10:08
05 May '93	15	757	511	24.7	3.0	2.4	23:30
15 June '93	28	283	94	<1.15		9.7	01:43
07 August '93	44	347	273	32.1		2.9	00:25
31 August '93	31	289	277	22.9	4.2	3.2	10:14
23 September '93	46	700	826	43.7	6.7		-01:26
07 October '93	16	355	450	22.0		3.9	02:18
23 November '93	5	1,480	1,529	40.6	1.8		

Field Data

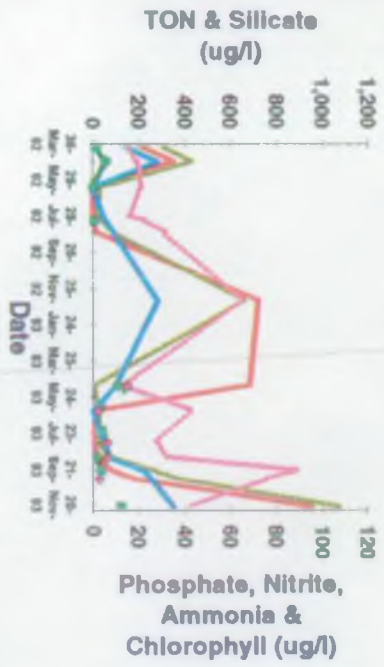
Date	Temp (deg C)	Saln. Field (p.p.t.)	Sample Depth (m)	Water Depth (m)	pH Field	DO Field (% Satn)	DO Field (mg/l)
05 April '92	7.2	31.2		8.0			
28 April '92	9.4	30.5		10.2		94	
10 June '92	14.1	31.0		8.3		104	
29 July '92	16.9	29.9		7.5		117	
05 August '92	17.2	30.7		7.9		97	
17 August '92	15.9	31.4		7.4		101	
25 August '92	16.0	28.8		7.8	8.1	109	
28 September '92	14.1	27.4		7.3	8.0	96	
10 November '92	8.7		0.5	10.2	8.0	97	
15 December '92	6.9	29.5		10.0	9.9	99	9.9
29 January '93	5.2		1.0	9.6	8.0		
15 March '93	5.7	33.2	0.5	10.0	7.9	100	10.0
07 April '93	7.0	32.0	1.0	10.4	8.2	98	9.6
05 May '93	9.6	31.9	1.0	8.7	8.2	95	8.9
15 June '93	13.8	32.1	1.0	9.9	8.5	125	10.5
07 August '93	15.6	31.9	1.0	8.9	8.0	94	9.4
31 August '93	14.8	33.0	1.0	10.0	8.1	100	8.3
23 September '93	14.2	31.0	1.0	10.7	7.9	94	7.9
07 October '93	13.0	32.0	1.0	10.1		102	8.8
23 November '93	6.2	29.4	1.0	9.8		96	9.8

Table 12 : Lincolnshire Coast at Haile Sand Flat (LC11)

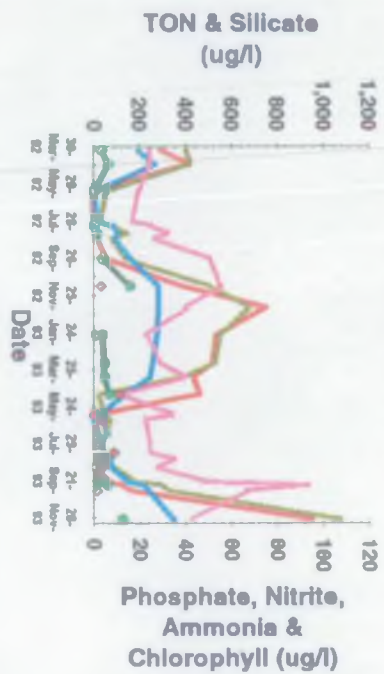


Figure 1 : 'Sea Vigil' Sampling Points
along the Lincolnshire Coast

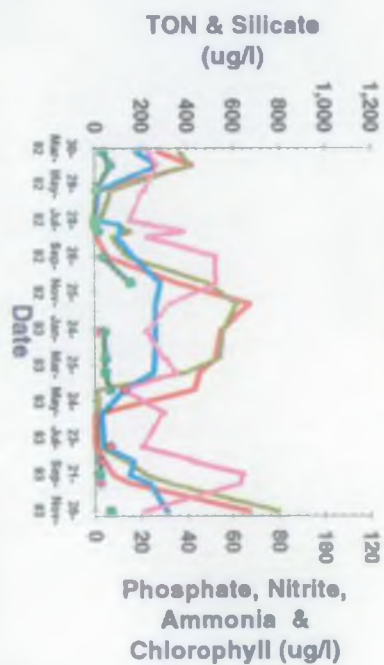
Wash-Lynn Deeps



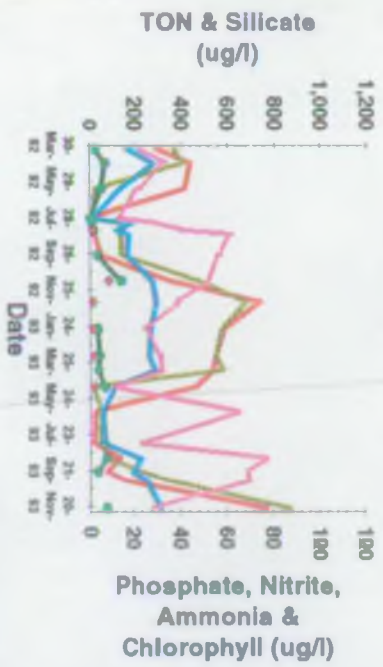
Outer Dogshead



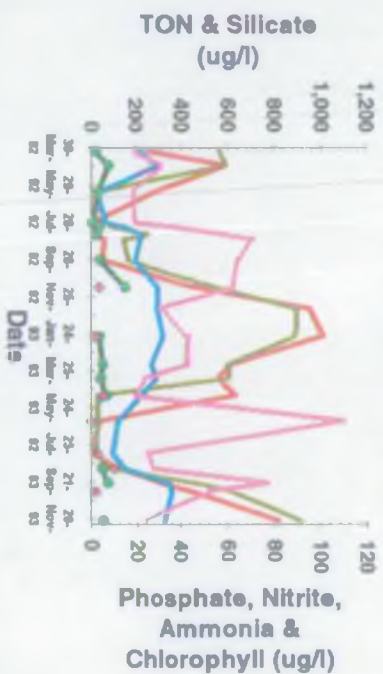
Skegness



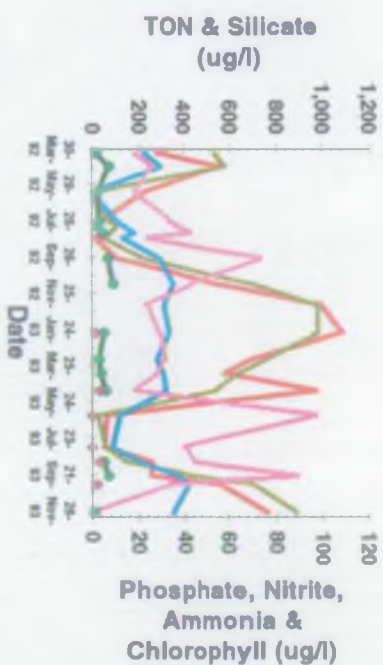
Ingoldmells



Chapel-St-Leonards



Hutft



Key:

