Nutrient Data from Belogorsk Cruise 78-04

16-29 November 1978

by

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Introduction

Between November 16 and 29, 1978 water samples were collected for nutrient analyses on the U.S.S.R. research ship P.T.M. Belogorsk (cruise 78-04) over the continental shelf of Georges Bank and the Gulf of Maine approximately between longitudes 67 and 71 west. The 7 depths at which samples were taken were determined by quantum submarine photometer to be at 100, 69, 46, 25, 10, 3 and 1% of the incident light intensity so that they would correspond to samples on which rates of primary productivity were measured.

We have estimated the concentrations of orthophosphorus, reactive dissolved silicon and nitrite, nitrate, urea and ammonium nitrogen. At the same depths and stations, other investigators made measurements of temperature, salinity, dissolved oxygen, chlorophyll-a, phaeophytin and primary productivity (nannoplankton, netplankton and release of dissolved organic matter).

Methods of Analysis

Shortly after collection, the seawater samples were filtered through combusted glass fiber filters (Whatman GF/F, nominal pore size = 0.7 µm). A 30 ml portion of sample was filtered to rinse the filter pad. The filtrate was then collected and frozen in 30 ml polypropylene tubes that had been cleaned with hydrochloric acid and deionized water.

Measurement of ammonium nitrogen onboard was not possible so samples were frozen in glass serum bottles with the phenol-alcohol reagent. Based on preliminary results (Berberian, pers. comm.), we adopted this method of storage as a preferable to simply freezing the samples. At this time we have no data as to its efficacy, however, Berberian's data suggest that samples so preserved are stable for a few months. The reagent blank determined during this survey was much higher than we have routinely found when samples are analyzed immediately at sea. On return to the laboratory the thawed samples were carried through the remainder of the phenolhypochlorite method of Solorzano (1969) as modified by Liddicoat et al. (1975).

All other measurements were made on a Technicon autoanalyzer II. Nitrite and nitrate were estimated using the naphthylethylenediamine-sulfanilamide system with cadmium reduction of nitrate after Wood et al. (1964). The inorganic phosphorus analysis utilized the molybdate-ascorbic acid procedure after Murphy and Riley (1962). The reactive dissolved silicone procedure is based on the use of oxalate to reduce a silicomolybdate complex and at the same time decompose any phospho- or arseno-molybdates (Mullin and Riley, 1955). The urea-analysis is an adaptation to seawater of March et al.'s (1965) blood urea method in which diacetylmonoxime reacts with urea in the presence of thiosemicarbizide and ferric ion intensifiers. Autoanalyzer standardizations were made in artificial seawater (31 g NaCl + 10g $MgSO_4 \cdot 7H_2O$ + 0.04 g $NaHCO_3$).e Those for ammonium were made by standard addition to replicates of a surface sample.

Results

Station locations, depths and dates of occupation are listed in Table 1. The estimated concentrations of nutrients in micro-moles of N, P, or Si per liter (μM/l) are listed in Table 2 along with sample identifications as follows: consecutive nutrient sample number, consecutive station number/standard MARMAP station number, depth in meters, nutrient concentrations. The mean euphotic zone nutrient concentrations were calculated by arithmetically integrating concentration over depth and dividing this value by the total depth of the euphotic zone. These have been plotted in Figures 2-6. This procedure gives a measure of the distribution of inorganic nutrients available for primary productivity, however for detail, it is necessary to look at Table 2. For example, at station 131, the nitrate concentration at the bottom of the euphotic layer was twice that measured in surface water.

The largest difference in mean euphotic zone nutrient concentration in the area surveyed on this cruise was observed in nitrate (Fig. 3) between the most northern stations (11.9 and 11.6 μM/l) and stations on the western end of Georges Bank and northwest of it (1.0 and 0.9 μM/l). Near the southern edge of the Bank (186 m), nitrate was higher than on the shelf proper. This pattern was also observed, though less dramatically, in silicon and phosphorus. Except for station 78, south of Rhode Island, the highest nitrite concentrations were observed on the southern edge of the Bank. Station 78 was also where the highest mean euphotic zone urea concentration was observed. A slightly elevated concentration seems to have been present on Georges Bank and as far west as station 78. However, this trend is not as sharply delineated as those of the other measurements. This urea method has not previously been applied to the shelf water samples and the salt correction is not as refined as we would like so we have been conservative in the estimation of urea concentration, but we feel the data are sufficiently unique to report here.

