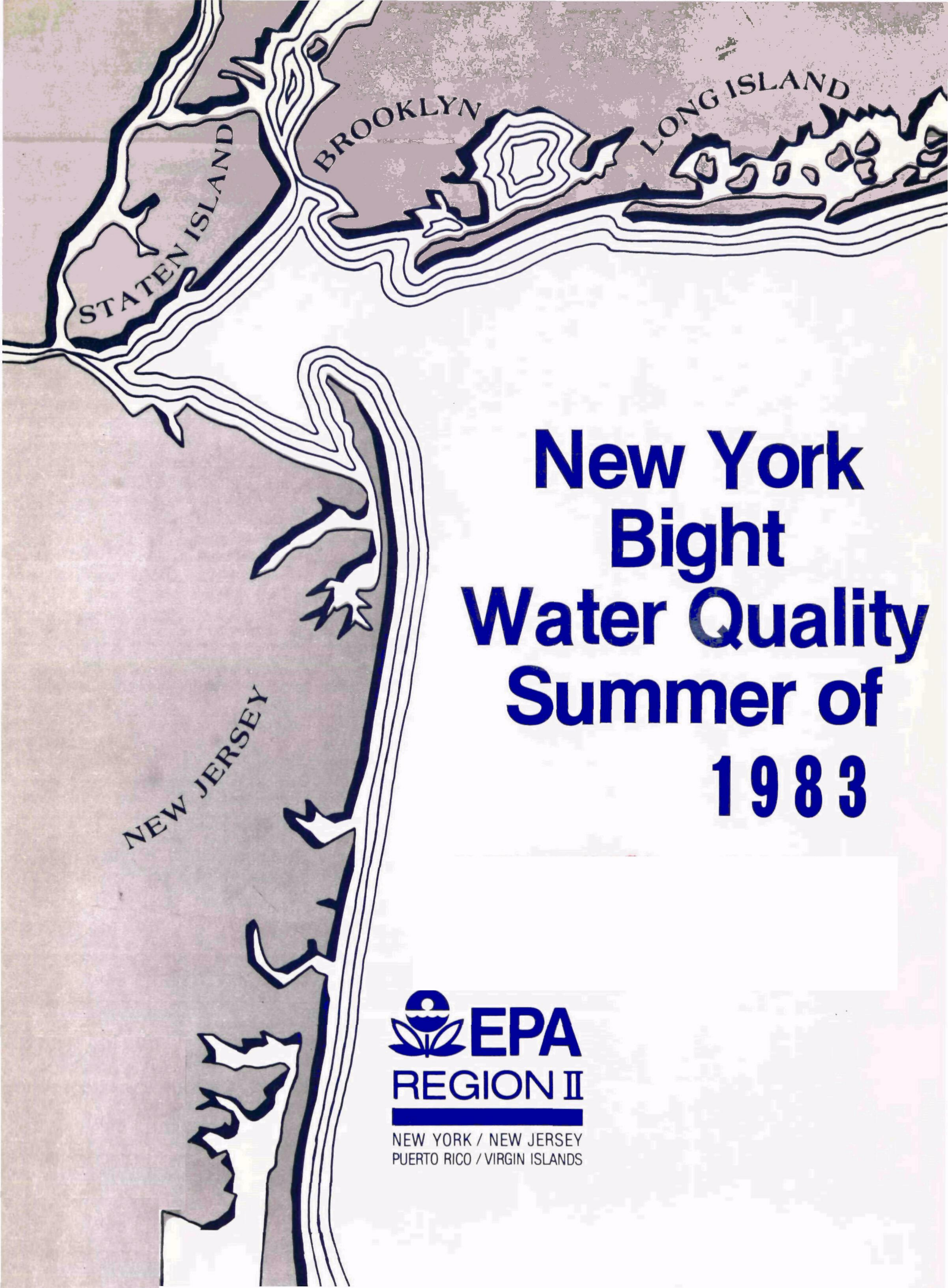

New York Bight Water Quality Summer of 1983

EPA
REGION II
NEW YORK / NEW JERSEY
PUERTO RICO / VIRGIN ISLANDS

NEW YORK BIGHT WATER QUALITY

SUMMER OF 1983

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ABSTRACT

The purpose of this report is to disseminate technical information gathered by the U.S. Environmental Protection Agency, Region II, during the 1983 New York Bight Water Quality Monitoring Program. The monitoring program was conducted using an EPA helicopter for water quality sample collection. During the summer period of May 18 to October 5, 1983, approximately 140 stations were sampled each week, weather permitting. The Bight sampling program was conducted 5 days a week, 6 days a week in July and August, and consisted of four separate sampling networks.

The beach station network was used to gather bacteriological water quality information at 26 Long Island coast stations and 40 New Jersey coast stations. The New York Bight station network was used to gather chemical and bacteriological information at 20 stations in the inner New York Bight. The perpendicular station network consisted of 12 transects extending from the New Jersey and Long Island coasts. Three transects extended south from the Long Island coast, with 4 stations in each transect and 9 transects extended east from the New Jersey coast, with 5 stations in each transect. The transects covered the inner Bight from Jones Beach on Long Island to Strathmere, along the New Jersey coast. Samples were collected for dissolved oxygen and temperature. The New York Bight Contingency Network consisted of 24 stations which were sampled twice weekly for dissolved oxygen and once a week for fecal coliform densities. Samples for phytoplankton identification and nutrient analysis were collected at 9 stations along the New Jersey coast and in Raritan Bay.

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I. INTRODUCTION

The U.S. Environmental Protection Agency has prepared this report to disseminate environmental data for the New York Bight Apex and the shorelines of New York and New Jersey. The New York Bight is an area of ocean bounded on the northwest by Sandy Hook, the northeast by Montauk Point, the southeast by the chemical wastes dump site, and the southwest by Cape May. Figure 1 shows the limits of the New York Bight. The New York Bight Apex, which contains the sewage sludge, dredged material, acid waste, and cellar dirt dump sites, is shown in Figure 2.

This report is the tenth in a series and reflects the monitoring period between May 18, 1983 and October 5, 1983. The New York Bight monitoring program is EPA's response to its mandated responsibilities as defined under the Marine Protection, Research and Sanctuaries Act of 1972 and the Water Pollution Control Act Amendments of 1972 and 1977.

Since its initiation in 1974, the New York Bight ocean monitoring program has been modified several times to be more responsive and to concentrate on specific areas of concern during the critical summer period. Most of these changes occurred after the summer of 1976, when anoxic conditions caused a fishkill in the Bight and an unusually heavy washup of debris occurred on Long Island beaches. It was clear that summer conditions in the Bight called for more intensive monitoring in order to predict environmental crises, to investigate the origins of these crises, and to use data gathered from New York Bight monitoring to guide and direct any decisions regarding protection of the Bight's water quality.