TON (ug/l N) Silicate (ug/l Si) Phosphate (ug/l P) Nitrite (ug/l N) Ammonia (ug/l N) Chlorophyll (ug/l)

Figure 2a : Lincolnshire Coast Nutrients by Site
5th April 1992 to 23rd November 1993

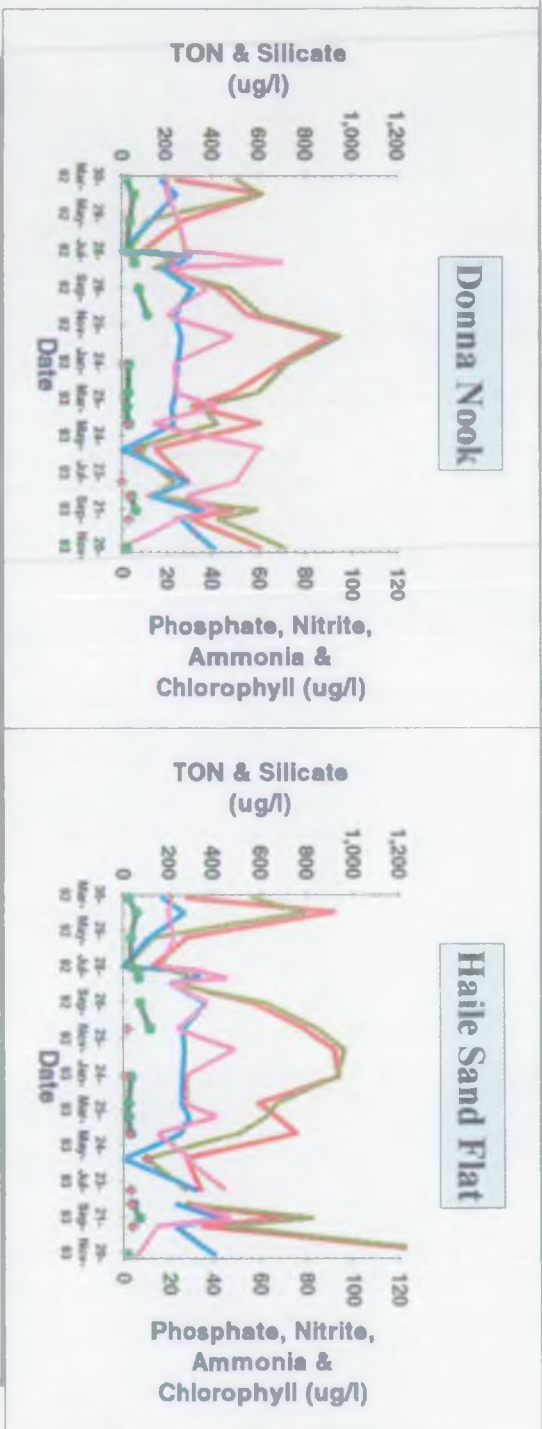
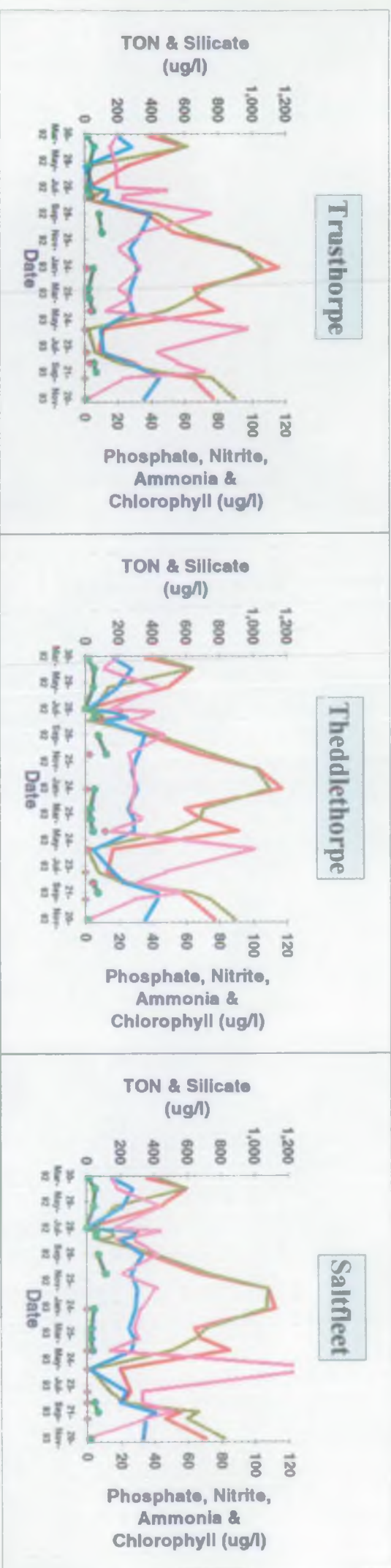


Figure 2b : Lincolnshire Coast Nutrients by Site
5th April 1992 to 23rd November 1993