We can discern a qualitative relation between our measurements and those on phytoplankton (O'Reilly and Busch, 1979; Evans _et al._, 1979). Where the nutrient concentrations were low, chlorophyll-_a_ and total primary productivity were highest. Where nutrients were highest, nannoplankton chlorophyll-_a_ predominated over the netplankton and vice versa. This includes the area along the south edge of Georges Bank.

Acknowledgements

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Berberian, George.

NOAA, Atlantic Oceanographic and Meterological Laboratory, Ocean Chemistry Lab., 15 Rickenbacker Causeway, Miami, Fl. 33149.

Evans, C. A., J. E. O'Reilly and J. P. Thomas.

1979. Report on chlorophyll measurements made on MARMAP surveys between October 1977 - December 1978. Report No. SHL 79-10. Northeast Fisheries Center, Highlands, New Jersey 07732.

Liddicoat, M. I., S. Tibbitts, and E. I. Butler.

1975. The determination of ammonia in seawater. Limno. and Oceano. 20: 131.

Marsh, W. H., B. Fingerhut, and H. Miller.

1965. Automated and manual direct determination of blood urea. Clinic. Chem. 11: 624.

Mullin, J. B., and J. P. Riley.

1965. The spectrophotometric determination of silicate silicon in natural waters with special reference to seawater. Anal. Chim. Acta. 12: 162.

Murphy, J., and J. P. Riley.

1962. A modified single solution method for the determination of phosphate in natural waters. Anal. Chim. Acta. 27: 31.

O'Reilly, J. E. and D. A. Busch.

1979. Summary of Measurements of Primary Productivity Made During MARMAP Surveys (Belogorsk 78-01, 78-03, 78-04). Report No. SHL 79-09, Northeast Fisheries Center, Highlands, New Jersey 07732.

Solorzano, L.

1969. Determination of ammonia in natural waters by the phenolhypochlorite method. Limno. and Oceano. 14: 799.

Wood, F. D., F. A. J. Armstrong, and F. A. Richards.

1964. Determination of nitrate in sea water by cadmium-copper reduction to nitrite. J. Mar. Bio. Assoc. U.K. 47: 25.

TABLE 1

Belogorsk Cruise 78-04 Stations 16-29 November 19781

Station Number Consecutive/MARMAP		Lat. N	Long. W	Station Depth (m)	Date Yr/Mo/Dal
2	115	40°05'	69°01'	329	78/11/16
8	109	40°39'	69°09'	170	78/11/17
101	127	41°59'	68°39'	168	78/11/17
151	123	41°11'	68°08'	30	78/11/18
161	120	40°48'	68°17'	37	78/11/18
211	152	40°05'	67°40'	2560	78/11/19
221	151	40°221	67°40'	800	78/11/19
291	144	42°36'	67°42'	201	78/11/20
301	143	42°591	67°42'	185	78/11/20
341	140	43°58'	68°11'	110	78/11/21
351	138	43°58'	68°35'	66	78/11/21
411	136	43°08'	69°011	163	78/11/22
421	131	42°451	68°46'	196	78/11/22
47	106	42°35'	69°14'	219	78/11/23
48	105	43°06'	69°18'	174	78/11/23
54	100	42°50'	70°00'	179	78/11/24
55	99	42°48'	70°32'	100	78/11/24
61	461	41°491	69°41'	160	78/11/25
62	94	41°32'	69°26'	64	78/11/25
66	89	40°411	70°111	48	78/11/27
67	86	40°42'	70°35'	58	78/11/27
72	78	40°58'	71°10'	49	78/11/28
73	79	40°411	71°021	62	78/11/28
77	83	39°48'	70°35'	1298	78/11/29

TABLE 2

Nutrient Data Listing

BELOGORSK 78-03

NUTRIENTS

ID	STATION	DEPTH	ORTHOPHOS-PHATE-P	DISSOLVED SILICON-Si	NITRITE-N	NITRATE-N	UREA-N
536	120/32	1	0.226	2.062	0.180	1.928	BD
537	120/32	2	0.291	2.140	0.173	1.632	BD
538	120/32	3	0.323	2.140	0.182	1.161	0.41
539	120/32	5	0.269	1.946	0.201	0.905	BD
540	120/32	5	0.269	1.946	0.201	1.419	0.01
541	120/32	12	0.323	2.490	0.244	1.231	0.10
542	120/32	17	0.258	1.440	0.180	1.163	BD
543	122	1	0.539	4.281	0.565	2.967	0.61
544	122	3	0.603	4.203	0.579	4.574	0.06
545	122	4	0.539	4.086	0.569	3.357	BD
546	122	7	0.528	4.086	0.560	2.734	BD
547	122	11	0.571	4.670	0.569	2.909	BD
548	122	14	0.592	4.203	0.546	3.183	0.15

