NRA-Southern 175

COASTAL BASELINE SURVEY -
1990-93 I. Nutrients

063/6/S
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Project 063

SUMMARY.

The Southern Region Coastal Baseline Survey was initiated in 1990 to determine concentrations of nutrients, metals and organic pesticides in coastal waters. Twenty-four stations, including four monitored as part of the National Monitoring Plan, have been sampled four times per annum since December 1990. This report presents results for nutrients over the period 1990 to November 1993. The full programme will terminate in March 1994 and a final report will be circulated. Future monitoring requirements are currently being reviewed both Nationally and Regionally. Future monitoring needs in Southern Region will be established by these reviews.

Gradients of nutrient concentration were evident in major estuaries such as the Thames and Solent. Concentrations were higher in the estuaries than in adjacent coastal waters reflecting the importance of rivers as sources of nutrients. Concentrations were higher during the winter than the summer, again reflecting the importance of rivers, which generally discharge higher volumes during the winter period. There was little evidence of local effects from rivers discharging to the coasts of southern Kent and Sussex. Here, sampling stations were located off-shore and the plumes from the relatively small rivers are dispersed close to the shore.

Levels of nutrients during the summer months were reduced due to low river discharge and uptake by phytoplankton; concentrations of chlorophyll-A were generally higher during the summer period although peak 'bloom' events occurred earlier during the Spring in some locations. There was evidence that in sheltered waters with restricted dispersion, for instance the Solent, concentrations of chlorophyll-A can exceed the level at which waters are deemed to be susceptible to eutrophication (10 $\mu g l^{-1}$). Supersaturation in terms of dissolved oxygen during the day, might be indicative of reduced night-time concentrations, a further indicator of eutrophication susceptibility.

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1 INTRODUCTION

Surveys of marine and estuarine waters carried out by NRA Southern Region, and previously by Southern Water, have been designed, primarily, to determine concentrations of sanitary parameters, compliance with environmental quality standards of persistent compounds, or to meet the requirements of EC Directives. With the exception of surveys of nutrients and metals carried out in Southampton Water and the Solent between 1977 and 1983, and of "Red List" substances, which have been monitored throughout the region since 1989, surveys have rarely been designed to establish environmental concentrations of determinands with sufficient statistical precision to enable temporal trends to be determined.

The Southern Region Coastal Baseline Survey was initiated in 1990 to determine concentrations of nutrients, metals and pesticides in coastal waters in order to assess the success of recently implemented international and domestic pollution control measures in maintaining or reducing present levels of contamination. The programme was organised so as to fulfil obligations arising from the National Baseline Monitoring Programme (National Monitoring Plan - NMP) and to include sites previously monitored for the Joint Monitoring Programme of the Oslo and Paris Commissions. Data from the surveys will also be required for the designation of "sensitive waters" in respect of the European Urban Waste Water Treatment Directive (91/271/EEC).

The nutrients data presented in this report are from the period December 1990 to November 1993. Additional data collected as part of the Regional programme and our commitment to the NMP during the period 1989-92, are included in other reports (refs : 063/4/S Metals; 063/5/S Organics). Final reports on all determinands will be produced after the programme terminates in April 1994.

2 METHODS

Twenty-one sampling stations (Table 1 & Figure 1), remote from the immediate influence of anthropogenic inputs, were selected. In addition, three sites in Southampton Water and the Eastern Solent (Stations A, B & C), which had been previously monitored as part of the Joint Monitoring Programme, were included. Stations 6 (Selsey Bill), A, B and C represent the NRA Southern Region's monitoring requirements under the NMP.

Samples were collected at approximately 3-month intervals, with a minimum of two months between surveys. Occasionally it was possible to include additional surveys thereby reducing this interval. On each occasion, samples were taken from a depth of 0.5 m on both the outward and return journeys. Water column profiles of temperature, salinity and dissolved oxygen saturation were recorded to 5 m depth at each location.

Samples were collected using "blue book" methods wherever possible, so as to minimise the risks of contamination. Samples for nutrients analysis were filtered through 1.2 µm pore GF/C filters and immediately frozen in order to minimise deterioration prior to analysis.

Analyses were carried out at the NRA Welsh Region laboratory Llanelli, or Southern Region laboratory, Waterlooville, using comparable methodologies.

3 RESULTS & DISCUSSION

Results are presented in Tables 2-8 and Figures 2-9. In Figures 2-9, "winter" refers to the period October to April, and "summer", May-September inclusive. Results have not been compared statistically. The inclusion of standard errors in Figures 2-9 should not, therefore, be taken to imply statistical significance.

3.1 Dissolved oxygen saturation (Table 2 & Figure 2).

Oxygen saturation values were generally high at all stations throughout the year. Lowest values (70%) occurred during the winter period in the upper reaches of Southampton Water. It is possible that lower saturation conditions occur during the summer associated with algal blooms (see below), but the surveys reported here were not designed to investigate such impacts. Average summer values (99.5±3.3% across all sites) were higher than for the winter period (95.3±1.9) as a result of phytoplankton activity.

Low winter values in the Solent and Southampton Water are a consequence of local river and sewage discharges, consumption through natural estuarine processes, and the effects of limited dispersion and exchange with adjacent coastal waters. In contrast, supersaturation during the summer period is indicative of significant algal activity in the area; this was supported by chlorophyll data (see 3.7 below). Since surveys were routinely conducted during the day, the effects of diurnal variations, in terms of over-night deoxygenation, have not been measured. Historically, significant deoxygenation has been shown to occur in the major estuaries of the Solent (Test and Itchen) as a result of blooms of the ciliate *Mesodinium rubrum*. Although occurring throughout the Solent, significant blooms of *M. rubrum* appear to be restricted to the upper estuary and it is unlikely that it occurs in sufficient density to cause similar problems in the outer estuary. Other primary producers occurring in the outer estuary, while contributing to diurnal fluxes, are, similarly, unlikely to cause significant over-night deoxygenation.

3.2 Ammoniacal nitrogen (Table 3 & Figure 3).

Concentrations were generally higher in the winter (36.5±7.1 μgl^{-1}) than in the summer (30.5±5.8 μgl^{-1}), ranging from a minimum of < 3.0 μgl^{-1} at a number of coastal stations, to a maximum of 400 μgl^{-1} at Station A, Dockhead. This reflects the importance of riverine sources and algal activity; some species utilize ammonia as a nitrogen source during growth, while degradation in declining populations may release ammonia.

With the exception of high winter concentrations at Station 2, The Needles, and high summer concentrations at Station 6, Selsey Bill, maximum concentrations occurred in estuarine locations, a significant gradient being evident from Dockhead, through Southampton water and the Solent, to adjacent coastal waters. Sources include the rivers Test, Itchen and Hamble, which receive significant discharges of secondary treated sewage effluents, and also the discharges of sewage which currently receive only preliminary treatment; these include Eastney, East Cowes and Ryde in the eastern Solent.

Curiously, concentrations in the Thames estuary have been consistently low, comparable with levels measured off the south coast. This is difficult to explain since concentrations of other nutrients are elevated in the Thames as

expected. Recent surveys of nutrients around the Kent coast suggest that winter concentrations may indeed be higher than indicated by this baseline data. Thus, samples collected at approximately fortnightly intervals from January to mid February 1994, indicate that ammoniacal-nitrogen concentrations are in the range 100-200 μgl^{-1}, two to three times higher than indicated by the baseline surveys and comparable with concentrations recorded in the Solent and Southampton Water. These results suggest that samples collected for Baseline purposes may have deteriorated prior to analysis in spite of efforts to eliminate this; in particular, samples may have thawed during transit from the eastern end of the survey enabling nitrification processes to take place.

3.3 Nitrate nitrogen (Table 4 & Figure 4).

Concentrations ranged from a summer minimum of < 1 μgl^{-1} at a number of off-shore stations, to a maximum of > 2000 μgl^{-1} at Dockhead, again measured during the summer period. Concentrations were however generally higher in the winter (224±33 μgl^{-1}) than the summer (100±39 μgl^{-1}) as a result of higher river flows and reduced biological activity during the winter period. There was no evidence of elevated concentrations associated the discharge of rivers from Sussex and the south Kent coast. Similar winter concentrations (> 210 μgl^{-1}) have been reported for the English Channel by the Oslo and Paris Commissions (Anon, 1992).

Again, there was a significant concentration gradient from Southampton Water to adjacent coastal waters, but in the case of nitrate nitrogen, this was reflected in a similar gradient in the Thames. In both the Solent and the Thames, the annual mean concentration of nitrate nitrogen exceeded the 200 μgl^{-1} limit originally defined by the Urban Waste Water Implementation Group as evidence of sensitivity. Subsequent definitions have introduced the concept of hyper-nutrification when predicted summer concentrations of dissolved available inorganic nitrogen (DAIN) exceed approximately 168 μgl^{-1} (MPMMG, 1993). Summer concentrations of DAIN have approached this limit in both the Solent and the Thames estuaries, in spite of uptake by primary producers, and on the evidence of these surveys, both estuaries might qualify as "sensitive" or "hyper-nutrified" waters.

3.4 Nitrite nitrogen (Table 5 & Figure 5).

As with nitrate nitrogen, levels of nitrite were higher in the major estuaries than in off-shore coastal waters. Winter concentrations were also higher (7.3±1.5 μgl^{-1}) than those recorded over the summer period (3.2±0.7 μgl^{-1}). High coastal concentrations (up to 25.1 μgl^{-1}) which were measured during December 1990 at stations 8-10, Worthing-Newhaven, must be viewed with some suspicion since nitrite is transitory in nature and associated nitrogen species (nitrate and ammonia) were measured at only very low concentrations in these samples.

3.5 Orthophosphate (Table 6 & Figure 6).

The highest concentrations, up to 301 μgl^{-1}, were largely restricted to estuarine locations during the winter period. However, concentrations up to 145 μgl^{-1} were also recorded during the winter at station 2, The Needles. Elevated concentrations of other nutrients at this site and at station 1, Hengistbury Head, suggest that dispersion from Christchurch Bay is poor,

resulting in the accumulation of nutrients discharged from the western Solent and the major rivers of west Hampshire and Dorset. Unpublished results from current meters deployed by the Department of Oceanography, Southampton University, suggest that hydrodynamics in this area are complex, a number of semi-stable gyres contributing towards the inhibition of dispersion from the near-shore.

The mean winter and summer concentrations across all stations were 32.4±5.0 μgl^{-1} and 15.6±2.7 μgl^{-1} respectively, corresponding to patterns of drainage discharge and phytoplankton activity. Winter concentrations reported by the Oslo & Paris Commissions (Oslo and Paris Commissions, 1992) (> 26 μgl^{-1}) were similar to the results from these surveys.

