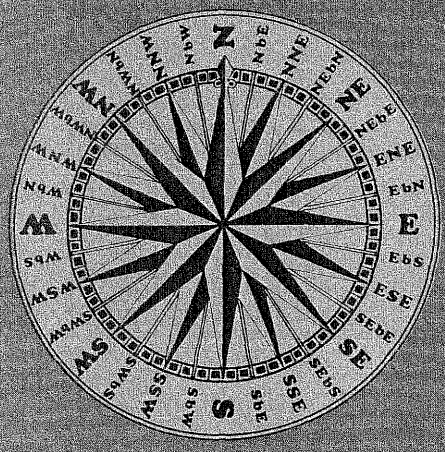

DISSOLVED OXYGEN LEVELS IN NEW YORK BIGHT WATERS DURING 1977

SEPTEMBER 1978

Dissolved Oxygen Levels in New York Bight Waters During 1977

by

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Technical Series Report No. 20

September 1978

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Abstract

Anoxia in bottom waters of the N. Y. Bight, and associated mass mortalities of marine organisms in 1976, caused concern that anoxia may become a chronic problem in the Bight. The Northeast Fisheries Center (NEFC), National Marine Fisheries Service (NMFS), established a series of periodic surveys early in 1977 to further understand the hydrologic "climate" of the Bight and to monitor dissolved oxygen (DO) levels. The Bight did not become anoxic in 1977, although a band of low DO levels was found along the New Jersey coast during the summer.

1.0 INTRODUCTION

An environmental event of major proportions, leading to mass mortalities of marine organisms in an area encompassing approximately 8600 km^2 (Figure 1), occurred on the continental shelf of the New York Bight during the summer and early fall of 1976. Mortalities of marine animals, including 69% of the valuable surf clam (Spisula solidissima) stocks off New Jersey (NJ), were apparently the result of dissolved oxygen depletion (anoxia) and development of toxic hydrogen sulfide.

The anoxia, its impacts and possible causative or contributing factors were studied by several state, federal and private research groups, during 1976, with much of the resulting data being reported and examined during a series of workshops held at Sandy Hook Laboratory (Northeast Fisheries Center, 1977). The causes of the 1976 event appear to be complex, with

several factors, e.g. unusual spring weather and a massive offshore phytoplankton bloom, which, when added to an already stressed environment (Mueller, Anderson and Jeris, 1976; Segar and Berberian, 1976) could contribute to oxygen depletion in the Bight during the summer.

The large area affected by anoxia (8600 km^2) and the impacts on marine organisms and fishery resources, an estimated loss of almost $500 million over the next five years (Figley, personal communications), resulted in concern that this situation could reoccur periodically, possibly annually, under appropriate conditions, and could affect much of the NJ coastal economy. The 1976 event was the fourth reported occurrence of critically depressed DO levels along the NJ coast in the last ten years; other minor developments were reported in 1968, 1971 and 1974 (Northeast Fisheries Center, 1977). In response to this public concern, as well as the interest of scientific groups in understanding causes of the phenomenon and the role of NMFS in protecting fisheries resources and habitats, the NEFC carried out a series of hydrographic surveys to examine the DO levels during 1977, along with other hydrographic parameters, and to assess the status of recovery of the marine community from the 1976 mortalities. This report is a summary of the results of the DO monitoring data resulting from these surveys.

2.0 METHODS

An array of stations was sampled periodically by National Ocean Survey (NOS) or NMFS vessels during February-September, 1977. At each station: 1) water samples were collected (at surface, mid-depth or 10 m and 30 m, and at the bottom) with 1.5 l Niskin water bottles and 2) a bathythermograph (XBT)

was cast. The water samples were analyzed for DO and salinity; the DO concentrations were determined by the azide modification of the Winkler titration method and the salinities determined with a Beckman RS 7-C* induction salinometer. To examine the vertical hydrographic profile of the waters off NJ, a transect of sampling locations east of Barnegat Inlet was selected with stations occupied during four sampling periods: February, June, July and August/September, 1977.

3.0 RESULTS

3.1 February, 1977

As a result of the initial survey for 1977, in February, we determined that the bottom DO in the Bight ranged from 8.2 ml/l (100% saturated) to 4.8 ml/l (76% saturated). Higher values were concentrated inshore, off both the New Jersey and Long Island coasts; the lower values were located offshore near the continental shelf break (Fig. 2a). This pattern had remained basically unchanged since November, 1976 (Steimle, 1977a) although DO values were elevated, as might be expected for this season, to near maxima. The vertical pattern of the Barnegat transect (Fig. 2b) indicated a well mixed water column, with DO concentrations, throughout, near saturation on the inner continental shelf.

3.2 April-June, 1977

The spring surveys, April-June (Fig. 3-5a), showed a gradual reversal of the November 1976-February 1977 winter pattern of bottom DO levels. In early June (Fig. 5a), the lowest concentrations were

* Use of brand names by NOAA does not necessarily constitute endorsement.

generally inshore and the range of values lower: 5.9 ml/l (85% saturation) to 4.1 ml/l (60% saturation). The vertical profile of DO concentration along the Barnegat transect in early June (Fig. 5b) showed an evident seasonal stratification of the water column with a thermocline developing at about 20 m.

3.3 July, 1977

As the summer season progressed, the band of bottom DO minima became more distinct, especially along the central NJ coast (Fig. 6-7a). The DO levels in mid-July generally ranged from 5.0 ml/l (75% saturation) to 2.2 ml/l (30% saturation). The lowest bottom DO concentrations were near the mouths of most estuaries or inlets along the NJ coast, e.g. Hudson-Raritan estuary, Manasquan Inlet, Barnegat Inlet, and Great Egg Inlet below Atlantic City (Fig. 7a). The vertical profile along the Barnegat transect showed that the highest DO values were found at the surface, within 30 km of shore, and at the 10 m sampling depth offshore (Fig. 7b), most likely reflecting subsurface primary productivity activity. The horizontal DO distribution pattern from this survey differed greatly from the pattern observed a year earlier, July 1976, when an anoxic condition had developed 5-40 km off the central NJ coast (Fig. 8).

3.4 August-September, 1977

By late August/early September 1977, DO concentrations along the NJ coast declined further. The band now extended along most of the NJ coast, with the 3.0 ml/l contour located approximately

20 km offshore (Fig. 9a). Bottom water DO concentrations within this band were generally in the range of 20-40% saturation. The vertical profile of the transect off Barnegat (Fig. 9b) again reflected a strong thermal stratification. During the same period in 1976, the anoxic water mass, detected in July, had expanded to include approximately 25% of the coastal waters off NJ, to 70-80 km from shore (Fig. 10); also, about 70% of the bottom water along the NJ coast, within 75 km, contained less than 2.0 ml/l DO (≈30% saturation).

3.5 September-October, 1977

Although little DO data are available from NMFS surveys beyond September 1977, inshore sampling by the New Jersey Department of Environmental Protection (NJDEP) (Figley et al., 1977) found the inshore minimum DO band to persist for only a few more weeks, until early October; DO values then generally improved to greater than 50% saturation. Their data also showed that by early November, 1977, the seasonal water column mixing was occurring and DO levels, throughout, were near 90% saturated.

4.0 DISCUSSION AND CONCLUSIONS

Because of the limited data on DO concentration patterns of the Bight prior to the 1976 anoxia event, data from 1977 surveys are especially useful in making comparisons with what can be regarded as more normal conditions. To make these comparisons, bottom DO values, collected within a square bounded

by 39° to 40°N longitude and 73° to 74°W latitude, were averaged by month or major survey period for data collected in 1976 and 1977. These averages were plotted and compared to Armstrong's (1977) historical annual DO level trends (Fig. 11). Although the data sets being compared contain information from somewhat different sampling locations, non-randomness of samples within the square, and variation in numbers of samples used in obtaining averages for each sampling period, the deviation of the annual trend of DO concentrations in 1976, compared to 1977 and historical levels, is obvious.

Extensive mortalities of marine organisms, which were prominent in 1976, were not found in 1977. There were, however, two apparent anomalies: low abundance of bottom fish and the development of extensive populations of a few species of polychaete worms. Commercial fishermen and recreational divers reported that the abundance of bottom fish was below that of 1976. This could have been partially caused by residual effects of the 1976 anoxia and reduction of available benthic forage species, or by normal year-to-year fluctuations in abundance and distribution. The worm population explosion was probably related to the 1976 anoxia problem when opportunistic species took advantage of unfilled niches resulting from mortalities in benthic invertebrates which occurred in 1976 (see Steimle, 1977b; Radosh, Frame and Wilhelm, 1977). On the positive side, lobsters appeared to return to full abundance in 1977 along the NJ coast. The data collected in 1977, in addition to further illustrating the abnormality of the 1976 anoxic episode, also raised more questions about the NY Bight ecosystem; for example, why did the bank of depressed DO levels only develop along NJ and not Long Island? To investigate this question, and

others, NOAA is planning for long-term monitoring in this area. The area has been established as one of the 20 areas which will be monitored periodically by the Ocean Pulse environmental monitoring program being developed by NEFC, NMFS.

ACKNOWLEDGMENTS

Many NMFS personnel assisted in collecting the data upon which this report is based; these include: Anthony Pacheco, David Radosh, James Thomas, Myron Silverman, Cindy Dey, Henry Slater, Robert Mako, Nancy Rawson and Mary Grojean. Elin Haugen and William Emory, of the Southern Maine Vocational Institute, also participated in some of the surveys.

Michelle Cox prepared the figures and graphs and Joann Evans and Diane Gibson typed the manuscript and tables.

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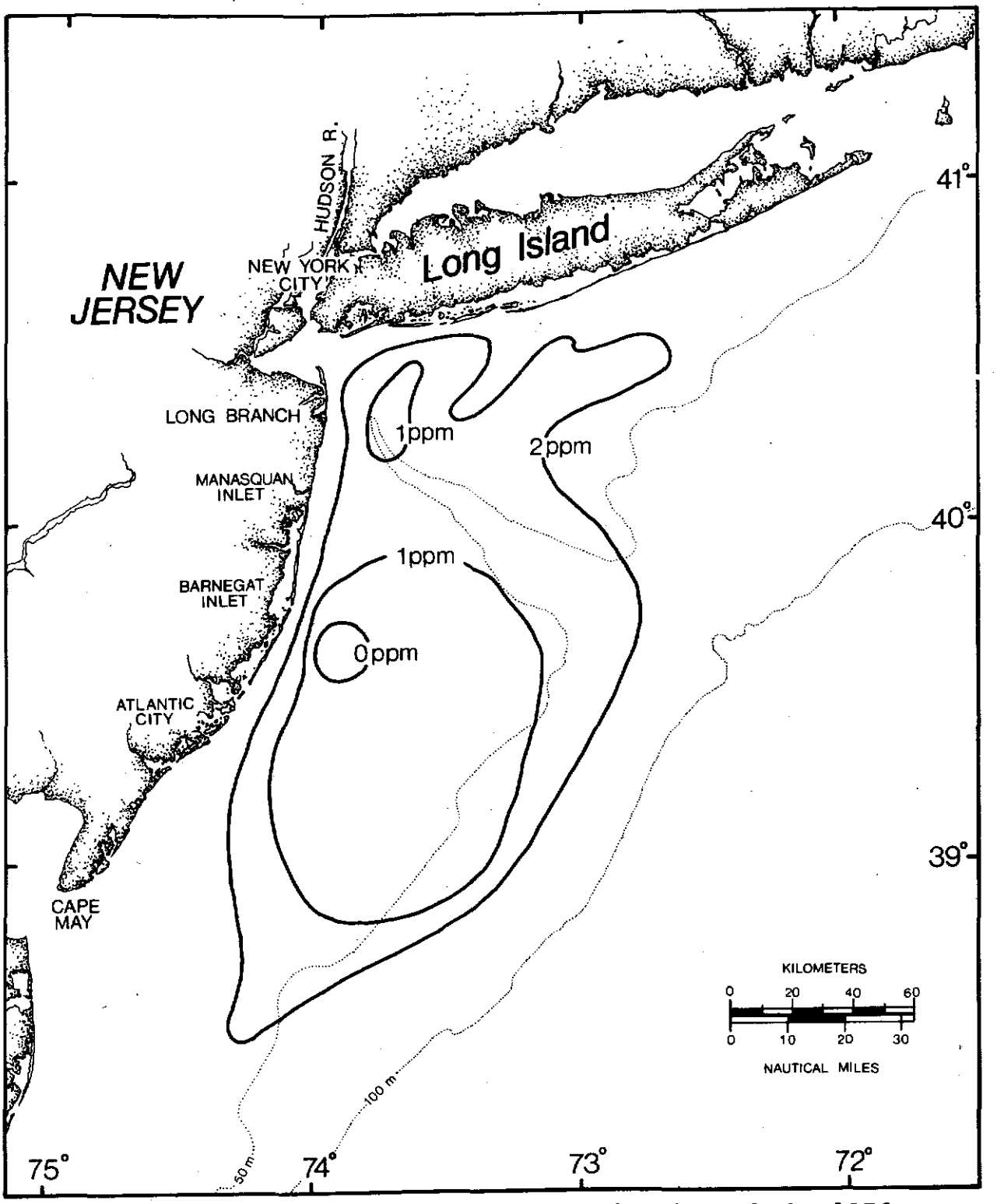

Figure 1. The maximum areal distribution of the 1976 anoxia impact, occurring during September.