DONE

Symbols
M=missing analysis
BD=below detection

BELOGORSK 78-04

NUTRIENTS

ID	STATION	DEPTH	ORTHOPHOS-PHATE-P	DISSOLVED SILICON-Si	NITRITE-N	NITRATE-N	UREA-N	AMMONIUM-N
549	2/115	1	0.539	4.281	0.534.	4.698	M	
550	2/115	3	0.571	4.670	0.555.	3.055	M	
551	2/115	9	0.560.	3.853.	0.527.	3.426.	BD	
552	2/115	18	0.722.	5.448.	0.726.	4.031.	0.29	
553	2/115	24	0.495.	3.697.	0.479.	2.683.	BD	
554	2/115	30	0.614.	10.469.	0.543.	3.331.	0.04	
555	2/115	39	0.592.	4.709.	0.557.	3.053.	0.04	
556	8/109	1	0.808.	5.838.	0.629.	6.356.	0.09	
557	8/109	2	0.733.	2.023.	0.427.	1.483.	0.25	
558	8/109	5	0.765.	1.829.	0.410.	4.465.	0.44	
559	8/109	8	0.754.	1.946.	0.427.	1.457.	0.06	
560	8/109	14	0.700.	2.218.	0.427.	1.299	0.45	
561	8/109	25	0.517.	1.556.	0.337.	1.059.	BD	
562	8/109	32	0.614.	1.673.	0.341.	0.659.	BD	
563	10/127	1	0.614.	1.556.	0.334.	1.035.	0.17	5.03
564	10/127	3	0.571.	4.397.	0.303.	0.816	0.20	
565	10/127	6	0.689.	2.218.	0.273.	0.952	0.14	5.18
566	10/127	11	0.700.	2.957.	0.375.	1.127	0.66	
567	10/127	17	0.733.	2.724.	0.261.	0.701	0.11	5.04
568	10/127	26	0.700.	3.191.	0.273.	0.755	0.11	
569	10/127	35	0.765.	3.541.	0.289.	0.830	0.23	5.28
570	15/123	1	0.377.	4.865.	0.199.	0.710.	0.11	5.83
571	15/123	2	0.441.	3.035.	0.182.	1.280.	0.27	
572	15/123	4	0.431.	3.386.	0.178.	0.744	0.03	4.95
573	15/123	6	0.388.	2.724.	0.170.	0.685.	0.11	
574	15/123	10	0.388.	2.919.	0.189.	0.640.	0.08	6.21
575	15/123	17	0.344.	3.892.	0.206.	1.006.	0.25	
576	15/123	21	0.323.	2.724.	0.154.	2.323.	BD	5.52
576	15/123	21	0.323.	2.724.	0.154.	2.323.	BD	
577	16/120	1	0.517.	5.876.	0.458.	3.891.	0.40	
578	16/120	4	0.517.	5.448.	0.439.	3.580.	0.09	
579	16/120	6	0.495.	5.215.	0.394.	3.164.	0.05	
580	16/120	10	0.528.	5.448.	0.370.	3.794.	0.27	
581	16/120	16	0.377.	3.580.	0.265.	2.185.	BD	
582	16/120	21	0.377.	4.475.	0.246.	1.980.	0.08	
583	21/152	1	0.539.	4.086.	0.201.	5.702.	BD	
584	21/152	2	0.506.	4.281.	0.436.	3.965.	0.17	
585	21/152	4	0.528.	4.242.	0.436.	3.938.	BD	
586	21/152	7	0.722.	5.643.	0.600.	5.501.	0.17	
587	21/152	13	0.614.	4.826.	0.538.	5.036.	0.17	
588	21/152	26	0.679.	5.604	0.572.	5.161	0.04	
589	21/152	42	0.646	5.838.	0.576.	5.261.	0.23	
590	22/151	1	0.754	5.448.	0.588.	6.001.	0.13	5.78.
591	22/151	3	0.733	5.915	0.332.	7.114.	0.49	
592	22/151	6	0.625	5.448.	0.315.	6.537.	0.16	5.86
593	22/151	11	0.743	6.694	0.339.	7.370.	0.26	
594	22/151	18	0.679	5.370.	0.322.	6.939	0.26	5.04
595	22/151	27	0.733	6.616	0.339.	7.528	0.23	

