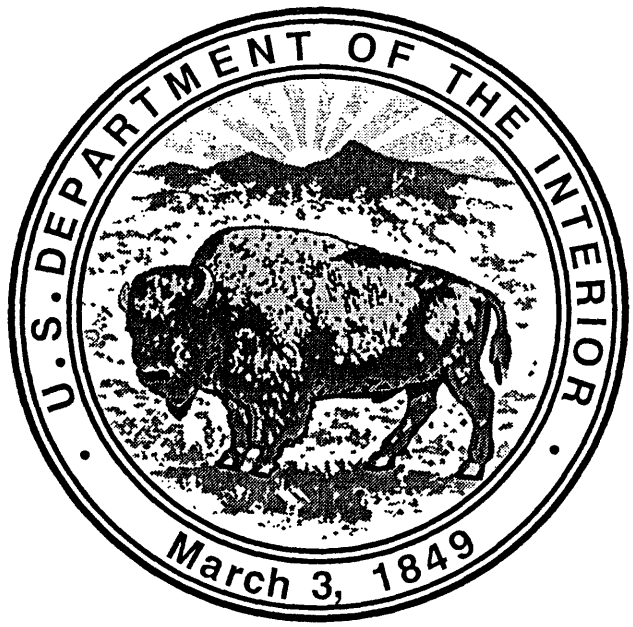
DISSOLVED NUTRIENT DATA FOR THE SAN FRANCISCO BAY ESTUARY, CALIFORNIA, FEBRUARY THROUGH NOVEMBER 1994



U. S. GEOLOGICAL SURVEY

Open-File Report OFR 97-17

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By Stephen W. Hager

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Prepared as part of a continuing study of the
San Francisco Bay estuary

Menlo Park, California
1997

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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Denver, Colorado 80225

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CONVERSION FACTORS

Multiply	by	to obtain
μm (micrometers)	0.00003937	inches
mm (millimeters)	0.03937	inches
L (liters)	0.2642	gallons (U.S)
kPa (kiloPascals)	0.147	pounds per in^2
for NO_2^-, $NO_3^- + NO_2^-$, and NH_4^+;		
μM (microMolar, micromoles per liter)	14.01	μg N per liter
for DRP;		
μM	30.97	μg P per liter
for SiO_2;		
μM	60.08	μg SiO_2 per liter

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ABSTRACT

The U.S. Geological Survey conducted hydrologic investigations in San Francisco Bay between February and November of 1994. Dissolved inorganic plant nutrients, nitrate, nitrite, ammonium, silica, and reactive phosphorus were measured in surface and in near-bottom waters at previously established locations in both northern and southern reaches of the bay. This report presents the sampling and analytical methods and the data from these studies. Measured and estimated salinity values for the nutrient samples are also reported. Data on the variability due to sampling and sample handling procedures, and on the precision of the analytical methods are also presented.

INTRODUCTION

As part of a continuing study of the San Francisco Bay estuary, sampling cruises were conducted between February and November 1994 (Table 1). The main objectives of these cruises were to examine the effects of different amounts of freshwater inflow to the bay on phytoplankton dynamics, and thus on the concentrations of the dissolved plant nutrients (nitrite, nitrate, ammonium, reactive phosphorus, and silica). Sampling during this period of variable freshwater inflow will enable comparisons with data collected during the preceeding drought and with other "normal" inflow periods. Salinities of the surface waters, independently measured, are also reported. The basic hydrologic data for these cruises are given by Edmunds and others (1995).

This report presents the sampling and analytical methods used for these nutrient studies, and the data.

METHODS

Data were collected at previously established stations throughout San Francisco Bay (Table 2, fig. 1). Table 3 identifies the measurements made and the abbreviations and units used in the report. At each channel station, a two-liter sample for dissolved nutrients was collected from the bow pump of the R/V Polaris, while the sensors for conductivity, temperature and depth (CTD, Sea-Bird Electronics model SBE 911) were being lowered. Because the bow intake of the R.V. Polaris is about 1.5 meters below the surface, salinities calculated from conductivity and temperature (using Sea-Bird software) for the 1.5- to 2.5-meter interval (2-meter CTD salinities) are used as the salinity values reported in the first part of this report.

Shallow water samples were taken from a small boat by immersing the 2 liter bottle in the surface waters after rinsing the bottle twice with surface water. In the data tables, the sampling depth of these samples is given as "sfc". For some shallow water samples, the only estimate of salinity was that made using a handheld, temperature-compensated refractometer (American Optical). These values are identified, and are reported to the nearest 0.5 psu.

As a check on the adequacy of the channel station sampling protocol, salinity bottles also were routinely taken from the bulk nutrient sample. These samples were analyzed in the laboratory using an Autosal 8400A salinometer. Where available, the bottle salinities are reported, and identified as such. Salinity is given in practical salinity units (psu; Lewis, 1980).

Beginning with the cruise of 26 October 1994, an on-line salinometer (Seacat thermosalinograph Model SBE 21) provided continuous salinity values for the pumped stream, logged on a Multiple Input Data Acquisition System (MIDAS, Oasis Associates, Waveland, MS). These salinities were averaged over the duration of sampling, usually one minute, and are the reported values in the latter parts of this report, as specified in the data tables.

Within about 15 minutes of collection for channel samples, samples were filtered through 47 mm diameter, 0.4 mm pore-sized, Nuclepore, polycarbonate, membrane filters under vacuum (less than 14 kPa). Filtered samples were stored in 30 mL, high-density polyethylene bottles (Nalgene 2002-0001), that had been rinsed with acetone, and then rinsed with and stored filled with a 2.5 meq/L solution of sodium bicarbonate. These samples were refrigerated from the time of processing until analysis the next morning. On some cruises, these samples were frozen for later analysis.

The shallow water samples were held for longer periods of time before filtration. These samples were placed immediately in an opaque cooler with ice from the -20 °C freezer, and taken to the Polaris, where they were filtered, usually within two or three hours of sampling. Thereafter, the protocols were identical to those for the channel samples.

Concentrations of ammonium (NH4), nitrate plus nitrite (N+N), nitrite (NO2), dissolved reactive phosphate (DRP), and dissolved silica (DSi) were measured simultaneously on a Technicon AutoAnalyzer II system. Analyzer responses were usually linear over the ranges of concentrations encountered in this study. When responses were outside of the linear range of the analysis, as for nitrate in the lower South Bay, the samples were diluted with distilled water and reanalyzed. Blanks and single concentration upscale standards were analyzed at two- to four-hour intervals. Standards were prepared in artificial river water (1.0 meq/L solution of sodium bicarbonate) and artificial seawater (Strickland and Parsons, 1972, p. 76), except for NH4, for which natural seawater was used. The analyzer was maintained at constant temperature by circulating 37°C water through glass tubes inserted through the centers of the glass mixing coils on each manifold.

The NH4 method uses a 0.8 mL/min sample pump tube to which is added 0.23 mL/min salicylate reagent (140 g sodium salicylate and 0.90 g sodium nitroferricyanide to 1 L of distilled water), and 0.32 mL/min air. Immediately thereafter, 0.42 mL/min of oxidizing/complexing reagent (200 mL of stock solution [90 g sodium citrate dihydate and 6 g sodium hydroxide to 1 L of distilled water], 0.120 g sodium dichloroisocyanurate and 8 drops of Brij-35 surfactant) is added. Following a ten turn mixing coil, the stream enters the 37°C heating bath, followed by two 20-turn coils thermostatted at 37°C. The stream then passes through a 10-turn coil at room temperature before entering the colorimeter. Absorbance is determined at 630 nm in a 15 mm flowcell. Blanks vary non-linearly with salinity and were estimated using a six-point calibration curve consisting of mixtures of natural seawater and artificial river water (0, 20, 40, 60, 80, 100 percent seawater). This method is preliminary, and was based primarily on work by Verdouw and others (1978) and Bower and Holm-Hansen (1980).

The N+N method was the Technicon (1973) method number 100-70W with one twenty-turn coil added to increase reaction time for better color stability. Copper sulfate (0.121 g per 20 liters) was added to the ammonium chloride reagent, as suggested by Connors and Beland (1976).

The pH of this reagent was not adjusted. Preparation of cadmium for the reduction columns was similar to that described by Wood and others (1967). Nitrate can be calculated by subtracting the corresponding concentration of NO2 from the results of this analysis.

The NO2 method was an adaptation of the Technicon (1973) method number 100-70W with the cadmium column removed.

The DSi method was a modification of the Technicon (1976) method number 105-71W. The acid-molybdate reagent was diluted and its flow rate increased, keeping the acid- and molybdate-to-sample ratios unchanged. Additional mixing coils were added to give more complete color development.

The method for DRP was a modification of that of Atlas and others (1971), using ascorbic acid (70 g plus 50 mL acetone per liter of solution) as a reductant. To increase reaction time for maximum color development, ten-turn coils replaced the five-turn coils and a twenty-turn coil replaced the ten-turn coil in the manifold design.

When samples had been stored frozen at -20°C, they were removed from the freezer at least 14 hours before analysis, and allowed to thaw at room temperature. After being shaken twice, they were analyzed as above.

FACTORS AFFECTING THE QUALITY OF THE DATA

Sampling Error

Plots of nutrient concentrations as a function of salinity are important to an understanding of the behavior of the nutrients in the estuary. Because the ordinary sampling protocol for the nutrient samples was to begin sampling as near as possible (+/- 1/2 minute) to the CTD measurements and to use the 2-meter CTD salinity value as the salinity of the sample, comparison of bottle salinities with 2-meter CTD salinities is used as a check on the adequacy of this protocol. In other words, the degree of agreement between the 2-meter CTD salinity and the bottle salinity indicates the amount of the scatter in nutrient / salinity plots that can be expected due to sampling error.