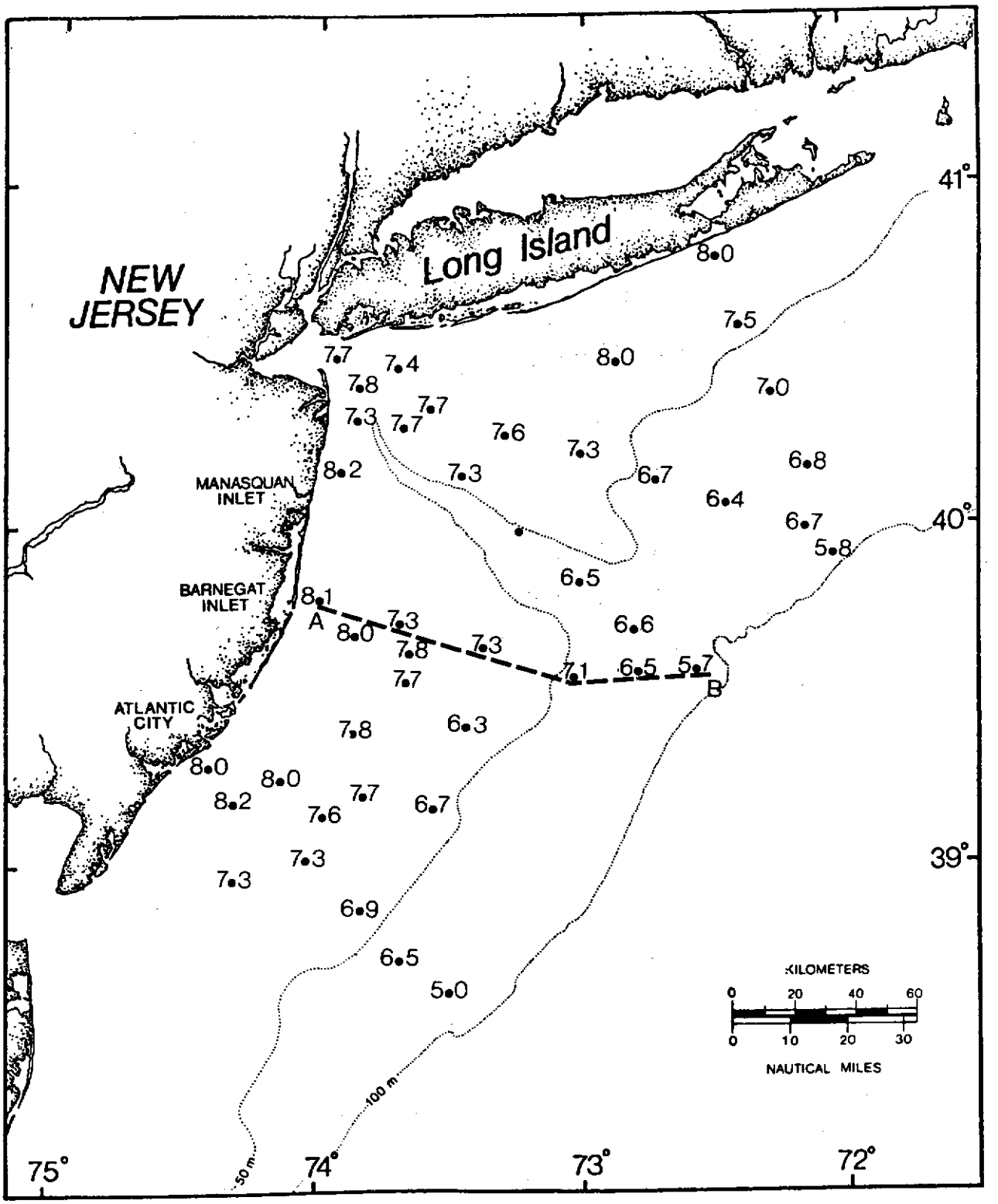

Figure 2 a. Bottom D.O. (ml/l) distribution for February 4-18, 1977; vertical profile transect is indicated, A-B.

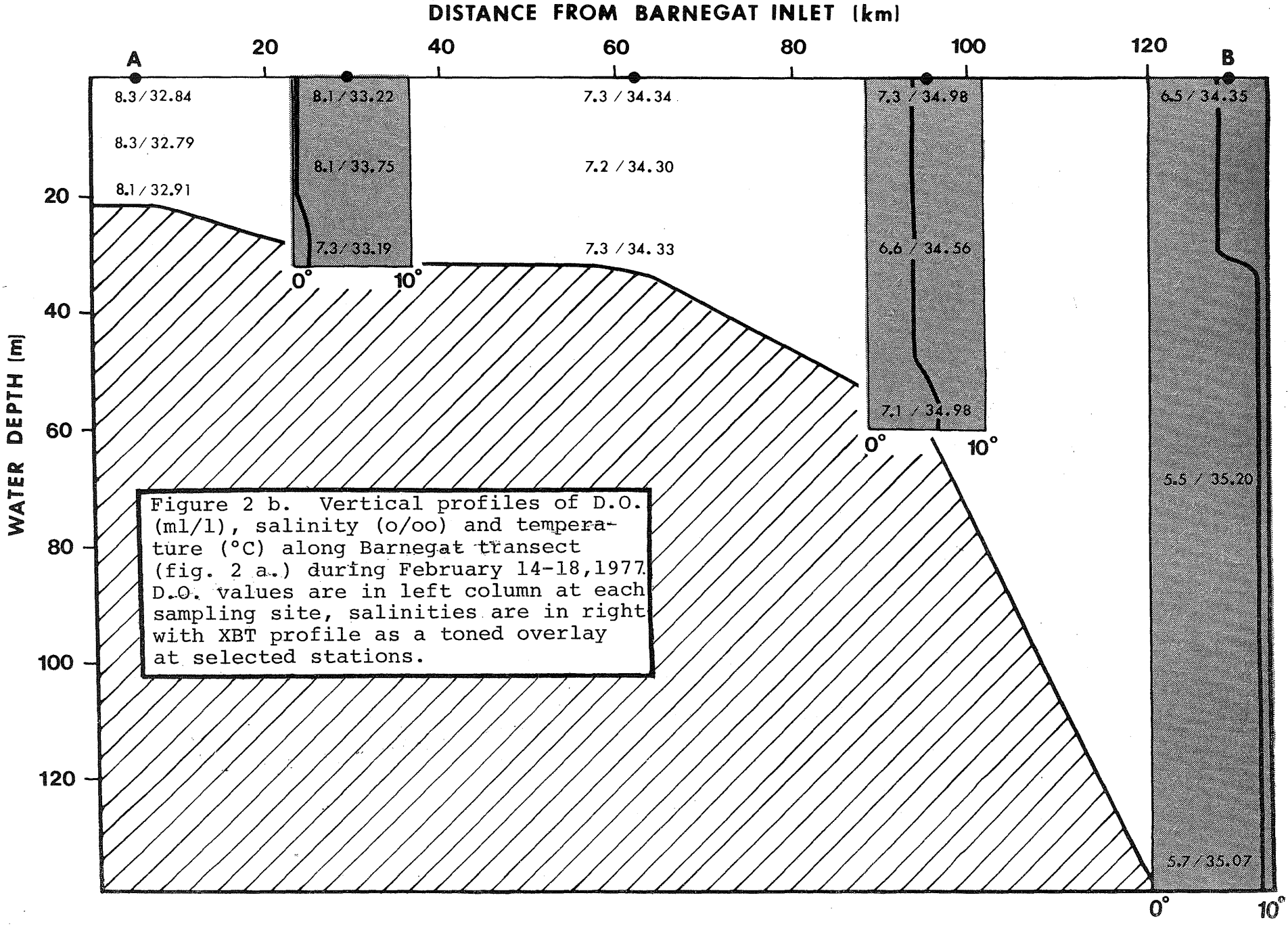

Figure 2 b. Vertical profiles of D.O. (ml/l), salinity (o/oo) and temperature (°C) along Barnegat transect (fig. 2 a.) during February 14-18,1977. D.O. values are in left column at each sampling site, salinities are in right with XBT profile as a toned overlay at selected stations.

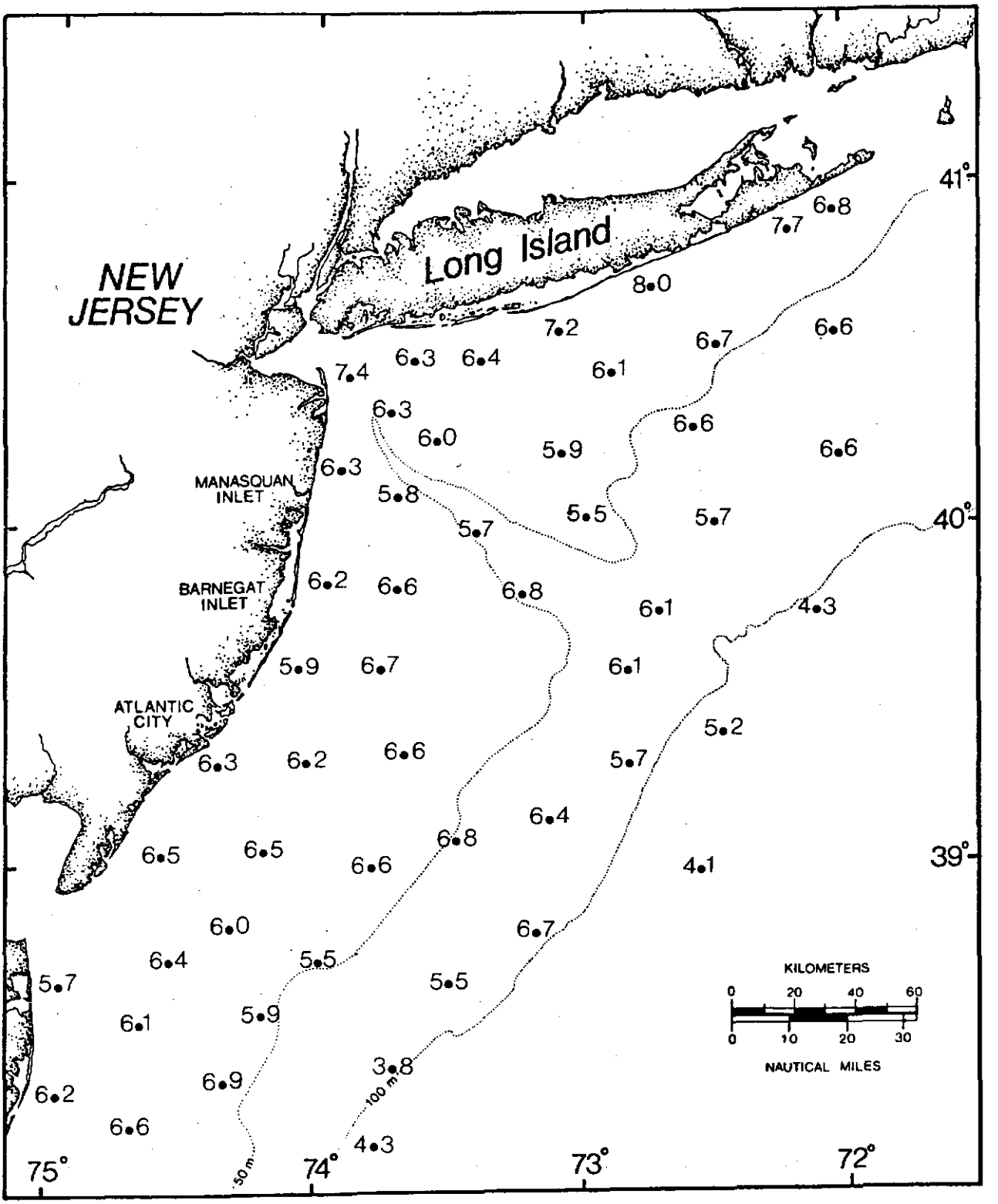

Figure 3. Bottom D.O. (ml/l) distribution for April 12-23, 1977.