653	54/100	1	0.546	3.835	0.335	6.132	0.04	6.86
654	54/100	2	0.573	3.979	0.342	6.254	0.04	
655	54/100	5	0.618	3.814	0.345	6.010	0.04	6.62
656	54/100	9	1.565	4.124	0.308	6.449	0.09	
657	54/100	14	0.564	3.711.	0.332	5.700	BD	5.52
658	54/100	22	0.673	3.814.	0.371	5.968	BD	
659	54/100	29	0.500	3.773.	0.379	6.040.	0.07	6.35
660	55/99	1	0.546	5.938.	0.252	3.367	0.24	
661	55/99	3	0.455	3.113.	0.308	2.797.	0.07	
662	55/99	6	0.546	3.134.	0.235	3.207.	BD	
663	55/99	9	0.500	3.484.	0.249	3.210	BD	
664	55/99	13	0.455	3.608.	0.229	3.036.	BD	
665	55/99	17	0.546	3.216.	0.268	2.386.	BD	
666	61FF	1	0.518	3.587.	0.499	4.617.	BD	
667	61FF	4	0.546	4.000.	0.489	4.594	BD	
668	61FF	7	0.564	3.711.	0.493	4.719.	BD	
669	61FF	11	0.564	3.505.	0.491	4.721.	BD	
670	61FF	16	0.591.	5.835.	0.503	4.484.	0.11	
671	61FF	21	0.628.	3.690.	0.500	4.809.	0.01	
672	62/94	1	0.546.	4.227.	0.517	4.888.	0.28	
673	62/94	3	0.746.	4.742.	0.398	4.879.	0.04	
674	62/94	5	0.555.	5.051.	0.581	4.647.	0.12	
675	62/94	9	0.591.	4.639.	0.399	4.990.	0.03	
676	62/94	15	0.600.	5.361.	0.403	4.906	BD	
677	62/94	22	0.628.	5.876.	0.395	4.994.	BD	
678	62/94	30	0.700.	5.670.	0.357	7.462.	0.07	
679	66/89	1	0.464.	2.680.	0.637	1.856.	0.10	5.48
680	66/89	4	0.473.	2.577.	0.670	1.903.	0.22	
681	66/89	7	0.455.	6.082.	0.759	1.943.	0.22	6.44
682	66/89	12	0.455.	2.742.	0.636	1.664	0.08	
683	66/89	19	0.473.	2.680.	0.653	1.888.	0.05	6.75
684	66/89	25	0.455.	2.474.	0.598	1.702.	0.19	5.62
685	67/86	1	0.455.	3.361.	0.507	1.583.	0.15	
686	67/86	4	0.455.	3.402.	0.499	1.672.	0.04	
687	67/86	7	0.500.	4.020.	0.496	1.675.	0.15	
688	67/86	11	0.436.	3.464.	0.471	1.588.	0.15	
689	67/86	17	0.473.	3.670.	0.487.	1.717.	0.07	
690	67/86.	23	0.455.	3.134.	0.477.	1.646.	0.07	
691	72/78	1	0.600.	4.742.	0.752.	2.160.	0.22	
692	72/78	5	0.637.	4.124.	0.695.	2.731.	0.15	
693	72/78	9	0.637.	6.392.	0.671.	2.674.	0.47	
694	72/78	14	0.582.	3.381.	0.653.	2.644.	0.48	
695	72/78	22	0.600.	3.670.	0.678.	2.861.	0.07	
696	72/78	29	0.609.	3.773.	0.685.	2.822	0.04	
697	73/79	1	0.409.	3.196.	0.350.	1.725.	0.16	
698	73/79	3	0.436.	2.680.	0.352.	1.739.	0.10	
699	73/79	5	0.582.	2.639.	0.369.	1.753.	0.50	
700	73/79	9	0.418.	2.721.	0.321.	1.769.	0.34	
701	73/79	13	0.418.	2.886.	0.313.	1.778	0.11	
702	73/79	17	0.418.	2.556.	0.392.	1.474.	0.16	
703	77/83	1	0.418.	2.886	0.310.	2.183.	0.04	
704	77/83	4	0.436.	2.845.	0.495.	2.995.	0.11	
705	77/83	8	0.500.	2.783.	0.325.	2.892.	0.04	
706	77/83	18	0.436.	2.969.	0.330.	2.887.	0.17	
707	77/83	33	0.409.	2.763.	0.331.	2.725.	0.04	
708	77/83	48	0.345.	2.165	0.380.	1.871.	0.02.	