3.6 Silica (Table 7 & Figure 7).

Maximum concentrations of silica (> 7000 μgl^{-1}) were recorded in estuarine locations during the winter period, and minimum concentrations (2.0 μgl^{-1}) in open-coast locations. The mean winter and summer concentrations were 281±48 μgl^{-1} and 65±13 μgl^{-1} respectively reflecting the importance of rivers as major sources of silica. Turbulent mixing may also mobilise silica from the sediments during the winter period, while uptake by diatoms will result in lower concentrations of the dissolved fraction during spring and summer bloom events.

3.7 Chlorophyll-A (Table 8; Figures 8 & 9).

Elevated concentrations of nutrients in estuaries would be expected to stimulate primary production if retention times are sufficiently long to accomodate cell multiplication. This has been shown to be the case for the Solent and Southampton Water where maximum concentrations of chlorophyll-A have exceeded 30 μgl^{-1}; the level above which a receiving water is deemed to be susceptible to eutrophication is 10 μgl^{-1} (MPMMG, 1993). As mentioned above, these waters may in consequence qualify as "sensitive" under the terms of the European Waste Water Directive.

In contrast, chlorophyll concentrations in the Thames estuary have been found to be low. This could be due to higher flushing rates or light attenuation caused by suspended silt, but is more likely to be a result of the pre-programmed nature of the baseline surveys; extensive algal blooms are regularly observed along the north-Kent coast, but quarterly surveys are not necessarily suited to detecting such ephemeral events.

4 CONCLUSIONS

Nutrient species are present at relatively low concentrations in the coastal waters of Southern Region. Higher levels observed during the winter period, October to April, and in the major estuaries of the Solent and Thames, reflect the importance of rivers and, where dispersion is poor, sewage discharges, as sources of nutrients. This can stimulate primary production where retention times are favourable. Hence, concentrations of chlorophyll-A in the Solent have exceeded the level above which waters are deemed to be susceptible to eutrophication. However, occasional, pre-programmed surveys such as these may not be the optimum means of monitoring ephemeral events such as algal blooms. Such events would be more accurately monitored by means of dedicated surveys.

At present, the nutrient status of the Solent approximates to other major estuaries such as the Mersey (NRA, 1993). The Thames carries even higher levels of nutrients, comparable with levels in the Severn estuary, presumably because of the larger river discharge. Significant improvements in terms of water quality and in particular, the nutrient status of major estuaries such as the Solent, can be anticipated with the implementation of pollution control legislation, including the European Urban Waste Water Treatment Directive. However, it is not possible to quantify the likely improvements at this stage. The development of detailed nutrient budgets and a predictive computer model by Southern Region NRA will enable this for the Solent within the next 2-3 years. The results from these Baseline surveys will be used to monitor the success of these measures.

5 REFERENCES

NRA (1993) National Coastal Baseline Survey Results: 1992-1993.

Oslo and Paris Commissions (1992) *Nutrients in the Convention Area*. Publ. Oslo and Paris Commissions.

TABLES

Table 1 : The location of Marine Baseline Survey monitoring stations.

		Latitude	Longitude
Base A *	Dockhead	50° 52.90 N	1° 23.50 W
Base B *	Calshot	50° 49.20 N	1° 18.00 W
Base C *	East Brambles Buoy	50° 47.20 N	1° 13.55 W
Base 1	Hengistbury Head	50° 42.00 N	1° 45.00 W
Base 2	The Needles	50° 38.20 N	1° 39.00 W
Base 3	St Catherines Point	50° 33.00 N	1° 18.00 W
Base 4	West Princessa Buoy	50° 40.15 N	1° 03.50 W
Base 5	Nab Tower	50° 40.10 N	0° 57.00 W
Base 6 *	Selsey Bill	50° 40.00 N	0° 50.00 W
Base 7	Middleton-on-Sea	50° 44.70 N	0° 35.07 W
Base 8	Worthing	50° 46.20 N	0° 22.50 W
Base 9	Brighton	50° 47.00 N	0° 10.08 W
Base 10	Newhaven	50° 45.50 N	0° 00.12 E
Base 11	Beachy Head	50° 42.50 N	0° 16.00 E
Base 12	Bexhill	50° 47.00 N	0° 30.00 E
Base 13	Rye Bay	50° 51.00 N	0° 44.00 E
Base 14	Dungeness	50° 53.50 N	1° 00.00 E
Base 15	Sandgate Bay	51° 02.20 N	1° 11.10 E
Base 16	South Foreland	51° 08.00 N	1° 23.50 E
Base 17	Goodwin Fork Buoy	51° 13.30 N	1° 27.00 E
Base 18	East Brake Buoy	51° 19.50 N	1° 29.00 E
Base 19	East Margate Buoy	51° 27.00 N	1° 25.14 E
Base 20	Shivering Sand Buoy	51° 30.00 N	1° 04.90 E
Base 21	Medway Buoy	51° 28.80 N	0° 53.10 E

* National Baseline Monitoring Programme

Table 2 : Coastal Baseline Survey 1990-93 Dissolved Oxygen Percent Saturation

Site	90 Dec Out	90 Dec Retn	91 Jan Out	91 Jan Retn	91 Feb Out	91 Feb Retn	91 Apr Out	91 Apr Retn	91 Jul Out	91 Jul Retn	91 Oct Out	91 Oct Retn	92 Feb Out	92 Feb Retn	92 May Out	92 May Retn	92 Jun Out	92 Jun Retn	92 Jul Out	92 Jul Retn	92 Oct Out	92 Oct Retn
A			96	92	91	87	88	96	139	92	77	70	90	90	97	97			97	103	90	88
B			100	95	91	89	93	96	126	91	82	77	95	90	101	101			103	99	93	94
C			100	98	95	96	94	95	131	89	82	78	95	90	99	99			100	88	92	96
1	106		107	104	95	96	91	98	130	92	90	82	94	87			99	101		99	95	97
2	106		104	103	97	93	91	96	118	91	89	83	96	87			97	106		96	95	95
3	111		106	106	97	93	90		116		86	84	97	86			98	108		93	96	95
4	112	121	107	102	97	95	91	102	121	89	85	85	96	90			103	111		86	97	97
5	110	122	107	101	95	96	97	100	124	94	85	84	99	90			85	113		86	96	99
6	113	120	104	102	101	97	107	100	129	95	83	83	98	89	97	97			105	90	96	95
7	104	122	103	101	98	97	95	98	101	93	85	84	98	90			107	108	102	90	98	95
8	109	122	108	101	96	99	103	102	99	91	85	84	98	90			109	107	108	95	95	96
9	106	121	106	102	96	100	112	106	100	96	86	85	98	90			115	114	108	93	95	98
10	107	120	105	102	93	101	108	115	98	92	85	84	97	92			113	108	105	92	94	94
11	104	119	102	99	98	92	103	93	97	88	85	81	98	87			113	104	103	92	95	94
12	104	121	106	100	98	96	106	109	99	92	84	84	97	90			112	113	110	97	95	95
13	104	122	106	102	93	93	100	100	102	91	83	87	96	90			123	115	112	98	94	95
14	106	119	107	103	99	94	96	100	99	89	83	82	97	90			115	111	109	99	94	95
15	112	117	104	100	100	96	96	95	95	91	83	84	95	91			112	103	103	104	95	94
16	115	121	106	102	98	92	95	95	96	86	86	82	93	92			103	105	100	101	94	92
17	121	117	107	99	97	94	98	96	93	89	86	85	95	92			105	105	104	103	94	92
18	121	116	104	100	96	94	98	98	97	88	85	85	94	89			99	109	108	67	94	94
19			105	102	90	94	102	102	97	91	85	86	95	92			99	101	107	73	95	94
20			103	101	91	94	100	101	96	91	85	85	95	87			99	96	115	82	94	94
21			99	98	91	88	97	100	90	88	83	84	93	88			95	104	110	91	93	93

Site	93 Jan Out	93 Jan Retn	93 Apr Out	93 May Retn	93 Aug Out	93 Aug Retn	93 Oct Retn	93 Nov Out	93 Nov Retn
A	91	90	91	115	91	85	82	83	95
B	90	88	97	134	98	89	88	86	
C	92	90	96	132	97	89	118	84	93
1	100	85	98	103	101	104		87	
2	95	84	97	107	104	96		86	
3	93		98	111	94		90	86	
4	93	90	98	114	89	95	97	86	95
5	94	91	99	109	89	91	118	86	96
6		91	104	102	86	95	93	86	95
7	94	91	105	101	91	93	92	85	94
8	93	91	109	103	91	94	93	84	95
9	95	92	106	105	91	91	103	85	94
10	94	92	107	104	91	89	102	90	95
11	89	91	109	105	87	88	100	88	94
12	94	91	103	100	92	98	99	89	91
13	89	83	99	96	89	91	89	89	92
14	89	85	98	95	89	93	92	89	92
15	89		102	96	92	94	81	90	90
16	89	81	100	96	91	94	92	90	89
17	88	91	102	96	91	93		89	91
18	88	91	104	98	87	92		90	92
19	92	92	103	96			79	93	93
20	90	92	107	99			71	94	92
21	90	91	108	94			86	92	93

Table 3 : Coastal Baseline Survey 1990-93 Ammoniacal nitrogen concentrations (µg/l)