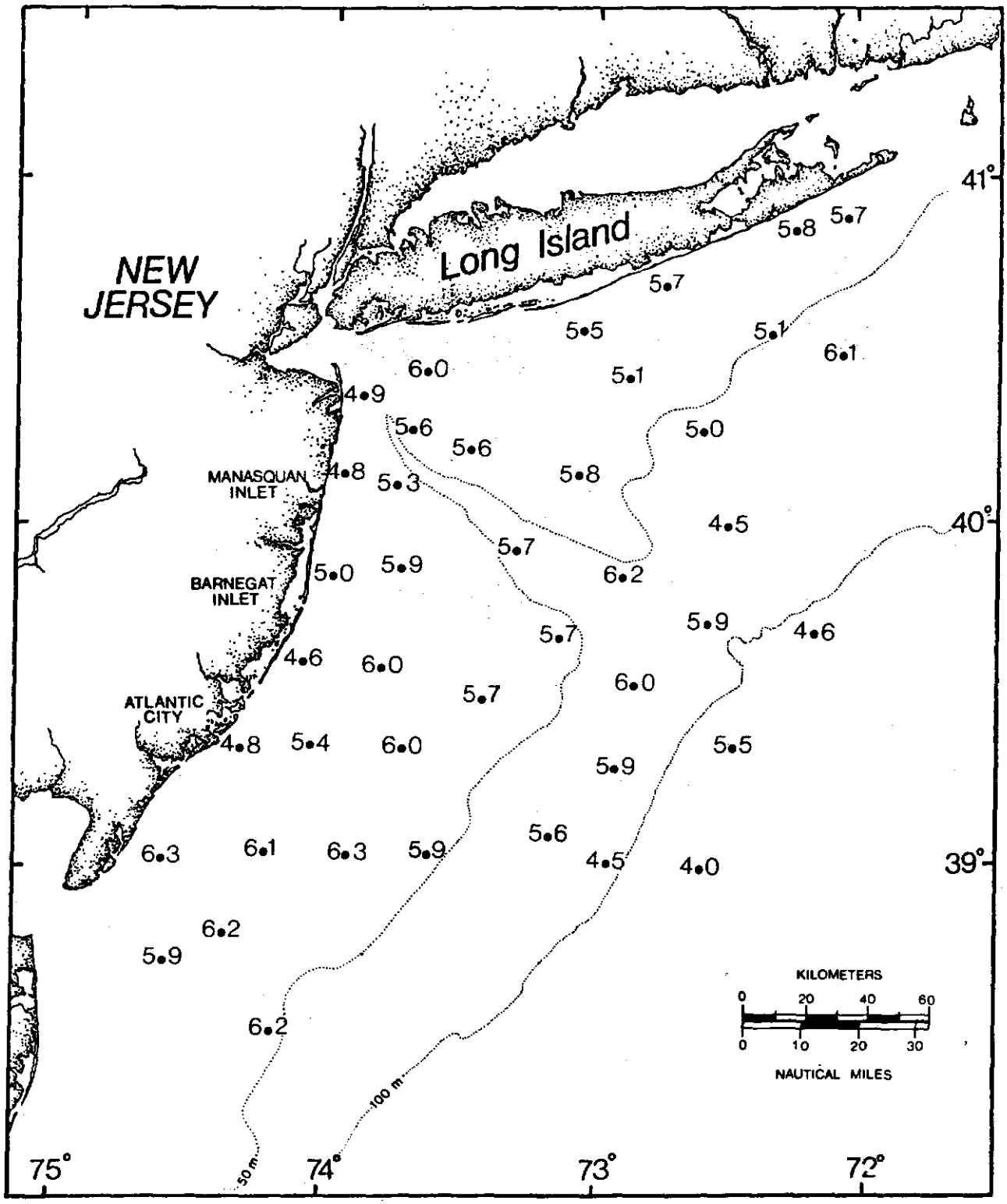

Figure 4. Bottom D.O. (ml/l) distribution for May 19-20, 1977.

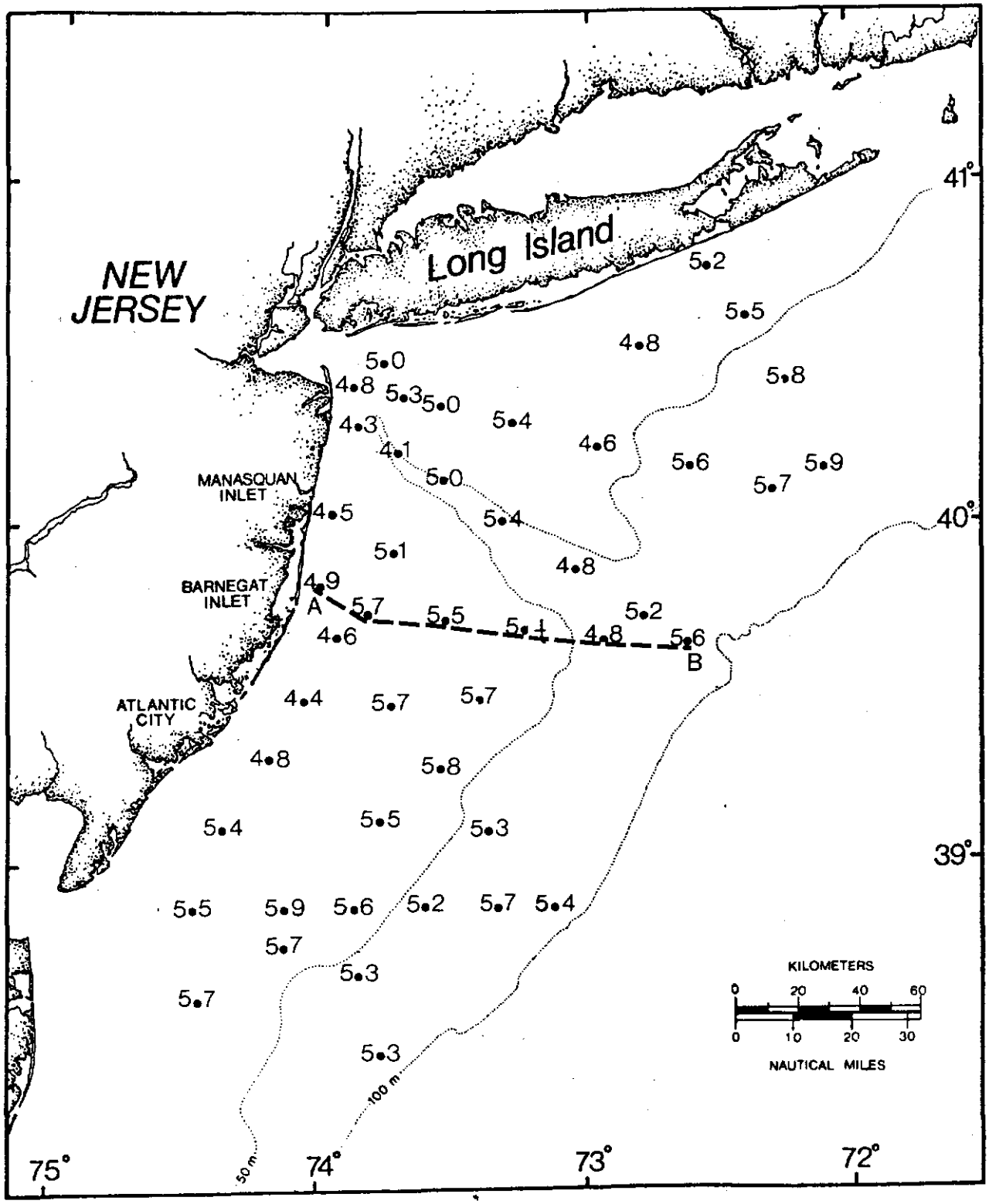

Figure 5 a. Bottom D.O. (ml/l) distribution for June 1-5, 1977; vertical profile transect is indicated, A-B.