The results are shown in figure 2, plotted as the difference between the 2-meter CTD salinity and the corresponding bottle salinity versus the bottle salinity, for the northern and southern parts of San Francisco Bay, respectively. The 2-meter CTD values appear to be slightly higher on the average, with relatively few points below the zero line. This difference is in the right direction to be caused by sampling error. The bow pump intake is actually at about 1.5 m depth, and thus, in waters where there is significant near-surface salinity gradient, the CTD values for 2 m, averaged from 1.5 m to 2.5 m, would be higher. The range of these differences is considerably smaller than that shown for earlier data (Hager, 1994).

Analytical Precision, Dissolved Inorganic Nutrients

A regular program of replication was performed which involved duplicate filtrations from the bulk sample aboard the research vessel, and sometimes reanalysis of previously analyzed samples in the laboratory. Each reanalysis was generally within 4 hours of the original analysis. The pooled standard deviations of the duplicate analyses (Ku, 1969) for the reanalyzed samples are shown in table 3 and for the duplicate filtrations in table 4. The standard deviations for the reanalyzed samples are probably a little larger than the typical precision of the analytical methods, because the reanalyses were often performed to check a questionable result. The standard deviations for the duplicate filtrations indicate that, with the exception of DRP and NH4, the filtration procedure is probably not a major source of variation in the data. For DRP, on two of four cruises with more than 4 reanalyses, the pooled standard deviation for the duplicate filtrations was larger than that for the reanalyzed samples. However, even in the worst situation, the coefficient of variation did not exceed 2 percent, and on 8 of the 9 cruises it was 1 percent or less. For NH4, the pooled standard deviation for the duplicate filtrations was also larger than that for the reanalyzed samples on two of the four cruises with more than 4 reanalyses. The coefficient of variation was greater than 7 percent on one cruise, but less than 2 percent on the remaining 8 cruises. These results for NH4 are slightly worse than those reported previously (Hager, 1994).

DATA TABLES

Data for southern San Francisco Bay are presented chronologically in tables 6 through 11, and data from northern San Francisco Bay in tables 12 through 30. Notes at the beginning of each table give information concerning all samples in that table. Notes at the end of each table give information concerning specific samples.

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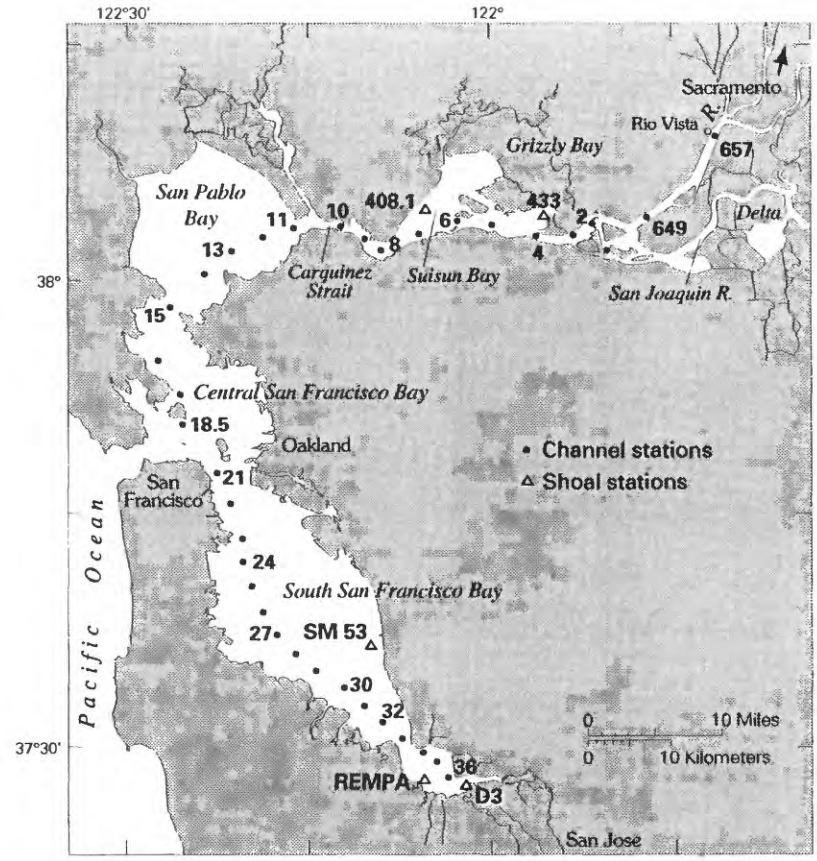

Figure 1. Location map of the San Francisco Bay estuarine system.

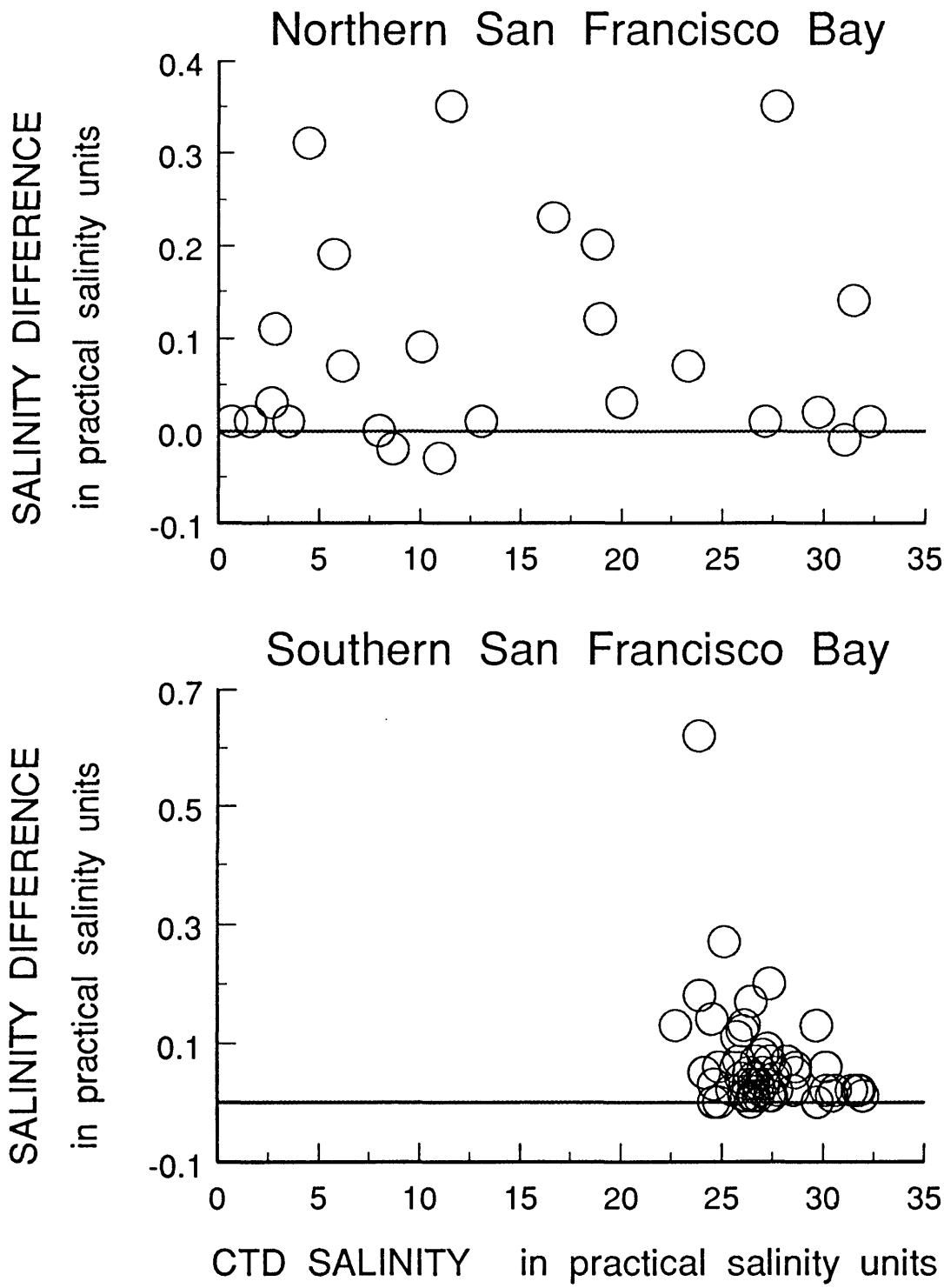

Figure 2. Salinity comparison for the purpose of estimating sampling error for northern San Francisco Bay, and southern San Francisco Bay. The salinity difference is the salinity for two meters depth as measured by the CTD sensors minus the corresponding bottle salinity from the pumped sample.