Site	90 Dec Out	90 Dec Retn	91 Jan Out	91 Jan Retn	91 Feb Out	91 Feb Retn	91 Apr Out	91 Apr Retn	91 Jul Out	91 Jul Retn	91 Oct Out	91 Oct Retn	92 Feb Out	92 Feb Retn	92 May Out	92 May Retn	92 Jun Out	92 Jun Retn	92 Jul Out	92 Jul Retn
A	370.0		199.0	400.0	4.1	114.0	137.0	109.0	20.2	54.6	149.0	112.0	165.0	193.0	241.0	102.0			133.0	42.0
B	109.0		307.0	90.0	5.0	8.5	95.4	9.1	14.3	11.2	154.0	75.6	88.0	88.0	70.0	151.0			99.0	25.0
C	20.0		185.0	26.0	8.4	187.0	35.6	9.9	11.8	13.7	79.8	25.1	95.0	95.0	22.0	35.0			75.0	33.0
1	6.7		78.0	303.0	6.8	106.0	22.8	7.8	4.5	29.5	53.1	24.0	<4.0	29.0			8.6	22.0	36.0	24.0
2	21.0		203.0	4.0	5.6	187.0	28.7	13.2	15.7	10.2	68.5	20.2	4.0	12.9			8.7	21.0	26.0	9.0
3	<3.0		32.0	<3.0	5.1	15.1	11.8		9.4		54.8	21.2	4.0	8.1			10.5	23.0	40.0	4.0
4	<3.0		16.0	<3.0	5.5	21.3	9.5	16.6	19.5	13.4	62.0		8.0	2.0			13.6	23.0	25.0	29.0
5	<3.0	<3.0	<3.0	<3.0	9.5	10.6	37.8	9.0	15.2	11.4	14.6	21.1	15.0	7.6			18.5	21.0	21.0	29.0
6	4.7	25.0	19.0	<3.0	6.5	34.8	24.4	13.8	9.3	28.9	41.3	21.8	8.0	8.7	100.0	51.0			20.0	29.0
7	13.0	<3.0	39.0	<3.0	10.4	61.7	12.8	12.7	12.4	12.6		17.6	<4.0	10.4			12.3	22.0	13.0	23.0
8	11.0	<3.0	<3.0	<3.0	9.2	55.6	18.5	11.2	14.2	10.9	12.7	17.7	<4.0	2.0			7.9	28.0	23.0	26.0
9	24.0	7.6	15.0	<3.0	15.8	19.6	15.6	9.0	6.3	10.6	13.5	15.4	7.0	4.2			13.0	22.0	31.0	20.0
10	11.0	17.0	<3.0	8.1	4.6	5.6	14.6	11.2	23.5	10.6	12.9	14.5	<4.0	5.2			17.0	22.0	16.0	30.0
11	<3.0	7.0	17.0	<3.0	7.5	54.6	20.8	16.7	18.2	25.8	11.3	13.7	<4.0	16.0			30.5	21.0	33.0	32.0
12	<3.0	<3.0	<3.0	<3.0	4.0	145.0	10.8	13.5	23.4	9.9	1<3.0	14.4	4.0	7.0			20.3	16.0	20.0	17.0
13	<3.0	<3.0	<3.0	<3.0	5.6	7.5	12.2	8.5	13.1	9.9	10.9	12.6	<4.0	10.0			11.8	20.0	18.0	24.0
14	<3.0	3.2	<3.0	<3.0	5.5	8.1	9.9	9.3	14.1	10.6	9.9	22.1	5.7	8.0			3.9	12.0	19.0	17.0
15	<3.0	<3.0	<3.0	<3.0	2.9	91.7	15.6	6.5	15.7	12.1	24.5	12.7	<4.0	8.0			4.3	10.0	45.0	2.0
16	<3.0	<3.0	<3.0	<3.0	10.9	43.3	8.4	30.2	18.7	9.6	8.8	13.1	5.4	7.0			7.9	10.0	49.0	16.0
17	<3.0	<3.0	<3.0	<3.0	8.1	83.9	30.8	18.2	9.8	15.5	59.7	20.1	13.0	12.0			3.8	10.0	55.0	5.0
18	3.7	<3.0	5.4	<3.0	17.8	<3.0	14.6	6.4	15.1	17.8	17.7	9.1	89.0	13.0			50.0	11.0	60.0	45.0
19			3.0	<3.0	<3.0	5.7	36.3	13.8	12.0	14.2	17.7	20.1	9.6	16.0			42.0	34.0	58.0	30.0
20			<3.0	<3.0	26.7	23.3	<3.0	12.2	12.4	25.7	11.9	8.9	18.0	24.0			57.0	34.0	62.0	45.0
21			30.0	21.0	77.4	9.3	26.6	12.5	12.1	12.4	8.2	9.2	22.0	25.0			46.0	48.0	98.0	82.0

Site	92 Oct Out	92 Oct Retn	93 Jan Out	93 Jan Retn	93 Apr Out	93 May Retn	93 Aug Out	93 Aug Retn	93 Oct	93 Nov Out	93 Nov Retn
A	232.0	233.0	123.0	74.0	380.0	90.0	100.0	180.0	214.0	130.0	330.0
B	71.0	115.0	100.0	29.0	70.0	30.0	40.0	70.0	155.0	60.0	80.0
C	63.0	62.0	70.0	21.0	40.0	20.0	50.0	60.0	44.0	70.0	100.0
1	27.0	35.0	4.0	40.0	20.0	20.0	20.0	20.0	32.0	60.0	50.0
2	19.0	67.0	62.0	30.0	30.0	20.0	30.0	20.0	46.0	80.0	60.0
3	127.0	39.0	71.0		20.0	30.0		20.0	52.0	60.0	
4	8.0	28.0	60.0	30.0	20.0	20.0	30.0	20.0	30.0	40.0	50.0
5	36.0	43.0	70.0	40.0	30.0	<20.0	30.0	40.0	<20.0	80.0	50.0
6		33.0	88.0	5.0	30.0	10.0	30.0	30.0	43.0	80.0	50.0
7	8.0	43.0	4.0	68.0	<20.0	30.0	20.0	30.0	55.0	70.0	70.0
8	19.0	30.0	4.0	7.0	20.0	<20.0	<30.0	20.0	48.0	70.0	60.0
9	40.0	33.0	9.0	50.0	20.0	<20.0	50.0	60.0	22.0	60.0	70.0
10	41.0	69.0	2.0	35.0	<20.0	40.0	50.0	40.0	52.0	70.0	40.0
11	35.0	52.0	6.0	68.0	20.0	20.0	50.0	40.0	29.0	70.0	40.0
12	13.0	34.0	2.0	8.0	20.0	30.0	40.0	40.0	32.0	60.0	40.0
13	18.0	25.0	10.0	7.0	<20.0	30.0	50.0	50.0	23.0	60.0	30.0
14	14.0	19.0	8.0	6.0	<20.0	30.0	40.0	40.0	39.0	60.0	50.0
15	9.0	56.0	14.0	5.0	20.0	20.0	30.0	30.0	20.0	60.0	40.0
16	23.0	17.0	4.0	9.0	10.0	30.0	30.0	40.0	31.0	60.0	40.0
17	11.0	8.0	9.0	5.0	20.0	20.0	30.0	30.0	60.0	60.0	40.0
18	45.0	14.0	9.0	5.0	20.0	30.0	30.0	40.0	33.0	60.0	40.0
19	22.0	7.0	17.0	97.0	10.0	20.0			29.0	60.0	40.0
20	26.0	10.0	48.0	60.0	20.0	30.0			30.0	60.0	40.0
21	60.0	16.0	21.0	8.0	20.0	20.0			22.0	60.0	40.0

Table 4 : Coastal Baseline Survey 1990-93 Nitrate nitrogen concentrations (µg/l)

Site	90 Dec Out	90 Dec Retn	91 Jan Out	91 Jan Retn	91 Feb Out	91 Feb Retn	91 Apr Out	91 Apr Retn	91 Jul Out	91 Jul Retn	91 Oct Out	91 Oct Retn	92 Feb Out	92 Feb Retn	92 May Out	92 May Retn	92 Jun Out	92 Jun Retn	92 Jul Out	92 Jul Retn
A	438	811	468	914	1052	1182	929	570	397	297	202	329	519	533	941	341			>2000	158
B	318	309	588	428	581	482	624	325	50	19.	228	140	366	296	284	297			1568	52
C	120	306	322	197	359	416	193	410	51	16	92	124	334	281	164	172			370	21
1	158		355	263	368	585	366	328	4	3	127	53	439	306			22	10	937	14
2	158		336	211	277	334	197	387	8	<2	47	74	188	252			4	4	49	26
3	98		190	132	208	233	171		16		31	49	172	194			7	2	161	32
4	82		59	146	163	161	61	89	12	138	23		121	131			10	<1	55	42
5	102	143	136	171	172	149	124	126	4	2	13	45	200	129			18	2	43	36
6	111	78	170	123	172	220	38	89	4	14	13	131	160	136	79	90			<1	28
7	116	82	233	137	91	104	34	51	13	3		68	104	137			23	<1	3	9
8	122	106	114	147	87	194	57	54	5	<2	14	16	127	102			9	<1	2	12
9	140	97	98	107	94	107	33	58	7	3	13	20	169	112			5	7	113	16
10	94	95	90	79	135	158	43	66	7	<2	9	17	216	210			7	3	7	46
11	196	170	160	62	127	78	14	65	14	15	8	22	236	234			3	<1	14	21
12	163	151	59	85	94	83	51	12	9	<2	11	67	201	162			1	2	9	33
13	177	177	89	89	119	81	97	88	3	4	<2	9	229	145			4	2	7	18
14	177	189	58	82	102	105	116	108	<10	4	38	128	236	225			<1	4	2	16
15	177	144	70	66	87	81	94	180	9	14	137	149	243	222			3	<1	17	12
16	267	200	99	143	127	110	122	148	18	10	67	145	232	219			2	<1	19	77
17	189	222	125	187	108	108	123	126	27	13	273	158	295	233			10	61	7	125
18	166	177	181	218	323	85	216	154	50	16	138	330	335	192			34	2	59	99
19			232	207	578	120	347	283	90	119	132	296	178	282			67	10	45	61
20			435	303	594	390	200	129	384	360	199	221	353	306			78	73	106	142
21			1143	1373	1196	850	815	42	322	185	243	197	303	641			>100	>100	727	1140

Site	92 Oct Out	92 Oct Retn	93 Jan Out	93 Jan Retn	93 Apr Out	93 May Retn	93 Aug Out	93 Aug Retn	93 Oct	93 Nov Out	93 Nov Retn
A	393	524	1230	840	890	490	290	470	1026	610	1450
B	99	120	1150	630	510	250	80	140	599	190	300
C	56	37		580	340	40	80	70	72	110	400
1	63	73	230	185	280	250	<10	<10	45	130	270
2	48	75	330	235	260	160	20	<10	56	180	220
3	93	44		200	190	120		20		150	
4	13	12	300	460	160	20	<10	<10	32	50	140
5	12	19	350	370	140	10	<10	<10	<10	130	130
6		25	400	150	20	10	<10	<10	63	150	90
7	11	31	140	290	<10	10	<10	<10	114	130	150
8	20	6	140	530	<10	20	<10	<10	35	120	130
9	33	22	120	160	<10	<10	20	20	23	150	170
10	76	62	310	180	<10	20	<10	<10	38	110	140
11	80	62	110	140	<10	20	<10	<10	11	210	100
12	76	51	110	120	30	90	<10	<10	15	110	120
13	98	36	90	120	50	160	20	<10	<10	130	70
14	54	27	110	190	60	180	20	20	14	110	110
15	79	47	120	110	140	180	20	<10	<10	140	120
16	135	47	130	490	220	230	30	20	16	230	160
17	126	65	120	620	240	200	40	30	18	320	240
18	153	81	130	660	230	370	<10	20	<10	530	300
19	76		510	1630	290	380			99	230	210
20	82		1120	1250	530	480			236	340	330
21	753	119	1280	1690	1040	420			490	690	700

Table 5 : Coastal Baseline Survey 1990-93 Nitrite nitrogen concentrations (µg/l)