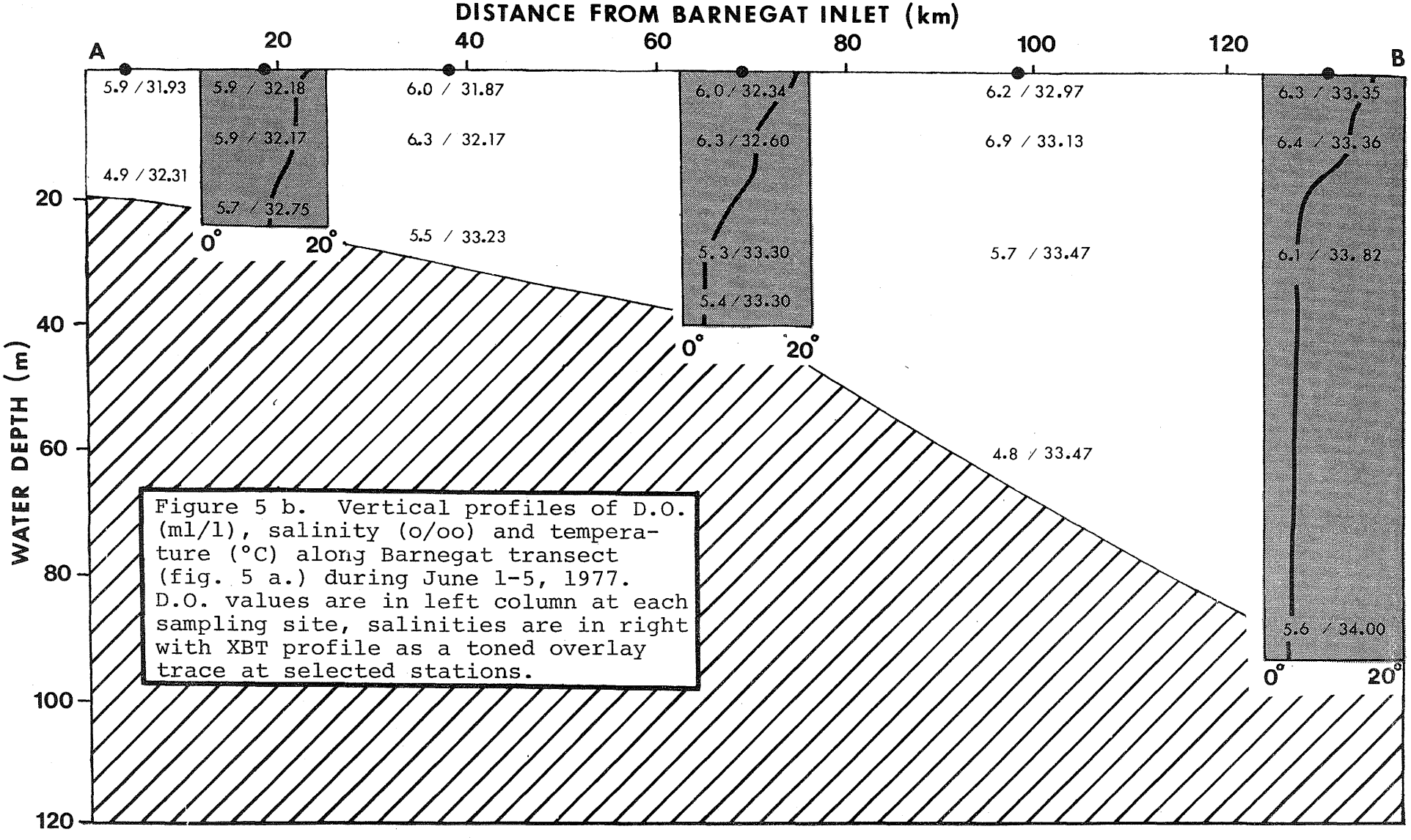

Figure 5 b. Vertical profiles of D.O. (ml/l), salinity (o/oo) and temperature (°C) along Barnegat transect (fig. 5 a.) during June 1-5, 1977. D.O. values are in left column at each sampling site, salinities are in right with XBT profile as a toned overlay trace at selected stations.

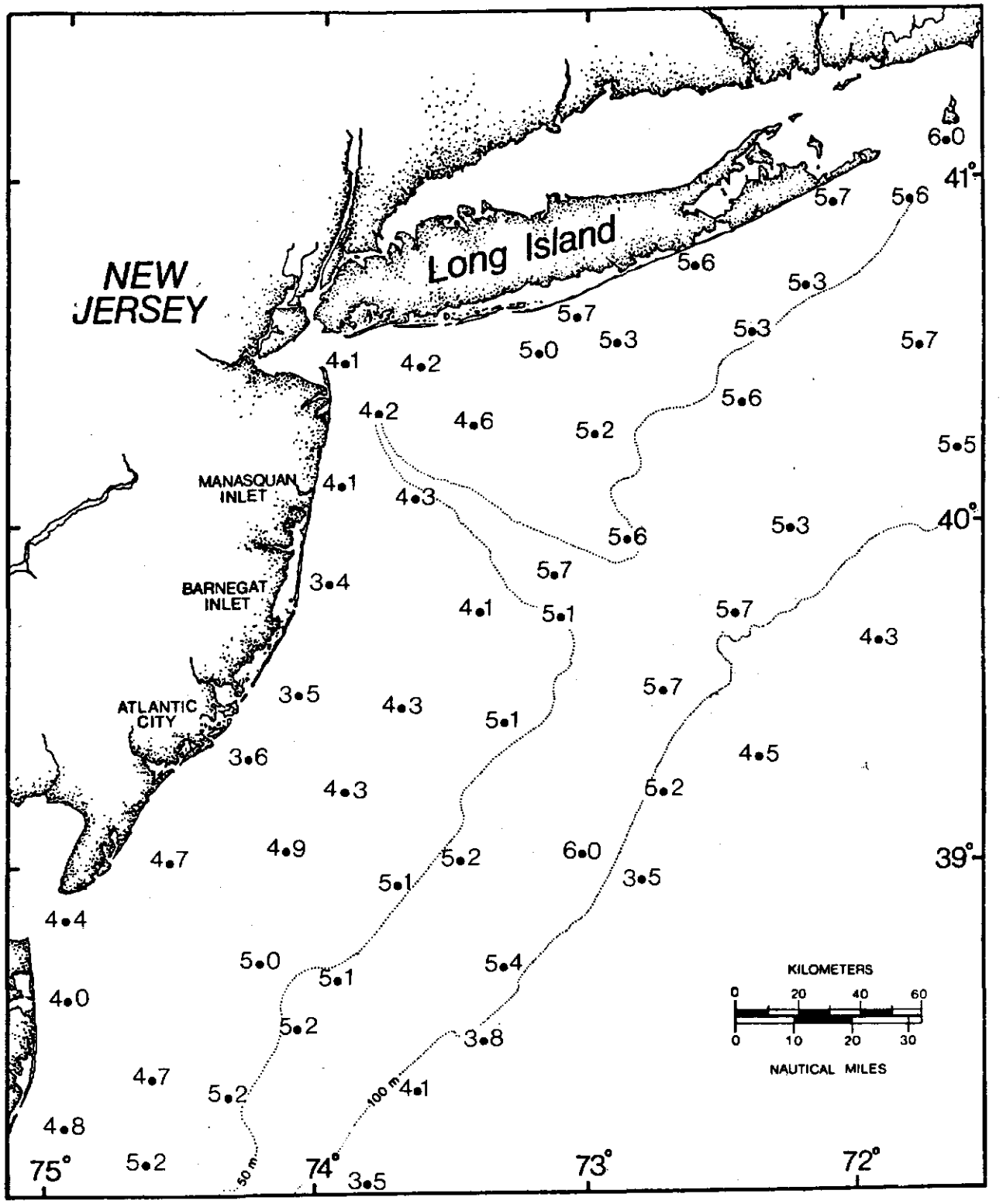

Figure 6. Bottom D.O. (ml/l) distribution for June 20-30, 1977.

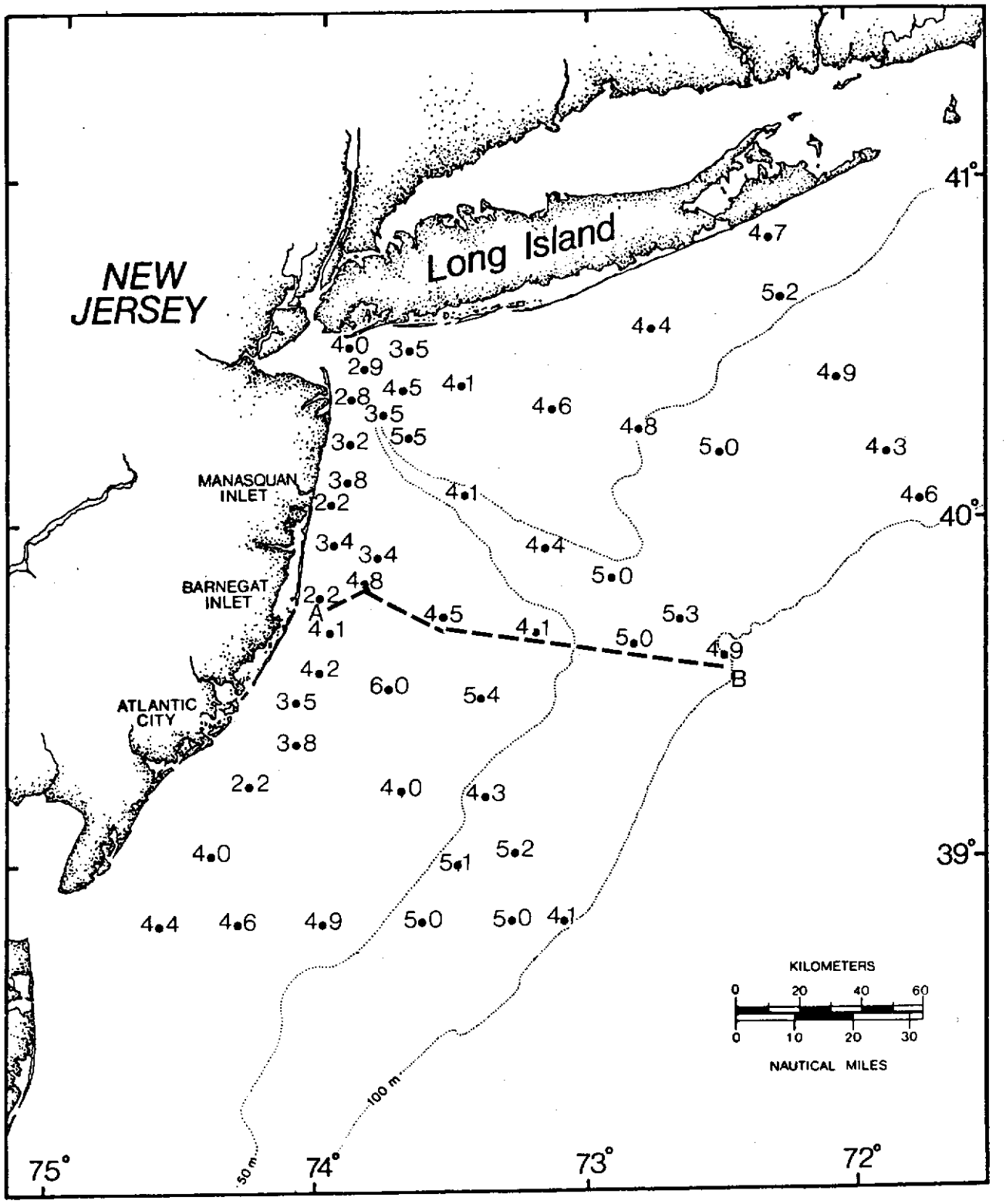

Figure 7 a. Bottom D.O. (ml/l) distribution for July 18-22, 1977; vertical profile transect is indicated, A-B.