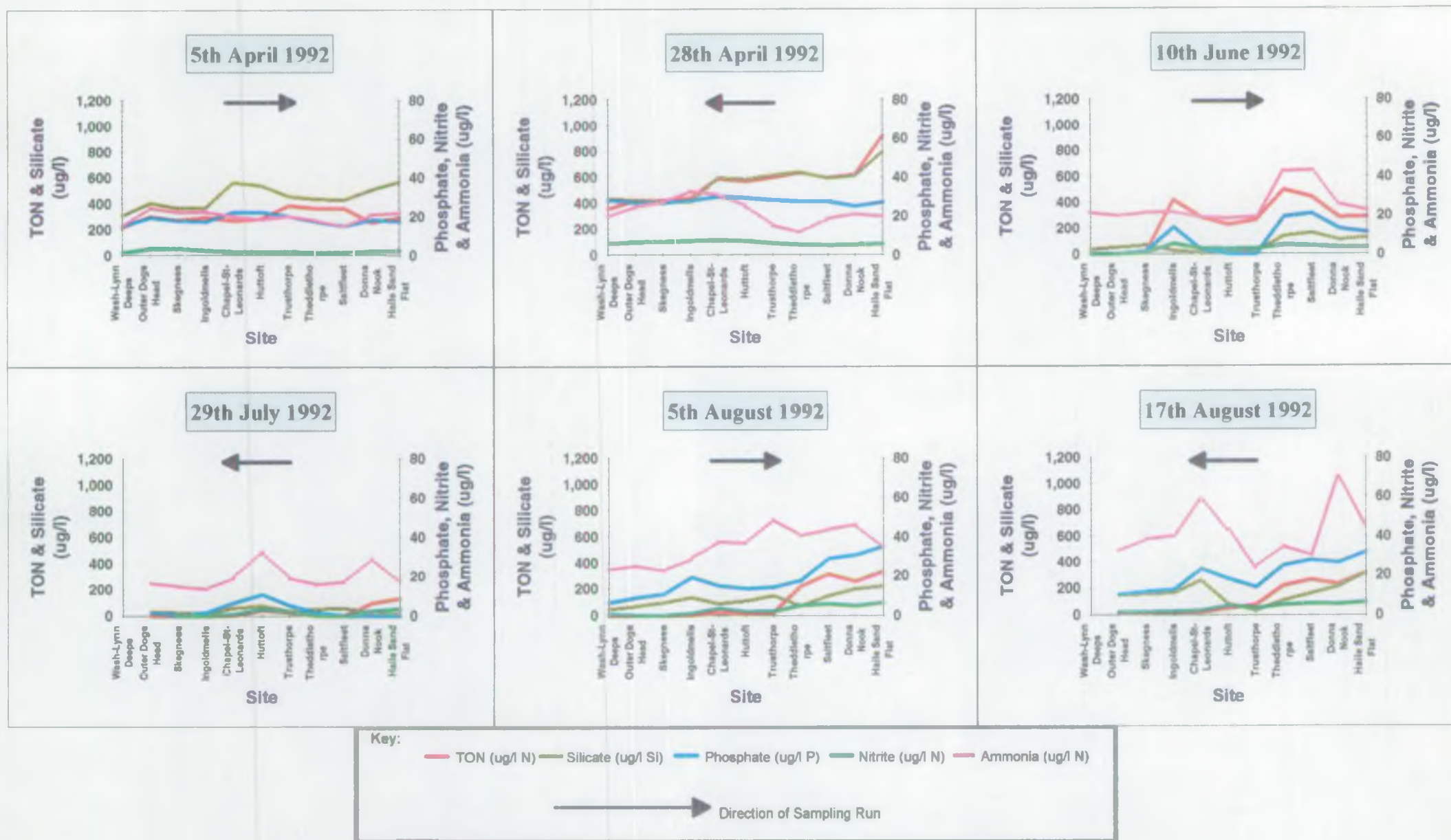


Figure 3a : Lincolnshire Coast Nutrients by Survey