Table 1: Cruise dates and station coverage

Date	Station Coverage		
	North Bay	South Bay	Shallows
16 February 94	18.5 to 657 749 to 757	--	--
17 February 94	--	21 to 36	--
25 February 94	--	21 to 36	SM53 to D3
09 March 94	--	21 to 36	SM53 to D3
15 March 94	--	--	SM53 to D3
16 March 94	18.5 to 657	21 to 36	408.1 and 433
22 March 94	--	--	SM46 and SM41
29 March 94	--	21 to 36	SM53 to D3
05 April 94	--	21 to 36	SM53 to D3
12 April 94	--	21 to 36	SM41 to D3
15 April 94	--	21 to 36	SM53 to SWH1
19 April 94	18.5 to 657	21 to 36	--
21 April 94	--	--	SM53 to D3
27 April 94	--	24 to 36	SM53 to D3
04 May 94	--	21 to 36	SM53 to D3
15 June 94	18.5 to 657 747 to 757	21 to 36	--
22 September 94	--	29.5 to 36	SM53 to D3
29 September 94	--	29.5 to 36	SM53 to D3
26 October 94	18.5 to 657	21 to 36	408.1 and 433
29 November 94	18.5 to 657	20 to 36	433

Table 2. San Francisco Bay station locations.
(N.= north, W.= west, deg.= degrees, min.= minutes).

Area	Station Number	N. Latitude deg.	N. Latitude min.	W. Longitude deg.	W. Longitude min.
Sacramento River	657	38	9.2	121	41.3
	655	38	7.2	121	42.3
	653	38	5.8	121	42.0
	651	38	4.7	121	45.8
	649	38	3.6	121	47.8
North Bay					
Chain Island	2	38	3.8	121	51.3
Pittsburgh	3	38	3.0	121	52.7
Simmon's Point	4	38	2.9	121	56.1
Middle Ground	5	38	3.6	121	58.8
Roe Island	6	38	3.9	122	2.1
Avon Pier	7	38	2.9	122	5.8
Martinez	8	38	1.8	122	9.1
Benicia	9	38	3.0	122	10.4
Crockett	10	38	3.6	122	12.5
Mare Island	11	38	3.7	122	15.8
N. of Pinole Point	13	38	1.9	122	21.9
Pt. San Pablo	15	37	58.2	122	26.2
Red Rock	16	37	54.9	122	27.0
Raccoon Strait	17	37	52.9	122	25.6
Angel Island	18.5	37	50.8	122	25.2
Shallows	408.1	38	4.7	122	3.4
	433	38	4.3	121	56.0
South Bay					
Blossom Rock	20	37	49.0	122	24.3
Bay Bridge	21	37	48.0	122	22.2
Potrero Point	22	37	45.7	122	21.5
Hunters Point	23	37	43.6	122	20.2
Candlestick Point	24	37	42.0	122	20.3
Oyster Point	25	37	40.3	122	19.5
San Bruno Shoal	26	37	38.2	122	19.0
San Francisco Airport	27	37	37.1	122	17.5
N. San Mateo Bridge	28	37	36.0	122	16.2
S. San Mateo Bridge	29	37	34.9	122	14.8
	29.5	37	34.2	122	13.5
Redwood Creek	30	37	33.3	122	11.5
Coyote Hills	31	37	31.8	122	9.4
Ravenswood Point	32	37	31.1	122	8.1
Dumbarton Bridge	33	37	30.6	122	7.4
Newark Slough	34	37	29.6	122	5.3
Palo Alto	35	37	28.9	122	4.7
Calaveras Point	36	37	28.3	122	3.8
Shallows	SM53	37	36.47	122	10.00
	SM46	37	35.58	122	9.93
	SM41	37	34.63	122	9.77

continued ...

San Francisco Bay station locations - continued.
(N.= north, W.= west, deg.= degrees, min.= minutes).

Area	Station Number	N. Latitude deg.	min.	W. Longitude deg.	min.
	SM35	37	33.62	122	9.27
	SM28	37	32.78	122	8.35
	SWH1	37	31.63	122	7.63
	D11	37	28.75	122	5.93
	REMPA	37	27.70	122	5.00
	D3	37	27.78	122	1.55

Table 3. Summary of measurements, abbreviations, and units

Measurement	Column Title	Units
Local time	TIME	hours : minutes, 24 hour clock
Station	STA	--
Depth	DEP	meters, m
Salinity	SAL	practical salinity units, scale of 1978, psu
Dissolved reactive phosphorus	DRP	micromolar, μM
Dissolved silica	DSi	micromolar, μM
Nitrate plus nitrite	N+N	micromolar, μM
Nitrite	NO2	micromolar, μM
Ammonium	NH4	micromolar, μM
Dissolved inorganic nitrogen	DIN	micromolar, μM

Table 4. Precision of analyses as estimated from reanalysis of samples

Date	Number of samples	DRP	DSi	N+N	NO2	NH4
		Pooled Standard Deviation / Coefficient of Variation				
		micromolar / percent				
18 Feb 94	12	0.02 0.3	0.15 0.2	0.21 0.4	0.01 0.5	0.05 0.5
26 Feb 94	1	0.02 0.6	0.11 0.2	0.08 0.4	0.03 3.4	0.02 6.9
10 Mar 94	5	0.01 0.3	0.20 0.6	0.17 2.1	0.01 1.9	0.07 11.0
17 Mar 94	1	0.02 0.4	0.12 3.0	0.03 19.3	0.02 274	0.01 8.3
20 Apr 94	none	-- --	-- --	-- --	-- --	-- --
17 Jun 94	none	-- --	-- --	-- --	-- --	-- --
27 Oct 94	4	0.06 1.4	0.13 0.1	0.11 0.3	0.01 0.3	0.10 1.6
30 Nov 94	7	0.02 0.5	0.37 0.2	0.13 0.4	0.01 0.8	0.11 0.7

Table 5. Precision of data as estimated from duplicate filtrations

Date	Number of samples	DRP	DSi	N+N	NO2	NH4
		Pooled Standard Deviation / Coefficient of Variation				
		micromolar / percent				
18 Feb 94	11	0.03 0.7	0.25 0.2	0.09 0.3	0.01 0.9	0.07 0.7
26 Feb 94	5	0.02 0.4	0.06 0.1	0.04 0.2	0.02 1.0	0.11 1.8
10 Mar 94	5	0.12 2.9	0.06 0.1	0.20 1.2	0.01 0.7	0.20 7.3
17 Mar 94	11	0.02 0.4	0.21 0.2	0.11 0.4	0.01 0.7	0.11 1.4
20 Apr 94	10	0.01 0.2	0.10 0.1	0.05 0.2.	<0.01 0.3	0.03 0.5
03 May 94 frozen	5	0.05 0.6	0.13 0.2	0.20 0.5	0.01 0.5	0.11 1.3
17 Jun 94	12	0.02 0.3	0.22 0.2	0.09 0.3	<0.01 0.4	0.04 0.7
27 Oct 94	11	0.05 0.7	0.13 0.1	0.13 0.4	<0.01 0.2	0.03 0.6
30 Nov 94	11	0.02 0.3	0.17 0.2	0.14 0.4	0.01 0.3	0.04 0.4

Data for northern San Francisco Bay

Table 6. Nutrient data for 16 February 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
8:50	18.5	36	29.76[1]	1.65	37.85	11.06	0.62	4.58	15.64
8:46	18.5	1.5	26.29	2.18	69.38	16.78	0.71	7.12	23.90
9:17	17	1.5	23.00	2.39	93.74	20.17	0.75	8.18	28.35
9:39	16	1.5	20.96	2.57	132.6	24.89	0.84	10.05	34.94
10:11	15	1.5	16.64[1]	2.63	149.4	26.78	0.89	10.68	37.45
10:33	14	1.5	18.30	2.68	139.9	25.77	0.86	10.35	36.12
10:50	13	1.5	18.80[1]	2.63	132.0	25.06	0.82	9.96	35.02
11:45	12	1.5	14.90	2.65	168.6	28.55	0.92	11.57	40.12
12:05	11	1.5	13.03	2.65	184.6	29.51	0.95	12.45	41.96
12:31	10	1.5	7.48	2.57	230.4	32.07	1.02	13.72	45.79
12:46	9	1.5	6.19[1]	2.54	239.6	32.57	1.02	13.88	46.45
13:11	8	1.5	4.93	2.51	257.1	33.17	1.00	13.73	46.90
13:49	7	1.5	4.49	2.64	261.5	33.58	0.99	15.14	48.72
14:14	6	1.5	1.62[1]	2.47	283.0	34.31	0.91	13.20	47.51
14:40	5	1.5	0.48	2.42	292.5	34.95	0.83	12.12	47.07
14:58	4	1.5	0.19	2.32	289.4	34.15	0.75	11.38	45.53
15:29	3	1.5	0.24	2.32	292.0	35.11	0.82	12.35	47.46
15:43	2	1.5	0.25	2.34	291.7	35.28	0.77	11.36	46.64
16:02	649	1.5	0.10	2.36	293.9	29.65	0.65	13.40	43.05
16:16	651	1.5	0.10	2.13	304.0	28.89	0.63	13.08	41.97
16:35	653	1.5	0.10	2.23	311.5	28.80	0.61	13.93	42.73
16:46	655	1.5	0.10	2.19	316.3	26.58	0.56	13.98	40.55
17:02	657	1.5	0.10	2.20	314.2	25.08	0.55	14.50	39.58
7:05[2]	749	1.5	0.60	2.38	289.1	34.64	0.85	12.01	46.65
7:40[2]	753	1.5	0.30	2.39	293.9	37.39	0.86	12.18	49.57
8:22[2]	757	1.5	0.20	2.04	297.6	44.43	0.83	7.61	52.04