DONE

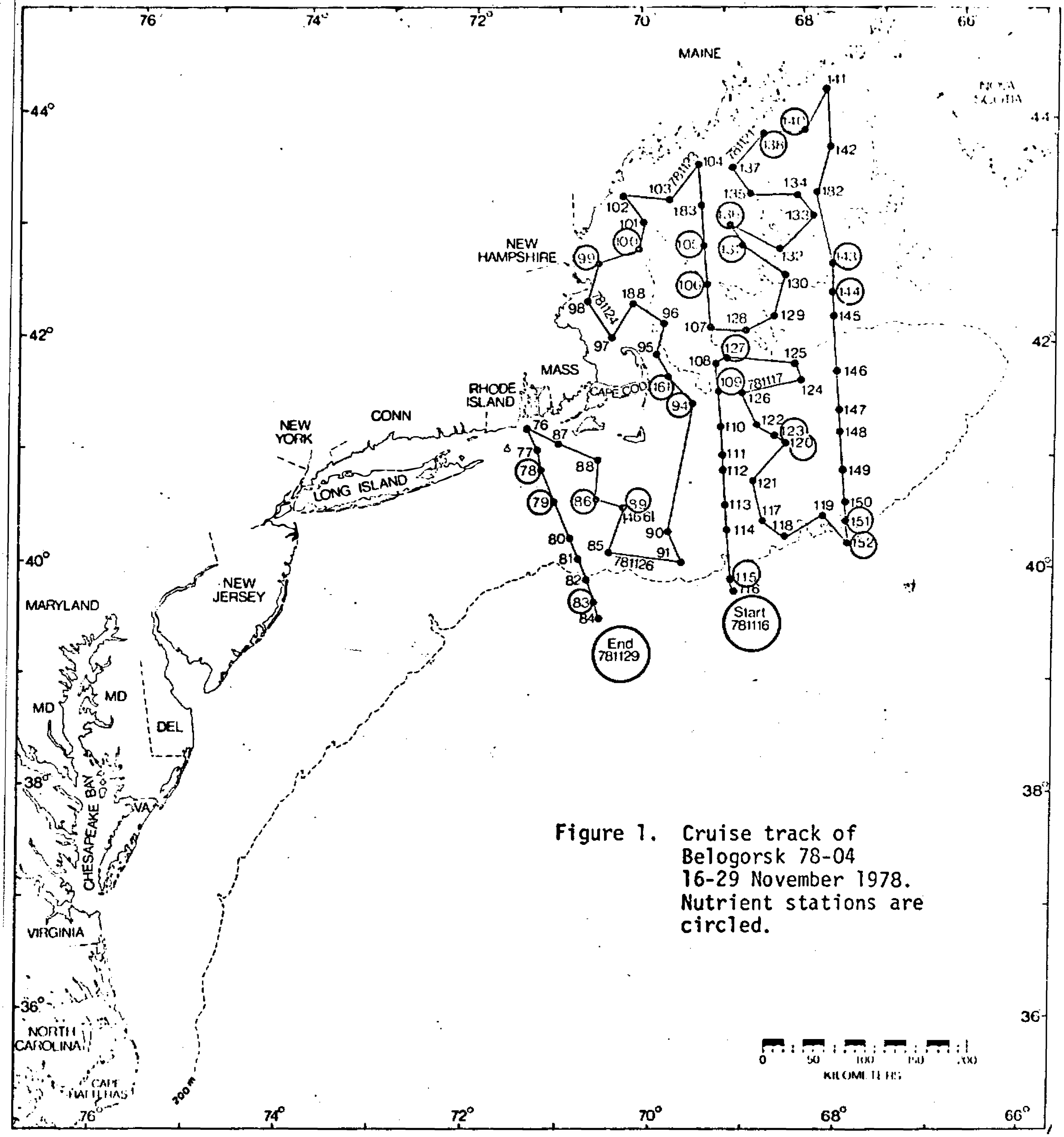

Figure 1. Cruise track of Belogorsk 78-04 16-29 November 1978. Nutrient stations are circled.