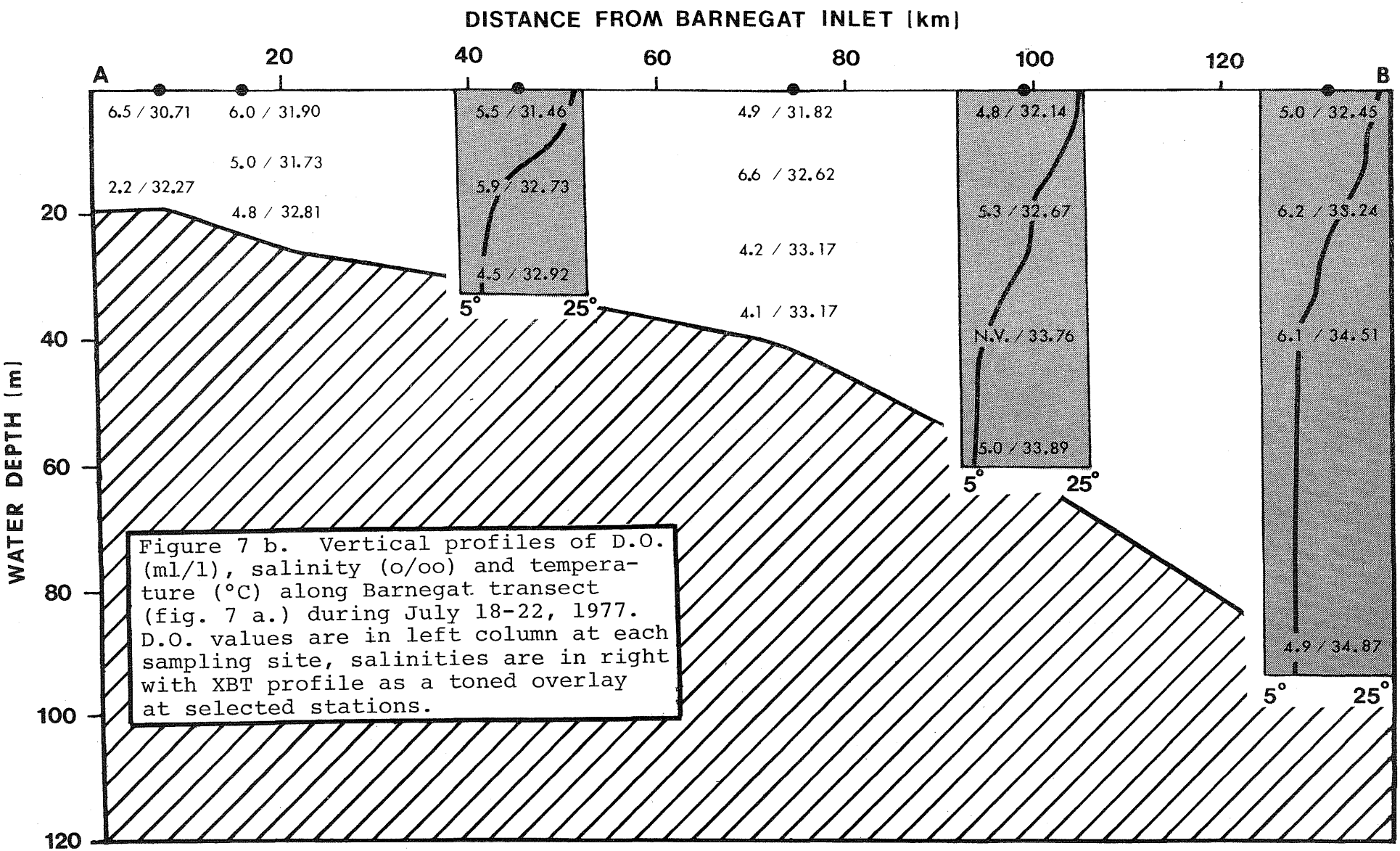

Figure 7 b. Vertical profiles of D.O. (ml/l), salinity (o/oo) and temperature (°C) along Barnegat transect (fig. 7 a.) during July 18-22, 1977. D.O. values are in left column at each sampling site, salinities are in right with XBT profile as a toned overlay at selected stations.

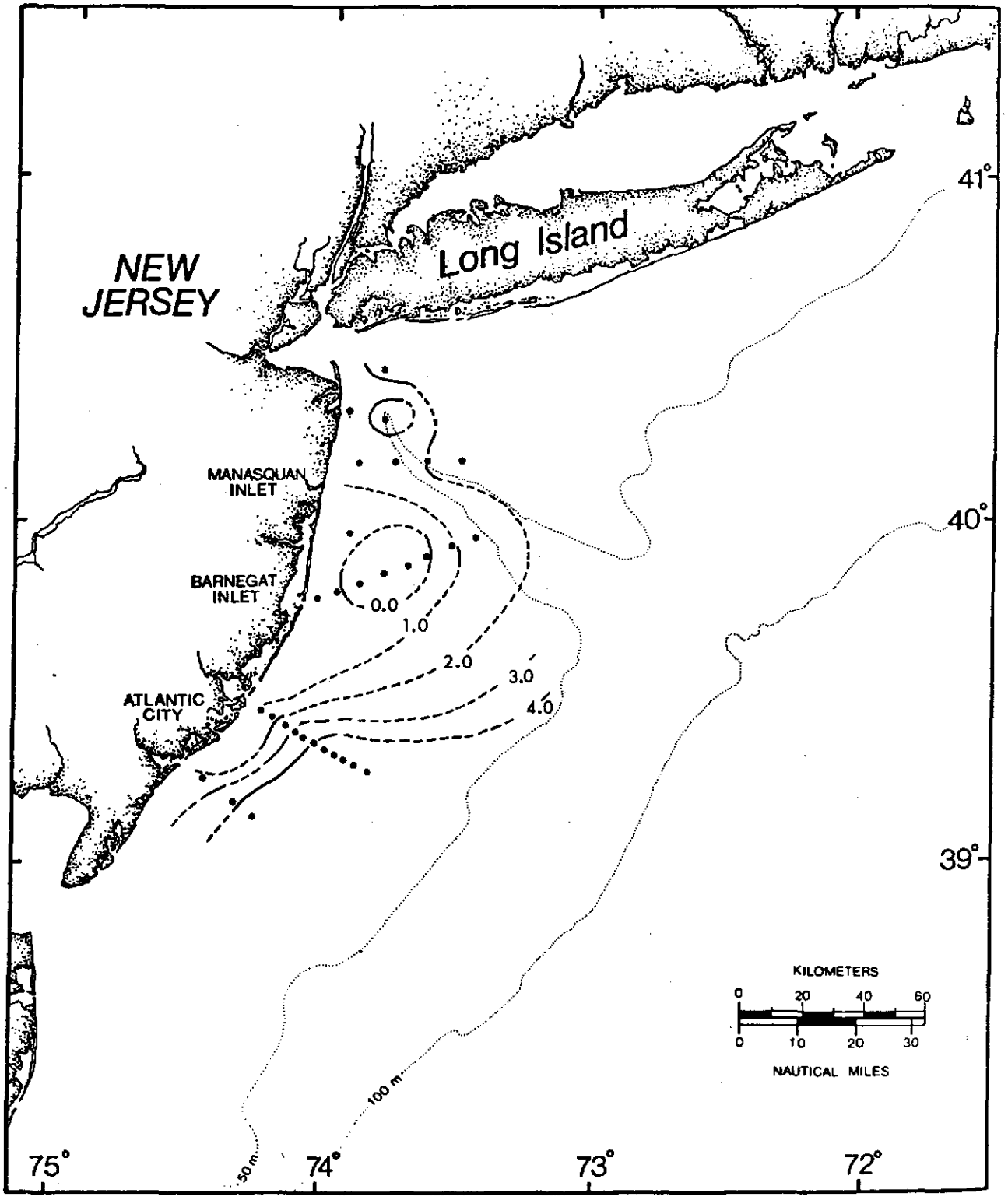

Figure 8. Bottom D.O. (ml/l) distribution for mid-July, 1976.

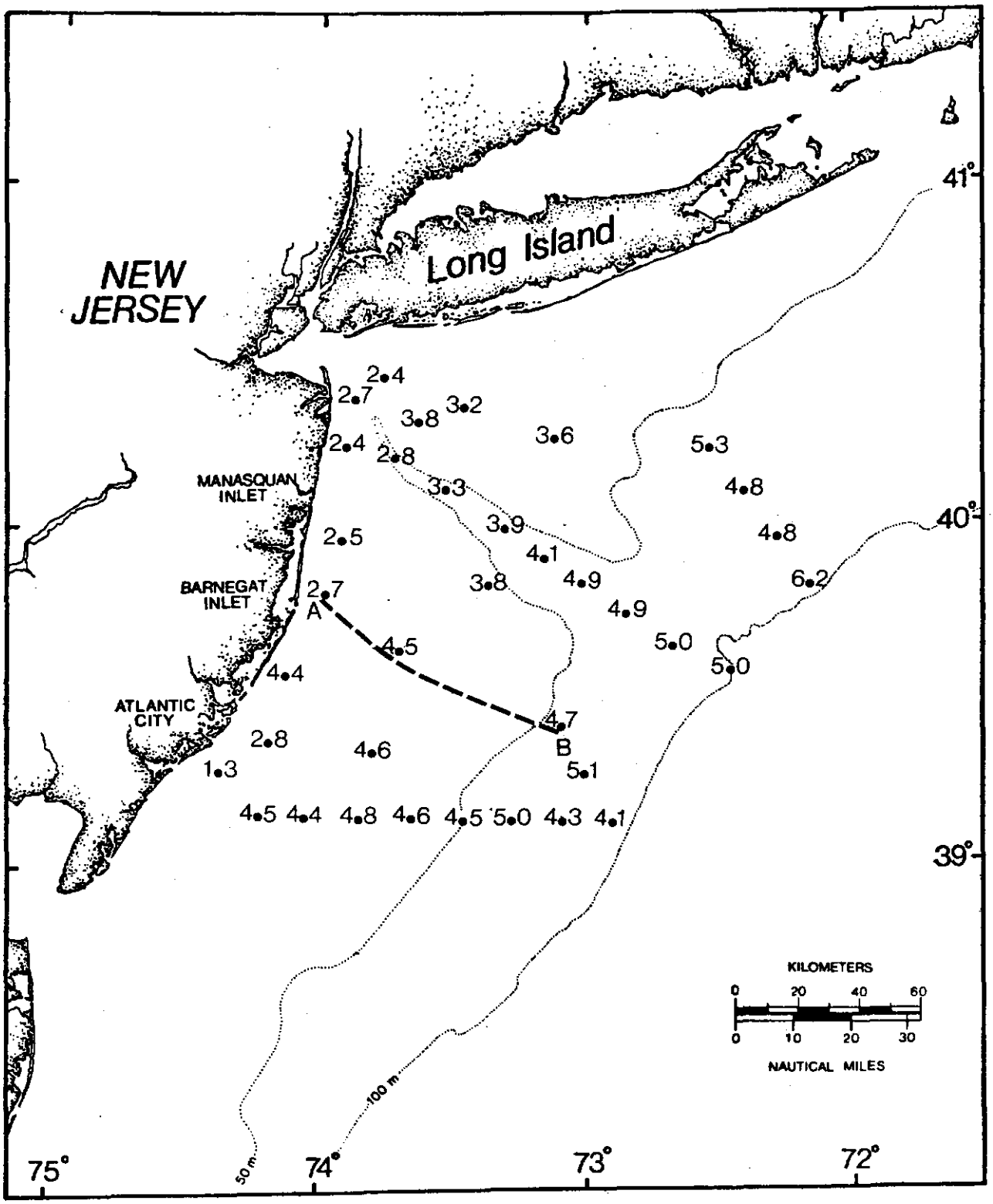

Figure 9 a. Bottom D.O. (ml/l) distribution for August 29-September 3, 1977; vertical profile transect is indicated, A-B.