1. Bottle salinity.
2. Taken on February 17th.

Table 7. Nutrient data for 16 March 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
11:20	18.5	44	27.69[1]	1.92	54.93	14.63	1.40	4.77	19.40
11:22	18.5	1.5	26.96	2.14	61.32	15.89	1.39	5.24	21.13
11:39	17	1.5	23.72[1]	2.26	90.97	19.86	1.45	5.07	24.93
11:57	16	1.5	22.96	2.43	112.9	23.00	1.52	5.59	28.59
12:23	15	1.5	20.28	2.58	138.6	27.39	1.67	5.93	33.32
12:42	14	1.5	18.45	2.61	144.2	27.19	1.74	6.44	33.63
13:01	13	1.5	18.83	2.63	147.5	27.77	1.74	6.47	34.24
13:44	12	1.5	14.31	2.78	175.1	31.30	1.84	8.17	39.47
14:00	11	1.5	11.72	2.83	203.6	34.33	1.98	9.47	43.80
14:19	10	1.5	8.70	2.84	224.0	36.34	2.04	10.11	46.45
14:35	9	1.5	8.70[1]	2.86	220.5	36.11	2.02	10.01	46.12
14:53	8	1.5	7.20	2.92	238.3	37.65	2.12	10.77	48.42
15:18	7	1.5	4.12	2.84	259.0	39.13	2.07	10.49	49.62
15:41	6	1.5	2.87[1]	2.80	272.7	39.84	2.08	10.53	50.37
16:02	5	1.5	0.88	2.59	293.6	38.91	1.80	8.13	47.04
16:18	4	1.5	0.31	2.47	300.0	37.13	1.64	8.45	45.58
16:37	3	1.5	0.23	2.42	300.7	36.24	1.64	8.55	44.79
16:56	2	1.5	0.19	2.41	301.1	35.97	1.65	8.32	44.29
17:14	649	1.5	0.13	2.29	304.9	29.39	1.54	11.36	40.75
17:27	651	1.5	0.12	2.32	305.3	26.70	1.54	13.77	40.47
17:40	653	1.5	0.12	2.30	304.9	25.67	1.53	14.68	40.35
17:54	655	1.5	0.11	2.35	305.2	22.63	1.51	16.76	39.39
18:14	657	1.5	0.11	2.34	305.4	22.28	1.52	17.20	39.48
15:13	408	sfc	3.41[1]	2.71	266.3	39.64	2.20	9.98	49.62
15:42	433	sfc	--	2.45	294.6	37.89	1.81	7.73	45.62

1. Bottle salinity.

Table 8. Nutrient data for 19 April 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
11:40	18.5	41	31.05[1]	1.77	27.09	13.60	0.56	3.53	17.13
11:37	18.5	1.5	27.84	2.32	54.54	16.20	0.64	3.45	19.66
12:03	17	1.5	27.82[1]	2.27	45.50	15.87	0.65	3.88	19.75
12:32	16	1.5	25.58	2.59	74.94	18.71	0.70	4.33	23.04
13:06	15	1.5	23.48	2.96	119.2	22.86	0.81	3.59	26.45
13:31	14	1.5	21.81	3.00	127.7	24.66	0.88	4.44	29.10
13:52	13	1.5	21.63	2.96	113.2	23.48	0.86	5.22	28.69
14:50	12	1.5	18.28	3.14	143.1	28.41	1.04	6.82	35.23
15:11	11	1.5	16.37	3.18	158.1	30.65	1.11	8.15	38.80
15:37	10	1.5	11.85	3.29	192.9	35.67	1.25	9.90	45.57
15:51	9	1.5	10.11[1]	3.31	206.8	37.37	1.30	9.86	47.24
16:20	8	1.5	7.90	3.26	228.5	39.55	1.36	8.72	48.27
16:53	7	1.5	5.94	3.16	239.9	39.90	1.31	8.78	48.68
17:17	6	1.5	3.50[1]	3.00	258.4	40.06	1.19	7.58	47.64
17:54	5	1.5	1.76	2.85	268.5	38.43	1.07	7.87	46.30
18:29	4	1.5	1.13	2.71	269.8	36.80	0.99	7.64	44.44
18:50	3	1.5	0.68[1]	2.56	269.1	35.27	0.90	6.80	42.08
19:03	2	1.5	0.51	2.41	263.5	36.25	0.78	4.01	40.26
19:20	649	1.5	0.17	2.35	275.5	29.91	1.03	11.94	41.85
19:33	651	1.5	0.14	2.31	276.3	29.86	1.01	12.40	42.26
19:46	653	1.5	0.11	2.47	284.8	27.08	1.12	16.65	43.73
19:59	655	1.5	0.10	2.52	288.3	25.80	1.15	18.00	43.80
20:11	657	1.5	0.10	2.55	287.1	24.14	1.10	19.46	43.60

1. Bottle salinity.

Table 9. Nutrient data for 15 June 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
12:05	18.5	39	31.49[1]	2.93	53.56	27.76	0.92	5.68	33.44
12:07	18.5	1.5	30.78	3.18	61.82	28.68	0.96	5.98	34.66
12:35	17	1.5	28.92[1]	3.43	73.48	30.02	1.00	6.30	36.32
12:55	16	1.5	27.05	3.68	87.25	31.52	1.05	6.19	37.71
13:22	15	1.5	25.02	3.94	101.2	32.95	1.08	5.67	38.62
13:43	14	1.5	23.98	4.00	105.4	34.04	1.14	5.91	39.95
14:00	13	1.5	23.34[1]	4.02	107.6	34.42	1.16	5.97	40.39
14:50	12	1.5	20.21	4.09	124.1	36.78	1.31	7.17	43.95
15:06	11	1.5	17.55	4.10	130.7	37.85	1.31	7.97	45.82
15:28	10	1.5	14.40	4.03	143.3	37.91	1.20	8.35	46.26
15:40	9	1.5	13.07[1]	3.95	145.7	38.02	1.15	8.24	46.26
15:57	8	1.5	11.67	3.86	149.5	37.43	1.05	7.63	45.06
16:27	7	1.5	10.35	3.94	150.7	36.70	1.06	8.91	45.61
16:48	6	1.5	7.99[1]	3.46	149.6	34.25	0.90	7.28	41.53
17:09	5	1.5	4.70	3.08	139.8	29.60	0.74	7.44	37.04
17:26	4	1.5	3.60	2.95	134.2	27.71	0.69	7.60	35.31
17:49	3	1.5	2.68[1]	2.80	127.9	25.66	0.64	7.48	33.14
18:04	2	1.5	2.31	2.75	123.4	24.93	0.62	7.31	32.24
18:23	649	1.5	1.59	2.57	119.3	23.39	0.56	6.38	29.77
18:36	651	1.5	1.00	2.39	124.0	22.69	0.62	5.57	28.26
18:48	653	1.5	0.48	2.30	132.5	23.27	0.76	4.95	28.22
19:00	655	1.5	0.27	2.32	156.9	25.21	1.14	5.17	30.38
19:20	657	1.5	0.13	2.34	195.0	28.06	1.58	7.03	35.09
8:25	747	1.5	1.61	2.60	113.5	23.59	0.53	6.77	30.36
7:45	753	1.5	0.35	2.82	109.1	22.77	0.78	4.81	27.58
7:13	757	1.5	0.20	2.33	126.4	23.74	1.18	6.54	30.28

1. Bottle salinity.

Table 10. Nutrient data for 26 October 1994.
[Salinities are Midas salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
12:30	18.5	40	32.28[1]	2.61	38.95	19.99	1.40	2.93	22.92
12:33	18.5	1.5	31.64	3.19	47.02	21.93	1.58	3.71	25.64
12:52	17	1.5	30.72[1]	3.23	54.83	22.01	1.38	2.66	24.67
13:09	16	1.5	30.35	3.28	57.51	22.80	1.41	2.67	25.47
13:35	15	1.5	28.25	3.62	76.07	23.89	1.41	2.54	26.43
13:59	14	1.5	28.51	3.63	71.93	24.46	1.47	2.58	27.04
14:14	13	1.5	27.14[1]	3.76	82.29	26.07	1.58	2.57	28.64
14:58	12	1.5	23.86	4.15	105.2	29.20	2.02	4.02	33.22
15:26	11	1.5	23.05[2]	4.24	112.9	30.04	2.18	4.28	34.32
15:46	10	1.5	21.22[2]	4.30	124.6	31.38	2.39	4.68	36.06
15:57	9	1.5	20.04[1]	4.32	131.2	32.12	2.50	4.66	36.78
16:18	8	1.5	17.26	4.45	150.7	34.33	2.80	7.15	41.48
16:43	7	1.5	15.53	4.46	164.4	34.19	2.98	7.85	42.04
17:04	6	1.5	11.54[1]	4.21	190.4	33.78	3.23	4.18	37.96
17:25	5	1.5	9.09	4.04	208.8	32.40	3.18	4.05	36.45
17:41	4	1.5	7.74	3.93	219.2	31.15	3.04	4.33	35.48
18:02	3	1.5	5.75[1]	3.73	231.4	29.34	2.73	4.78	34.12
18:17	2	1.5	5.30	3.62	236.8	29.01	2.58	4.97	33.98
18:35	649	1.5	3.82	3.42	247.0	27.26	2.10	4.84	32.10
18:48	651	1.5	3.00	3.23	256.2	26.49	1.79	4.66	31.15
19:02	653	1.5	1.28	2.88	273.0	25.35	1.18	4.53	29.88
19:14	655	1.5	1.02	2.72	276.0	24.91	1.06	4.63	29.54
19:29	657	1.5	0.40	2.63	280.4	24.74	0.98	5.81	30.55
16:45	408.1	sfc	13.22[1]	4.28	178.0	34.16	3.12	3.89	38.05
17:07	433	sfc	9.19[1]	4.00	205.6	32.34	3.10	3.86	36.20