Site	90 Dec Out	90 Dec Retn	91 Jan Out	91 Jan Retn	91 Feb Out	91 Feb Retn	91 Apr Out	91 Apr Retn	91 Jul Out	91 Jul Retn	91 Oct Out	91 Oct Retn	92 Feb Out	92 Feb Retn	92 May Out	92 May Retn	92 Jun Out	92 Jun Retn	92 Jul Out	92 Jul Retn
A	15.6	12.9	9.8	16.5	14.8	15.5	11.1	5.3	14.5	13.9	21.9	17.1	14.6	17.2	9.1	8.1			16.3	11.0
B	16.9	6.3	14.0	8.9	7.4	3.9	8.9	2.1	2.4	4.6	14.1	9.0	10.9	10.2	7.0	7.4			11.9	3.6
C	12.3	6.3	7.4	5.4	4.7	3.6	2.4	2.5	2.9	0.9	7.9	7.3	10.9	8.7	4.0	4.4			5.1	3.2
1	11.9		8.1	3.3	2.5	3.2	2.1	1.6	<0.5	1.5	3.8	1.7	4.6	6.3			0.9	1.4	3.5	1.8
2	11.9		6.0	3.0	1.7	1.5	1.3	1.4	0.7	0.8	4.7	2.0	4.1	5.6			0.4	0.9	2.4	1.4
3	11.4		3.1	2.4	1.7	1.0	1.2		1.0		5.1	1.4	3.3	3.8			0.8	1.3	1.2	1.8
4	7.7		1.1	6.6	2.9	1.1	1.0	0.5	0.6	1.7	5.4		2.5	3.0			1.3	1.3	2.2	2.1
5	9.6	6.4	3.4	6.1	3.5	1.6	1.5	0.9	<0.5	1.3	5.7	2.4	8.4	3.7			0.7	0.9	1.7	1.8
6	11.0	5.5	6.9	12.0	3.8	2.3	0.8	0.6	<0.5	2.2	5.3	1.6	6.7	5.0	2.6	2.9			0.7	1.3
7	8.7	3.5	9.8	11.0	1.2	0.9	<0.5	<0.5	<0.5	0.7		1.7	3.2	8.3			1.8	1.0	0.9	1.0
8	23.8	25.1	11.0	14.0	1.5	3.0	<0.5	<0.5	<0.5	<0.5	1.2	<0.5	15.4	2.0			0.5	1.3	1.0	1.2
9	21.1	24.1	15.0	7.2	2.6	1.3	<0.5	<0.5	<0.5	0.6	1.2	<0.5	20.0	2.2			1.4	0.7	1.0	1.4
10	18.8	19.5	2.7	2.8	2.3	2.1	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	12.0	8.8			1.5	0.7	1.4	1.6
11	2.5	4.2	4.6	1.5	2.2	0.6	<0.5	<0.5	<0.5	3.1	2.1	1.1	3.8	7.3			1.5	0.9	3.5	1.6
12	2.2	2.3	<0.7	3.1	1.4	0.9	<0.5	<0.5	1.6	<0.5	0.7	<0.5	2.4	1.5			2.4	0.2	1.9	1.0
13	<0.7	<0.7	2.6	3.2	2.5	1.0	<0.5	0.9	<0.5	<0.5	2.1	<0.5	3.6	1.7			1.7	1.0	1.0	1.2
14	<0.7	<0.7	1.0	1.6	1.9	1.4	<0.5	0.8	<0.5	<0.5	0.7	11.1	3.0	3.9			1.9	0.9	1.2	2.7
15	<0.7	<0.7	1.3	0.7	1.5	2.0	<0.5	1.1	0.8	2.1	0.7	11.0	2.6	3.4			1.5	0.9	2.5	1.8
16	<0.7	<0.7	2.0	2.4	1.8	1.0	<0.5	1.0	1.0	1.5	7.9	4.3	2.3	3.0			1.1	1.1	3.7	4.9
17	<0.7	<0.7	2.6	1.9	1.9	0.9	0.7	0.8	1.0	1.1	7.8	6.4	2.6	5.1			0.9	1.2	4.7	
18	<0.7	<0.7	2.0	1.9	2.2	1.6	0.9	1.1	1.1	2.0	2.1	1.3	5.4	3.1			2.9	1.6	3.9	
19			2.1	1.9	2.2	1.3	1.3	1.4	1.7	5.1	<0.5	1.6	3.2	4.3			1.2	1.7	3.0	
20			2.3	1.7	1.7	1.2	0.9	1.7	6.1	5.5	<0.5	<0.5	3.6	5.9			3.0	2.7	6.2	
21			5.8	3.0	5.2	3.3	1.3	1.8	3.9	3.5	<0.5	0.9	3.7	4.7			5.1	5.0	13.3	

Site	92 Oct Out	92 Oct Retn	93 Jan Out	93 Jan Retn	93 Apr Out	93 May Retn	93 Aug Out	93 Aug Retn	93 Oct	93 Nov Out	93 Nov Retn
A	<20.0	42.0	23.0	12.7	14.0	70.0	13.0	18.0	40.0	12.0	23.0
B	12.4	10.0	10.0	11.5	6.0	7.0	6.0	9.0	24.0	86.0	9.0
C	7.1	5.8		9.4	5.0	4.0	7.0	7.0	15.0	6.0	10.0
1	9.5	6.7	6.0	5.0	4.0	5.0	<20.0	3.0	14.0	5.0	7.0
2	6.7	7.7	7.0	5.0	4.0	3.0	3.0	3.0	10.0	6.0	26.0
3	7.0	7.1	4.0		4.0	6.0		4.0	16.0	6.0	
4	4.4	3.9	7.0	8.4	3.0	2.0	2.0	3.0	15.0	5.0	9.0
5	3.4	4.3	8.7	8.7	3.0	2.0	2.0	3.0	16.0	7.0	8.0
6	13.9	6.0	9.0	6.2	<10.0	3.0	<2.0	2.0	16.0	7.0	11.0
7	4.8	6.1	9.1	6.8	<2.0	3.0	<2.0	2.0	16.0	16.0	14.0
8	5.4	4.6	8.6	9.6	<2.0	2.0	<2.0	<2.0	16.0	13.0	21.0
9	7.4	7.9	7.4	7.0	<2.0	2.0	2.0	3.0	16.0	13.0	27.0
10	11.8	12.6	8.9	8.0	<2.0	2.0	2.0	3.0	15.0	18.0	28.0
11	12.9	19.0	6.3	6.8	<2.0	<2.0	3.0	3.0	17.0	32.0	18.0
12	15.5	27.0	5.1	5.0	2.0	3.0	2.0	3.0	17.0	16.0	17.0
13	14.9	24.0	3.7	5.7	2.0	3.0	3.0	3.0	16.0	18.0	24.0
14	16.0	12.6	6.4	5.8	2.0	3.0	4.0	4.0	17.0	15.0	21.0
15	10.2	15.6	8.3	3.9	3.0	3.0	3.0	3.0	16.0	20.0	20.0
16	11.9	13.7	9.6	8.4	3.0	3.0	4.0	4.0	14.0	18.0	16.0
17	11.2	12.4	7.4	11.3	3.0	3.0	4.0	3.0	17.0	11.0	10.0
18	9.9	10.0	10.8	10.8	4.0	5.0	2.0	4.0	16.0	8.0	6.0
19	6.3		9.5	15.8	3.0	4.0			17.0	6.0	5.0
20	53.0		11.3	12.2	5.0	4.0			16.0	7.0	6.0
21	40.0	11.0	14.9	14.9	8.0	4.0			19.0	9.0	7.0

Table 6 : Coastal Baseline Survey 1990-93 Orthophosphate concentrations (µg/l)

Site	90 Dec Out	90 Dec Retn	91 Jan Out	91 Jan Retn	91 Feb Out	91 Feb Retn	91 Apr Out	91 Apr Retn	91 Jul Out	91 Jul Retn	91 Oct Out	91 Oct Retn	92 Feb Out	92 Feb Retn	92 May Out	92 May Retn	92 Jun Out	92 Jun Retn	92 Jul Out	92 Jul Retn
A	81.0	85.0	57.0	121.0	3.8	32.0	117.0	52.4	24.5	46.7	88.2	64.7	64.0	80.0	41.0	30.0			69.0	33.0
B	57.0	3.1	44.0	42.0	3.9	134.0	43.2	23.6	2.5	7.5	61.1	38.3	39.0	45.0	23.0	22.0			48.0	10.0
C	26.0	30.0	23.0	28.0	15.7	34.5	18.4	20.1	1.1	1.9	34.8	32.5	40.0	32.0	10.0	11.0			43.0	9.0
1	31.0		17.0	27.0	2.7	36.8	23.9	21.9	1.1	1.4	16.0	18.3	22.0	32.0			25.0	8.0	14.0	5.0
2	27.0		15.0	23.0	2.9	145.0	26.0	18.2	0.8	1.5	20.5	22.1	24.0	26.0			16.0	19.0	13.0	4.0
3	19.0		19.0	20.0	9.8	34.7	20.3		3.3		22.3	15.6	21.0	19.0			12.0	7.0	9.0	0.5
4	17.0		17.0	21.0	2.9	30.0	5.1	7.6	3.5	1.5	22.4		19.0	20.0			8.0	6.0	8.0	5.0
5	17.0	1.5	23.0	21.0	11.8	21.3	6.2	13.9	0.4	4.6	18.4	17.9	20.0	16.0			21.0	4.0	15.0	3.0
6	19.0	16.0	20.0	20.0	4.4	20.1	5.9	6.6	0.4	1.6	17.7	26.3	21.0	18.0	7.0	8.0			16.0	4.0
7	19.0	24.0	27.0	24.0	2.5	19.2	5.7	6.5	4.2	1.7		23.1	16.0	17.0			12.0	3.0	7.0	2.0
8	22.0	19.0	20.0	17.0	8.8	23.7	5.2	5.6	3.4	5.2	12.7	11.4	19.0	13.0			7.0	3.0	7.0	3.0
9	27.0	19.0	17.0	22.0	4.8	18.3	5.2	6.3	3.3	1.7	14.1	12.5	24.0	14.0			6.0	3.0	3.0	2.0
10	21.0	20.0	19.0	19.0	13.5	18.5	5.0	10.4	3.2	2.4	12.2	11.4	31.0	29.0			5.0	9.0	1.0	2.0
11	42.0	33.0	22.0	15.0	1.7	13.1	5.6	9.6	3.6	6.3	16.7	20.6	33.0	34.0			4.0	3.0	1.0	0.5
12	32.0	24.0	15.0	17.0	16.9	15.4	6.7	5.8	6.4	4.3	11.8	11.6	27.0	22.0			3.0	4.0	0.5	2.0
13	39.0	27.0	20.0	19.0	14.7	8.1	16.0	11.1	0.4	3.6	14.5	11.3	32.0	19.0			3.0	4.0	0.5	12.0
14	30.0	57.0	15.0	18.0	1.7	15.3	16.2	14.9	0.8	3.9	27.0	30.6	36.0	35.0			3.0	8.0	1.0	17.0
15	34.0	23.0	15.0	26.0	1.3	9.7	18.9	18.5	5.3	4.2	49.3	45.9	35.0	33.0			5.0	7.0	2.0	7.0
16	57.0	39.0	23.0	30.0	18.3	13.7	18.5	18.6	15.1	5.4	40.0	43.8	33.0	37.0			8.0	8.0	1.0	18.0
17	40.0	48.0	27.0	43.0	20.7	12.2	21.6	14.1	5.3	5.6	86.0	49.9	46.0	40.0			10.0	10.0	52.0	18.0
18	30.0	28.0	45.0	52.0	62.2	5.7	29.7	24.5	10.5	7.9	43.6	93.8		29.0			22.0	4.0	25.0	42.0
19			59.0	50.0	141.0	19.3	38.3	21.4	22.2	31.6	41.5	99.0	25.0	57.0			17.0	10.9	21.0	35.0
20			1.5	79.0	136.2	1.9	30.9	23.6	70.5	76.4	57.1	67.9	74.0	74.0			34.0	36.0	67.0	36.0
21			30.0	21.0	56.1	21.2	166.0	18.9	56.7	50.1	77.4	82.0	70.0	149.0			93.0	72.0	84.0	87.0