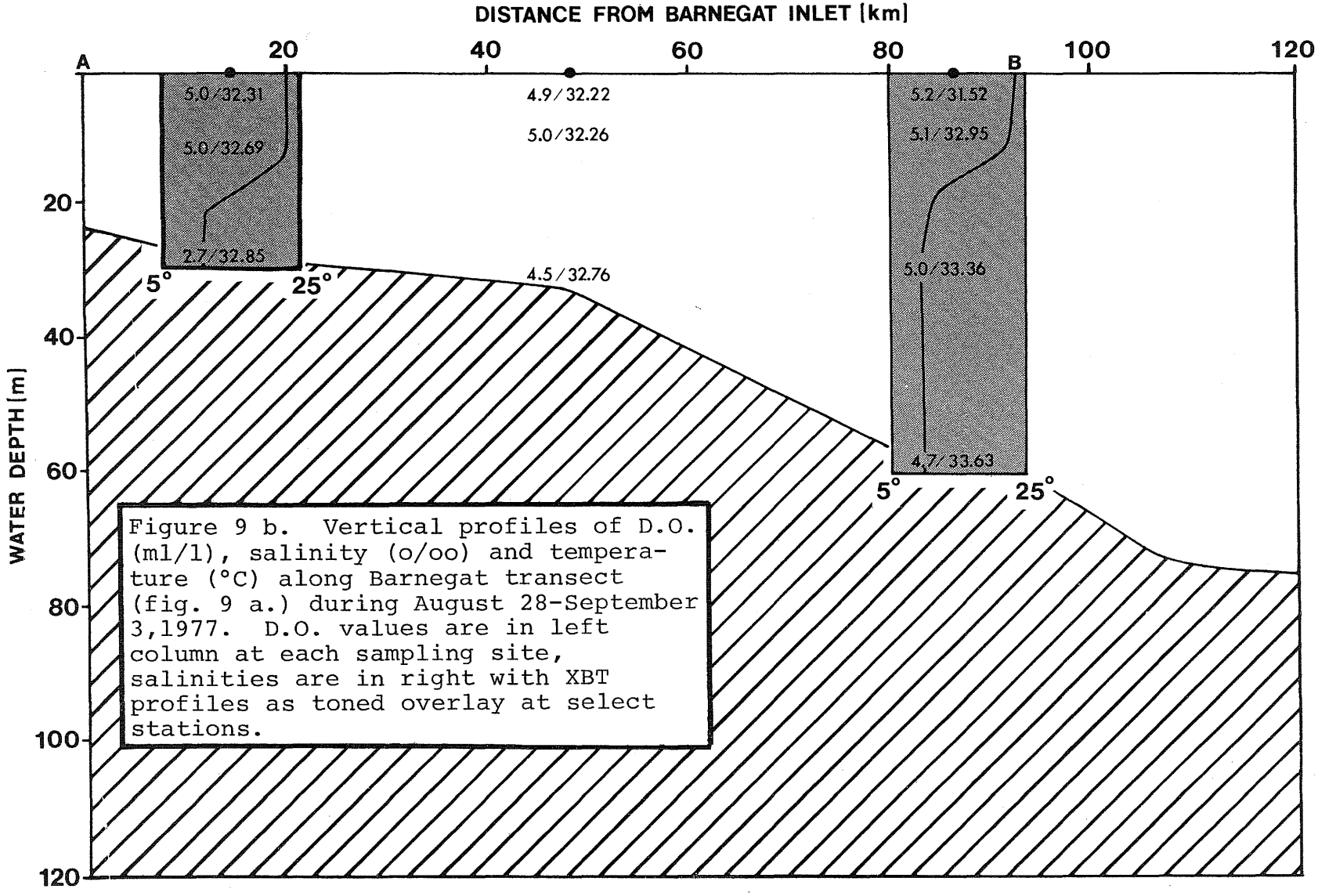

Figure 9 b. Vertical profiles of D.O. (ml/l), salinity (o/oo) and temperature (°C) along Barnegat transect (fig. 9 a.) during August 28-September 3,1977. D.O. values are in left column at each sampling site, salinities are in right with XBT profiles as toned overlay at select stations.

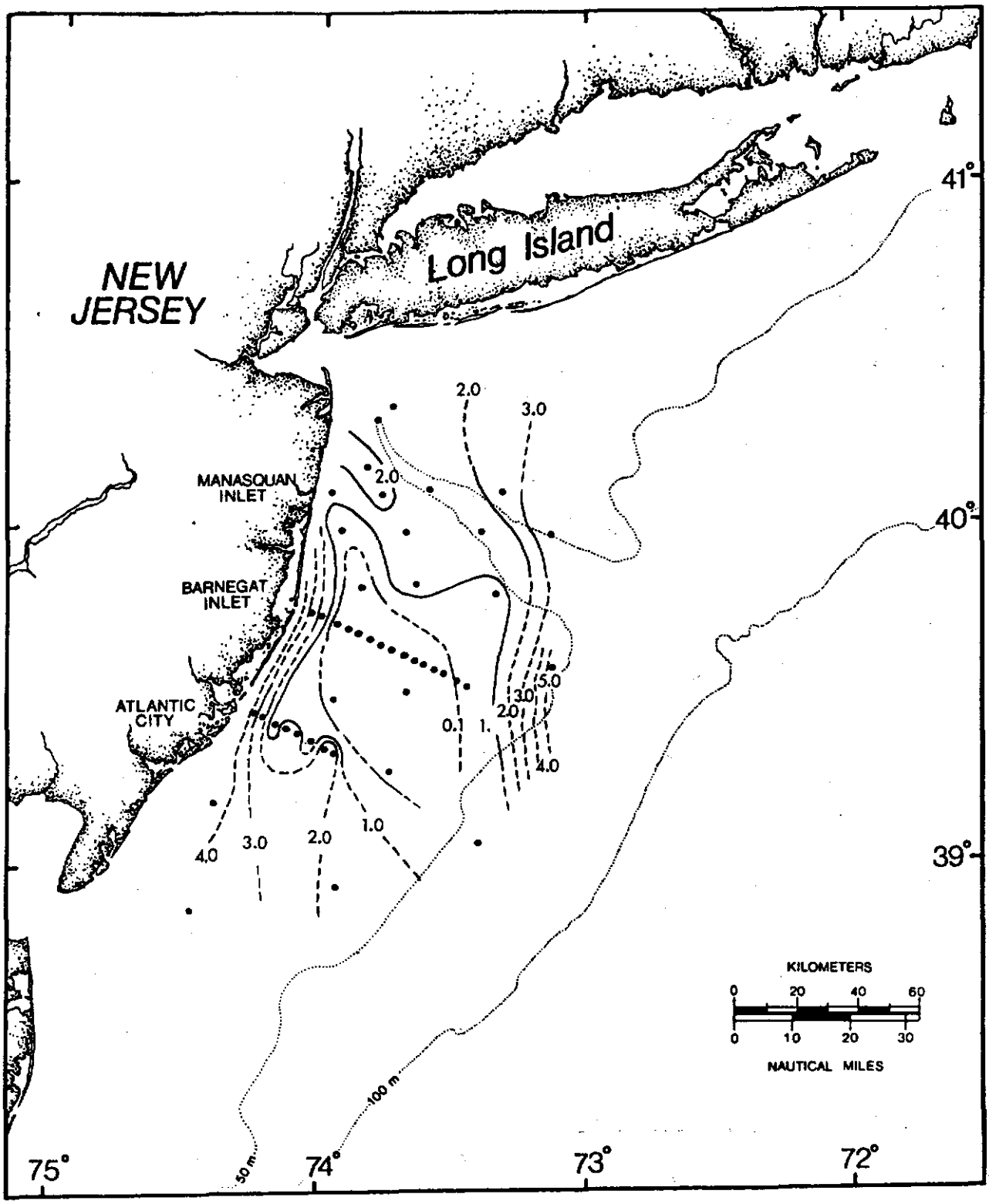

Figure 10. Bottom D.O. (ml/l) distribution for early September, 1976.

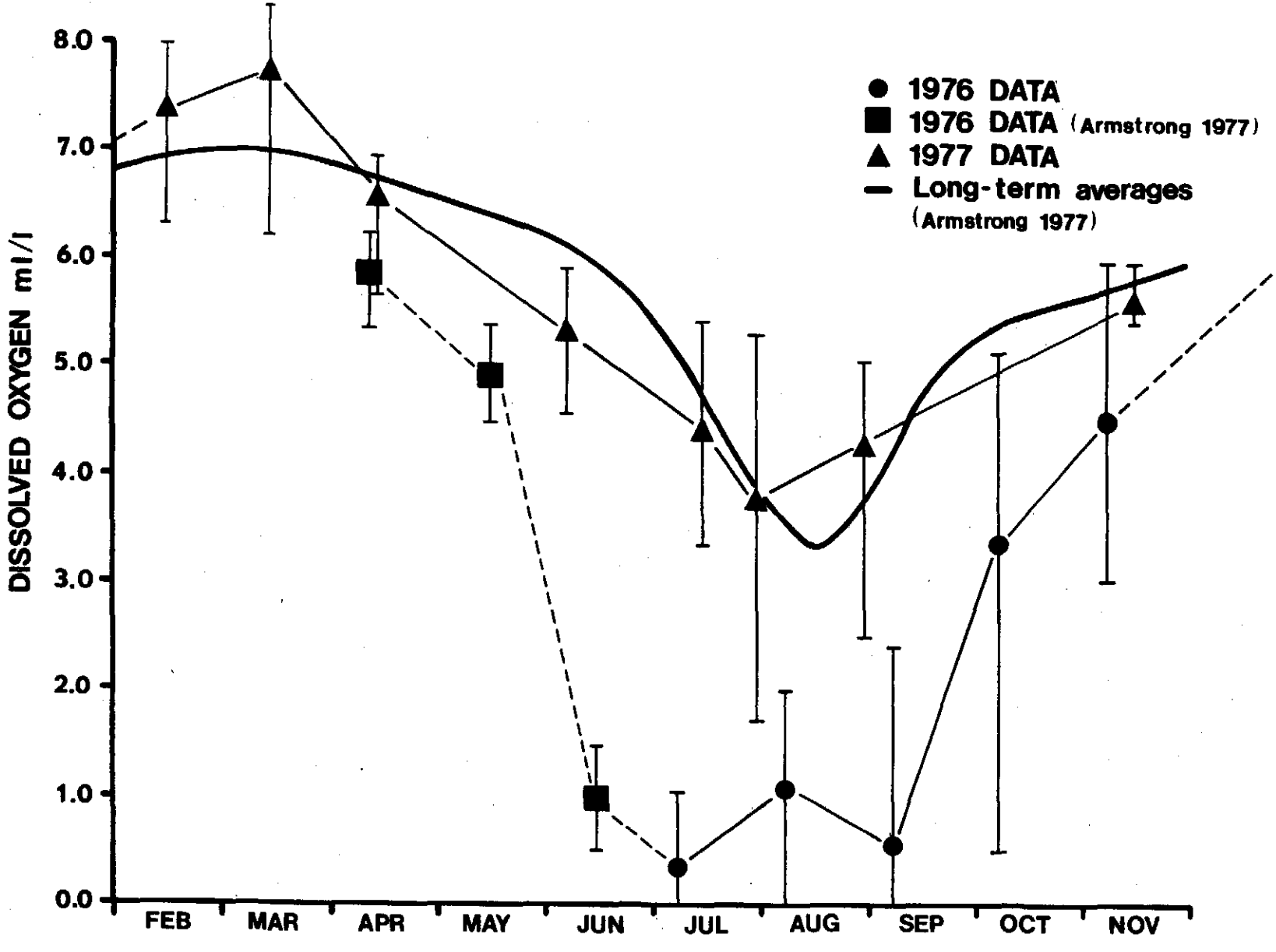

Figure 11. A Comparison of bottom D.O. averages within 39-40°N, 73-74°W square for various sampling periods during 1976, 1977 and historical trends.

TABLE 1: Hydrographic data collected February 14-18, 1977, in the New York Bight (NMFS Cruise KE-77-01)