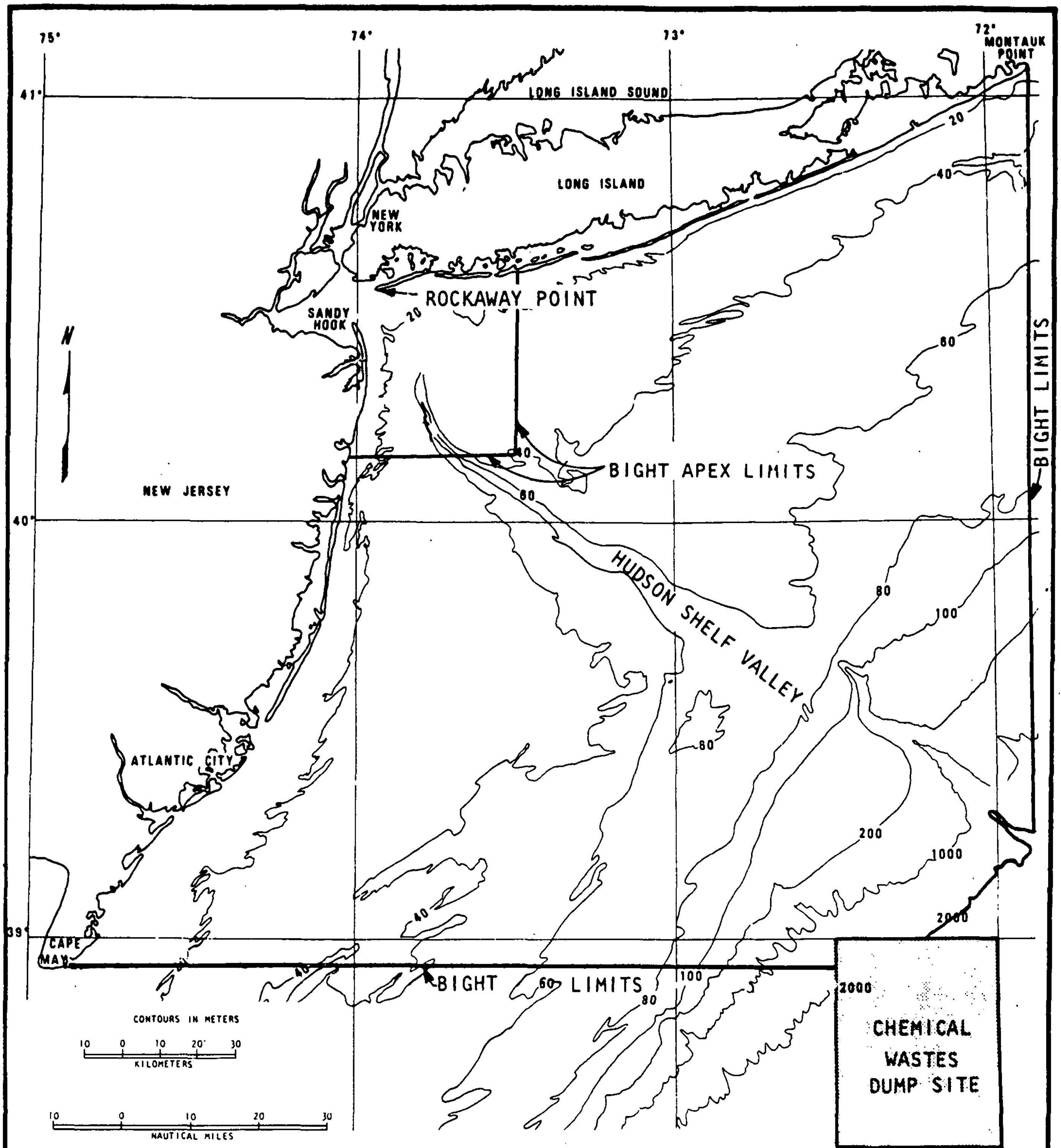


FIGURE 1

THE NEW YORK BIGHT

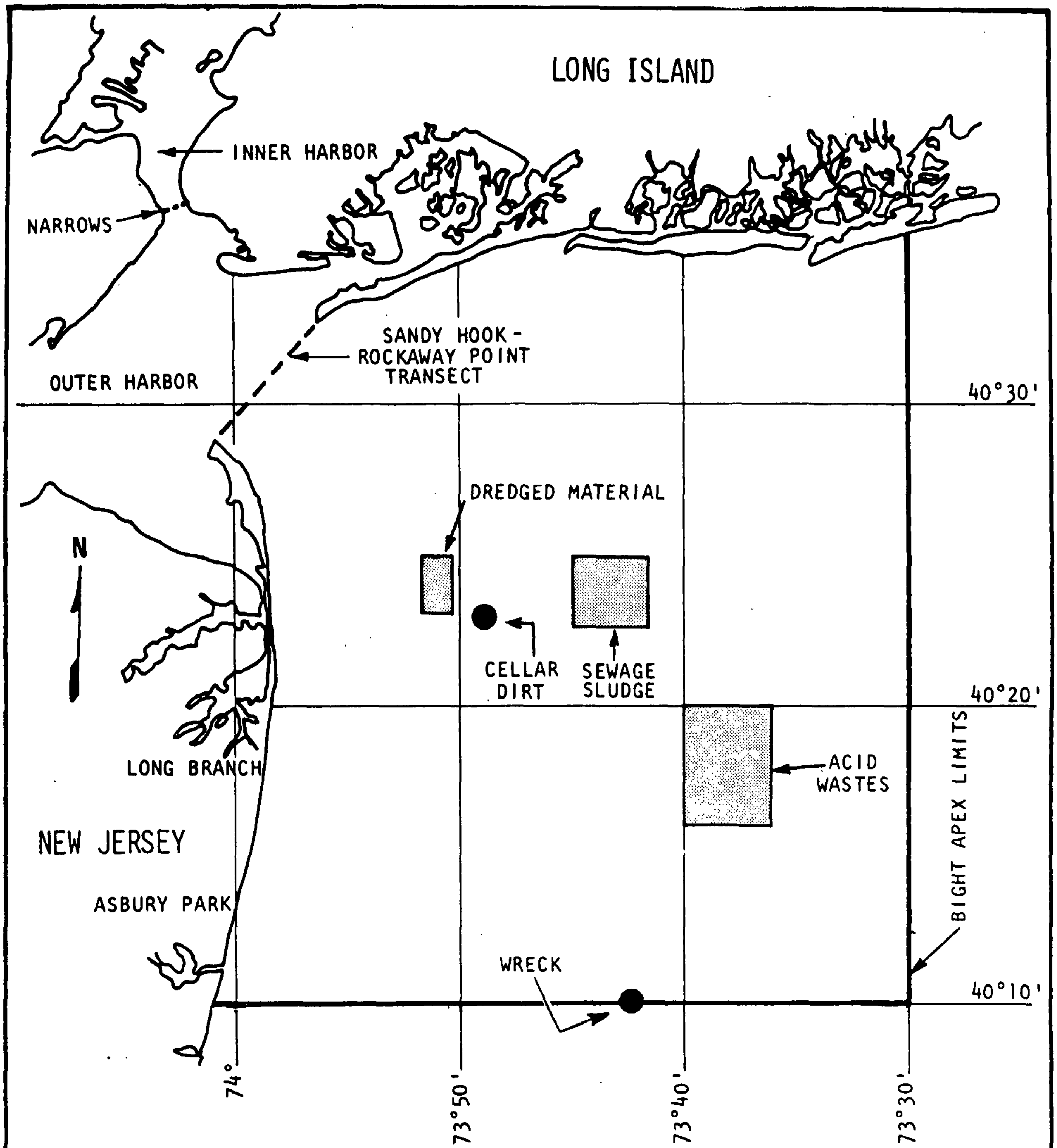
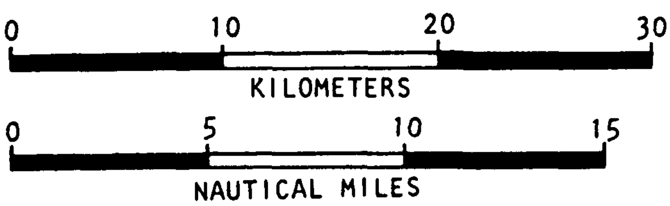


FIGURE 2

BIGHT APEX AND EXISTING DUMP SITES



In recent years, monitoring has been expanded to include analyses of Bight sediments for heavy metals, toxics, and benthic organisms for species diversity and number, and analyses of water in the sewage sludge disposal area for viruses and pathogens. The sediment and benthic organism sampling was conducted from EPA's ocean survey vessel "Antelope" and the data will be presented in a separate report. Ongoing revisions to the program are intended to improve the EPA's ability to track pollution sources and to protect New York Bight water quality.

As in previous years, results indicated that New York Bight water quality was generally good during the summer sampling period. Some stressful dissolved oxygen (DO) conditions were found at the New Jersey perpendicular stations and New York Bight Apex stations from mid to late summer during periods of low wind and storm activity. These depressed levels occurred in specific isolated areas and did not remain low for extended periods of time. The low DO in certain areas of the Bight is attributed to the combined effects of the respiration of organisms in organic-rich sediments, the decomposition of the algal blooms which occur in the nutrient-rich areas of the Bight, thermal water column stratification, and no vertical mixing due to a lack of storm activity.

Bacteriological data indicated that fecal coliform densities at the beaches along both the New Jersey and Long Island coasts were well within the acceptable limits for water contact recreation.

II. SAMPLE COLLECTION PROGRAM

During the period of May 1983 through October 1983, ambient water quality monitoring was carried out using the EPA Huey helicopter 5 days a week, except for July and August when sampling occurred 6 days a week.

Table 1 is an outline of the 1983 sampling program. Table 2 lists the parameters analyzed for each group of stations.

Table 1

Outline of 1983 sampling program

Station Group	Frequency per Week	Parameter	Sample Depth
Long Island Beaches (Rockaway Pt. to Fire Island Inlet)	1	Bacteriological	Top[1]
North Jersey Beaches (Sandy Hook to Barnegat)	1	Bacteriological	Top[1]
Long Island Beaches (Fire Island Inlet to Shinnecock Inlet)	Bimonthly	Bacteriological	Top[1]
South Jersey Beaches (Barnegat to Cape May)	Bimonthly	Bacteriological	Top[1]
Long Island Perpendiculars	1	Dissolved Oxygen	Top[1], Bottom[2]
North Jersey Perpendiculars (Long Branch to Seaside)	1	Dissolved Oxygen	Top[1], Bottom[2]
South Jersey Perpendiculars (Barnegat to Strathmere)	Bimonthly	Dissolved Oxygen	Top[1], Bottom[2]
Bight Contingency	2	Dissolved Oxygen	Top[1], Bottom[2]
Bight Contingency	1	Bacteriological	Top[1], Bottom[2]
Phytoplankton	1	Phytoplankton, Nutrients	Top[1]
Inner New York Bight	1	Bacteriological Dissolved Oxygen	Top[1], Bottom[2]

1 One meter below the surface
2 One meter above the ocean floor

Table 2

Parameters evaluated for each station group

Parameters	L.I. & N.J. Beaches*	L.I. & N.J. Perpendiculars**	N.Y. Bight**	Bight Contingency**	Phytoplankton*
Fecal Coliform	X		X	X	
Salinity Chlorinity					X
Temperature		X	X	X	
Dissolved Oxygen (DO)		X	X	X	
Total Phosphorus (TP)					X
Phosphate Phosphorus (PO_4-P)					X
Ammonia Nitrogen (NH_3-N)					X
Nitrite Nitrogen (NO_2-N)					X
Nitrate Nitrogen (NO_3-N)					X
Silica (SiO_2)					X
Plankton					X

*Sample Depth: 1 meter below the surface
**Sample Depth: 1 meter below the surface and 1 meter above the ocean floor.