Site	93 Jan Out	93 Jan Retn	93 Apr Out	93 May Retn	93 Aug Out	93 Aug Retn	93 Oct	93 Nov Out	93 Nov Retn
A	67.0	46.0	70.0	20.0	40.0	70.0	74.0	100.0	130.0
B	58.0	36.0	20.0	<20.0	20.0	30.0	44.0	50.0	30.0
C	30.0	33.0	<20.0	<20.0	20.0	20.0	<20.0	140.0	30.0
1	35.0	40.0	<20.0	30.0	<20.0	<20.0	<20.0	130.0	20.0
2	51.0	20.0	<20.0	30.0	<20.0	<20.0	<20.0	120.0	20.0
3	70.0		<20.0	<20.0		<20.0	<20.0	70.0	
4	40.0	27.0	<20.0	<20.0	<20.0	<20.0	<20.0	40.0	20.0
5	47.0	24.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	20.0
6	30.0	44.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	<20.0
7	24.0	26.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	20.0
8	24.0	24.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	20.0
9	22.0	25.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	30.0
10	40.0	25.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	20.0
11	17.0	30.0	<20.0	<20.0	<20.0	<20.0	<20.0	30.0	20.0
12	22.0	28.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	20.0
13	22.0	10.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	<20.0
14	26.0	80.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	20.0
15	23.0	10.0	<20.0	<20.0	<20.0	<20.0	<20.0	20.0	20.0
16	20.0	48.0	20.0	<20.0	<20.0	<20.0	<20.0	40.0	20.0
17	26.0	69.0	20.0	20.0	20.0	<20.0	<20.0	10.0	30.0
18	42.0	53.0	20.0	30.0	<20.0	<20.0	20.0	80.0	40.0
19	37.0	149.0	30.0	40.0			<20.0	30.0	30.0
20	113.0	301.0	60.0	50.0			36.0	50.0	40.0
21	113.0	119.0	120.0	40.0			110.0	100.0	100.0

Table 7 : Coastal Baseline Survey 1990-93 Silica concentrations (µg/l)

Site	90 Dec Out	90 Dec Retn	91 Jan Out	91 Jan Retn	91 Feb Out	91 Feb Retn	91 Apr Out	91 Apr Retn	91 Jul Out	91 Jul Retn	91 Oct Out	91 Oct Retn	92 Feb Out	92 Feb Retn	92 May Out	92 May Retn	92 Jun Out	92 Jun Retn
A	696	1669	1098	2504	1695	1798	937	377	452	407	1124	965	1079	1134	372	347		
B	535	608	1085	892	875	631	430	146	24	26	773	336	651	683	259	261		
C	214	623	561	477	507	552	182	170	33	25	231	246	715	546	88	98		
1	357		460	464	471	730	187	113	18	20	7	12	464	574			101	43
2	357		432	407	383	428	181	136	5	44	48	63	426	452			49	49
3	135		345	310	295	357	153		5		6	2	347	357			41	39
4	107		150	319	231	300	88	73	8	12	2		261	255			21	41
5	107	107	330	364	246	231	84	83	4	11	2	2	300	250			32	29
6	107	180	327	250	255	336	67	91	7	11	2	2	280	270	24	28		
7	107	107	422	280	174	202	95	125	23	17		12	220	280			79	21
8	210	180	259	272	177	167	93	70	34	27	2	2	257	218			34	47
9	244	180	201	250	185	161	71	70	27	16	2	2	336	231			30	43
10	231	214	214	191	242	229	58	65	40	29	2	2	402	295			60	21
11	357	250	319	173	203	150	51	69	35	44	2	7	405	385			43	64
12	214	214	156	246	171	220	58	46	23	23	2	2	345	235			30	28
13	250	214	253	272	248	134	87	90	45	29	2	2	407	233			9	19
14	250	250	169	218	208	212	72	94	51	36	31	168	419	413			32	11
15	214	180	186	158	153	150	76	104	42	70	103	107	415	409			34	75
16	357	357	295	291	210	216	64	66	36	46	9	106	407	402				17
17	250	357	300	370	181	227	38	49	27	41	218	147	460	422			19	43
18	214	212	332	385	351	162	54	30	14	39	98	289	400	351			54	17
19			432	402	561	213	80	77	13	20	109	250	336	482			47	49
20			670	482	638	460	30	63	13	19	142	155	582	571			34	56
21			1584	957	1271	875	92	93	17	28	214	212	556	856			32	45

Site	92 Jul Out	92 Jul Retn	92 Oct Out	92 Oct Retn	93 Jan Out	93 Jan Retn	93 Apr Out	93 May Retn	93 Aug Out	93 Aug Retn	93 Oct	93 Nov Out
A	422	477	400	550	2320	1400	1300	700	700		4700	1100
B	<28	53	180	170	1920	1200	400	280	200	300	2000	600
C	142	57	120	80	1200	800	400	<200	300		440	700
1	76	52	110	110	520	300	200	<200	<200	<200	300	600
2	56	52	90	120	640	800	300	<200	200	300	<200	400
3	55	<47	160	80	450		200	<200		<200	300	200
4	34	37	60	40	691	<500	<200	<200	<200	200	621	214
5	41	37	40	40	757	600	<200	<200		300	556	
6	14	46		50	600	550	<200	<200		<200	<200	300
7	63	36	30	60	<500	500	<200	<200		<200	400	200
8	70	49	40	20	<500	<500	<200	<200		<200	<200	200
9	42	31	124	50	<500	<500	<200	<200		<200	<200	200
10	25	29	130	120	500	<500	<200	<200			<200	200
11	79	56	120	90	<500	<500	<200	<200			<200	200
12	62	41	110	<200	<500	<500	<200	<200	300		<200	200
13	66	99	140	90	<500	<500	<200	<200	400	300	<200	200
14	90	155	<200	90	<500	<500	<200	<200	300	400	<200	400
15	122	78	110	110	<500	<500	<200	<200	200	<200	<200	200
16	126	140	120	130	<500	650	<200	<200	200	<200	<200	300
17	106	92	130	110	<500	750	<200	<200	<200	<200	200	300
18	59	62	130	140	<500	600	<200	<200	<200	600	300	500
19	60	55	110	<200	7500	1800	<200	<200			300	200
20	27	196	150	140	4500	1200	<200	<200			300	300
21	83	270	200	<500	5400	1300	<200	<200			600	700

Table 8 : Coastal Baseline Survey 1990-93 Chlorophyll-A concentrations (µg

Site	91 Apr Out	91 Apr Retn	91 Jul Out	91 Jul Retn	91 Oct Out	91 Oct Retn	92 Feb Out	92 Feb Retn	92 May Out	92 May Retn
A	1.2	3.9	13.3	8.5	1.8	0.8	0.9	1.3	1.8	1.6
B	1.5	2.4	8.7	2.1	1.8	1.6	1.3	0.8	2.6	3.0
C	1.7	3.1	10.0	3.5	0.9	1.0	1.0	0.8	2.5	3.3
1	2.2	2.9	1.8	1.4	0.9	0.7	1.0	1.1		
2		1.8	1.9	2.9	1.3	0.8	0.9	0.9		
3	0.8		1.6		0.8	1.7	0.6	0.9		
4	1.2	4.7	1.3	1.3	1.1	2.4	0.6	0.5		
5	3.2	4.2	1.7	1.7	1.7	1.1	0.8	0.8		
6	2.9	5.8	2.2	1.7	0.5	0.8	1.2	1.0	1.7	1.3
7	1.5	1.1	0.3		1.4	0.7	1.2	0.8		
8	1.0	1.6	0.4	0.6	1.8	1.2	0.8	1.0		
9	3.8	1.8	0.5	0.9	1.3	1.9	1.3	0.9		
10	2.1	4.1	1.8	1.8	0.9	1.5	1.0	0.5		
11	3.9	3.3	1.0	2.1	1.3	1.9	0.9	0.5		
12	4.1	4.7	1.7	2.4	1.7	1.7	1.2	0.6		
13	2.4	5.3	3.3	3.4	1.9	2.5	1.2	0.6		
14	1.2	1.9	2.0	2.1	1.5	1.9	0.6	0.6		
15		2.6	1.9	2.2	2.2	2.0	1.4	0.9		
16	1.9	2.1	1.6	1.4	2.3	1.7	1.6	1.6		
17	3.0	1.7	1.7	1.7	0.7	2.7	2.0	2.0		
18	7.8	4.9	2.8	2.0	2.7	2.5	2.4	1.9		
19	12.0	6.3	2.5	2.5	2.2	4.2	1.7	1.6		
20	7.2	7.7	6.9	4.8	3.0	3.1	1.6	3.0		
21	14.2	5.3	2.5	2.5	2.2	2.4	1.4	1.6		