Long N	Lat W	Depth m	Surface Sal o/oo	Surface Temp °C	Surface D.O. ml/l	Middle Sal o/oo	Middle Temp °C	Middle D.O. ml/l	Bottom Sal o/oo	Bottom Temp °C	Bottom D.O. ml/l
40°27.6	73°47.1	28	32.83	0.5	8.3	33.68	0.5	7.9	33.86	1.8	7.4
40°30	72°40.8	38	33.65	0.8	8.0	33.72	1.0	8.0	33.69	1.2	8.0
40°48	72°27.5	27	33.08	-0.3	8.3	33.27	-0.2	8.2	33.31	-0.2	8.0
40°35.5	72°18	48	33.73	1.6	7.8	33.79	1.6	7.8	33.89	2.5	7.5
40°22.8	72°07.3	62	33.31	1.3	8.1	34.58	5.5	6.7	34.40	5.8	7.0
40°08	71°56.5	78	34.29	4.8	6.8	34.28	5.3	6.9	34.35	5.8	6.8
39°56.7	71°58.1	94	34.34	4.6	6.9		8.2	6.8	34.23	8.2	6.7
40°01	72°16.2	79	34.47	5.3	6.5	34.56	5.4	6.4	34.76	6.4	6.3
40°05.9	72°35.4	57	33.93		7.8	34.00		7.6	34.74	5.0	6.7
40°10.6	72°54.1	50	34.20	2.2	7.6	34.34	2.2	7.5	34.39	5.0	7.3
40°15.6	73°10.6	41	34.08	3.1	8.0	34.03	5.5	7.8	34.18	4.2	7.6
40°21.9	73°31.3	27	33.55	1.3	8.3	33.55	1.3	8.3	33.55	1.9	7.7
40°25.7	73°50.1	27	32.28	1.1	8.2	33.33	1.1	8.1	33.87	0.8	7.4
40°20.5	73°33.5	30	33.49	0.3	8.4	33.49	0.5	8.4	33.71	1.5	7.7
40°08	73°25	43	33.60	1.0	8.3	33.64	1.8	8.3	34.20	1.5	7.2
39°58.5	73°10.4	63	34.37	0.8	7.6	34.40	9.7	7.6	34.43	5.7	7.4
39°48	72°55.5	72	34.35	3.0	7.3	34.42	3.2	7.1	34.98	3.4	6.5
39°38.5	72°41.1	73	34.76	3.5	6.3	35.02	3.9	6.5	34.98	6.2	6.6
39°31.8	72°24.2	183	34.35	7.2	6.5	35.20	6.7	5.5	35.07	6.2	5.6
39°32.8	72°38.4	76	34.52	6.7	6.5	34.52	9.7	6.5	35.03	8.7	6.5
39°31.7	72°59.3	61	34.98	6.6	7.2	34.56	6.7	6.6	34.98	7.0	7.1
39°35.3	73°18	37	34.34	4.3	7.3	34.30	4.3	7.2	34.33	5.4	7.3
39°39.6	73°38.4	36	33.22	3.6	8.0	33.75	4.3	8.1	33.20	4.4	7.3
39°44.1	74°01	21	32.84	0.0	8.3	32.79	0.0	8.3	32.91	1.3	8.1
39°37.6	73°50.1	30	33.27	-0.9	8.0	32.26	-0.9	8.1	32.30	-0.9	7.9
39°27.5	73°34.5	34	33.50	-0.1	8.0	33.47	0.2	8.0	33.69	1.8	7.7
39°17.8	73°19.6	50	34.36	0.8	7.3	34.36	1.0	7.5	34.93	1.3	6.3
39°05.4	73°30.9	55	34.32	3.4	7.6	34.75	4.2	7.1	35.05	6.4	6.7
39°01.2	73°50	37	34.00	3.7	7.7	34.01	4.8	7.7	34.23	6.6	7.7
39°09.6	74°09	32	33.60	2.5	7.8	33.61	2.8	7.9	33.62	3.2	7.9
39°12.6	74°30.9	17	32.79	1.7	8.4	32.84	4.0	8.4	33.40	2.4	7.9
39°05.6	74°20.7	26	33.22	0.9	8.2	33.25	2.0	8.2	33.36	3.4	8.2
38°50.9	74°05	42	34.34		7.6	34.34		7.6	34.48		7.5
38°45.2	73°51.5	43	34.26	3.0	7.6	34.52	3.7	7.0	34.55	8.0	6.9
38°34.5	73°36.5	63	35.37		5.9	35.36		6.0	35.06		6.5
38°30	73°30	220	36.13	14.9	5.2	35.64	11.6	4.9	35.38	10.0	5.0
38°54.3	74°17.5	39	33.65	1.0	7.8	33.76	1.3	7.8	34.18	2.2	7.4
39°03.6	74°02.6	34	34.06		7.8	34.06		7.8	34.21		7.7
39°18	73°49	37	33.66		7.9	33.70		7.9	33.91		7.7
39°33.2	73°34.5	37	33.75		8.0	33.76		7.9	33.89		7.7
39°48.5	73°33.2	35	34.07	2.5	7.6	34.17	2.7	7.7	34.08	2.7	7.8
40°09.3	74°25.4	17	32.99	0.2	8.3	33.07	0.3	8.0	33.15	0.4	8.3
40°17.7	73°47.7	59	33.48	0.8	8.1	33.73	1.3	8.1	34.02	2.2	7.4
		11	33.25	1.0	7.6				33.28	1.1	7.7

TABLE 2: Hydrographic data collected June 1-5, 1977 in New York Bight (NMFS Cruise DE-77-06)

Long N	Lat W	Depth M	Sal o/oo	Surface Temp °C	D.O. ml/l	Sal o/oo	10 M Temp °C	D.O. ml/l	Sal o/oo	30 M Temp °C	D.O. ml/l	Sal o/oo	Bottom Temp °C	D.O. ml/l
40°27.3	73°46	21	31.06	16.7	5.6	31.65	13.3	6.1						
40°30	72°41	40	32.41	16.6	5.9	32.41	15.0	5.9	33.12	10.5	5.8	32.74	5.9	5.0
40°47.3	72°27.5	26	31.28	16.6	6.6	31.88	17.6	6.5				33.10	9.3	4.8
40°35	72°18	47	31.99	16.6	6.1	32.27	11.0	6.1	33.27	6.9	5.7	32.46	9.3	5.3
40°21.8	72°07.8	64	32.61	13.9	6.4	32.55	13.8	6.6	33.46	7.0	6.1	33.29	6.6	5.5
40°08.1	71°56.8	79	33.19	13.5	6.7	33.30	12.3	6.8	33.69	7.8	6.2	33.43		5.8
39°59.5	71°50.5	91	33.50	13.6	6.5	33.62	13.0	6.8	33.87	7.7	6.4	33.73	6.0	5.9
40°03.7	72°09.3	75	33.20	13.0	6.6	33.20	13.0	6.8	33.50	7.3	6.7	34.34	8.0	5.3
40°03.7	72°29	58	32.92	13.8	6.3	32.90	13.6	6.3	33.37	6.5	6.4	33.86	6.8	5.7
40°11.6	72°07.5	52	32.36	14.1	4.8	32.40	14.0	6.0	33.34	6.5	5.6	33.57	4.9	5.6
40°19.7	73°26.7	40	31.35	14.7	6.0	32.23	13.5	6.1	33.14	6.7	5.3	33.33	5.1	4.6
40°10.3	73°41.6	29	31.30		6.0	31.42		6.2				33.19	6.4	5.4
40°03	73°56	64	31.86	14.3	6.0	31.86	14.3	6.1	32.87	5.3	5.1	32.70		5.0
40°04.4	73°28.7	73	31.78	15.2	6.0	31.78	15.1	5.9	33.10	6.3		33.11	4.5	4.2
39°56.6	73.11.7	75	31.90	15.2	6.0	32.70	13.9	6.0	33.32	5.0	5.4	33.17	4.2	5.1
39°38	72°48.8	68	32.71	14.4	6.0	32.94	13.2	6.3	33.41	6.6	5.9	33.31	3.5	5.4
39°41	72°38	71	33.07	14.5	6.3	33.29	13.0	6.3	33.66	6.7	6.2	32.45	4.5	4.8
39°36.7	72°28.2	93	33.35	14.2	6.3	33.36	13.5	6.4	33.82	6.9	6.1	33.63	5.0	5.3
39°40	73°08.9	67	32.97	14.3	6.2	33.13	13.0	6.9	33.47	6.1	5.6	34.00	5.4	5.6
39°42	73°27	40	32.34	13.8	6.0	32.60	12.7	6.3	33.30	4.5	5.3	33.47	4.7	4.8
39°41.7	73°28.4	33	31.87	15.6	6.0	32.17	14.7	6.3				33.30	4.0	5.4
39°26.1	73°20.7	37	32.51	14.0	6.1	32.84	14.0	6.3	33.36	6.3	5.7	33.23	5.3	5.5
39°26	73°44	29	32.26	14.8	6.1	32.46	14.5	6.3				33.38	6.3	5.7
39°14.2	73°32	42	32.49	14.3	6.0	32.56	14.0	6.1	33.39	6.2	5.4	32.90	7.5	5.7
39°02.6	73°39	33	32.57	15.2	6.0	33.04	13.0	6.2	33.40	6.2	5.6	33.42	5.6	5.5
39°02.3	73°19	62	32.83	14.5	5.9	32.89	12.5	6.3	33.43	7.5	6.2	33.40	6.2	5.8
38°48.4	73°14.1	87	35.75	21.0	5.0	35.75	21.1	4.9	35.38	20.0	5.5	33.44	4.0	5.3
38°48.2	73°33.4	77	34.31	7.5	5.5	34.89	18.5	5.7	33.96	13.0	6.2	34.73	10.2	5.0
38°47.6	73°33.4	55	32.47	14.5	5.8	32.92	13.0	6.3	33.60	6.5	5.5	33.74	5.2	5.8
38°47.5	73°52.7	49	32.75	14.8	5.9	32.95	14.5	6.0	33.60	6.3	5.7	33.60	4.9	5.2
38°47.2	74°12.4	46	32.63	14.0	5.9	33.13	12.0	6.3	33.64	6.5	6.0	33.62	5.6	5.1
38°47.2	74°33	26	32.14	14.5	6.0	32.95	12.0					33.65	6.5	6.0
38°38	74°13	44	32.95	15.0	5.9	33.14	13.0	6.2	33.72	8.2	6.0		8.3	5.5
38°29.2	73°52.9	62	33.05	15.5	5.7	33.81	13.0	6.6	33.81	6.0	5.5	33.71	6.5	5.8
38°10.4	73°55.7	82	35.60	19.6	5.2	35.58	19.7	5.1	35.75	16.8	4.8	33.68	4.9	5.4
38°28.3	74°32.4	33	32.48	15.8	5.9	32.83	15.5	6.2	33.42	6.4	5.8	34.56	9.4	5.3
39°00.1	74°22.9	29	32.50	15.7	5.8	32.72	14.7	6.1				33.41	6.4	5.7
39°09	74°11	21	32.28	15.4	6.0	32.46	15.0	6.0				33.17	7.4	5.4
39°25.6	74°02.6	26	32.20	15.8	5.9	32.76	15.0	5.3				32.67	9.6	4.8
39°38.3	73°56.6	24	32.01	15.3	5.8	32.11	15.2	6.0				32.79	7.3	4.4
39°44.8	74°03.6	12	31.93	13.2	5.9							32.99	7.3	4.7
39°44	73°49	20	32.18	15.1	5.9	32.17	15.1	5.9				32.31	11.7	4.9
39°54.4	73°39.6	31	32.13	15.1	5.9	32.11	15.0	6.0				32.75	10.0	5.7
40°03	73°58.7	20	31.80	15.9	6.1	31.86	14.5	6.1				33.00	5.7	5.1
40°17	73°47	60	30.78	16.0	7.0	31.56	15.0	6.3	32.76	5.5	5.3	32.59	7.2	4.6
40°25	73°50	24	31.47	15.7	6.0	31.47	15.6	6.0				33.00	4.5	4.3
40°28	73°56	31	31.28		6.2	32.79		6.0				32.55	6.4	5.3
												32.65		4.8

TABLE 3: Hydrographic data collected July 18-22, 1977 in New York Bight (NMFS Cruise DE-77-08 II)