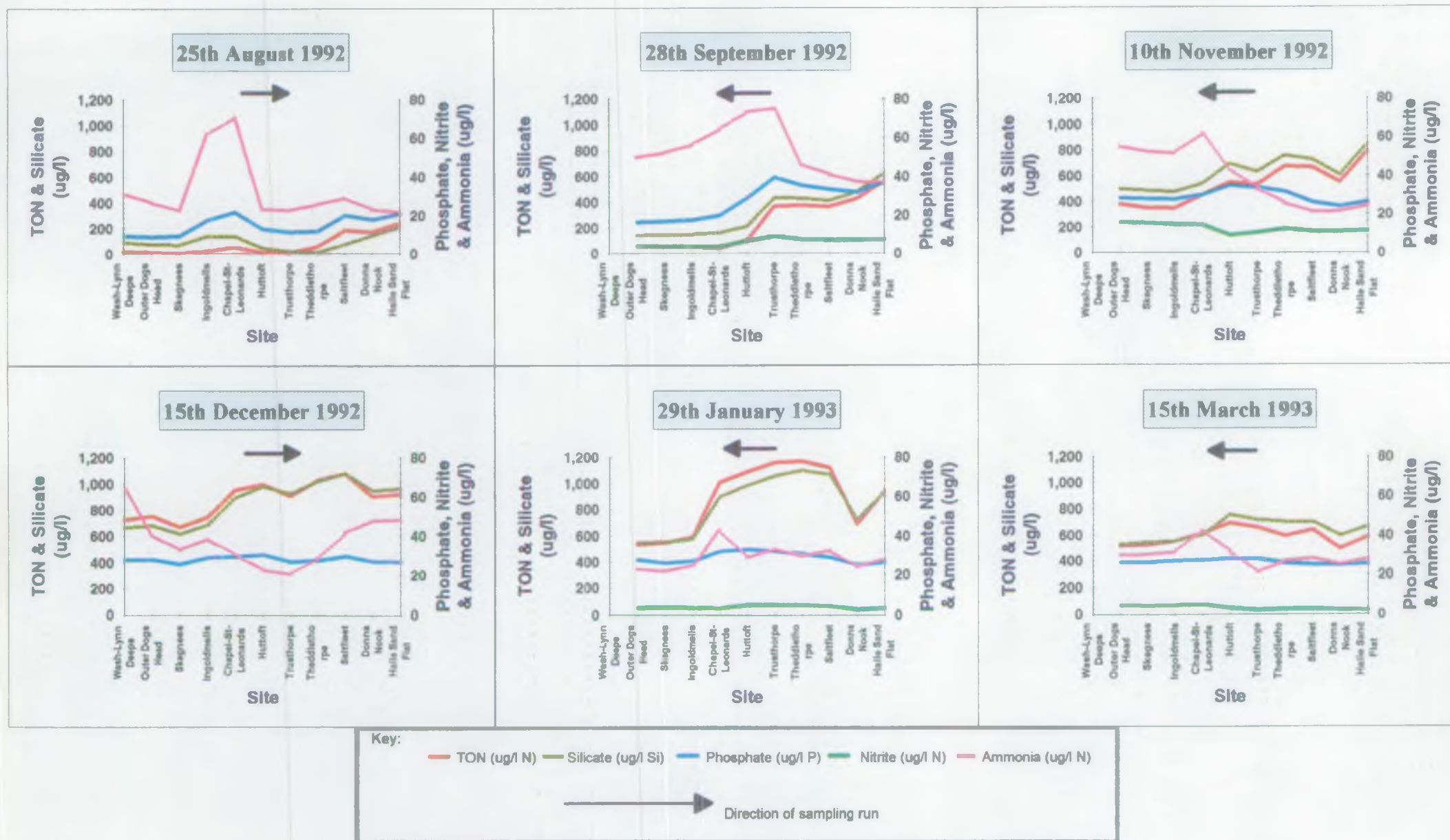
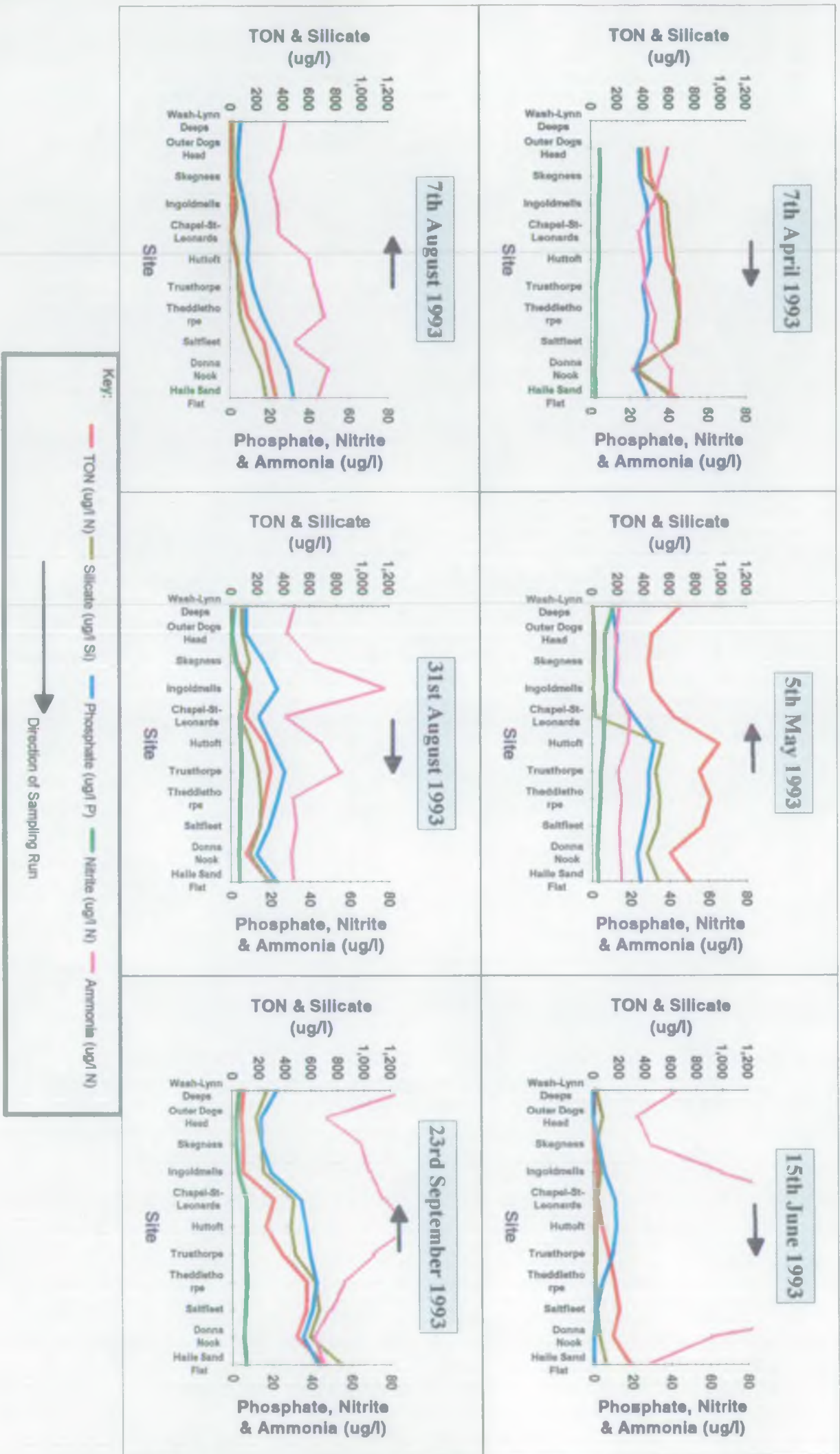