Site	92 Oct Out	92 Oct Retn	93 Jan Out	93 Jan Retn	93 Apr Out	93 May Retn	93 Aug Out	93 Aug Retn	93 Oct	93 Nov Out
A	1.7	1.1			1.6	28.6	5.4	2.1	0.5	0.4
B	1.5	1.2			6.2	28.8	3.6	3.7	0.6	0.4
C	1.5	1.2			2.5	38.9	4.6	2.9	0.5	
1	1.1	2.1			1.4	2.9	2.2	2.1	0.4	0.5
2	1.3	1.0			1.7	6.1	2.7	1.7	0.4	0.4
3	1.0	0.5			2.1	6.5		1.2	0.5	0.5
4	0.3	1.5			2.8	9.6	2.1	1.4		0.4
5	1.5	1.0			2.2	8.0	2.0	2.2	0.5	0.4
6	1.2	1.4			7.3	3.0	1.9	0.9	0.5	0.4
7	3.8	1.3			7.9	2.6	1.4	1.4	0.5	0.4
8	1.7	0.6			6.1	2.1	0.5	1.7	0.5	0.5
9	3.8	4.6			8.0	3.6	1.3	2.8	0.4	0.6
10	2.6	2.1			6.7	3.9	1.5	1.3	0.7	0.8
11	1.7	1.7			11.2	7.7	2.2	1.6		0.6
12	1.7	1.1			8.1	2.7	2.2	2.2	0.5	0.7
13	1.8	1.6			4.6	4.2	2.4	1.6	0.5	0.6
14	1.8	0.8			3.8	1.7	1.7	1.7	0.5	0.7
15	1.3	1.2			3.3	3.8	1.3	2.4	0.5	0.4
16	3.0	1.3			7.1	2.8	3.4	2.4	0.6	0.8
17	2.3	1.5			6.4	3.0	4.2	4.9	0.6	0.5
18	3.3	1.6			4.7	0.5	6.5	3.6	0.7	0.8
19	2.3	1.1			3.7	2.7			0.6	0.8
20	3.0	2.5			8.4	5.8			0.8	1.2
21	6.0	1.6			5.9	8.9			0.5	1.4

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92 Jun Out	93 Jun Retn	92 Jul Out	92 Jul Retn
		2.3	8.8
		2.9	4.7
		2.3	0.6
2.5	1.3	3.4	2.4
1.3	1.0	2.0	2.5
1.0	0.9	3.0	1.3
2.0	1.6	2.8	2.4
1.4	1.3	3.1	1.7
		2.4	3.3
1.2	1.4	1.9	1.4
1.3	1.8	1.7	0.6
2.6	2.1	2.1	1.7
3.3	2.9	3.4	1.4
3.4	4.5	1.8	1.7
4.1	4.6	4.9	1.7
5.6	9.8	2.1	1.3
7.6	8.4	2.5	3.7
6.5	3.3	2.1	3.1
3.6	3.7	1.2	2.3
3.7	3.8	2.4	3.2
2.7	2.9	1.9	3.8
1.8	1.4	3.6	3.8
1.5	1.9	6.0	3.8
3.1	2.9	4.4	6.2

FIGURES

Figure 1 : Map of Southern Region NRA showing the positions of the Marine Baseline Survey sampling stations.