1. Bottle salinity.
2. CTD salinity.

Table 11. Nutrient data for 29 November 1994.
[Salinities are Midas salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP	SiO2	N+N micromolar	NO2	NH3	DIN
11:33	18.5	1.5	31.44	2.36	39.20	20.34	0.82	3.68	24.02
11:58	17	1.5	30.00	2.71	48.69	22.09	0.91	4.75	26.84
12:23	16	1.5	29.27	2.82	56.60	23.83	0.92	5.17	29.00
12:57	15	1.5	27.77	3.00	67.04	24.89	0.95	5.60	30.49
13:25	14	1.5	26.76	3.06	73.14	25.59	0.96	5.86	31.45
13:47	13	1.5	25.87	3.17	79.80	26.36	0.98	6.23	32.59
14:34	12	1.5	23.93	3.29	93.31	27.89	1.02	7.16	35.05
14:48	11	1.5	22.63	3.38	102.9	28.92	1.03	7.85	36.77
15:18	10	1.5	21.24	3.45	112.7	30.57	1.08	8.66	39.23
15:36	9	1.5	18.96[1]	3.56	127.6	31.19	1.10	10.20	41.39
16:01	8	1.5	16.15	3.52	152.6	32.37	1.04	10.80	43.17
16:31	7	1.5	13.86	3.59	164.7	32.99	1.06	12.16	45.15
17:01	6	1.5	11.01[1]	3.56	185.9	33.40	1.02	12.47	45.87
17:28	5	1.5	8.37	3.46	207.0	33.32	0.96	12.00	45.32
17:50	4	1.5	6.35	3.36	223.1	33.16	0.93	12.10	45.26
18:14	3	1.5	4.52[1]	3.22	240.4	33.06	0.90	12.50	45.56
18:32	2	1.5	3.19	3.16	253.0	32.94	0.93	12.35	45.29
18:55	649	1.5	1.37	2.94	276.4	33.35	0.97	12.77	46.12
19:13	651	1.5	0.90	2.90	285.8	33.04	1.02	13.38	46.42
19:28	653	1.5	0.26	2.96	296.3	31.79	1.05	16.03	47.82
19:42	655	1.5	0.12	3.10	301.0	29.74	1.08	18.76	48.50
19:56	657	1.5	0.11	3.12	299.7	29.40	1.07	18.90	48.30
15:50	433	sfc	--	3.19	212.0	33.00	0.92	11.36	44.36

1. Bottle salinity.

Data for southern San Francisco Bay

Table 12. Nutrient data for 17 February 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
15:14	21	1.5	27.80	2.34	57.94	16.68	0.75	7.54	24.22
15:27	22	1.5	28.09	2.52	55.26	17.12	0.80	8.20	25.32
15:43	23	1.5	27.54	3.02	60.60	19.92	0.89	9.10	29.02
15:57	24	1.5	27.41[1]	3.46	63.59	22.41	1.00	9.90	32.31
16:13	25	1.5	27.50	3.91	68.24	27.27	1.16	9.62	36.89
16:29	26	1.5	27.72	5.26	77.95	37.97	1.52	9.56	47.53
16:42	27	1.5	27.77[1]	6.20	85.06	44.67	1.75	9.42	54.09
16:55	28	1.5	27.77	6.51	86.62	46.23	1.82	9.90	56.13
17:09	29	1.5	27.64	6.33	81.34	42.39	1.68	7.54	49.93
17:21	29.5	1.5	27.71	6.80	88.18	48.27	1.88	10.13	58.40
17:34	30	1.5	27.51[1]	7.30	91.64	52.24	1.96	9.64	61.88
17:53	31	1.5	27.01	8.20	97.07	61.41	2.10	9.60	71.01
18:06	32	1.5	26.66[1]	8.70	99.62	67.87	2.18	9.62	77.49
18:14	33	1.5	26.22	9.47	104.4	77.66	2.32	9.49	87.15
18:30	34	1.5	25.99	9.87	106.5	82.59	2.39	9.49	92.08
18:47	36	1.5	25.54[1]	10.57	111.2	92.00	2.54	9.83	101.8

1. Bottle salinity.

Table 13. Nutrient data for 25 February 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
9:11	21	1.5	27.32	2.47	61.89	16.86	0.86	7.13	23.99
9:27	22	1.5	27.27	2.44	59.75	16.56	0.85	6.98	23.54
9:42	23	1.5	27.03	2.70	62.52	18.02	0.90	7.33	25.35
9:56	24	1.5	26.36[1]	3.14	69.55	21.33	1.01	8.10	29.43
10:11	25	1.5	26.56	4.51	76.11	30.44	1.30	9.93	40.37
10:27	26	1.5	26.94	5.64	81.68	38.91	1.58	10.56	49.47
10:39	27	1.5	27.14[1]	6.16	83.85	43.24	1.72	9.33	52.57

continued ...

Nutrient data for 25 February 1994 - continued

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
10:52	28	1.5	27.18	5.79	81.08	40.39	1.63	9.11	49.50
11:09	29	1.5	27.21	5.04	72.76	34.53	1.45	6.39	40.92
11:20	29.5	1.5	27.17	4.85	69.36	33.52	1.43	4.15	37.67
11:42	30	1.5	27.05[1]	5.21	71.38	36.63	1.53	2.94	39.57
12:08	31	1.5	26.70	5.84	77.03	44.19	1.67	2.03	46.22
12:25	32	1.5	26.46[1]	6.25	79.75	48.31	1.75	2.64	50.95
12:36	33	1.5	25.99	6.90	84.68	55.50	1.85	3.25	58.75
12:52	34	1.5	25.84	7.07	85.93	57.37	1.88	3.45	60.82
13:05	35	1.5	25.69	7.38	88.32	60.57	1.93	4.07	64.64
13:16	36	1.5	23.90[1]	9.15	101.1	78.64	2.31	7.90	86.54
11:15	SM53	sfc	25.56[1]	3.84	55.95	18.75	0.81	0.29	19.04
11:19	SM46	sfc	26.48[1]	5.30	79.73	40.51	1.35	0.17	40.68
11:51	SM41	sfc	26.36[1]	6.35	81.69	50.55	1.79	1.66	52.21
12:00	SM35	sfc	26.32[1,2]	5.67	73.88	43.93	1.52	0.34	44.27
12:18	SM28	sfc	24.67[1]	5.85	70.93	41.15	1.41	0.25	41.40
12:39	SWH1	sfc	25.97[1,2]	6.31	79.30	50.33	1.68	0.75	51.08
12:50	D11	sfc	25.32[1,2]	7.71	90.26	61.94	1.99	4.56	66.50
12:59	REMPA	sfc	23.92[1]	9.16	101.4	78.64	2.28	7.95	86.59
13:05	D3	sfc	22.63[1]	10.43	110.8	96.19	2.76	10.63	106.8

1. Bottle salinity.
2. Salinity sample contained hydrogen sulfide. Analyzed after sparging.

Table 14. Nutrient data for 09 March 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
10:01	36	1.5	24.66[1]	4.93	30.16	7.43	0.33	0.53	7.96
10:15	35	1.5	25.38	4.25	27.25	2.39	0.17	0.40	2.79
10:28	34	1.5	25.63	4.16	27.35	4.41	0.29	0.99	5.40
10:44	33	1.5	25.79	3.98	28.23	3.96	0.31	0.65	4.61
10:55	32	1.5	25.99[1]	4.10	27.69	5.38	0.35	0.67	6.05

continued ...

Nutrient data for 09 March 1994 - continued

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP	SiO2	N+N micromolar	NO2	NH3	DIN
11:07	31	1.5	26.15	3.96	30.73	7.83	0.55	1.09	8.92
11:24	30	1.5	26.58[1]	3.74	36.57	13.01	0.75	0.74	13.75
11:39	29.5	1.5	26.75	4.10	44.16	18.90	0.91	1.54	20.44
11:51	29	1.5	26.85	4.18	52.38	23.22	1.03	0.84	24.06
12:08	28	1.5	26.87	5.28	67.56	34.19	1.24	3.72	37.91
12:20	27	1.5	26.83[1]	5.31	65.66	33.03	1.23	3.82	36.85
12:32	26	1.5	26.71	5.29	67.22	31.96	1.25	6.52	38.48
12:50	25	1.5	26.52	4.73	69.90	29.85	1.23	8.10	37.95
13:03	24	1.5	26.29[1]	3.24	69.09	22.19	1.08	7.56	29.75
13:16	23	1.5	26.37	2.62	65.96	17.91	0.98	6.54	24.45
13:31	22	1.5	26.62	2.56	65.18	18.21	0.98	7.10	25.31
13:46	21	1.5	26.72	2.38	62.46	16.66	0.93	6.19	22.85
7:31	SM53	sfc	26.16[1]	3.63	5.99	0.20	0.09	0.00	0.20
7:37	SM46	sfc	26.43[1]	2.25	3.81	0.07	0.08	0.00	0.07
8:22	SM41	sfc	26.42[1,2]	2.28	6.00	0.07	0.06	0.00	0.07
8:32	SM35	sfc	26.25[1]	2.25	4.60	0.04	0.05	0.02	0.06
9:25	SM28	sfc	26.03[1,2]	3.10	4.48	0.04	0.07	0.00	0.04
9:35	SWH1	sfc	25.91[1]	2.54	3.60	0.04	0.06	0.01	0.05
9:50	D11	sfc	25.34[1,2]	3.97	27.03	1.77	0.14	0.27	2.04
10:15	REMPA	sfc	24.66[1,2]	4.98	30.52	7.09	0.41	0.58	7.67
10:29	D3	sfc	23.38[1,2]	6.07	41.07	28.81	1.38	0.49	29.30

1. Bottle salinity.
2. Salinity sample contained hydrogen sulfide. Analyzed after sparging.

Table 15. Nutrient data for 15 March 1994.
[Salinities are bottle salinities.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP	SiO2	N+N micromolar	NO2	NH3	DIN
9:48	SM53	sfc	26.20	4.46	4.03	0.12	0.01	0.14	0.26
9:56	SM46	sfc	25.64[1]	5.70	9.32	0.11	0.01	0.11	0.22
10:45	SM41	sfc	26.20	4.12	1.17	0.05	0.00	0.04	0.09

continued ...