The weekly sampling program averaged approximately 140 stations. Beach stations along New York and New Jersey were sampled once a week. These stations were sampled for fecal coliform bacteria densities. This portion of the sampling program totaled 66 stations one week and 34 stations the following week. At the beach stations, samples were collected just offshore in the surf zone while the helicopter hovered approximately 3 meters from the surface. Sampling was accomplished by dropping a 1-liter Kemmerer sampler through a cut-out in the mid-section of the helicopter to approximately 1 meter below the water surface. The sample was transferred to a sterile plastic container and subsequently transported (within 6 hours) to the Edison Laboratory for fecal coliform analysis.

Twenty stations in the apex of the Bight were sampled once a week. Depending upon sea conditions, the EPA helicopter hovered or landed at the designated station and a 1-liter Kemmerer sampler was used to obtain water samples at 1 meter below the surface and 1 meter above the ocean bottom. After collection, portions of the water sample were transferred to a BOD bottle for dissolved oxygen analysis, and a sterile plastic bottle for fecal coliform analysis. The dissolved oxygen sample was immediately fixed at the station by the addition of 2 ml of manganous sulfate followed by 2 ml of alkali-iodide-azide reagent. The sample was shaken to facilitate floc formation and then placed in a metal rack and returned to the laboratory for analysis. The samples were held for less than 6 hours before returning to the laboratory for analysis by addition of 2 ml of sulfuric acid and titration with 0.0375M sodium thiosulfate.

The third scheduled sampling portion of the program consisted of sampling perpendicular stations once a week for dissolved oxygen and temperature. Again, as with the inner Bight stations, samples were collected while hovering or landing, at 1 meter below the surface and 1 meter above the bottom.

As part of the final Environmental Impact Statement on Ocean Dumping of Sewage Sludge in the New York Bight, a Bight Contingency Plan was developed in which criteria were established for the relocation of the sewage sludge dumpsite, if necessary. This called for the establishment of a 24-station network to be sampled twice a week for dissolved oxygen and once a week for fecal coliform densities. Part of the sampling requirements for the New York Bight contingency plan were satisfied by the regularly scheduled Bight and perpendicular sampling runs. Bacteriological samples for LIC 09, LIC 14, JC 14, and JC 27 perpendiculars were taken on the DO runs for those stations. The bacteriological requirements for NYB 20, 22, 24, and the NYB 40, 42 and 44 transects were met by the regular Bight sampling since bacteriological assays were performed for all Bight stations. Additional sampling of dissolved oxygen for the 24 stations was carried out once a week.

The fifth routinely scheduled sampling component involved the collection of water samples for phytoplankton identification and quantification and nutrient analysis. The phytoplankton analysis was done by the New Jersey Department of Environmental Protection (NJDEP) and the nutrient analysis was done by EPA. The samples were collected as close to the surface as possible, using 1-liter Kemmerer samplers. A 1-liter plastic cubitainer was filled for phytoplankton analysis. The phytoplankton sample was preserved with Lugols solution and kept at 4°C. A 1-liter plastic cubitainer was filled for nutrient analysis and kept at 4°C. The NJDEP picked the phytoplankton samples up within 24 hours of collection. The results of these analyses are contained in Appendix A.

III. DESCRIPTION OF SAMPLING STATIONS

Beach Stations

A total of 66 bathing beach areas were sampled routinely for bacteriological water quality along the Long Island and New Jersey coastlines. The Long Island sampling stations extend from the western tip of Rockaway Point 130 km eastward to Shinnecock Inlet with a total of 26 stations (LIC 01-LIC 28). Sample station location, nomenclature, and description are given in Table 3 and Figure 3. Forty New Jersey coast stations, from Sandy Hook at the north to Cape May Point at the south (JC 01A through JC 99), are described and identified in Table 4 and in Figures 4 and 5.

New York Bight Stations

The New York Bight stations established as part of the original ocean monitoring program cover the inner Bight area in approximately 3 km intervals via three transects as follows: New Jersey Transect (NYB 20-NYB 27) extending from Sandy Hook 20 km eastward to the sewage sludge dump site; Raritan Bay Transect (NYB 32-NYB 35) projecting along the Ambrose Channel from the mouth of Raritan Bay southeast to the sewage sludge dump site; and the Long Island Transect (NYB 40-NYB 47) extending from Atlantic Beach, Long Island southward to just beyond the sewage sludge dump site. The locations of the New York Bight stations are shown in Figure 6.

Table 3

Long Island coast-station locations

Station No.	Location
LIC 01	Rockaway Point, Breezy Point Surf Club
LIC 02	Rockaway, off foot of B169 Road
LIC 03	Rockaway, off foot of B129 Road
LIC 04	Rockaway, off foot of B92 Road
LIC 05	Far Rockaway, off foot of B41 Road
LIC 07	Atlantic Beach, Silver Point Beach Club
LIC 08	Long Beach, off foot of Grand Avenue
LIC 09	Long Beach, off foot of Pacific Boulevard
LIC 10	Point Lookout, off Hempstead public beach
LIC 12	Short Beach (Jones Beach), off "West End 2" parking lot
LIC 13	Jones Beach
LIC 14	East Overlook
LIC 15	Gilgo Beach
LIC 16	Cedar Island Beach
LIC 17	Robert Moses State Park
LIC 18	Great South Beach
LIC 19	Cherry Grove
LIC 20	Water Island
LIC 21	Bellport Beach
LIC 22	Smith Point County Park
LIC 23	Moriches Inlet West
LIC 24	Moriches Inlet East
LIC 25	West Hampton Beach
LIC 26	Tiana Beach
LIC 27	Shinnecock Inlet West
LIC 28	Shinnecock Inlet East

Table 4

New Jersey coast station locations

Station No.	Location
JC 01A	Sandy Hook, 1.2 km south of tip
JC 02	Sandy Hook, off large radome
JC 03	Sandy Hook, off Nature Center building (tower)
JC 05	Sandy Hook, just north of Park entrance
JC 08	Sea Bright, at public beach
JC 11	Monmouth Beach Bath & Tennis Club
JC 14	Long Branch, off foot of S. Bath Avenue
JC 21	Asbury Park, off building north of Convention Hall
JC 24	Bradley Beach, off foot of Cliff Avenue
JC 27	Belmar, off the "White House" near fishing club pier
JC 30	Spring Lake, south of yellow brick building on beach
JC 33	Sea Girt, off foot of Chicago Avenue
JC 37	Point Pleasant, south of Manasquan Inlet
JC 41	Bay Head, off foot of Johnson Street
JC 44	Mantoloking, off foot of Albertson Street
JC 47A	Silver Beach, off foot of Colony Road
JC 49	Lavallette, off foot of Washington Avenue
JC 53	Seaside Park, off foot of 5th Avenue
JC 55	Island Beach State Park, off white building north of Park Hq.
JC 57	Island Beach State Park, between two main parking lots in center of park
JC 59	Island Beach State Park, off white house next to the lookout tower

Table 4 (Continued)

Station No.	Location
JC 61	Barnegat, first rock jetty south of Barnegat Inlet
JC 63	Harvey Cedars, opposite Harvey Cedars standpipe
JC 65	Ship Bottom, opposite Ship Bottom water tower
JC 67	Beach Haven Terrace, opposite standpipe
JC 69	Beach Haven Heights, opposite the most southern water tower on Long Beach Island
JC 73	Brigantine, off large hotel on beach
JC 75	Atlantic City, off the Convention Center
JC 77	Ventnor City, just north of fishing pier
JC 79	Longport, off water tower
JC 81	Ocean City, opposite large apartment building
JC 83	Peck Beach, opposite large blue water tower
JC 85	Strathmere, off blue standpipe
JC 87	Sea Isle City, opposite blue water tower with bridge in the background
JC 89	Avalon, off beige building on the beach
JC 91	Stone Harbor, off large blue water tower
JC 93	Wildwood, off northern amusement pier
JC 95	Two mile beach, opposite radio tower
JC 97	Cape May, off white house with red roof on the beach
JC 99	Cape May Point, opposite lighthouse