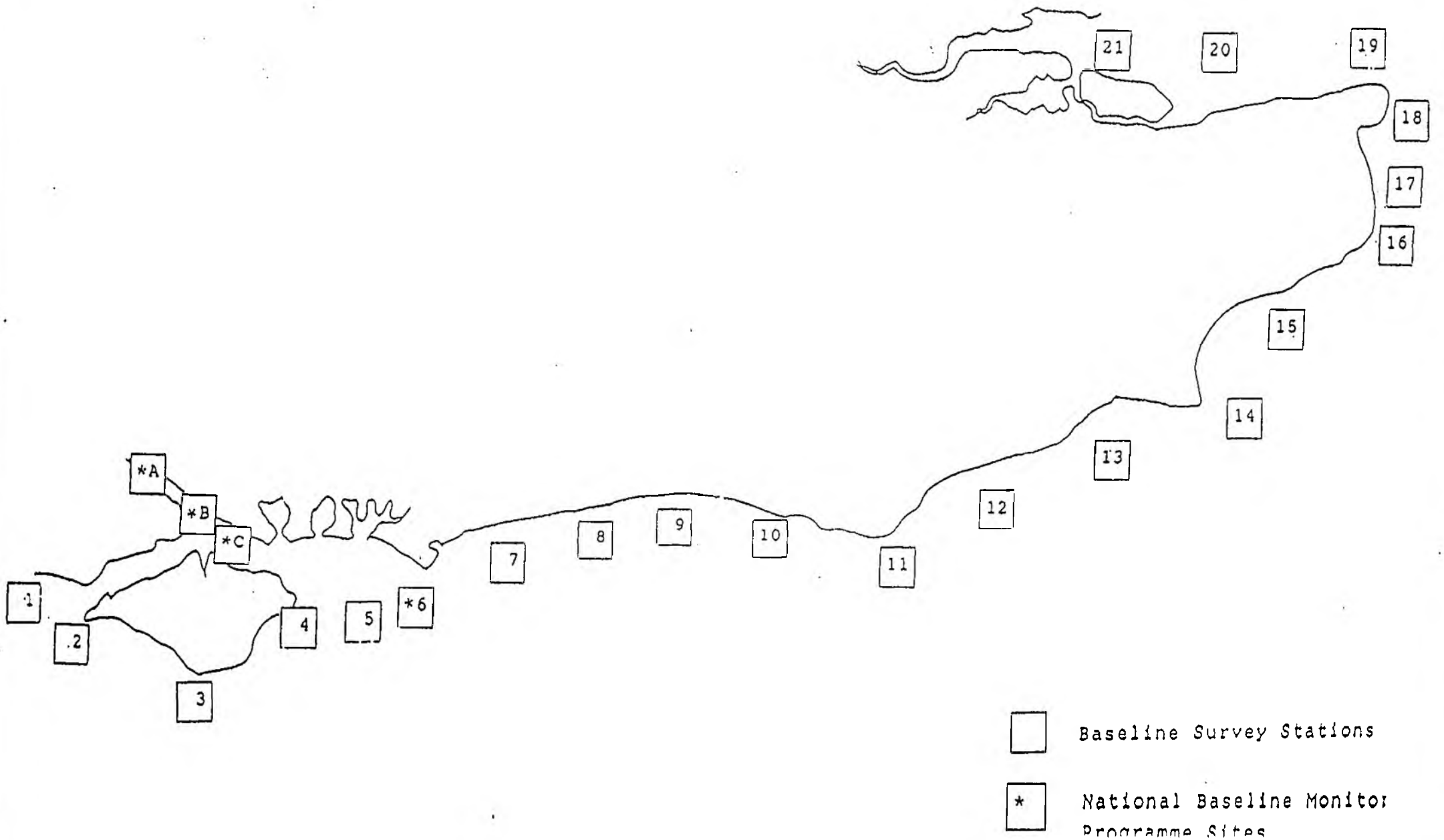


FIGURE 2 : COASTAL BASELINE SURVEY 1990-93 - MEAN WINTER AND SUMMER DISSOLVED OXYGEN SATURATION

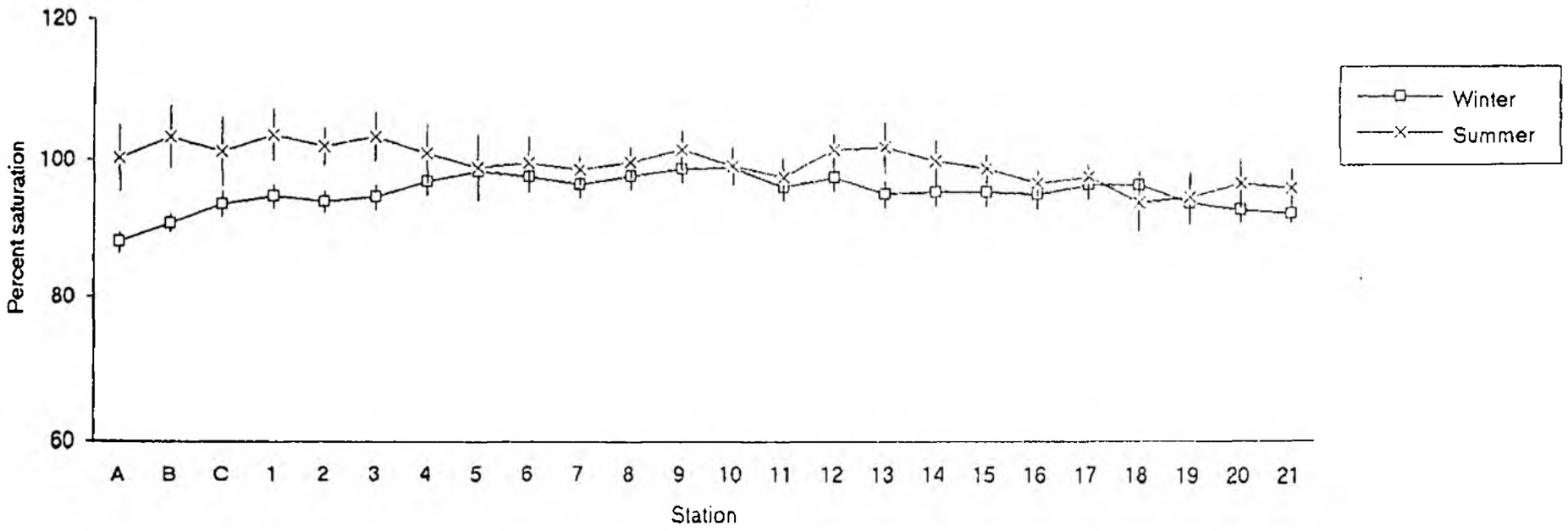


FIGURE 3 : COASTAL BASELINE SURVEY 1990-93 - MEAN WINTER AND SUMMER AMMONIACAL NITROGEN

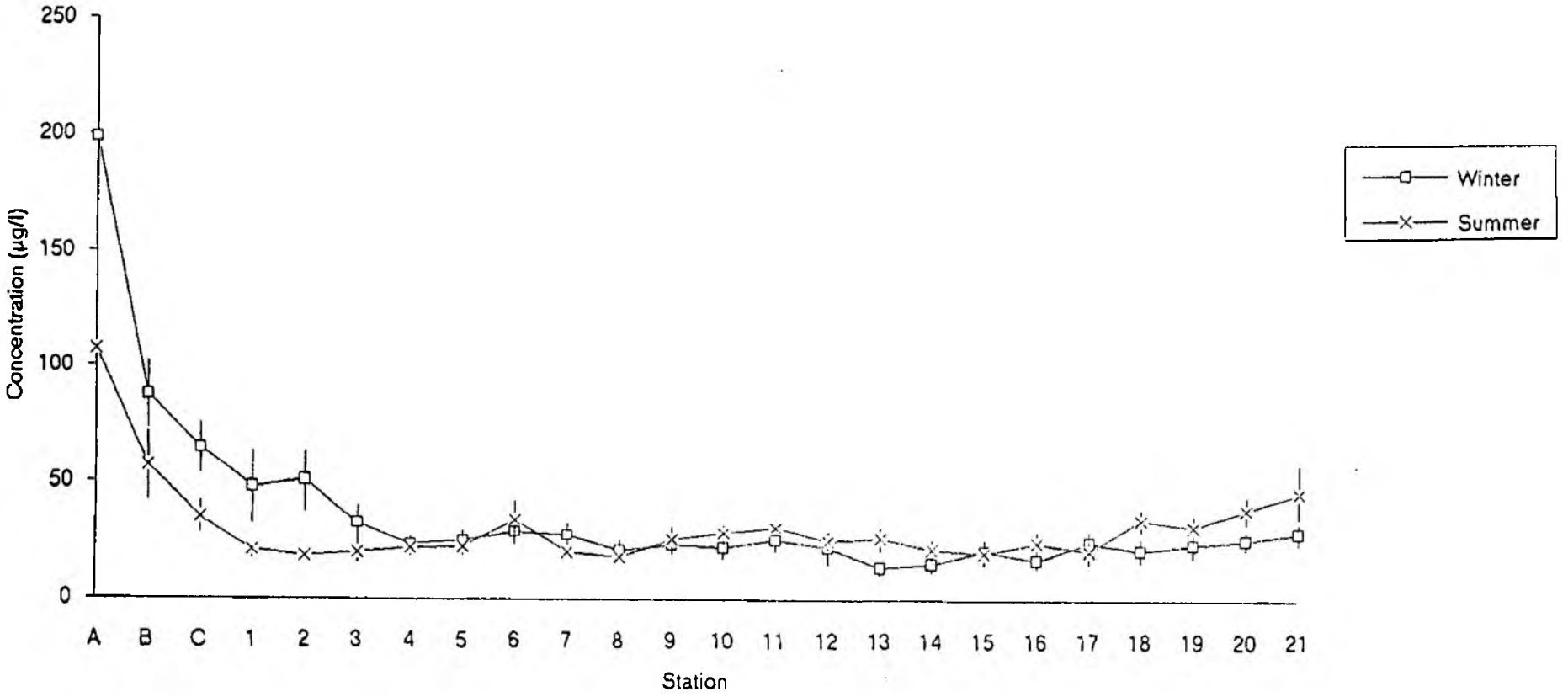


FIGURE 4 : COASTAL BASELINE SURVEY 1990-93 - MEAN WINTER AND SUMMER NITRATE-NITROGEN

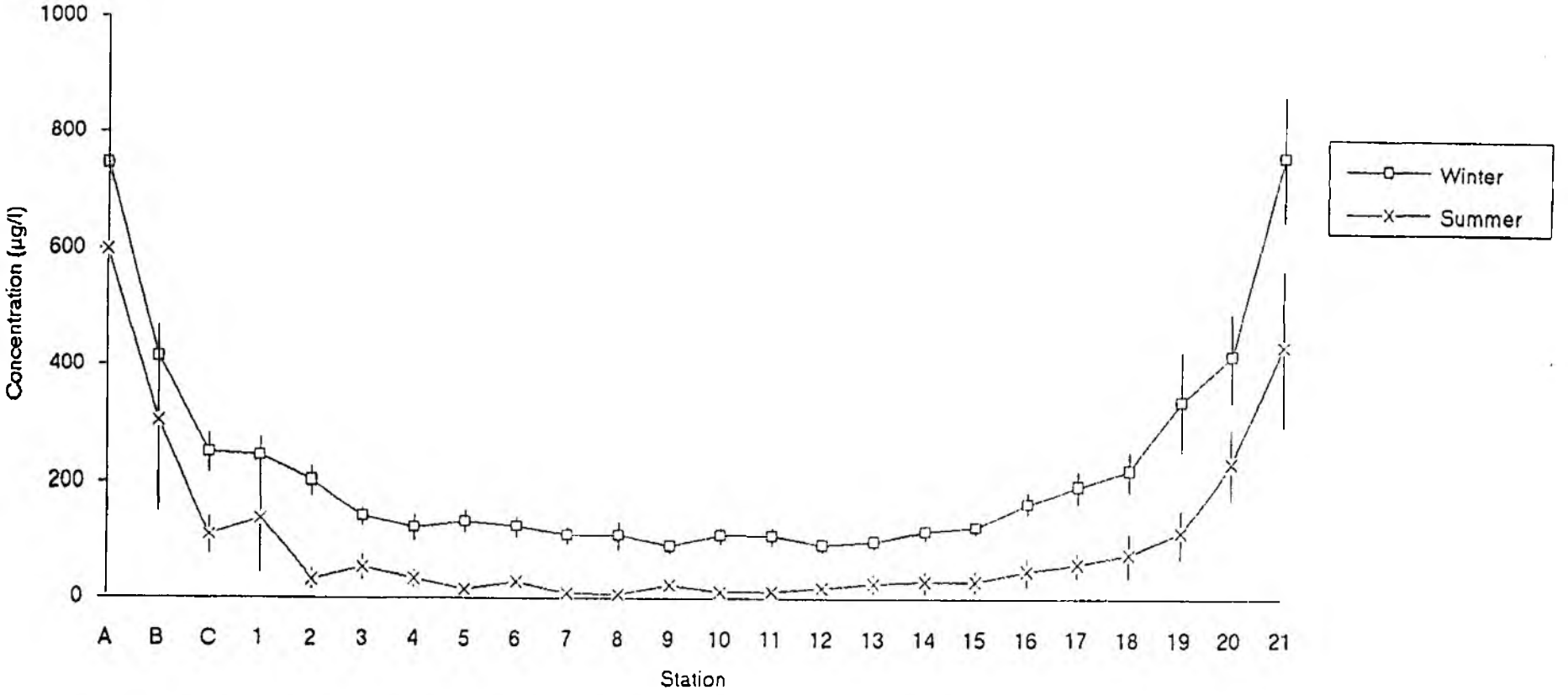


FIGURE 5 : COASTAL BASELINE SURVEY 1990-93 - MEAN WINTER AND SUMMER NITRITE-NITROGEN