Figure 3b : Lincolnshire Coast Nutrients by Survey

Figure 3c : Lincolnshire Coast Nutrients by Survey



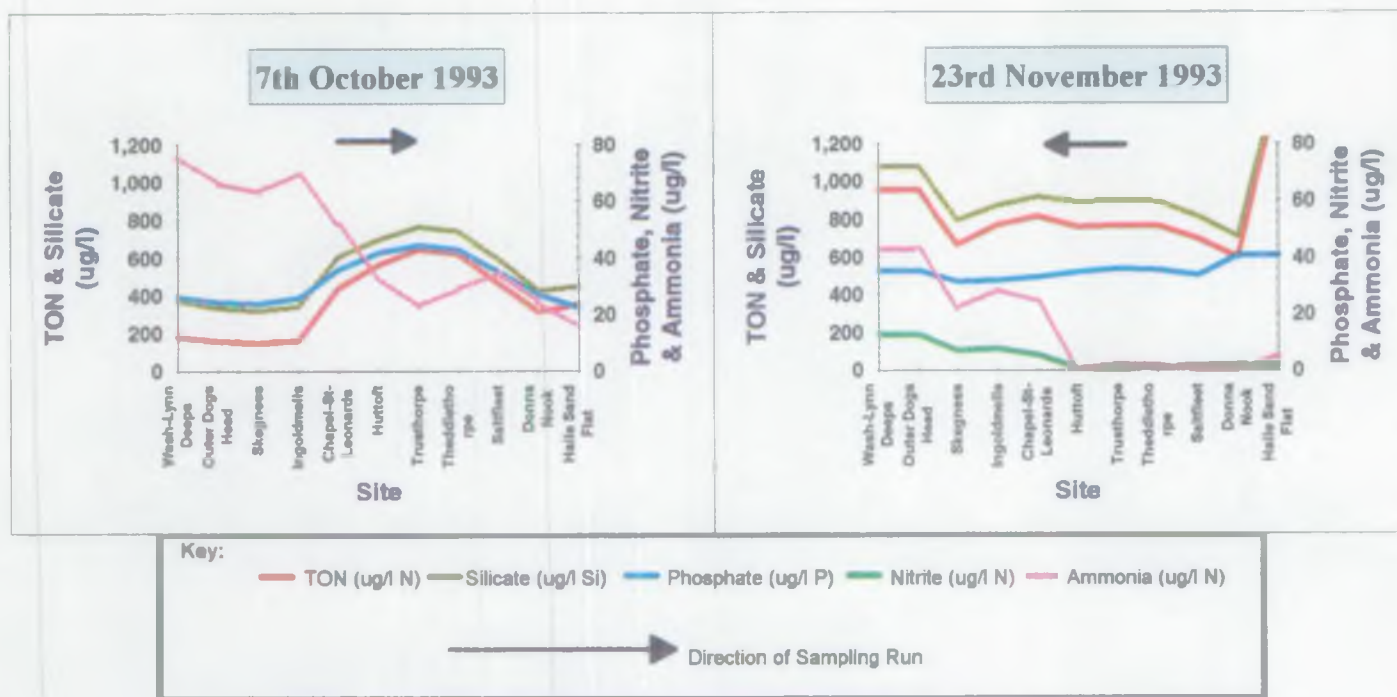
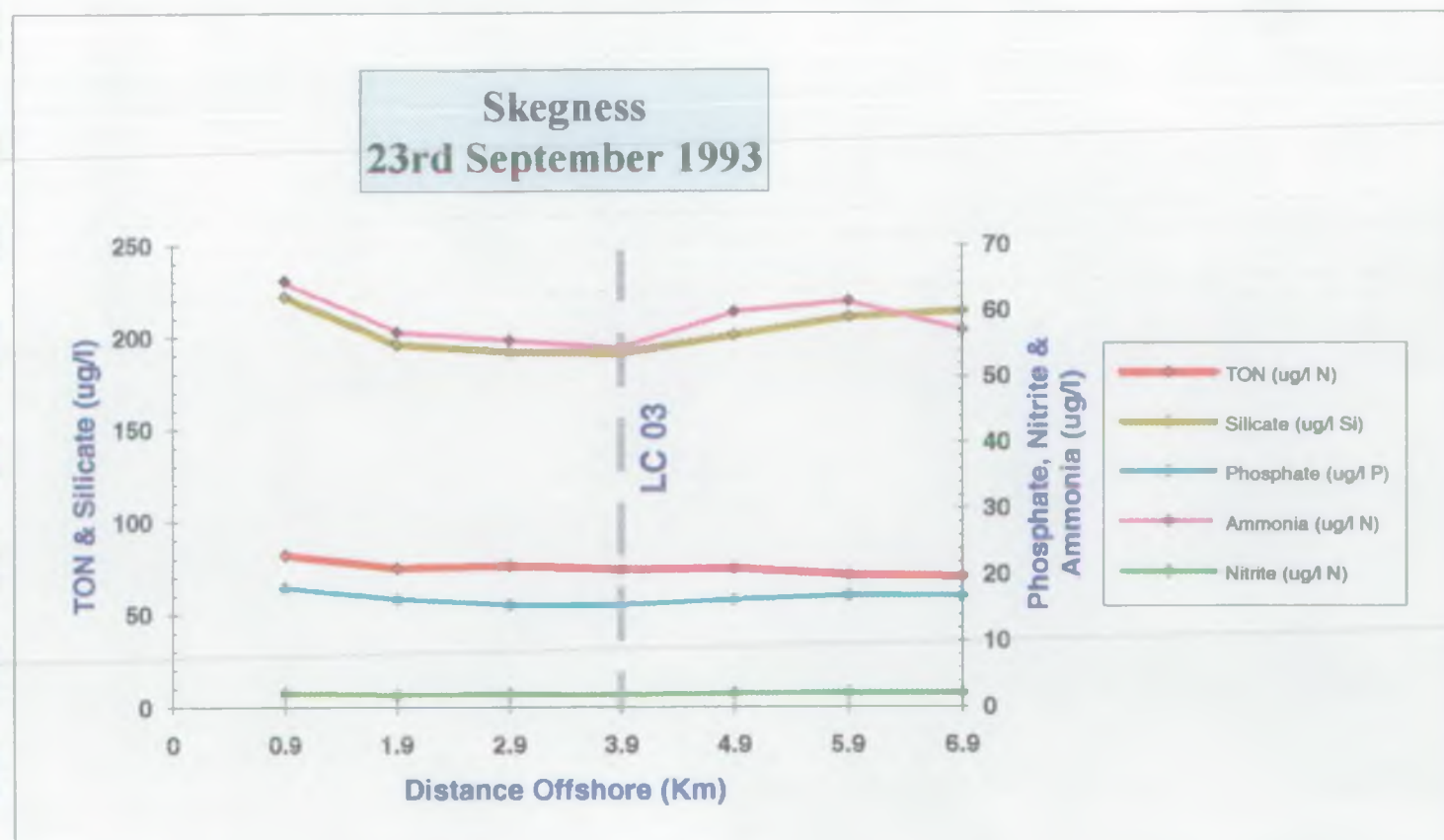
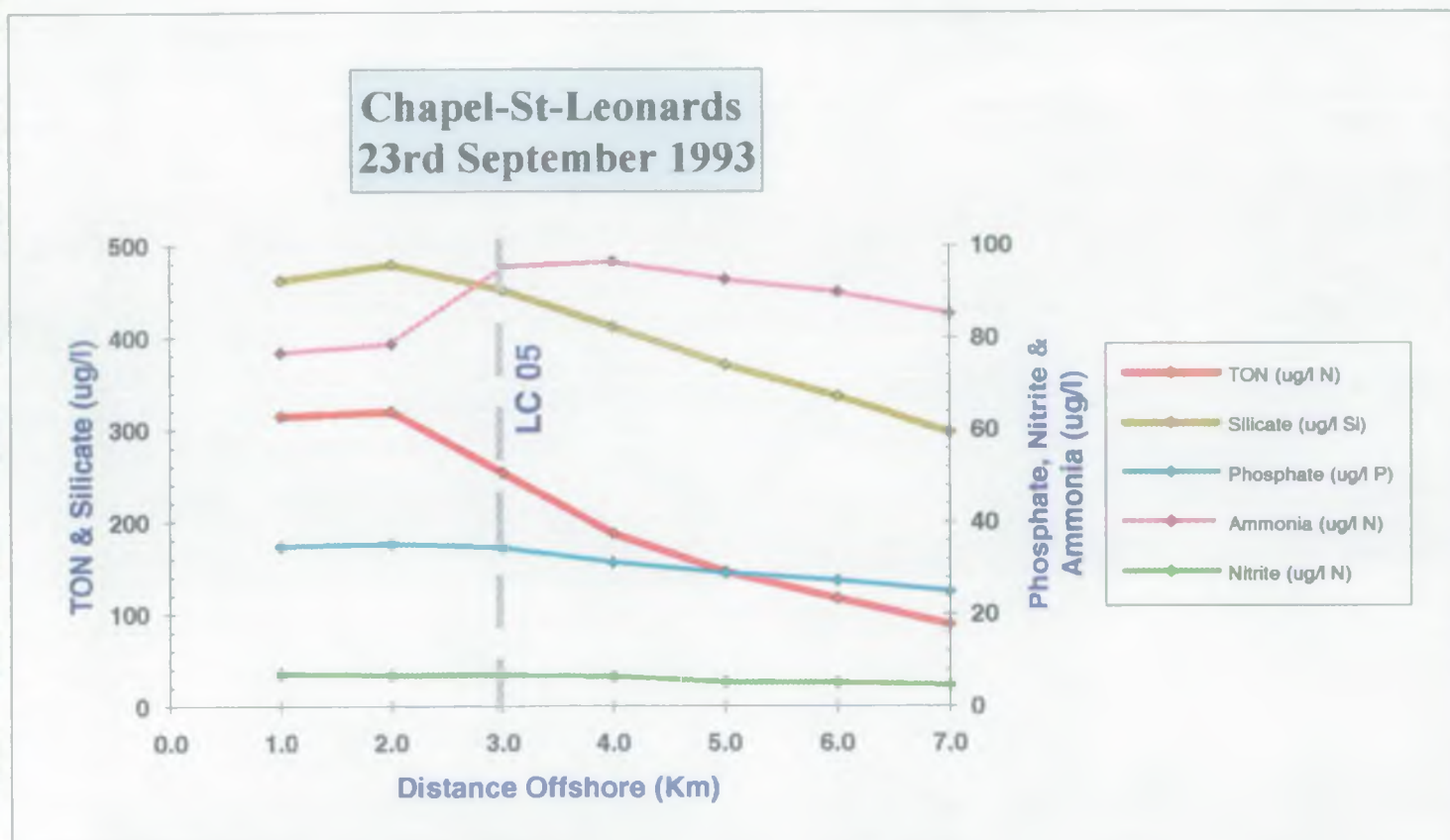