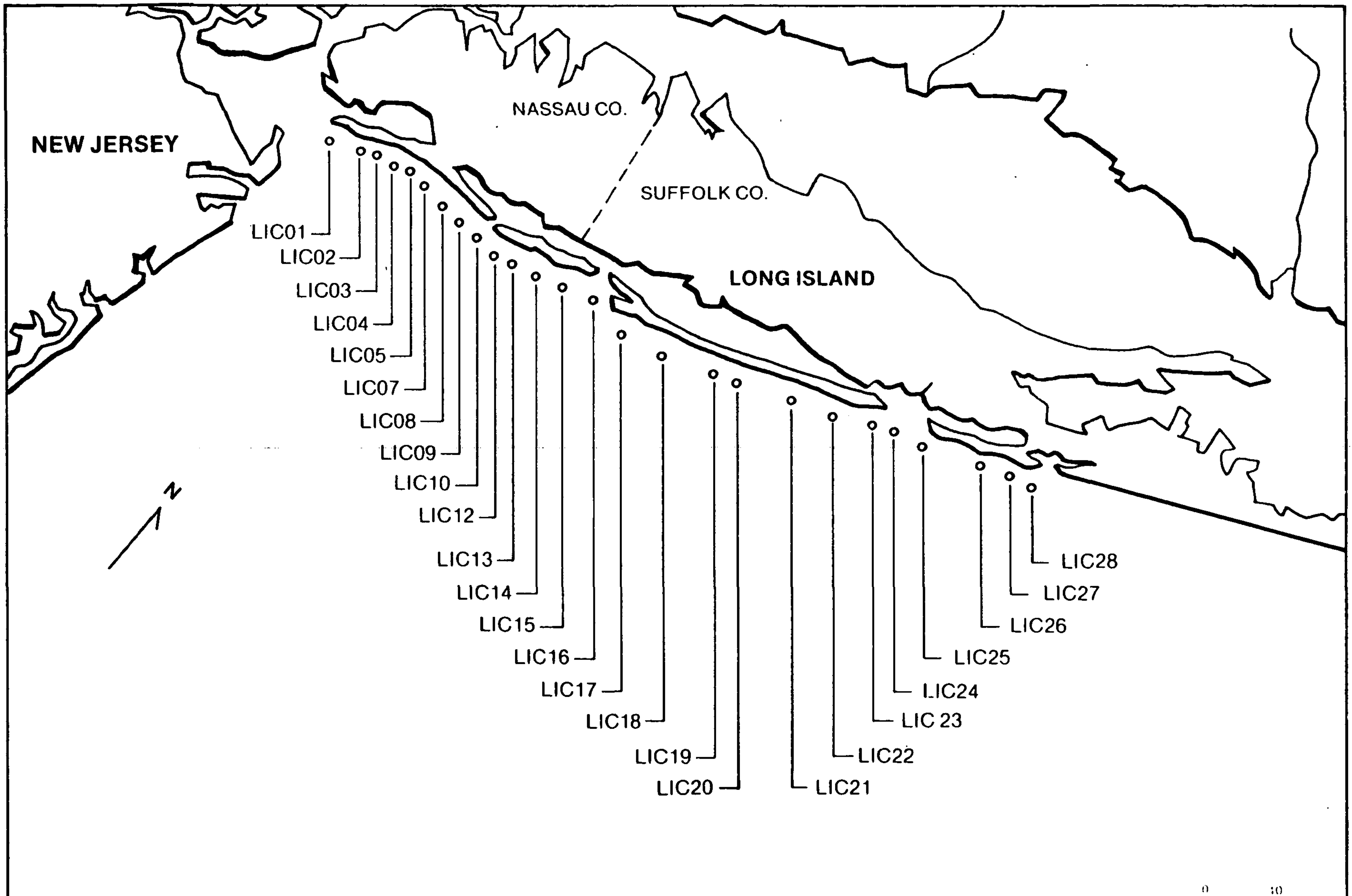


FIGURE 3
LONG ISLAND COAST STATION LOCATIONS

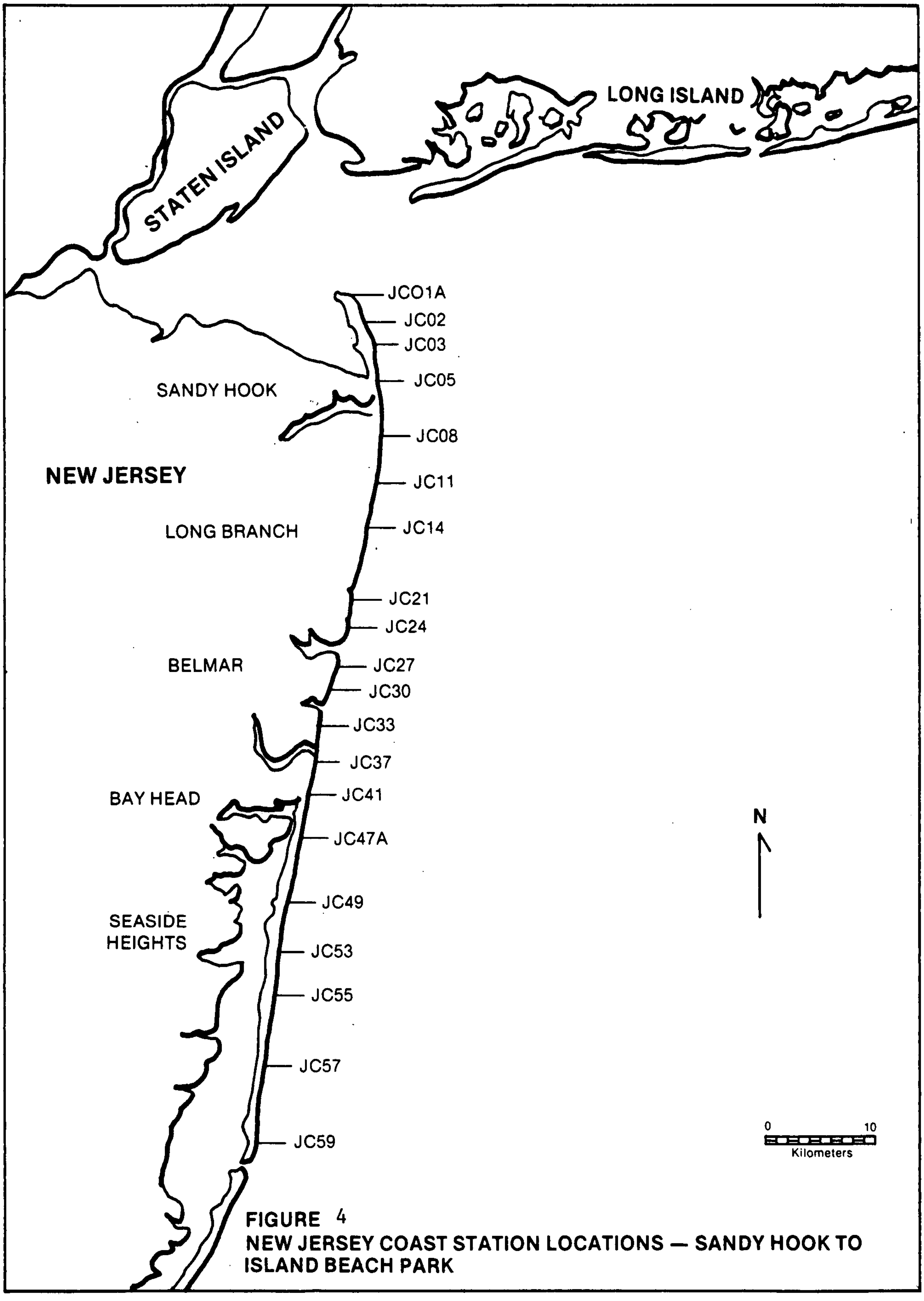


FIGURE 4
NEW JERSEY COAST STATION LOCATIONS — SANDY HOOK TO ISLAND BEACH PARK

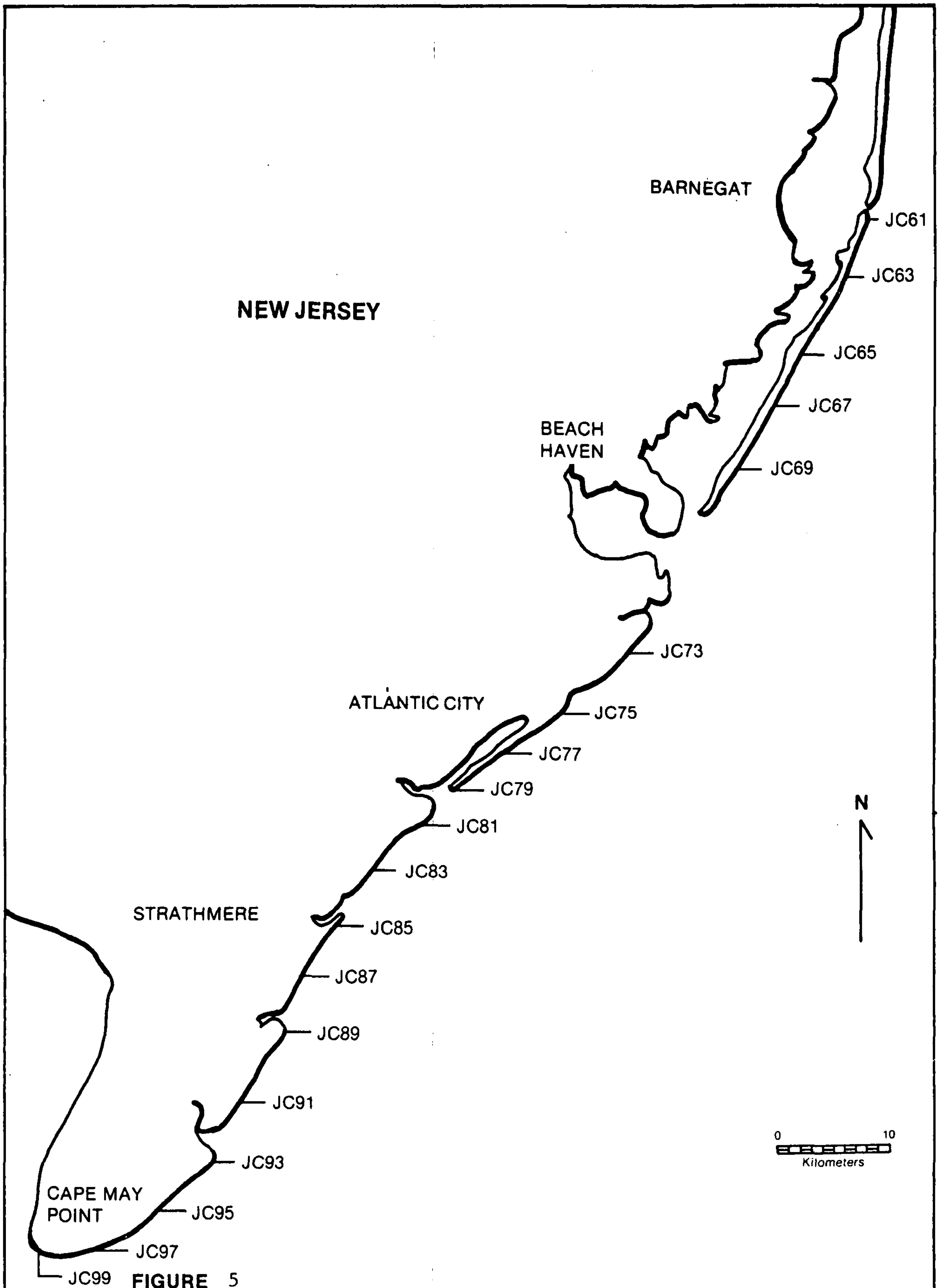


FIGURE 5
NEW JERSEY COAST STATION LOCATIONS — BARNEGAT TO CAPE MAY POINT

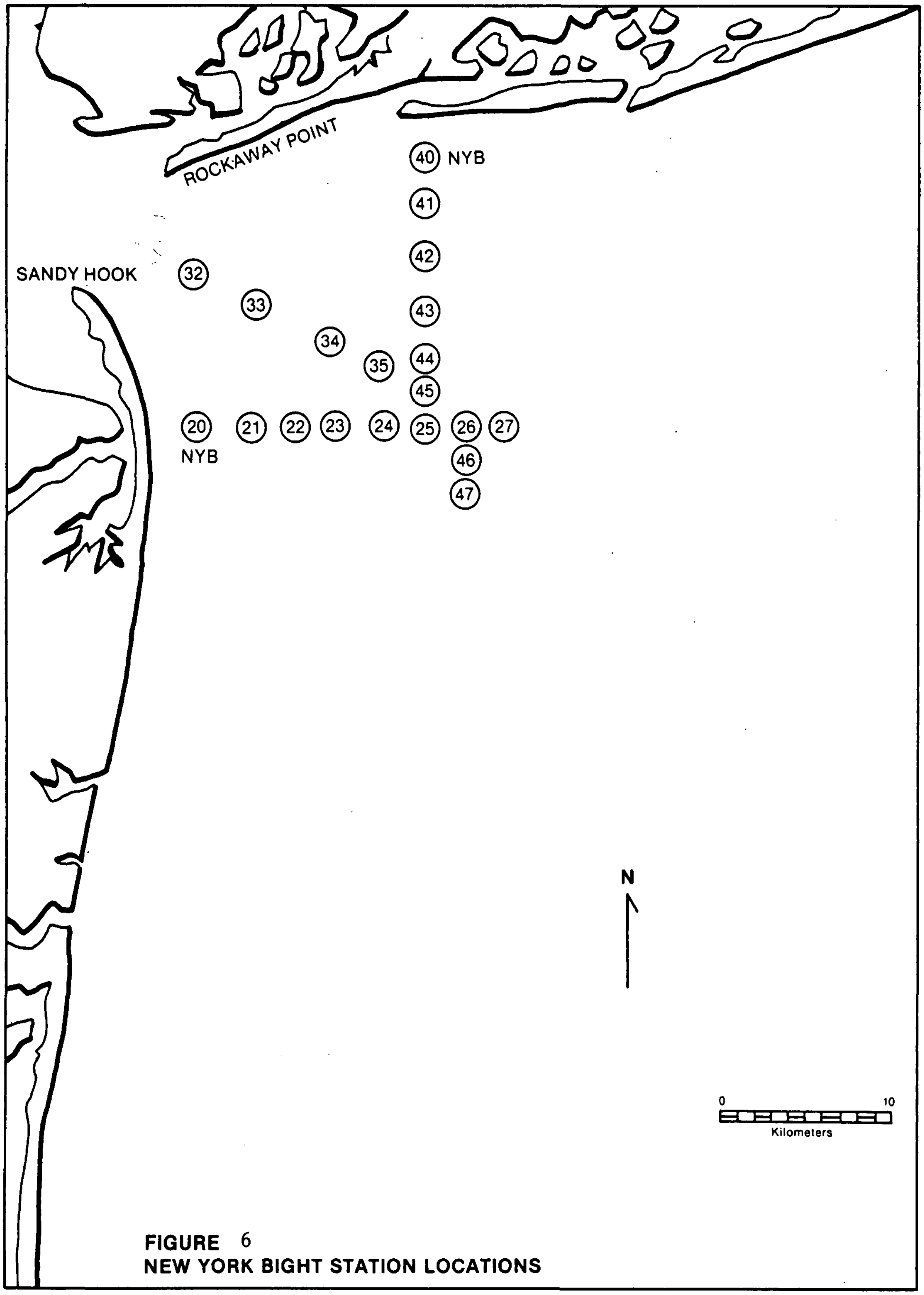


FIGURE 6
NEW YORK BIGHT STATION LOCATIONS

Perpendicular Stations

Sampling stations perpendicular to the Long Island coastline are 5.4 km, 12.6 km, 19.8 km, and 27 km (3, 7, 11, and 15 nautical miles) offshore. Sampling stations perpendicular to the New Jersey coastline start at 1.8 km and are spaced every 1.8 km out to 18 km (1 nautical mile with 1 nm increments to 10 nm) offshore. These stations are identified by suffixes E through N (MAS stations have corresponding suffixes 1 through 10). Normally, only every other New Jersey perpendicular station (3.6 km intervals) was sampled; the intermediate stations remained available should DO conditions warrant more intensive sampling.

The perpendicular stations were established to gather near-surface and near-bottom dissolved oxygen values in the critical areas of the New York Bight nearshore waters. Previous agreements had been made with NOAA to provide dissolved oxygen profiles from stations further out in the Bight in conjunction with their MESA project and Marine Fisheries Laboratory activities.

The perpendicular stations described above are plotted in Figures 7 and 8. Tables 3 and 4 describe the shore station locations from which the perpendicular stations originate.

New York Bight Contingency Plan Stations

The 24 stations sampled were:

NYB 20, 22, 24, 40, 42, 44,
LIC 09P, A, B, and C
LIC 14P, A, B, and C
JC 14E, G, I, K, and M
JC 27E, G, I, K, and M