Long N	Lat W	Depth M	Sal o/oo	Surface Temp °C	D.O. ml/l	Sal o/oo	10 M Temp °C	D.O. ml/l	Sal o/oo	30 M Temp °C	D.O. ml/l	Sal o/oo	Bottom Temp °C	D.O. ml/l
40°27.7	73°47.8	47	30.68	25.3	5.7		12.5	4.1				32.40	11.9	3.5
40°30	72°41	40	31.85		5.0	32.14		6.4	32.70		4.8	32.76		4.4
40°47.4	72°27.5	26	31.21		5.9	31.72	15.4	5.0				32.22	11.8	4.7
40°35	72°18	48	31.16	22.5	5.5	32.07	14.0	7.3	32.45	9.2		32.67	8.7	5.2
40°21.8	72°02.8	60	31.98	23.0	7.1	32.88	18.5	7.7	33.36	10.5	5.4	33.28	9.0	4.9
40°08	71°57	75	32.16	20.0	5.2	33.70	19.0	6.0	34.11	13.5	5.6	34.66	8.7	4.3
39°59	71°50.5	91	33.07	23.1	5.0	34.00	16.0	6.2	33.56	9.0	5.7	34.82	9.0	4.6
40°03.5	72°09.5	75	32.13	23.5	4.9	32.98	13.0	5.7	33.51	9.6		33.81	8.6	4.5
40°07.4	72°28.7	59	31.85		5.0	32.50		6.3	33.62		5.6	33.63		5.0
40°11.5	72°48.3	50	31.75	23.5	5.3	32.45	13.0	6.0	33.19	9.0	5.9	33.21	9.0	4.9
40°15.6	73°07.5	41	31.60	24.3	4.2	32.28	20.0	6.0				31.98	9.0	4.5
40°19.7	73°26.7	30	32.34	24.7	5.2	31.71	18.3	5.3				32.64	10.5	4.1
40°10.3	73°41.5	62	31.48	24.6	5.0	32.59	19.0	6.3	32.83	10.0	5.5	33.10	8.3	4.2
40°04.4	73°28.4	84	31.82	24.4	5.1	32.86	23.0		33.11	9.2	4.6	33.22	8.0	4.1
39°56.5	73°12	79	31.79	23.8	5.3	32.62	22.0	6.2	33.00	9.2	6.0	33.26	7.9	4.4
39°48.5	72°54.5	70	31.89	24.2	5.2	32.45	21.0	6.3	33.23	9.2	6.1	33.52	8.1	5.0
39°41	72°38	71	32.06	24.5	5.0	32.98	20.5	6.0	33.68	10.0	6.3	33.99	8.9	5.3
39°38.2	72°28.7	91	32.49	24.5	5.0	33.24	21.0	6.2	34.51	14.6	6.1	34.87	10.6	4.9
39°38.2	72°48.5	64	32.14	24.7	4.8	32.67	20.6	5.3	33.76	10.2		33.89	8.5	5.0
38°40	73°09	42	31.82	25.0	4.9	32.62	16.0	6.7	33.17	9.7	4.2	33.17	8.2	4.1
39°41.8	73°28.4	31	31.46	24.3	5.5	32.73	18.0	5.9				32.92	9.6	4.5
39°26	73°20.5	35	31.94	24.8	5.2	32.70	17.0	6.4				33.25	8.5	5.4
39°31.2	73°43	27	31.99	25.0	5.4	32.68	14.0	5.3				32.89	10.3	6.0
39°15	73°58.7	35	32.08	25.1	5.0	32.78	16.0	6.3				32.87	8.3	4.0
39°14.2	73°31.8	44	32.00	25.5	5.0	32.31	18.0	5.9	33.12	8.2	4.5	33.14	8.2	4.3
39°02.7	73°40.8	42	32.33	25.4	4.9	32.98	20.7	7.1	33.29	9.0	4.8	33.31	8.4	5.1
39°02.3	73°19.0	66	32.24	25.8	4.6	33.09	19.5	7.7	33.38	8.5	5.0	33.43	7.3	5.2
38°48.5	73°04.4	102	32.63	26.0	4.7	35.83	23.2	5.2	35.32	16.2	5.2	35.59	12.3	4.1
38°48	73°14	82	32.40		4.8	35.04		5.5	34.56		5.7	34.46		5.0
38°48	73°33.3	55	32.51	25.7	5.0	32.95	20.0	6.5	33.54	9.6	5.5	33.44		5.0
38°47.5	73°52.5	48	32.15		4.8	33.03		6.9	33.57		4.9	33.45		4.9
38°47.3	74°12.2	43	32.05		4.9	32.26		5.3	33.19		4.4	33.17		5.6
38°47	74°32.8	27	31.79	25.4	5.0	32.63	22.5	5.9	32.33			32.82	10.3	4.4
39°00	74°22.9	27	31.88		5.5	32.84		6.7				32.86		4.0
39°12.8	74°12.8	18	32.03	25.1	5.3	32.38	20.0	5.2				32.57	10.0	2.2
39°20	74°02	24	32.14		5.8	32.72		3.8				32.72		3.8
39°25.5	74°02.6	24	32.06	24.8	5.6	32.61	12.0	3.5				32.66	10.0	3.5
39°31	73°53.3	27	31.86		5.8	32.72		6.2				32.83		4.2
39°37.7	73°58.6	28	32.11		5.9	32.80		4.6				32.79		4.1
39°44.9	74°03.5	15	30.71	26.0	6.5		13.2					32.37	13.2	2.2
39°46	73°45.2	24	31.90		6.0	32.73		5.0				32.81		4.8
39°55.4	73°41.6	31	31.60	25.1	6.0	32.70	12.3	3.9				32.80	10.6	3.4
39°55.1	73°53.3	29	31.62	25.5	6.1	32.72	16.0	4.3				32.74	10.7	3.4
40°02	73°59	20	30.97		6.0	32.57		2.2				32.60		2.2
40°05.5	73°52	24	31.24		5.3	32.66		3.9				32.68		3.8
40°11	73°52.2	18	31.02		5.5	32.39		4.1				32.63		3.2
40°17	73°47.2	60	30.45	25.3	5.7	32.15	18.0	5.2	32.65	11.4	3.3	33.09	8.5	3.5
40°18.8	73°40	26	31.21		5.3	32.11		5.9				32.58		4.5
40°24.7	73°50	29	30.76		5.3	32.45		4.0				32.57		2.9
40°18.3	73°55	20												2.8
40°28.7	73°54.8	16												4.0

TABLE 4: Hydrographic data collected August 29-September 2,1977 in the New York Bight (NMFS Cruise DE-77-06II)

Long N	Lat W	Depth M	Sal o/oo	Surface Temp °C	D.O. ml/l	Sal o/oo	10 M Temp °C	D.O. ml/l	Sal o/oo	30 M Temp °C	D.O. ml/l	Sal o/oo	Bottom Temp °C	D.O. ml/l
40°25	73°48	33	31.62	22.0	5.0	31.49	21.7	4.2	32.67	10.4	2.9	32.73	10.1	2.8
40°21	73°26	31	31.68	22.3	5.1	31.63	22.1	5.2				32.32	18.1	3.2
40°19	73°10	25	31.71	21.3	5.5	31.49	20.8	5.5				32.63	10.8	3.6
40°18	72°28	53	33.63	21.6	5.4	33.76	20.0	5.3	34.15	10.9	5.2	34.52	9.8	5.3
40°08	72°21	71	33.42	21.7	5.1	33.76	19.7	5.8	34.54	10.2	6.1	34.87	9.1	4.8
40°00	72°15	80	34.02	23.0	4.9	34.56	22.7	4.9	35.09	13.8	6.3	35.15	9.1	4.8
39°50	72°08	91	34.35	24.0	4.9	34.47	22.0	5.2	34.89	13.6	6.6	35.30	9.5	6.2
39°36	72°29	91	33.85	24.0	5.2	34.68	23.3	5.4	35.12	14.3	6.6	35.30	8.8	5.0
39°41	72°40	69	32.98	24.0	5.3	33.44	22.2	5.2	34.92	14.2	6.7	35.12	9.6	5.0
39°47	72°51	68	33.14	24.5	5.1	33.31	22.1	5.1	34.17	10.1	5.0	34.69	9.7	4.9
39°52	73°03	75	31.51	21.9	5.6	32.02	21.5	5.7	33.54	10.4	5.4	33.69	9.0	4.9
39°57	73°14	67	31.52	23.0	5.4	31.71	20.0	5.5	32.96	9.3	6.2	33.28	9.4	4.1
40°02	73°25	73	31.49	22.7	5.2	31.47	22.3	5.2	32.89	10.3	5.4	33.27	8.8	3.9
40°19	73°38	25	31.70	22.6	5.0	31.71	22.2	5.0				32.26	13.3	3.8
40°07	73°30	72	31.52	22.4	5.2	31.42	22.2	5.2	32.55	9.8	4.2	33.24	8.7	3.3
39°55	73°31	38	31.37	23.5	5.5	31.38	22.0	5.1				32.61	10.0	3.8
39°21	73°08	60	31.52	24.3	5.2	32.85	22.3	5.1	33.35	9.9	5.0	33.63	9.2	4.7
39°11	73°02	71	31.60	24.2	5.1	31.91	22.7	5.2	34.15	14.0	5.5	35.31	9.3	5.1
39°00	72°55	90	32.46	24.9	4.9	35.45	25.8	4.6	35.81	23.5	5.2	34.10	11.3	4.1
39°00	73°07	91	32.24	24.0	5.1	33.80	23.3	5.0	34.36	12.6	6.3	35.05	11.4	4.3
39°00	73°19	67	31.51	24.2	5.0	32.09	23.1	5.1	33.12	10.0	5.7	33.81	9.4	5.0
39°00	73°32	51	32.14	24.2	4.9	32.47	23.8	5.0	32.85	9.3	5.1	33.26	9.3	4.5
39°00	73°44	41	32.35	24.7	4.8	32.37	24.3	4.9	33.02	9.4	4.9	33.04	9.3	4.6
39°10	73°45	36	31.91	23.8	5.0	31.87	23.2	5.0				33.00	10.0	4.6
39°21	73°45	36	32.22	24.5	4.9	32.26	23.7	5.0				32.76	10.0	4.5
40°15	73°47	59	32.02	23.5	5.2	31.99	22.3	5.1	32.65	11.6	3.2	32.88	10.0	2.8
39°00	73°56	35	32.67	24.7	4.8	32.57	23.8	4.6				33.34	9.5	4.8
39°00	74°08	37	32.56	25.0	4.8	32.61	24.0	5.0				33.33	9.7	4.4
39°00	74°20	35	32.51	23.0	5.2	32.80	20.7	5.2				33.26	10.0	4.5
39°11	74°26	19	32.40	24.0	5.4	32.93	12.7	1.3				32.95	12.5	1.3
39°30	74°15	8	32.24	22.0	5.2							32.37	16.7	4.4
39°14	74°12	27	32.52	23.7	5.0	32.99	13.5	3.1				33.00	11.6	2.8
39°40	73°55	26	32.31	23.7	5.0	32.69	23.5	5.0				32.85	12.2	2.7
39°55	73°55	24	32.39	23.0	5.0	32.21	21.7	4.9				32.39	11.3	2.5
40°13	73°56	18	32.21		5.1	32.33		5.0				32.90		2.4
40°23	73°51	24	30.61	20.7	4.7	31.62	20.2	3.8				32.42	11.6	2.7

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NUMBER	TITLE AND AUTHOR	DATE and NTIS No.
1	Proceedings of a workshop on egg, larval and juvenile stages of fish in Atlantic coast estuaries, by Anthony L. Pacheco (editor).	August 1973 COM75-10017/AS
2*	Diagnosis and control of mariculture disease in the United States, by Carl J. Sindermann (editor).	December 1974 PB263410/AS
3*	Oxygen depletion and associated environmental disturbances in the Middle Atlantic Bight in 1976 (composite authorship).	February 1977
4*	Biological and fisheries data on striped bass, Morone saxatilis (Walbaum), by W. G. Smith and A. Wells.	May 1977 PB283900
5	Biological and fisheries data on tilefish, Lopholatilus chamaeleonticeps Goode and Bean, by Bruce L. Freeman and Stephen C. Turner.	May 1977 PB283901
6	Biological and fisheries data on butterfish, Peprilus triacanthus (Peck), by Steven A. Murawski, Donald G. Frank, and Sukwoo Chang.	March 1978 PB283092
7	Biological and fisheries data on black sea bass, Centropristis striata (Linnaeus), by Arthur W. Kendall.	May 1977 PB283093
8*	Biological and fisheries data on king mackerel, Scomberomorus cavalla (Cuvier), by Peter Berrien and Doris Finan.	November 1977 PB283904
9*	Biological and fisheries data on Spanish mackerel, Scomberomorus maculatus (Mitchill), by Peter Berrien and Doris Finan.	November 1977
10*	Biological and fisheries data on Atlantic sturgeon, Acipenser oxyrhynchus (Mitchill) by Steven A. Murawski and Anthony L. Pacheco	August 1977 PB283906