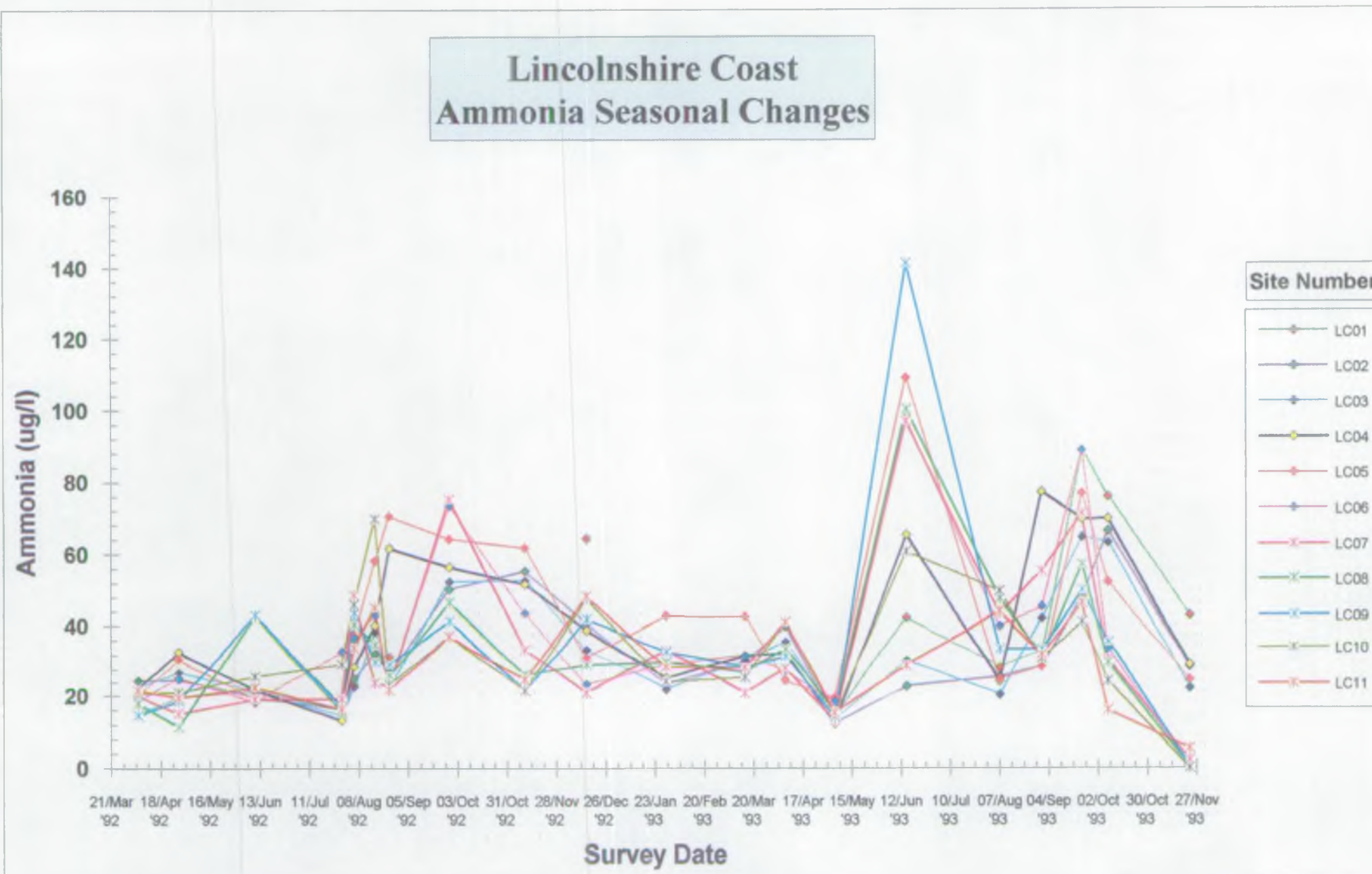
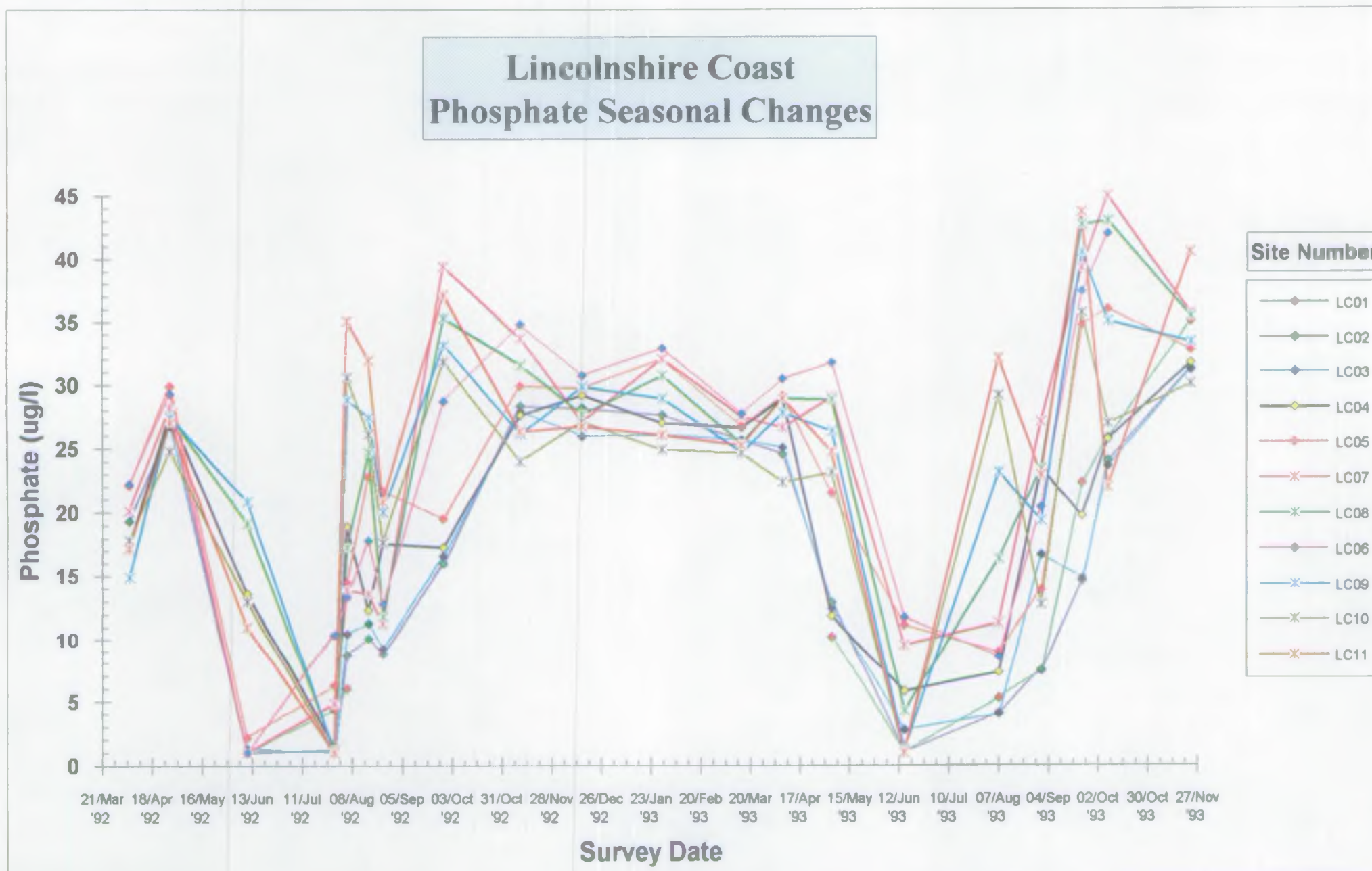
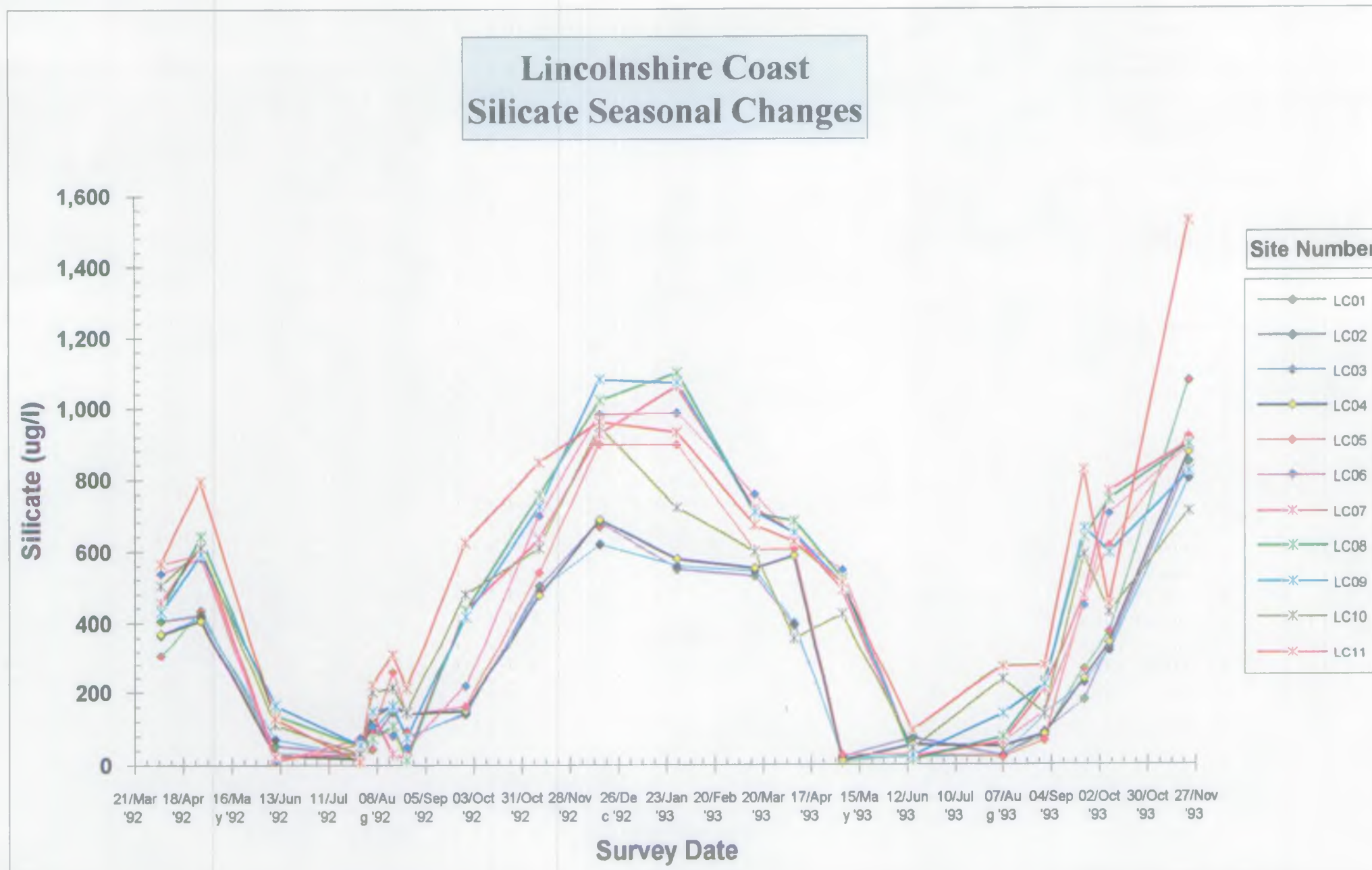