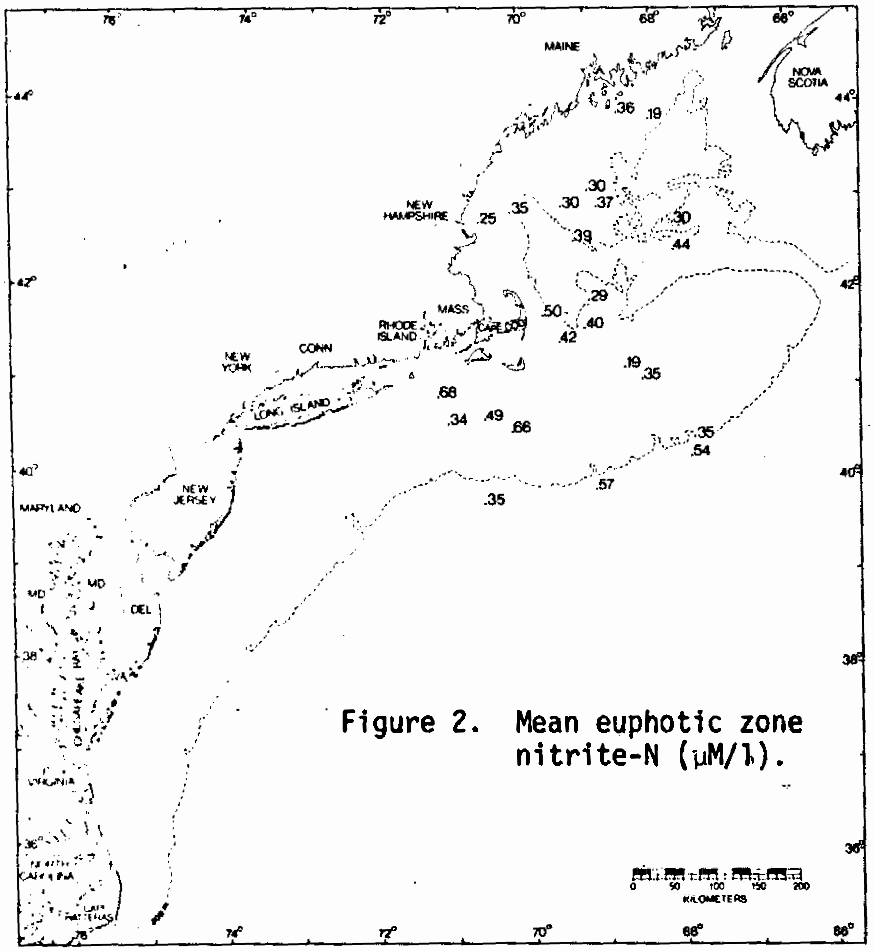

Figure 2. Mean euphotic zone nitrite-N (μM/l).

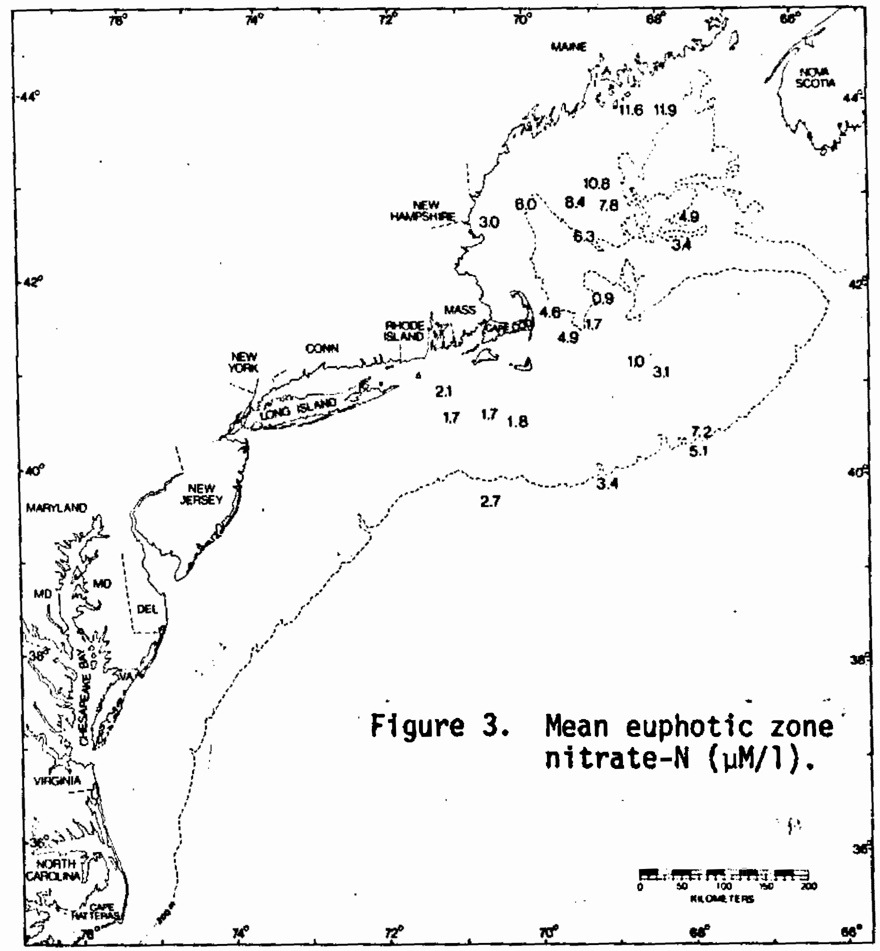

Figure 3. Mean euphotic zone nitrate-N (μM/l).