Nutrient data for 15 March 1994 - continued

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
10:50	SM35	sfc	25.61[1]	4.84	1.09	0.16	0.00	0.17	0.33
11:22	SM28	sfc	25.81	4.79	1.23	0.08	0.00	0.14	0.22
11:28	SWH1	sfc	25.98	4.77	6.14	2.66	0.26	0.72	3.38
11:40	D11	sfc	24.38	7.83	13.21	18.21	0.95	2.12	20.33
11:52	REMPA	sfc	23.38	9.35	26.14	39.35	1.98	1.81	41.16
12:03	D3	sfc	13.57	24.79	165.1	397.3	14.84	29.12	426.4

1. Salinity sample contained hydrogen sulfide. Analyzed after sparging.

Table 16. Nutrient data for 16 March 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
6:35	36	1.5	22.73[1]	11.14	37.78	67.87	3.27	7.32	75.19
6:47	35	1.5	23.94	9.51	23.58	35.94	1.89	5.78	41.72
6:57	34	1.5	23.91	9.34	26.40	31.22	1.79	5.42	36.64
7:11	33	1.5	24.28	8.49	19.81	28.24	1.51	4.55	32.79
7:19	32	1.5	24.89[1]	7.23	10.49	12.77	0.81	3.38	16.15
7:31	31	1.5	25.34	6.58	8.37	8.88	0.64	3.86	12.74
7:50	30	1.5	25.74[1]	5.86	7.55	6.20	0.51	4.42	10.62
8:20	29.5	1.5	26.10	4.92	6.73	3.32	0.33	1.32	4.64
8:33	29	1.5	26.30	5.03	14.20	7.67	0.55	4.35	12.02
8:48	28	1.5	26.46	4.97	22.32	11.19	0.68	5.57	16.76
9:01	27	1.5	26.55[1]	4.87	28.43	13.51	0.74	5.38	18.89
9:15	26	1.5	26.70	4.88	40.87	18.79	0.95	4.92	23.71
9:34	25	1.5	26.75	5.31	46.67	22.44	1.16	6.21	28.65
9:50	24	1.5	26.58[1]	5.24	55.96	24.23	1.39	9.80	34.03
10:08	23	1.5	26.48	4.74	53.72	20.17	1.41	11.36	31.53
10:27	22	1.5	26.62	3.60	62.37	21.24	1.35	8.38	29.62
10:41	21	1.5	26.81	2.86	59.38	17.09	1.25	6.91	24.00

1. Bottle salinity.

Table 17. Nutrient data for 22 March 1994.
[These samples were filtered soon after collection, and frozen until the evening before analysis, on April 20 1994. Salinities are bottle salinities.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP	SiO2	N+N	NO2	NH3	DIN
				micromolar					
9:00	SM46	sfc	26.85	4.99	7.87	0.10	0.00	0.19	0.29
9:50	SM41	sfc	26.68	4.34	4.90	0.06	0.00	0.18	0.24

Table 18. Nutrient data for 29 March 1994.
[These samples were filtered soon after collection, and frozen until the evening before analysis, on April 20 1994. Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP	SiO2	N+N	NO2	NH3	DIN
				micromolar					
8:16	21	1.5	27.21	4.44	48.51	14.29	1.10	11.14	25.43
8:45	22	1.5	27.12	4.48	46.43	15.46	1.09	9.22	24.68
9:04	23	1.5	26.79	5.12	39.95	15.12	1.03	8.06	23.18
9:19	24	1.5	26.92[1]	5.02	45.22	16.14	1.16	9.21	25.35
9:34	25	1.5	26.73	5.10	40.87	14.94	0.99	8.00	22.94
9:49	26	1.5	26.58	5.57	35.18	13.20	0.90	8.13	21.33
10:03	27	1.5	26.46[1]	6.02	31.62	12.20	0.92	8.35	20.55
10:19	28	1.5	26.38	6.25	29.62	11.88	0.90	7.80	19.68
10:33	29	1.5	26.24	6.59	28.20	12.22	0.88	7.15	19.37
11:01	30	1.5	26.04[1]	7.02	27.04	14.09	0.92	6.04	20.13
11:17	31	1.5	25.96	7.39	27.96	15.96	0.95	6.10	22.06
11:29	32	1.5	25.77[1]	7.72	27.45	18.60	1.00	4.66	23.26
11:38	33	1.5	25.60	7.79	27.07	20.20	1.13	4.66	24.86
12:17	36	1.5	24.66[1]	10.15	39.91	42.91	1.85	7.31	50.22
10:30	SM53	sfc	25[2]	5.32	2.27	0.11	0.02	0.33	0.44
10:35	SM46	sfc	24[2]	5.29	0.91	0.09	0.02	0.30	0.39
11:23	SM35	sfc	25[2]	5.02	1.76	0.06	0.01	0.20	0.26
12:07	SM28	sfc	24[2]	5.31	1.43	0.06	0.00	0.35	0.41
12:12	SWH1	sfc	25[2]	7.11	27.10	17.11	1.01	3.78	20.89
12:24	D11	sfc	24[2]	9.08	33.84	33.18	1.44	5.45	38.63
12:34	REMPA	sfc	20[2]	10.35	41.45	47.42	1.99	6.75	54.17

continued ...

Nutrient data for 29 March 1994 - continued

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP	SiO2	N+N micromolar	NO2	NH3	DIN
12:40	D3	sfc	20[2]	16.19	86.24	184.6	5.78	17.54	202.2

1. Bottle salinity.
2. Refractometer salinity.

Table 19. Nutrient data for 05 April 1994.
[These samples were filtered soon after collection, and frozen until the evening before analysis, on April 20 1994. Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP	SiO2	N+N micromolar	NO2	NH3	DIN
12:23	21	1.5	28.12	3.42	41.43	11.15	0.70	7.80	18.95
11:39	24	1.5	27.70[1]	3.74	43.08	13.83	0.90	8.46	22.29
11:23	25	1.5	27.41	4.28	41.08	14.60	1.01	8.84	23.44
11:07	26	1.5	27.54	4.00	43.17	15.55	1.00	7.57	23.12
10:51	27	1.5	27.06[1]	4.56	38.92	15.16	1.04	6.56	21.72
10:35	28	1.5	26.81	5.40	36.33	14.85	1.15	8.03	22.88
10:18	29	1.5	26.71	5.65	35.05	14.65	1.19	8.84	23.49
10:05	29.5	1.5	26.48	6.38	34.54	15.25	1.28	9.25	24.50
9:41	30	1.5	26.38[1]	6.48	34.04	15.50	1.26	8.91	24.41
9:21	31	1.5	26.14	7.42	34.07	17.93	1.28	7.96	25.89
9:07	32	1.5	26.00[1]	7.78	34.88	19.57	1.26	7.26	26.83
8:55	33	1.5	25.96	8.04	35.79	21.24	1.32	7.07	28.31
8:15	36	1.5	24.88[1]	10.76	49.16	45.50	1.98	7.75	53.25
10:14	SM53	sfc	26.57[1,2]	6.64	42.97	15.30	0.79	2.85	18.15
10:07	SM46	sfc	26.35[1,2]	6.87	40.26	16.94	1.06	4.75	21.69
9:17	SM41	sfc	26.16[1,2]	7.40	36.65	18.66	1.20	5.61	24.27
9:09	SM35	sfc	26.52[1]	6.79	42.87	16.07	0.93	3.17	19.24
8:25	SM28	sfc	26.52[1,2]	6.74	40.16	15.39	0.76	1.14	16.53
8:17	SWH1	sfc	26.20[1]	7.09	35.66	18.05	1.04	2.75	20.80
8:02	D11	sfc	25.38[1,2]	9.53	43.41	33.20	1.52	7.27	40.47
7:50	REMPA	sfc	24.37[1,2]	11.77	54.50	59.71	2.35	7.64	67.35

continued ...