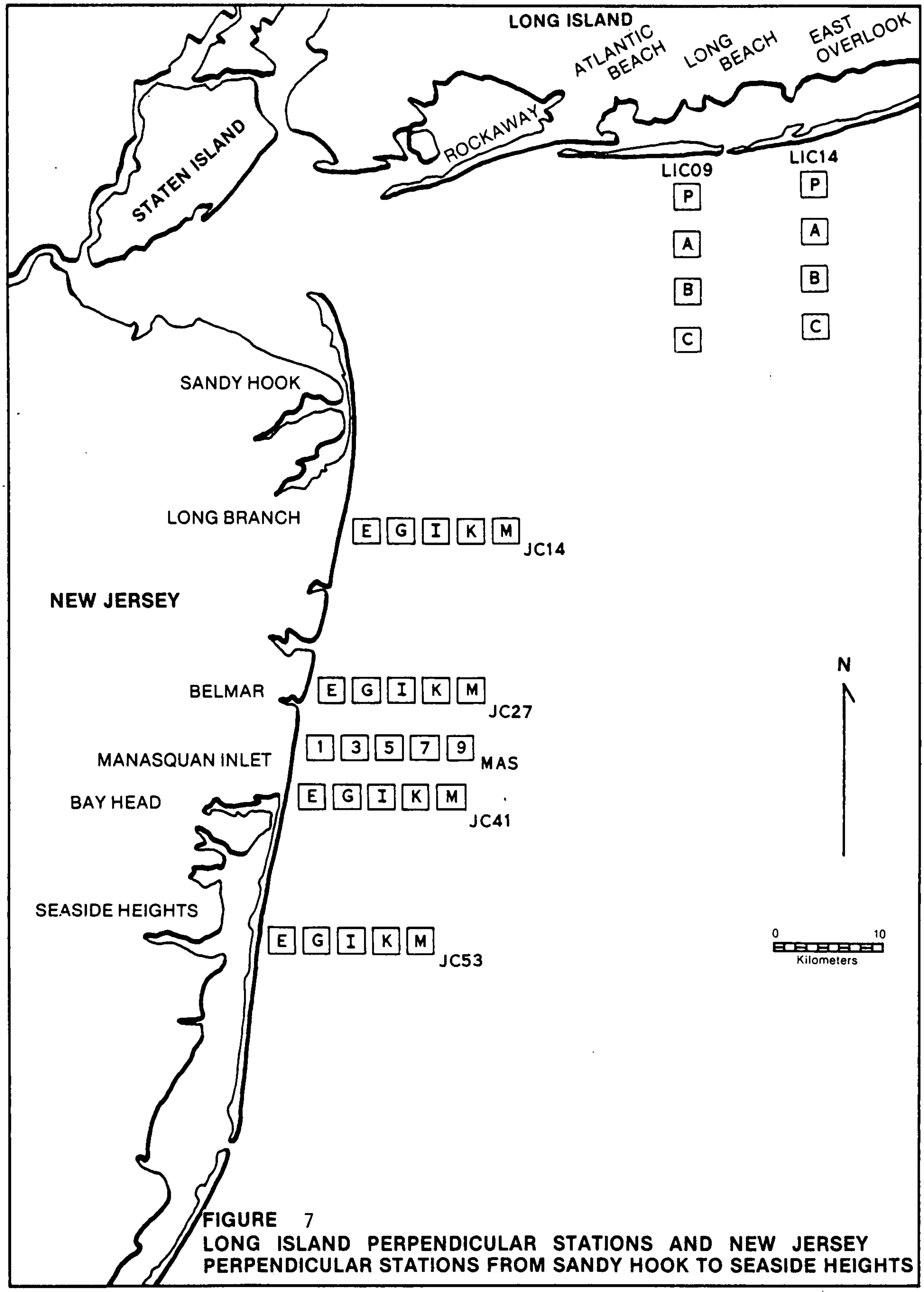


FIGURE 7
LONG ISLAND PERPENDICULAR STATIONS AND NEW JERSEY PERPENDICULAR STATIONS FROM SANDY HOOK TO SEASIDE HEIGHTS

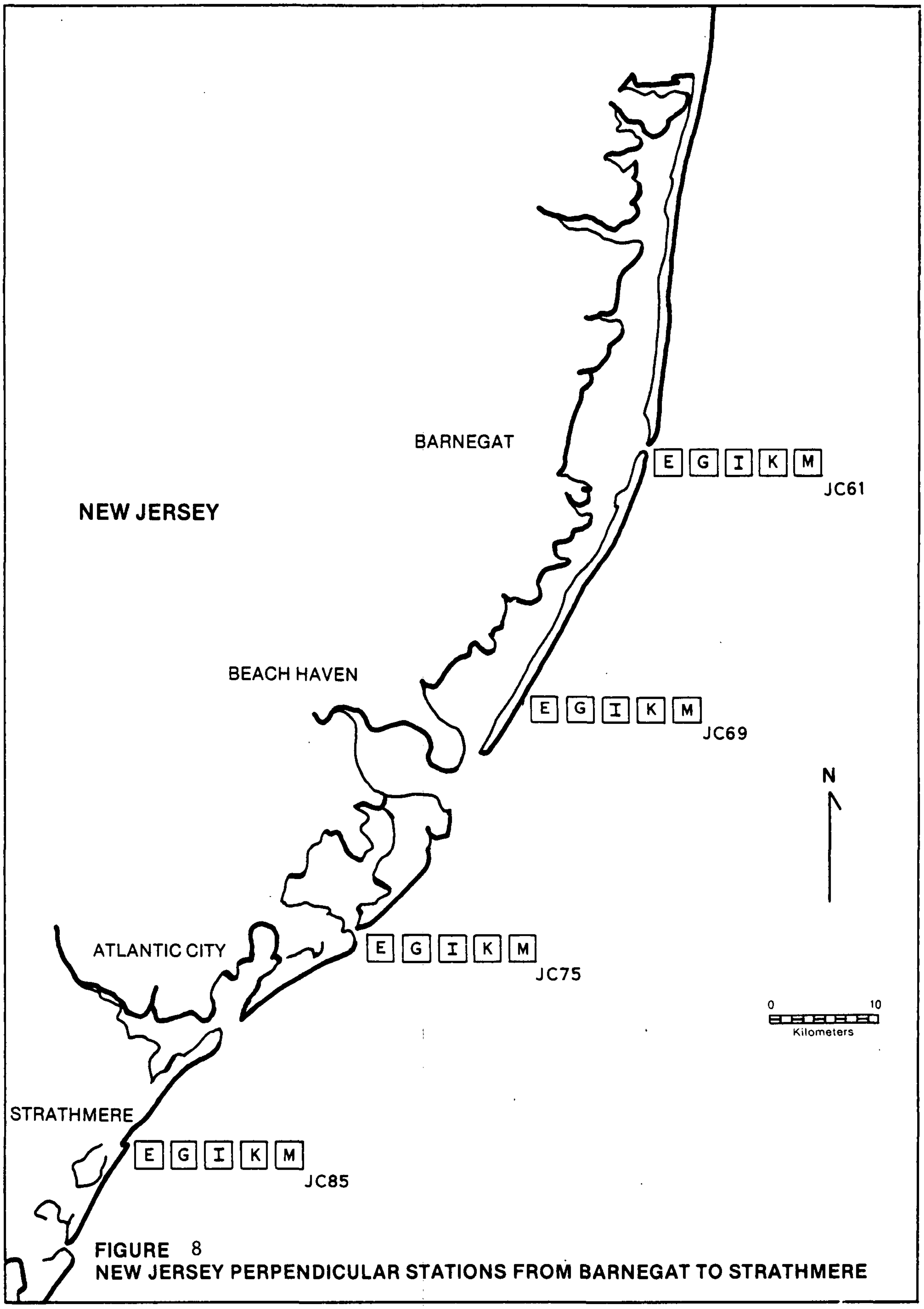


FIGURE 8
NEW JERSEY PERPENDICULAR STATIONS FROM BARNEGAT TO STRATHMERE

Their locations are described in the preceding tables and figures.

Phytoplankton Stations

Phytoplankton samples were collected once a week along the New Jersey coast at the following stations:

JC 05	JC 57
JC 11	NYB 20
JC 21	RB 32
JC 30	RB 15
JC 37	

A discussion of phytoplankton dynamics and bloom incidence in New Jersey waters is presented in Appendix A.

IV. DISSOLVED OXYGEN RESULTS AND DISCUSSION

Normal Trends in the Ocean

Two major processes act to replenish dissolved oxygen in the water column of the New York Bight area. These are the photosynthetic conversion of carbon dioxide to molecular oxygen and the mechanical reaeration of oxygen across the air-water interface. Subsequent turbulent diffusion then distributes the dissolved oxygen throughout the water column or into the upper warmer surface layer when stratified conditions prevail. Concurrent oxygen utilization (depletion) processes such as bacterial respiration and sediment oxygen demand act to influence the amount of oxygen in the water column at any one time or location.

A general description of the oxygen cycle during a calendar year is as follows:

> In early January, the waters of the Bight are completely mixed throughout the water column with temperatures ranging from 4°C to 10°C while dissolved oxygen values are between 8 and 10 mg/1 with slightly depressed values at the sediment-water interface. The warm spring air temperatures and solar heating increase the temperature of the upper water layer and, in the absence of high energy input from local storms or tropical hurricanes, a thermally stratified water column develops. This stratification effectively blocks the free transport of the oxygen-rich upper layer into the cool oxygen-poor bottom waters.

As hot summer weather conditions set in, the warmer upper layer of water remains completely mixed and rich in oxygen (7 to 9 mg/l). This upper layer ranges from 20 to 60 meters in depth depending on time and location. The bottom cooler water is effectively isolated from the upper layer by a 10°C temperature gradient. Respiration of bottom organisms, bacterial action on algal remains and detritus, and sediment oxygen demand depress the residual dissolved oxygen values in the bottom waters. In a typical year, the dissolved oxygen concentration in the bottom waters of the Bight reaches a minimum in mid to late summer of approximately 4 mg/l. At this time, cool evenings and reduced solar input causes the upper waters to cool, decreasing the temperature gradient between the two water masses. As the two masses become closer and closer in temperature, the energy required to break down the thermocline becomes less and less until finally, in many instances after a local storm, there is a complete mixing of the water column with concomitant reoxygenation of the bottom waters. The annual cycle begins again. Figure 9 depicts a representative history of dissolved oxygen concentration in the general ocean area off of New Jersey, New York, and New England.