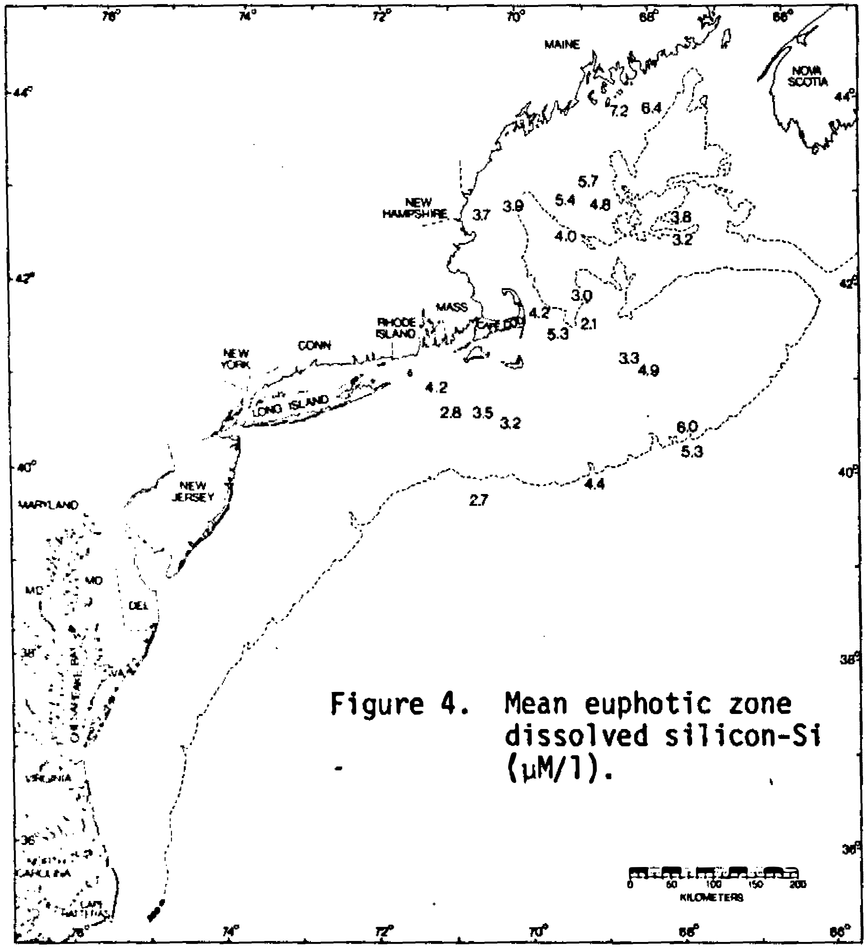

Figure 4. Mean euphotic zone dissolved silicon-Si (μM/l).