Nutrient data for 05 April 1994 - continued

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP	SiO2	N+N micromolar	NO2	NH3	DIN
7:40	D3	sfc	20.18[1]	18.99	105.8	220.7	6.77	18.97	239.6

1. Bottle salinity.
2. Salinity sample contained hydrogen sulfide. Analyzed after sparging.

Table 20. Nutrient data for 12 April 1994.
[These samples were filtered soon after collection, and frozen until the evening before analysis, on April 20 1994. Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP	SiO2	N+N micromolar	NO2	NH3	DIN
8:35	21	1.5	27.61	4.55	41.68	15.88	1.24	12.41	28.29
8:50	22	1.5	27.48	4.74	41.29	17.20	1.31	12.93	30.13
9:10	23	1.5	27.35	4.64	37.67	16.76	1.16	8.14	24.90
9:25	24	1.5	27.40[1]	4.41	38.34	16.31	1.08	7.24	23.55
9:40	25	1.5	27.26	4.90	38.22	16.10	1.10	7.19	23.29
9:55	26	1.5	26.96	5.74	41.08	17.11	1.25	8.68	25.79
10:07	27	1.5	26.64[1]	6.62	43.04	19.20	1.41	9.76	28.96
10:25	28	1.5	26.60	6.88	44.09	20.12	1.45	9.54	29.66
10:41	29	1.5	26.54	7.25	45.91	21.93	1.53	9.54	31.47
10:54	29.5	1.5	26.28	7.90	49.68	25.83	1.67	9.47	35.30
11:09	30	1.5	26.05[1]	8.28	52.09	28.58	1.72	9.48	38.06
11:27	31	1.5	25.92	8.86	55.79	32.66	1.88	9.95	42.61
11:42	32	1.5	25.13[1]	10.28	64.80	45.36	2.28	11.14	56.50
11:54	33	1.5	25.40	10.23	64.36	45.14	2.28	11.25	56.39
12:07	34	1.5	24.88	11.72	75.47	62.09	2.85	12.67	74.76
12:21	35	1.5	24.56	12.04	76.89	65.62	3.01	13.31	78.93
12:34	36	1.5	24.17[1]	12.84	80.70	73.06	3.43	14.24	87.30
12:03	D11	sfc	24.09[1]	13.01	82.20	78.31	3.39	14.06	92.37
12:13	REMPA	sfc	22.68[1,2]	15.30	95.97	120.3	4.92	17.09	137.4
12:25	D3	sfc	15.42[1]	24.45	160.0	381.2	12.79	38.29	419.4

continued ...

Nutrient data for 12 April 1994 - continued

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
11:09	SM41	sfc	26.29[1]	7.45	53.87	22.33	1.22	4.91	27.24
11:14	SM35	sfc	26.35[1]	7.92	50.65	21.84	1.41	5.43	27.27
11:47	SM28	sfc	26.39[1,2]	7.43	50.02	21.97	1.24	5.38	27.35
11:53	SWH1	sfc	25.46[1]	9.55	64.05	42.92	2.16	9.30	52.22

1. Bottle salinity.
2. Salinity sample contained hydrogen sulfide. Analyzed after sparging.

Table 21. Nutrient data for 15 April 1994.
[These samples were filtered soon after collection, and frozen until the evening before analysis, on April 20 1994. Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
12:38	21	1.5	28.73	3.03	39.86	15.16	0.84	6.89	22.05
11:39	24	1.5	27.72	4.18	36.92	16.84	1.05	7.26	24.10
10:50	27	1.5	26.63	6.99	46.94	23.15	1.52	9.13	32.28
9:49	30	1.5	25.72	10.28	70.27	47.87	2.36	10.42	58.29
9:17	32	1.5	24.56	12.50	85.51	72.75	3.35	12.44	85.19
8:19	36	1.5	22.40	17.83	114.1	151.2	6.86	20.78	171.9
9:10	SM53	sfc	26.56[1]	7.13	48.34	23.51	1.25	3.00	26.51
9:07	SM46	sfc	26.46[1]	7.75	59.72	21.65	1.30	2.66	24.31
8:29	SM41	sfc	26.41[1]	8.02	63.61	22.59	1.30	3.44	26.03
8:24	SM35	sfc	26.31[1]	8.40	69.56	20.49	1.61	4.85	25.34
7:48	SM28	sfc	26.43[1]	8.21	66.46	23.31	1.43	4.28	27.59
7:44	SWH1	sfc	26.02[1]	8.61	61.07	32.80	1.75	7.61	40.41

1. Bottle salinity.

Table 22. Nutrient data for 19 April 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
6:42	36	1.5	24.52[1]	13.22	94.91	72.08	3.29	12.32	84.40
6:54	35	1.5	25.47	10.60	67.83	44.87	2.16	8.01	52.88
7:05	34	1.5	25.85	9.43	58.76	34.68	1.70	6.43	41.11
7:20	33	1.5	26.06	8.63	54.75	32.10	1.61	4.51	36.61
7:29	32	1.5	26.13[1]	8.33	50.72	29.30	1.50	4.07	33.37
7:41	31	1.5	26.19	8.31	53.96	30.17	1.63	5.87	36.04
7:58	30	1.5	26.27[1]	8.08	54.08	29.82	1.73	7.60	37.40
9:00	29.5	1.5	26.39	7.74	51.09	27.98	1.70	8.14	36.12
9:12	29	1.5	26.54	7.39	50.44	25.27	1.66	10.22	35.49
9:26	28	1.5	26.77	6.69	46.68	22.23	1.48	9.33	31.56
9:39	27	1.5	26.86[1]	6.34	44.92	21.12	1.40	8.54	29.72
9:52	26	1.5	27.18	5.42	39.78	19.02	1.23	6.68	25.70
10:08	25	1.5	27.78	4.18	34.45	17.43	1.04	5.27	22.70
10:22	24	1.5	28.40	3.31	38.02	16.70	0.90	6.54	23.25
10:34	23	1.5	28.53	3.09	38.72	16.41	0.85	6.28	22.69
10:51	22	1.5	28.45	3.26	38.33	16.34	0.89	7.40	23.74
11:03	21	1.5	28.61	3.03	38.33	15.64	0.81	7.11	22.75

1. Bottle salinity.

Table 23. Nutrient data for 21 April 1994.
[These samples were filtered soon after collection, and frozen until the evening before analysis, on June 17 1994. All salinities are bottle salinities.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
8:16	SM53	sfc	27.23	5.45	30.44	15.63	0.40	0.81	16.44
8:20	SM46	sfc	27.31	5.06	27.37	15.38	0.51	0.29	15.67
8:45	SM41	sfc	27.06	5.46	23.54	15.55	0.63	0.20	15.75
8:49	SM35	sfc	27.08	5.38	23.56	15.64	0.61	0.42	16.06
8:41	SM28	sfc	27.03	5.32	25.01	14.13	0.54	0.63	14.76
9:45	SWH1	sfc	26.57	7.69	44.09	24.00	1.08	3.73	27.73

continued ...

Nutrient data for 21 April 1994 - continued

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
9:58	D11	sfc	24.68	13.48	89.69	70.35	3.13	10.34	80.69
10:10	REMPA	sfc	21.70	21.01	138.0	171.9	6.61	16.18	188.1
10:17	D3	sfc	22.71	19.09	128.6	135.4	5.54	15.00	150.4

Table 24. Nutrient data for 27 April 1994.
[These samples were filtered soon after collection, and frozen until the evening before analysis, on June 17 1994. Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
10:11	24	1.5	27.97	4.50	38.31	20.22	1.15	7.32	27.54
10:41	26	1.5	27.16	6.59	50.13	25.95	1.38	7.02	32.97
11:45	30	1.5	26.51	8.63	61.47	36.62	1.69	7.10	43.72
12:14	32	1.5	25.88[1]	10.03	71.06	50.55	2.14	8.15	58.70
12:54	36	1.5	23.93[1]	14.12	96.23	95.00	4.01	11.18	106.2
11:23	SM53	sfc	25 [2]	8.29	61.78	17.86	0.89	4.36	22.22
11:28	SM46	sfc	26.75[1]	7.46	56.13	24.05	0.90	3.24	27.29
11:58	SM41	sfc	24 [2]	8.21	55.98	29.68	1.31	4.92	34.60
12:03	SM35	sfc	26.74[1,3]	7.60	55.60	27.82	1.03	4.14	31.96
12:33	SM28	sfc	26.72[1]	7.86	58.30	24.67	0.93	4.12	28.79
12:40	SWH1	sfc	25.13[1,3]	11.38	79.21	68.24	2.76	8.98	77.22
12:50	D11	sfc	20 [2]	13.19	88.19	82.76	3.39	10.39	93.15
13:00	REMPA	sfc	20 [2]	15.07	103.0	118.3	4.64	12.62	130.9
13:07	D3	sfc	19.77[1]	17.11	124.2	180.9	4.25	17.23	198.2

1. Bottle salinity.
2. Refractometer salinity.
3. Salinity sample contained hydrogen sulfide. Analyzed after sparging.

Table 25. Nutrient data for 04 May 1994.

[These samples were filtered soon after collection, and frozen until the evening before analysis, on June 17 1994. Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
10:43	36	1.5	25.31	13.13	100.9	82.38	3.26	9.75	92.13
11:24	33	1.5	26.11	10.17	80.80	51.24	2.21	7.81	59.05
11:31	32	1.5	26.14[1]	10.12	79.68	50.81	2.18	7.81	58.62
11:42	31	1.5	26.54	9.19	72.75	43.13	1.98	7.78	50.91
11:58	30	1.5	26.75[1]	8.27	65.26	38.22	1.87	7.73	45.95
12:10	29.5	1.5	26.90	8.49	66.10	37.95	1.89	8.60	46.55
12:21	29	1.5	27.13	7.74	59.78	32.71	1.68	10.55	43.26
12:34	28	1.5	27.26	6.88	52.80	29.79	1.58	9.81	39.60
12:45	27	1.5	27.38[1]	6.42	49.30	28.16	1.52	8.55	36.71
12:57	26	1.5	27.80	5.92	46.29	26.19	1.42	8.05	34.24
13:13	25	1.5	28.18	4.68	40.97	22.27	1.22	8.13	30.40
13:26	24	1.5	28.66[1]	4.04	39.00	20.87	1.13	8.63	29.50
14:09	21	1.5	28.62	4.45	42.29	21.52	1.23	12.75	34.27
7:31	SM53	sfc	27.26[1]	7.30	59.62	30.34	0.95	3.57	33.91
7:35	SM46	sfc	27.49[1]	6.51	53.56	27.72	1.09	4.49	32.21
8:10	SM41	sfc	27.06[1]	7.48	60.76	33.91	1.49	5.48	39.39
9:04	SM28	sfc	27.24[1]	7.35	60.63	31.40	1.18	4.28	35.68
9:16	SWH1	sfc	26.21[1]	10.03	79.52	50.59	2.13	7.25	57.84
9:48	D11	sfc	25.12[1]	12.36	94.36	71.84	2.89	9.20	81.04
10:03	REMPA	sfc	20.91[1]	19.15	140.1	181.5	4.23	16.40	197.9
10:19	D3	sfc	21.08[1]	19.62	140.5	188.0	4.49	17.67	205.6