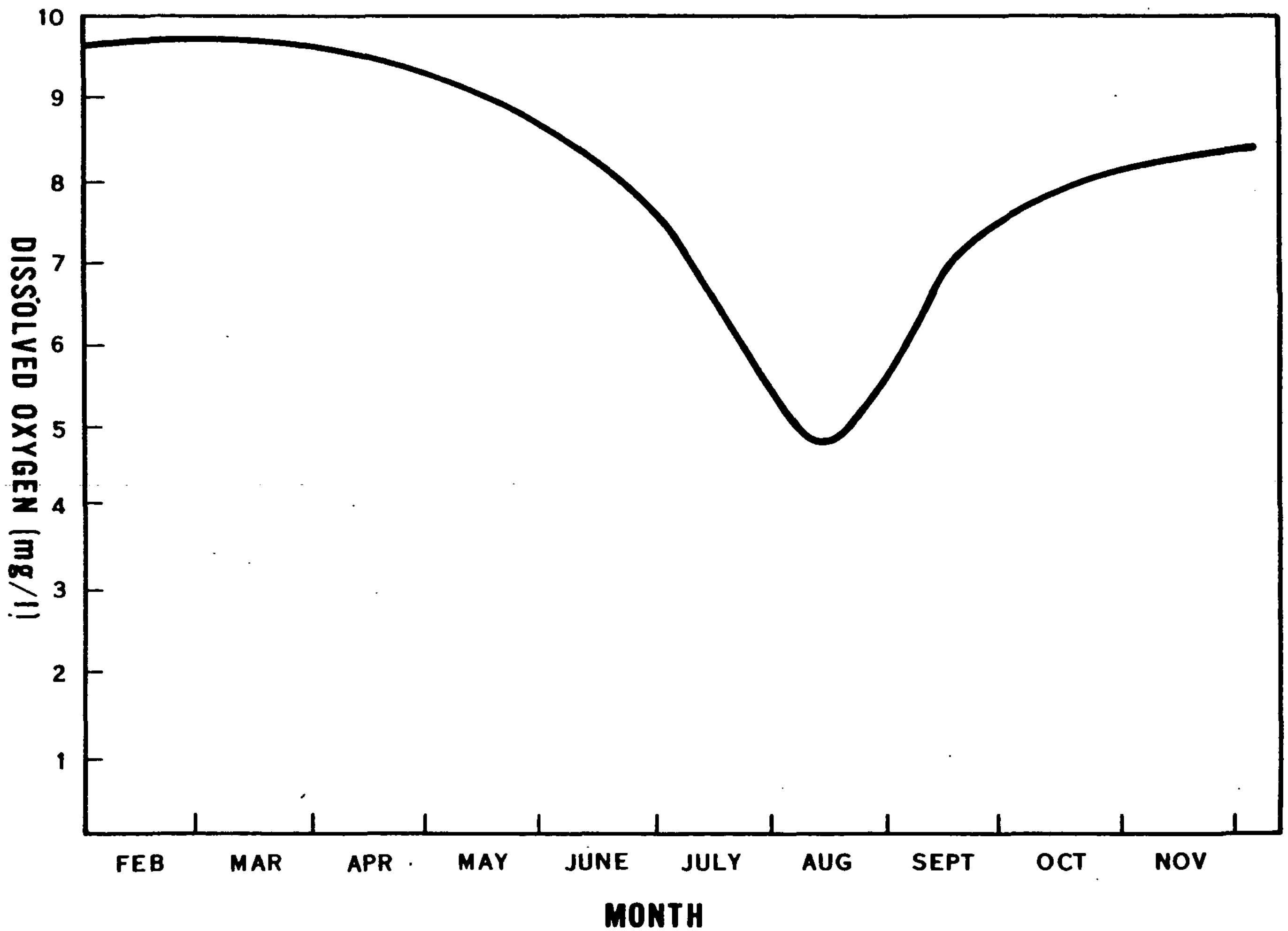


FIGURE 9
GENERALIZED ANNUAL MARINE DISSOLVED OXYGEN CYCLE OFF THE NORTHEAST U.S. (FROM NOAA)

Dissolved Oxygen Criteria

The dissolved oxygen levels necessary for survival and/or reproduction vary among biological species. Insufficient data have been accumulated to assign definitive limits or lower levels of tolerance for each species at various growth states. Rough guidelines are available for aquatic species for purposes of surveillance and monitoring. These are as follows:

5 mg/l DO and greater	healthy
4 - 5 mg/l DO	borderline to healthy
3 - 4 mg/l DO	stressful if prolonged
2 - 3 mg/l DO	lethal if prolonged
less than 2 mg/l	lethal in a relatively short time.

These criteria are consistent with biological information recorded in the New York Bight over the past several years. Most data concerning the lower tolerance levels were recorded during the summer of 1976. In 1976, widespread and persistent dissolved oxygen levels between 0.0 and 2.0 mg/l occurred over a large area of the Bight. This resulted in extensive fish kills and bottom dwelling organism mortality.

Surface Dissolved Oxygen - 1983

The completely mixed upper water layer had dissolved oxygen levels at or near saturation during the entire sampling period, May 24, 1983 through October 4, 1983, therefore no further discussion of surface dissolved oxygen will be presented in this report.

Bottom Dissolved Oxygen - 1983

Long Island Coast

As in previous years, the dissolved oxygen levels off the coast of Long Island were, for the most part, well above the 4 mg/l "borderline to healthy" guideline for the entire sampling period. Figure 10 shows semi-monthly averages of dissolved oxygen values found from June through September, 1983. Out of 47 samples taken throughout the summer, 7, or slightly less than 15 percent, were below the 4 mg/l guideline. Five of the seven samples were collected on September 27. No samples were collected along Long Island after September 27, therefore the recovery was not documented. Table 5 summarizes the dissolved oxygen values below 4 mg/l off the Long Island Coast during the summer 1983.

Table 5

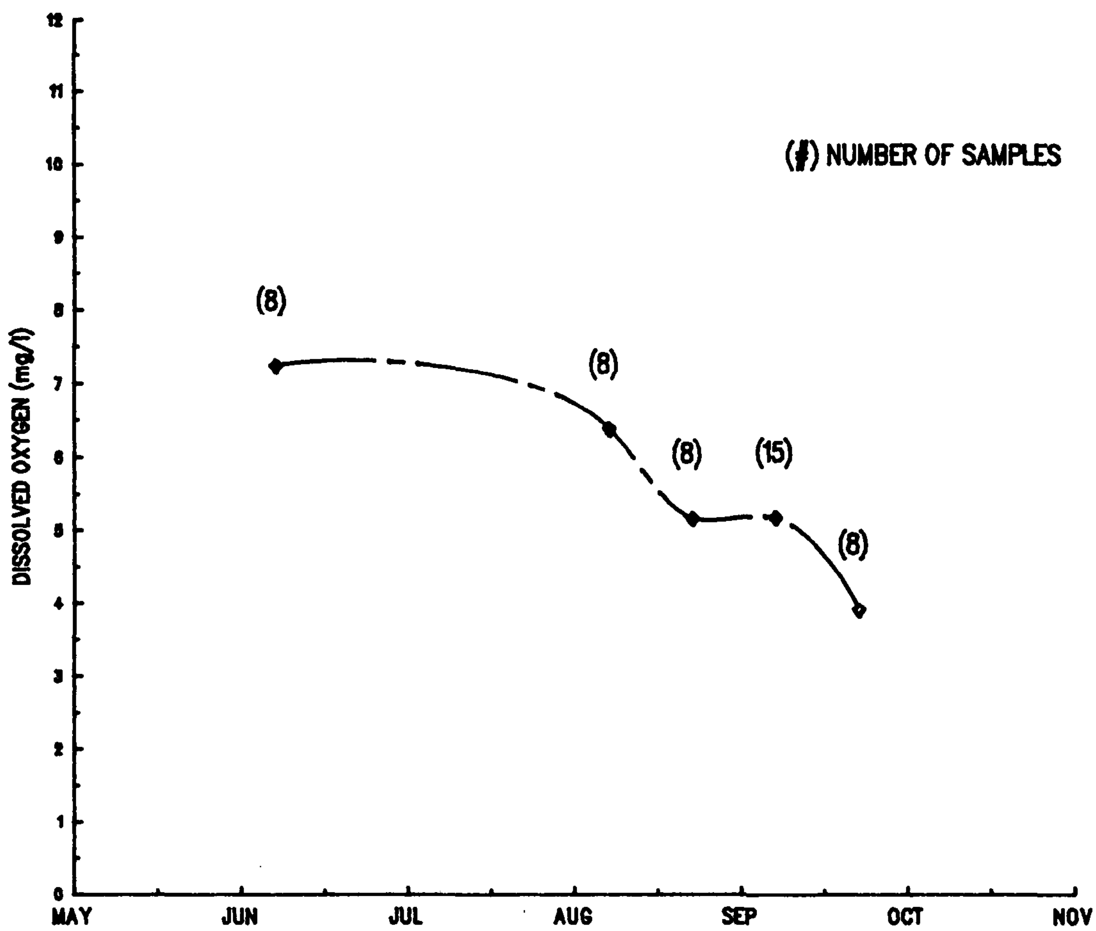
Dissolved oxygen concentrations less than 4 mg/l found off the Long Island coast, summer 1983.

Date	Station	D.O. (mg/l)
9/07	LIC 14P	3.0
9/13	LIC 14P	3.8
9/27	LIC 09P	2.5
9/27	LIC 09A	3.4
9/27	LIC 09B	2.2
9/27	LIC 09C	2.8
9/27	LIC 14A	2.9