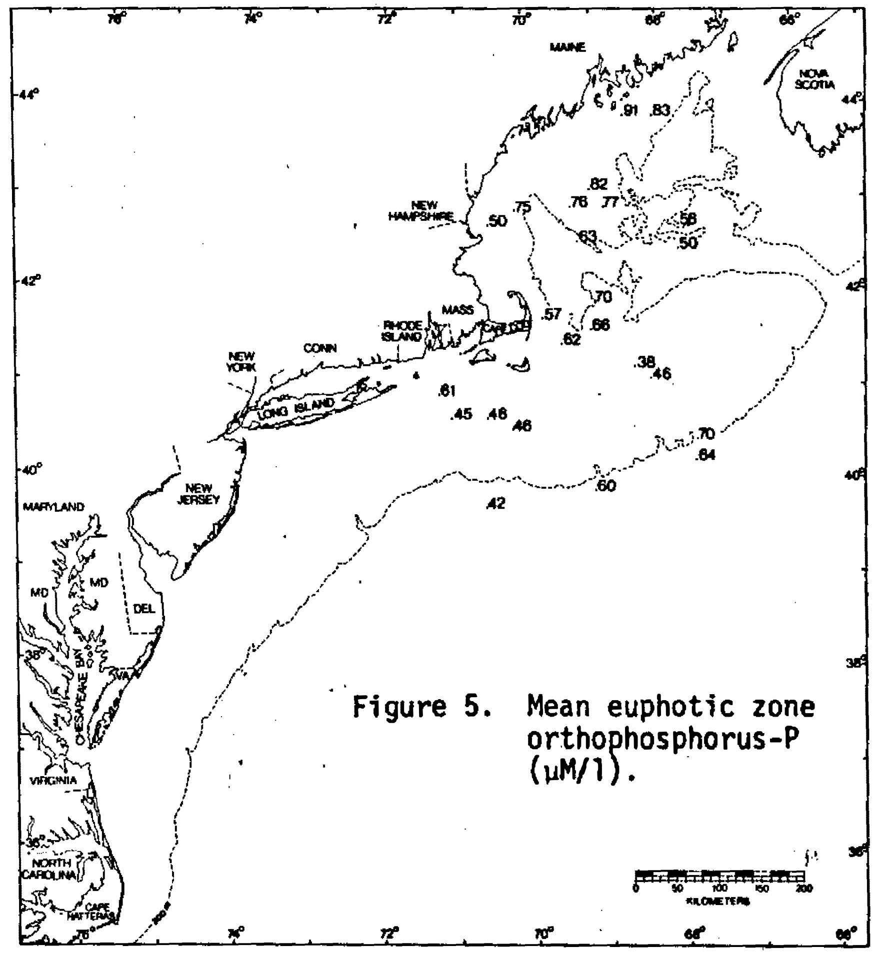

Figure 5. Mean euphotic zone orthophosphorus-P (μM/l).

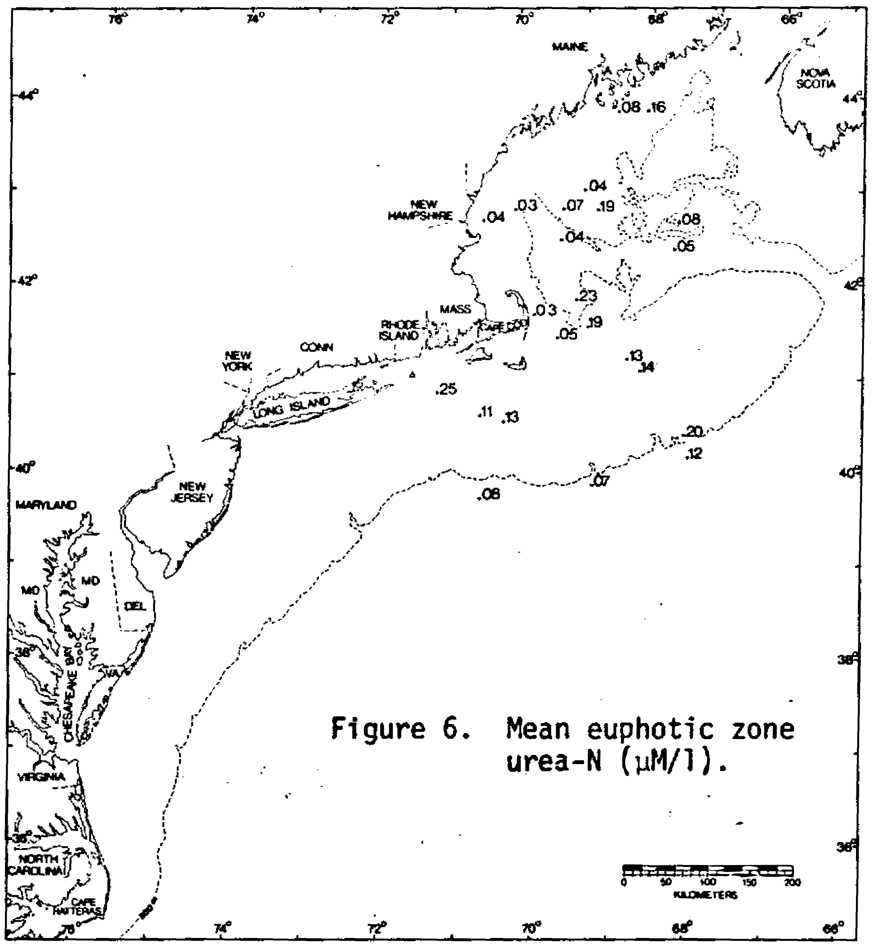

Figure 6. Mean euphotic zone urea-N (μM/l).