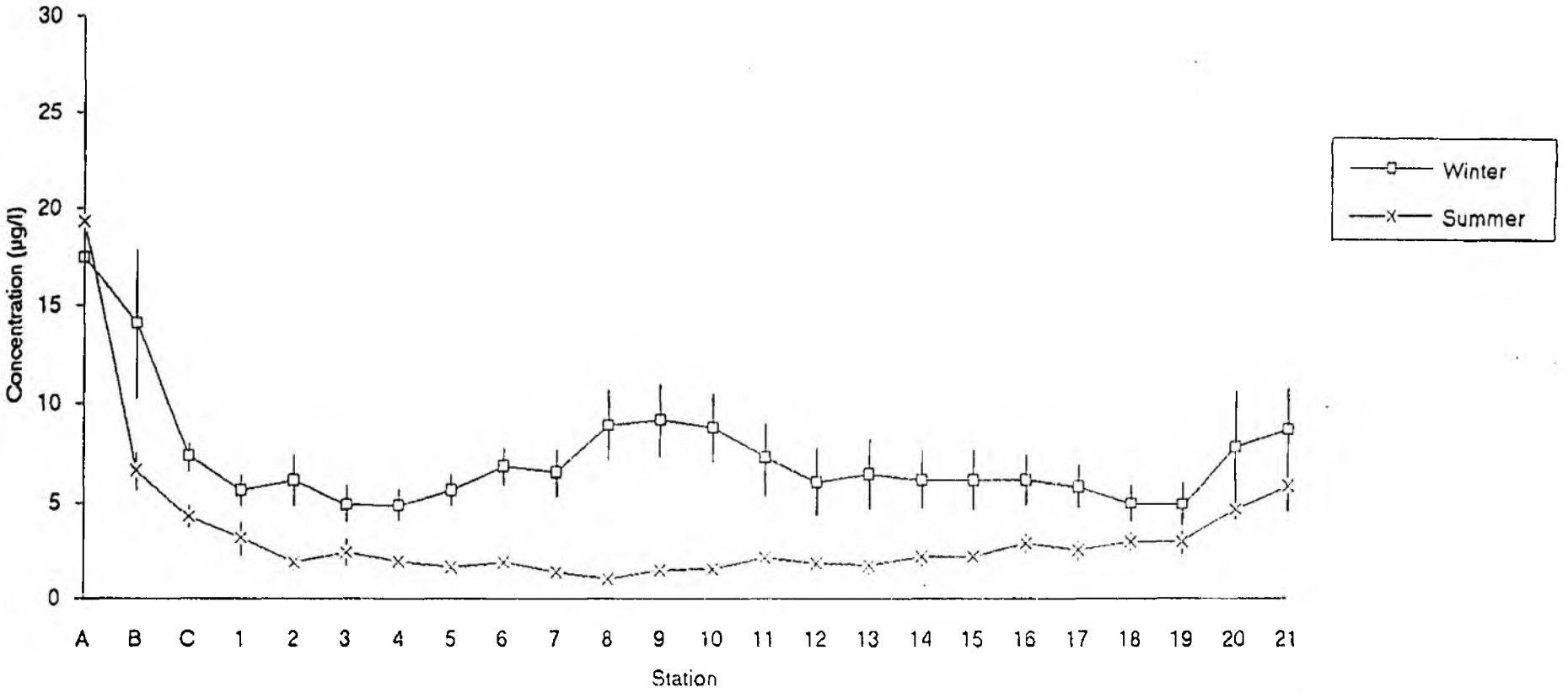


FIGURE 6 : COASTAL BASELINE SURVEY 1990-93 - MEAN WINTER AND SUMMER ORTHOPHOSPHATE

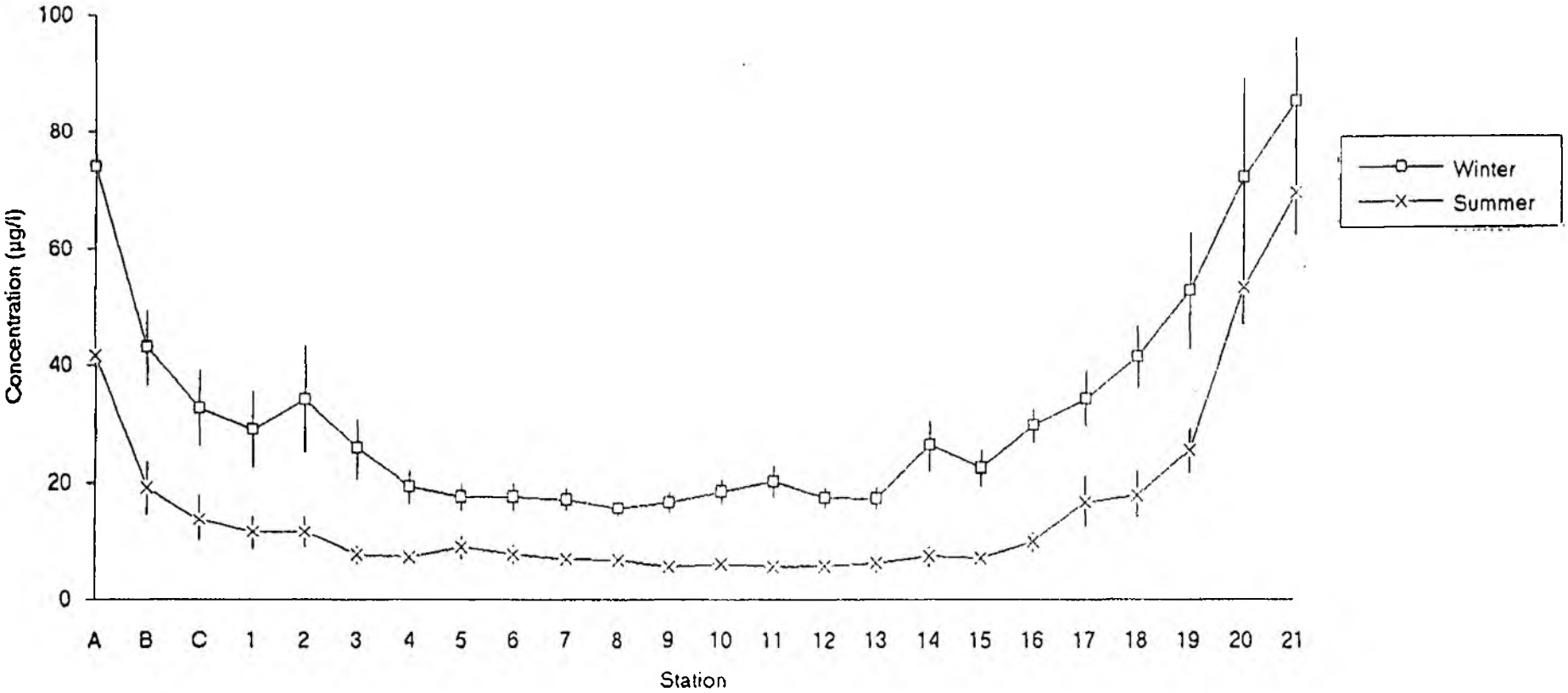
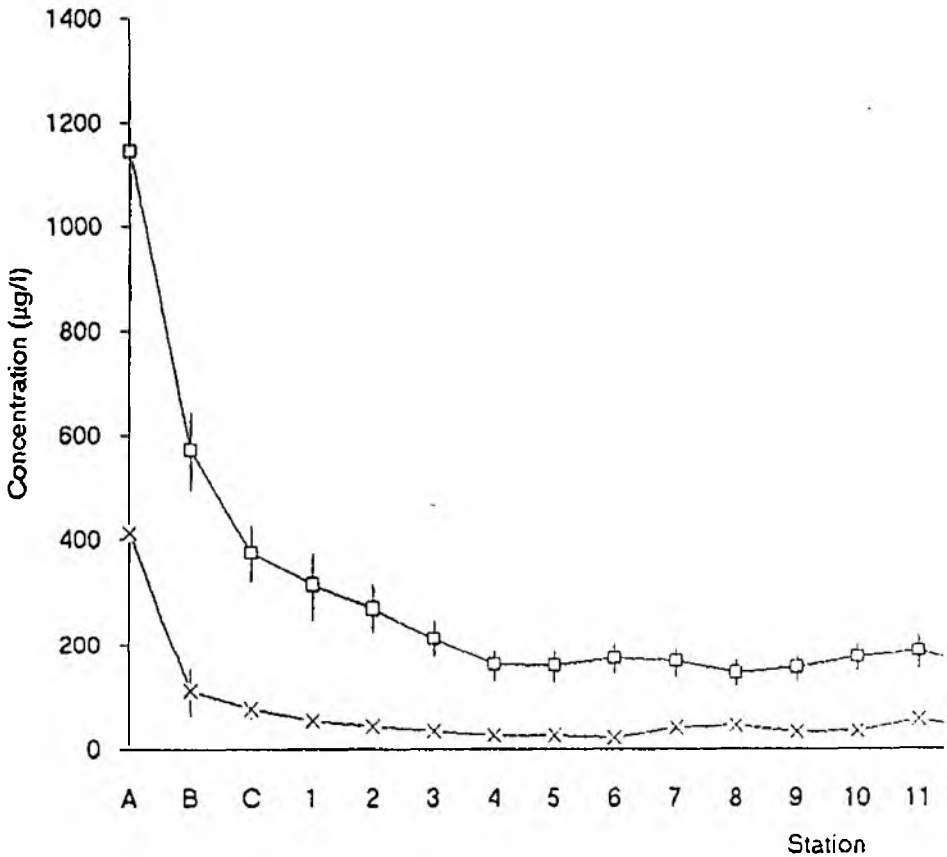


FIGURE 7 : COASTAL BASELINE SURVEY 1990-93



MEAN WINTER AND SUMMER SILICA

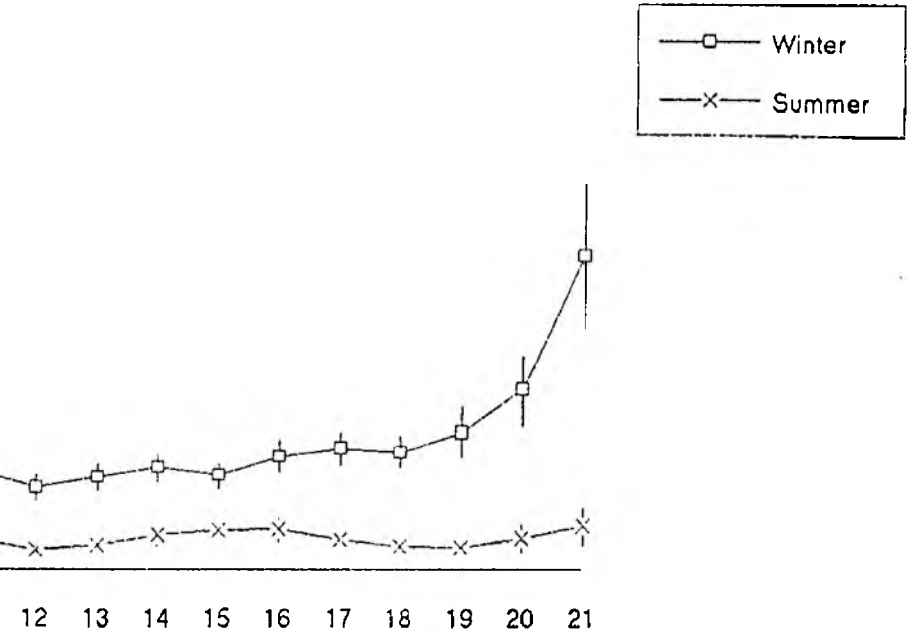


FIGURE 8 : COASTAL BASELINE SURVEY 1990-93 : WINTER AND SUMMER MEAN CHLOROPHYLL-A

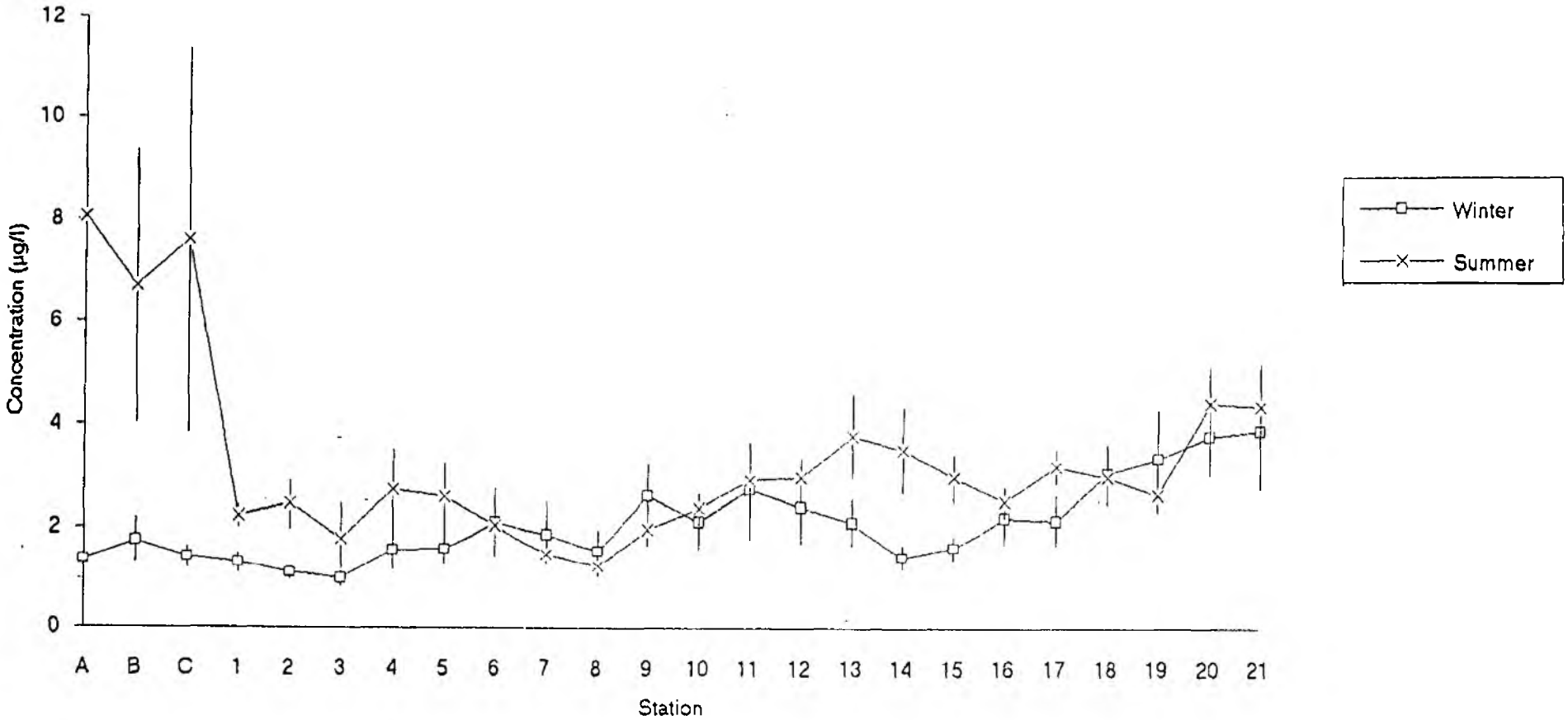


FIGURE 9 : COASTAL BASELINE SURVEY 1990-93 : WINTER AND SUMMER MEAN AND ANNUAL MAXIMUM CHLOROPHYLL-A