1. Bottle salinity.

Table 26. Nutrient data for 15 June 1994.
[Salinities are CTD salinities unless otherwise noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
7:37	36	1.5	27.29[1]	14.20	128.5	70.53	1.76	5.81	76.34
7:53	35	1.5	27.55	13.63	125.0	66.37	1.63	5.53	71.90
8:02	34	1.5	27.44	13.97	128.3	68.35	1.74	6.29	74.64
8:15	33	1.5	28.17	11.34	111.5	52.14	1.25	4.67	56.81
8:25	32	1.5	28.26[1]	10.68	107.8	48.78	1.16	4.27	53.05
8:38	31	1.5	28.57	9.36	98.86	42.43	0.96	3.50	45.93
8:55	30	1.5	28.58[1]	8.67	95.36	39.86	0.92	2.44	42.30
9:30	29.5	1.5	28.62	8.73	95.22	39.09	1.03	3.31	42.40
9:42	29	1.5	28.68	8.42	93.54	38.80	1.11	3.81	42.61
9:55	28	1.5	28.65	8.37	93.40	39.03	1.10	3.10	42.13
10:08	27	1.5	28.68[1]	8.08	91.14	38.66	1.16	3.38	42.04
10:20	26	1.5	28.93	7.43	86.29	37.20	1.26	5.24	42.44
10:36	25	1.5	29.34	5.48	71.31	33.41	1.43	6.61	40.02
10:51	24	1.5	29.76[1]	4.91	65.82	32.74	1.50	8.18	40.92
11:06	23	1.5	29.74	4.92	65.61	33.15	1.55	8.02	41.17
11:24	22	1.5	30.04	5.67	72.73	35.59	1.73	10.23	45.82
11:36	21	1.5	29.60	5.72	75.55	36.01	1.51	6.30	42.31

1. Bottle salinity.

Table 27. Nutrient data for 22 September 1994.
[These samples were filtered soon after collection, and frozen until the evening before analysis, on February 23 1995. All salinities are bottle salinities.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
12:14	H29.5	sfc	31.76	10.75	94.71	30.51	2.62	4.55	35.06
11:15	H30	sfc	31.56	11.82	101.3	32.08	2.10	3.13	35.21
12:40	H31	sfc	31.36	10.46	101.0	28.30	1.66	3.05	31.35
12:58	H32	sfc	30.99[1]	13.82	116.4	44.30	2.30	4.10	48.40
13:26	H33	sfc	30.80	14.59	121.5	48.64	2.40	4.57	53.21
13:06	H36	sfc	28.79	18.80	150.5	90.52	3.64	10.16	100.7

continued ...

Nutrient data for 22 September 1994 - continued

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
9:22	SM53	sfc	32.49	9.05	86.23	4.35	0.32	0.71	5.06
10:05	SM41	sfc	32.55	8.86	86.21	0.43	0.04	0.24	0.67
10:59	SM35	sfc	32.32	9.00	81.06	4.39	0.29	1.36	5.75
12:53	SM28	sfc	32.37	9.30	86.00	4.98	0.34	0.30	5.28
13:02	SWH1	sfc	31.27	12.79	109.6	36.79	1.67	1.88	38.67
13:17	REMPA	sfc	26.83	21.18	169.8	137.2	4.98	13.68	150.9
12:11	D3	sfc	16.44	29.89	244.3	414.5	12.25	31.68	446.2

1. Hydrogen sulfide in salinity sample at time of analysis.

Table 28. Nutrient data for 29 September 1994.
[These samples were filtered soon after collection, and frozen until the evening before analysis, on February 23 1995. All salinities are bottle salinities.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
7:50	H29.5	sfc	31.86	8.84	81.80	25.03	3.19	2.77	27.80
7:54	H30	sfc	31.82	10.52	94.81	30.28	3.08	1.48	31.76
8:48	H31	sfc	31.72	10.97	98.89	29.64	2.61	0.72	30.36
9:05	H32	sfc	31.68	10.92	98.74	28.72	2.25	0.51	29.23
9:08	H33	sfc	31.65	11.14	99.36	29.96	1.94	1.01	30.97
9:40	H36	sfc	29.89	15.60	137.1	61.46	2.48	1.20	62.66
7:33	SM53	sfc	33.15	8.58	78.45	0.82	0.03	0.33	1.15
7:37	SM46	sfc	32.69	8.32	68.91	0.71	0.03	0.26	0.97
8:10	SM41	sfc	32.78	8.77	78.45	0.59	0.02	0.32	0.91
8:19	SM35	sfc	32.55	8.79	81.75	0.53	0.02	0.23	0.76
8:56	SM28	sfc	32.17	8.98	85.43	5.79	0.28	0.21	6.00
9:02	SWH1	sfc	31.24	12.32	107.1	31.91	1.50	0.64	32.55
9:26	D11	sfc	30.46[1]	14.68	125.7	50.47	2.17	0.77	51.24
9:42	REMPA	sfc	28.10	19.61	163.8	102.8	3.36	1.22	104.1

continued ...

Nutrient data for 29 September 1994 - continued

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
9:54	D3	sfc	27.18	21.01	173.2	122.1	4.19	5.77	127.9

1. Hydrogen sulfide in salinity sample at time of analysis.

Table 29. Nutrient data for 26 October 1994.
[All salinities are Midas salinities except as noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
12:02	21	1.5	31.52	3.51	50.33	22.31	1.76	4.49	26.80
11:49	22	1.5	31.67	4.07	52.63	24.38	2.29	5.81	30.19
11:32	23	1.5	31.74	5.02	57.35	25.73	2.82	3.08	28.81
11:15	24	1.5	31.85[1]	8.08	76.29	32.21	4.49	3.44	35.65
11:02	25	1.5	31.98	9.23	84.33	33.95	4.41	2.85	36.80
10:46	26	1.5	32.01	9.46	87.03	37.20	5.90	0.99	38.19
10:33	27	1.5	32.00[1]	9.33	86.11	36.28	6.49	1.27	37.55
10:18	28	1.5	31.96	9.40	86.79	36.53	6.87	2.04	38.57
10:05	29	1.5	31.79	10.30	92.18	38.33	6.28	5.81	44.14
9:51	29.5	1.5	31.79	10.42	94.21	39.11	6.07	4.14	43.25
8:42	30	1.5	31.74[1]	10.65	96.72	40.76	5.87	2.87	43.63
8:25	31	1.5	31.57	11.58	103.9	44.66	5.13	2.31	46.97
8:13	32	1.5	31.45[1]	12.03	107.0	49.70	4.73	2.73	52.43
8:04	33	1.5	31.22	12.75	112.7	55.16	4.15	2.13	57.29
7:49	34	1.5	30.98	13.56	118.7	62.86	4.03	2.27	65.13
7:38	35	1.5	30.53	14.71	126.3	73.60	3.96	2.76	76.36
7:24	36	1.5	30.18[1]	15.37	130.8	82.78	4.25	3.80	86.58

1. Bottle salinity

Table 30. Nutrient data for 29 November 1994.
[All salinities are Midas salinities except as noted.]

LOCAL TIME h:m	STA	DEP m	SAL psu	Concentrations DRP micromolar	SiO2 micromolar	N+N micromolar	NO2 micromolar	NH3 micromolar	DIN micromolar
11:18	20	1.5	30.53	2.77	47.79	22.24	0.93	6.20	28.44
11:03	21	1.5	30.23	3.04	50.44	23.35	1.07	4.97	28.32
10:50	22	1.5	30.33	3.60	53.04	25.74	1.48	8.02	33.76
10:33	23	1.5	30.10	3.09	51.80	23.78	1.12	6.16	29.94
10:18	24	1.5	30.20[1]	3.68	53.52	25.73	1.38	6.50	32.23
10:04	25	1.5	30.31	6.16	65.70	33.88	2.85	8.29	42.17
9:47	26	1.5	30.48	8.27	77.35	40.94	3.97	10.36	51.30
9:33	27	1.5	30.65[1]	9.15	82.66	44.31	4.66	7.30	51.61
9:20	28	1.5	30.76	8.89	81.22	43.55	5.32	5.58	49.13
9:04	29	1.5	30.62	8.40	77.80	40.40	5.12	5.09	45.49
8:51	29.5	1.5	30.63	8.61	79.81	42.38	5.90	6.41	48.79
7:49	30	1.5	30.48[1]	9.05	83.02	46.14	6.18	7.15	53.29
7:28	31	1.5	30.33	9.47	86.50	50.38	6.02	6.67	57.05
7:14	32	1.5	29.69[1]	10.58	95.30	63.04	5.88	7.34	70.38
7:05	33	1.5	29.74	10.60	95.61	62.89	5.84	7.33	70.22
6:48	34	1.5	29.00	11.73	103.1	76.75	5.74	8.51	85.26
6:22	36	1.5	27.61[1]	13.82	116.1	103.6	5.68	10.99	114.6

1. Bottle salinity.