Figure 3d : Lincolnshire Coast Nutrients by Survey

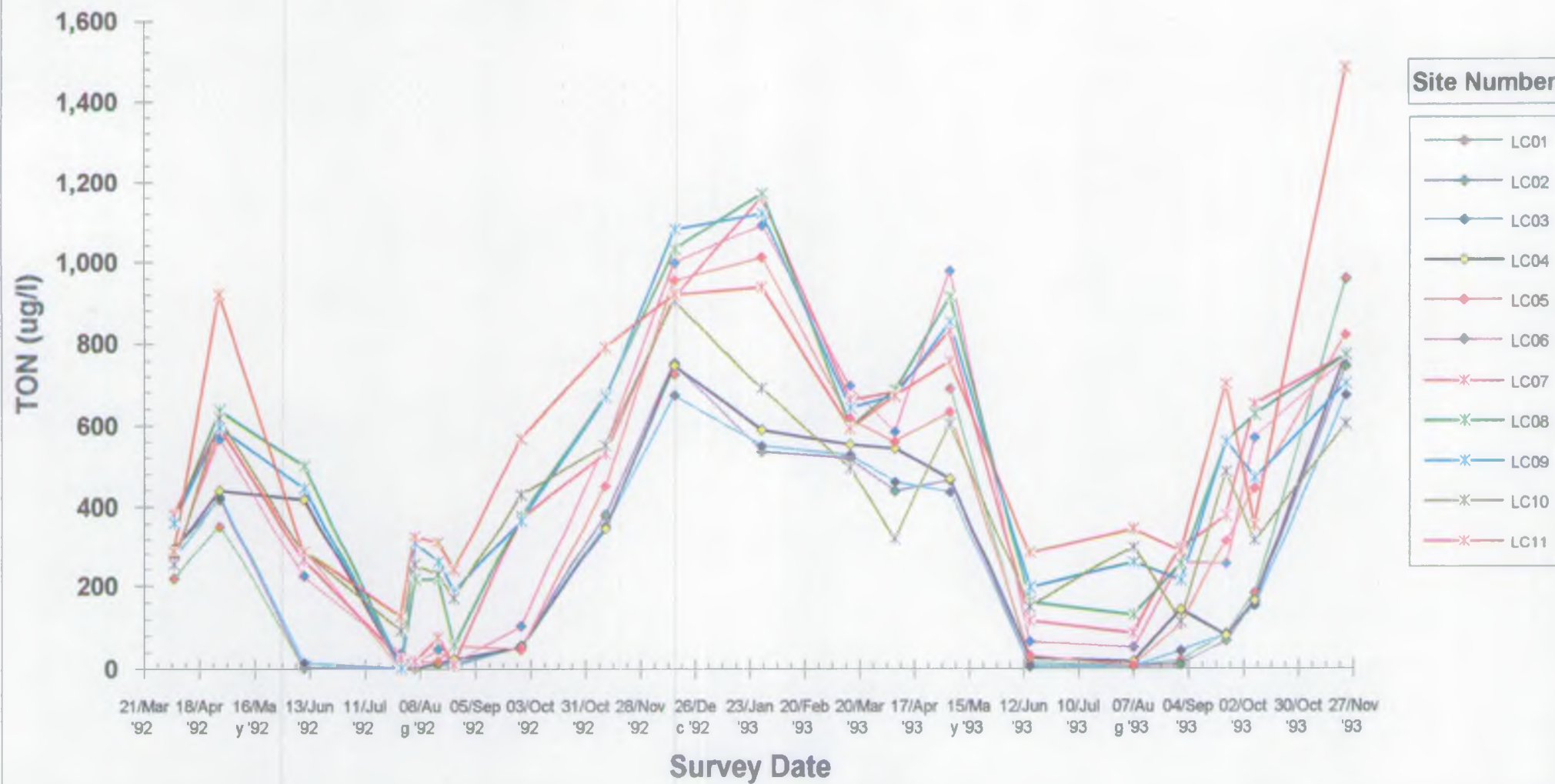


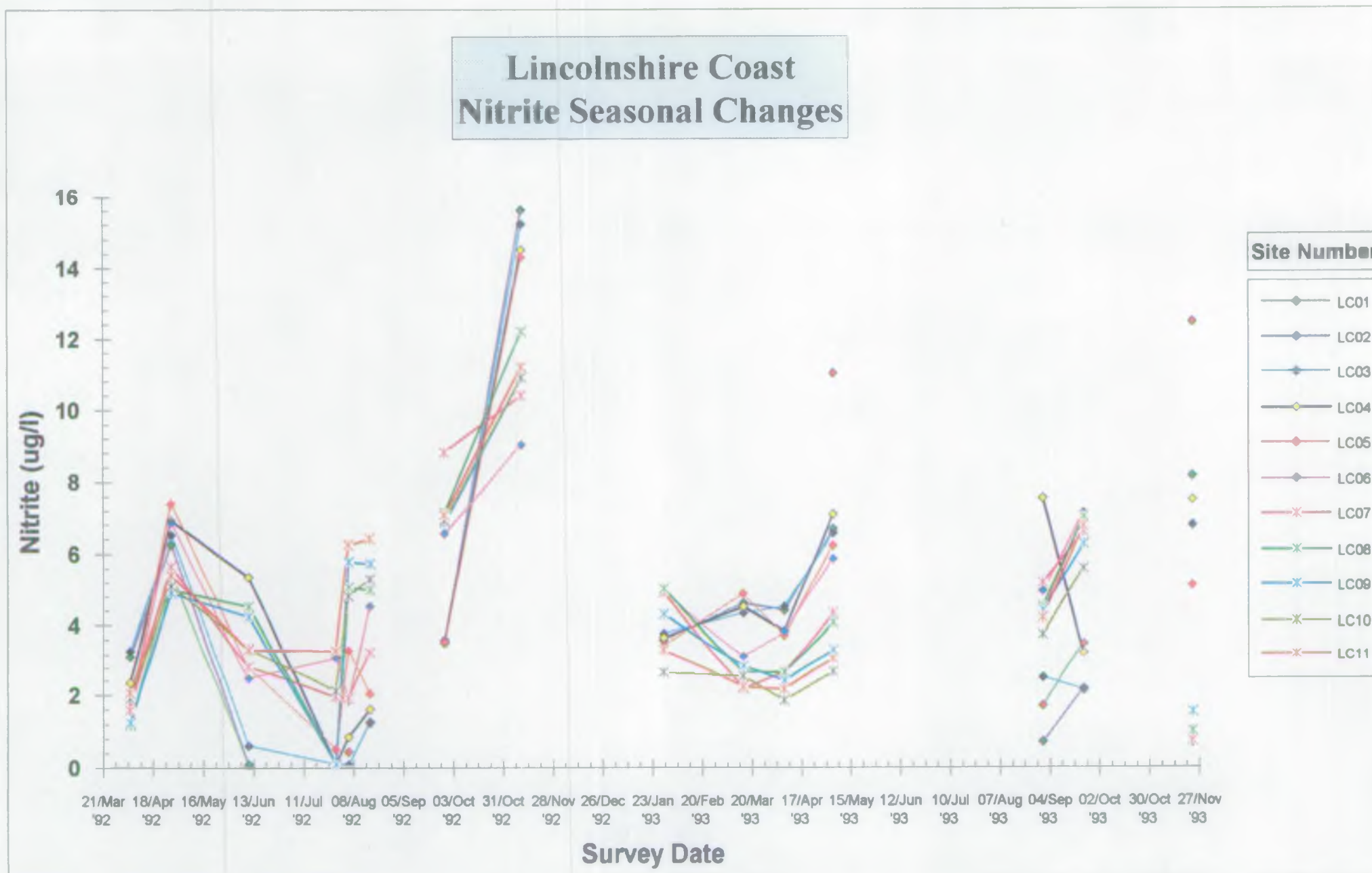






Lincolnshire Coast TON Seasonal Changes





Lincolnshire Coast Chlorophyll Seasonal Changes