New York Bight Apex

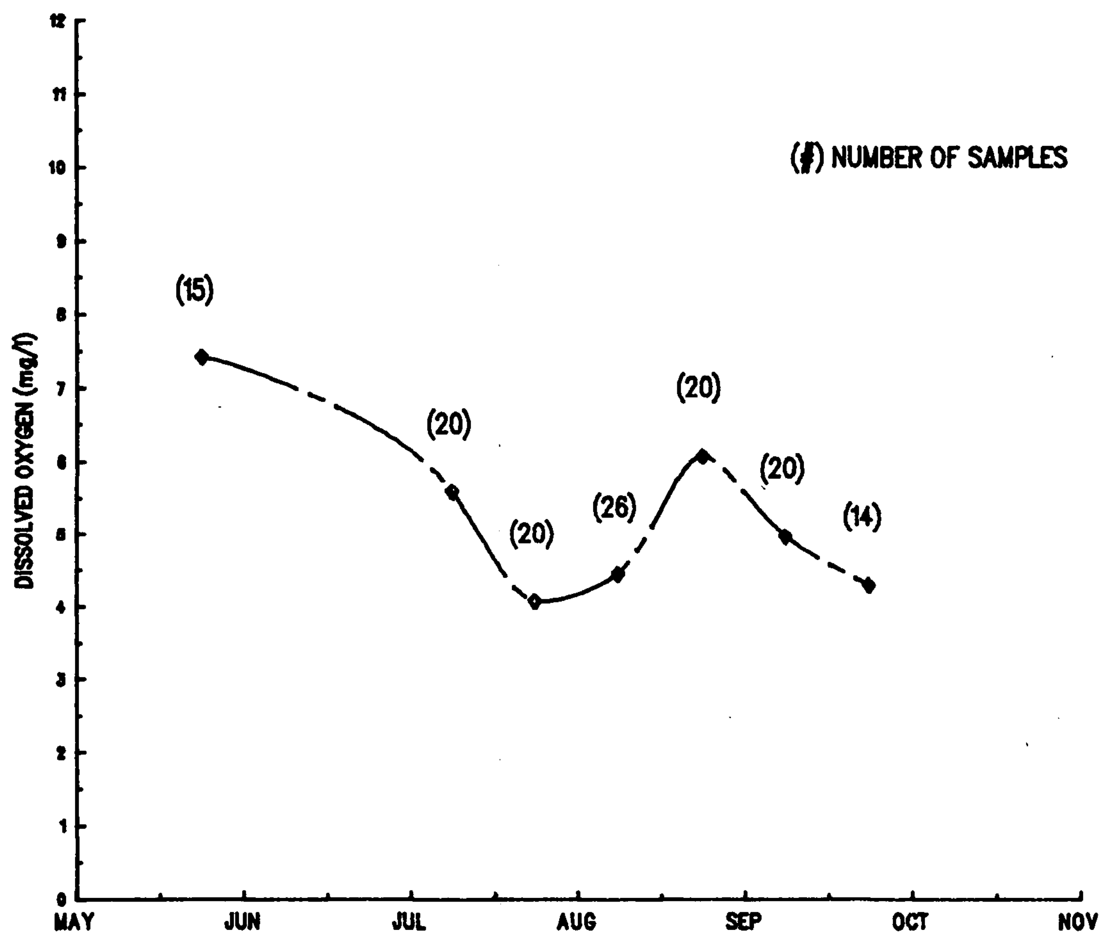
Figure 11 illustrates the semi-monthly dissolved oxygen averages found in the New York Bight stations from May through September, 1983. The "double minima" effect which has been observed in the New York Bight during the summer

FIGURE 10



LONG ISLAND COAST BOTTOM DISSOLVED OXYGEN, 1983
SEMIMONTHLY AVERAGE OF ALL LONG ISLAND PERPENDICULAR STATIONS.

FIGURE 11



NEW YORK BIGHT BOTTOM DISSOLVED OXYGEN, 1983
SEMIMONTHLY AVERAGE OF ALL NEW YORK BIGHT STATIONS.

months in other years, with the exception of 1982, was again apparent in 1983. The low point was observed in late July, followed by a 2 mg/l recovery throughout August and a subsequent 2 mg/l decline throughout September. The fall recovery was not documented in the New York Bight Apex this summer.

Out of 135 samples collected in the New York Bight from May 24-September 28 and measured for dissolved oxygen, 11 samples, or 8.1 percent, were between the 3-4 mg/l level considered "stressful if prolonged" for aquatic life, and 11 samples, or 8.1 percent, were between the 2-3 mg/l level considered "lethal if prolonged".

Table 6 summarizes the dissolved oxygen values below 4 mg/l in the New York Bight during the Summer 1983.

Table 6 - Dissolved oxygen concentrations less than 4 mg/l in the New York Bight Apex, summer 1983

DATE	STATION	D.O. (mg/l)
7/27	NYB22	2.0
7/27	NYB26	2.9
7/27	NYB34	2.4
7/27	NYB35	3.2
7/27	NYB41	3.5
7/27	NYB43	3.2
7/27	NYB44	2.8
7/27	NYB45	3.1
8/3	NYB20	3.8
8/3	NYB21	3.1
8/3	NYB22	2.6
8/3	NYB26	3.8
8/3	NYB34	2.8
8/3	NYB42	2.0
8/8	NYB22	3.2
8/8	NYB24	2.6
8/8	NYB44	2.6
9/8	NYB45	3.4
9/28	NYB22	3.7
9/28	NYB26	2.5
9/28	NYB27	2.8
9/28	NYB45	3.8

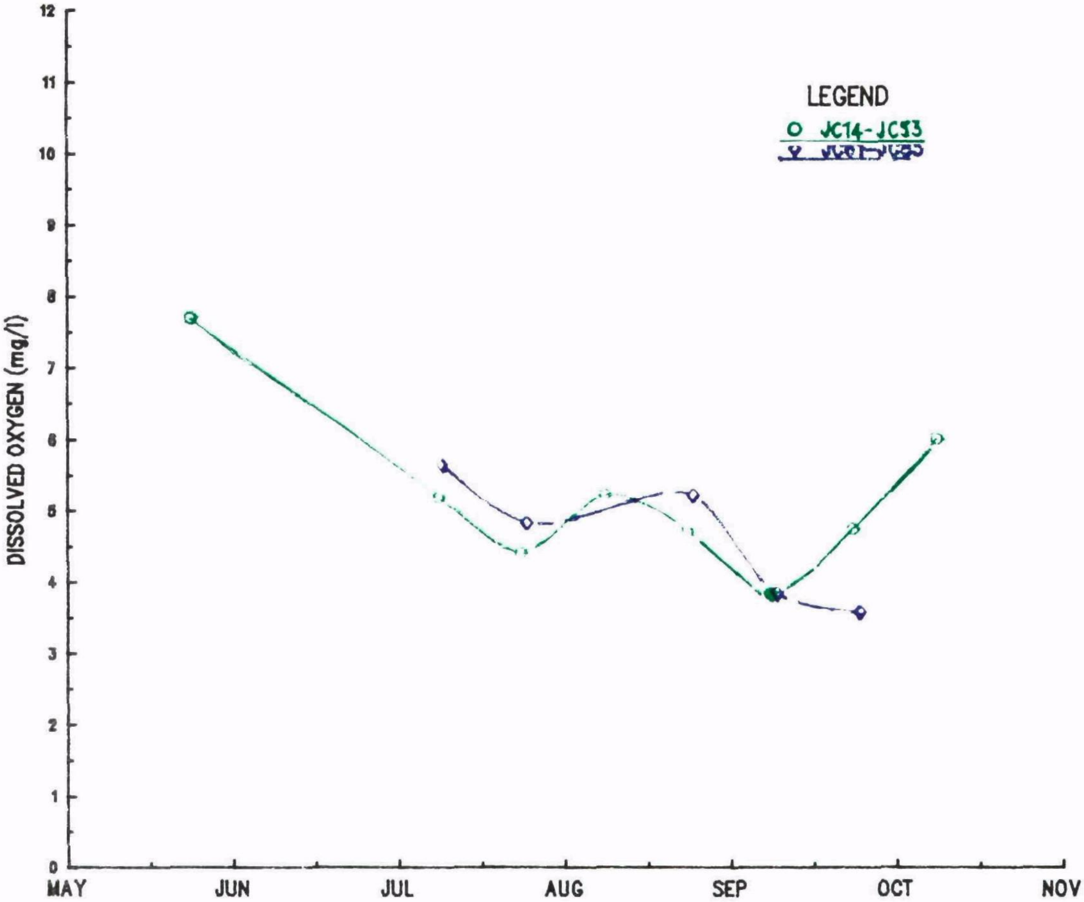
New Jersey Coast

Figure 12 illustrates the semi-monthly dissolved oxygen values off the New Jersey coast during the summer of 1983, with separate lines for the northern (JC 14-JC 53) perpendiculars and the southern (JC 61-JC 85) perpendiculars. The average dissolved oxygen values along the southern perpendiculars remained between 5.5 - 6.0 mg/l during July and August and decreased to about 4.0 mg/l during September. The northern perpendicular dissolved oxygen average exhibited the "double minima" phenomenon which occurred in previous years, with the exception of 1982. A low of 4.5 mg/l occurred in late July followed by a slight recovery in early August and a second low of about 4.0 mg/l in early September.

Table 7 summarizes the dissolved oxygen values for all the New Jersey coast perpendiculars. During the summer there were 72 values between 4-5 mg/l, 126 values between 2-4 mg/l and 13 values between 0-2 mg/l. This compares with 1982 when 72 values were between 4-5 mg/l, only 54 values were between 2-4 mg/l and 0 values were between 0-2 mg/l. In general, the DO values were slightly lower in 1983 than in 1982. Dissolved oxygen at the bottom reaches a minimum in late August/September due to a lack of reaeration and sediment oxygen demand. Values usually improve later in the season when storms and/or increased winds aid reaeration.

Figures 13, 14, and 15 show dissolved oxygen profiles along the coast for July, August, and September. The profiles show that, generally, DO increases with distance offshore and September values are lower than July and August. In Figure 13 there are no profiles for the Barnegat, Beach Haven, and Atlantic City perpendiculars because no data were collected along these three perpendiculars during August. The Strathmere perpendicular in August, below Atlantic City, was one of the few perpendiculars throughout the summer where the DO was higher closer to shore. This perpendicular

FIGURE 12



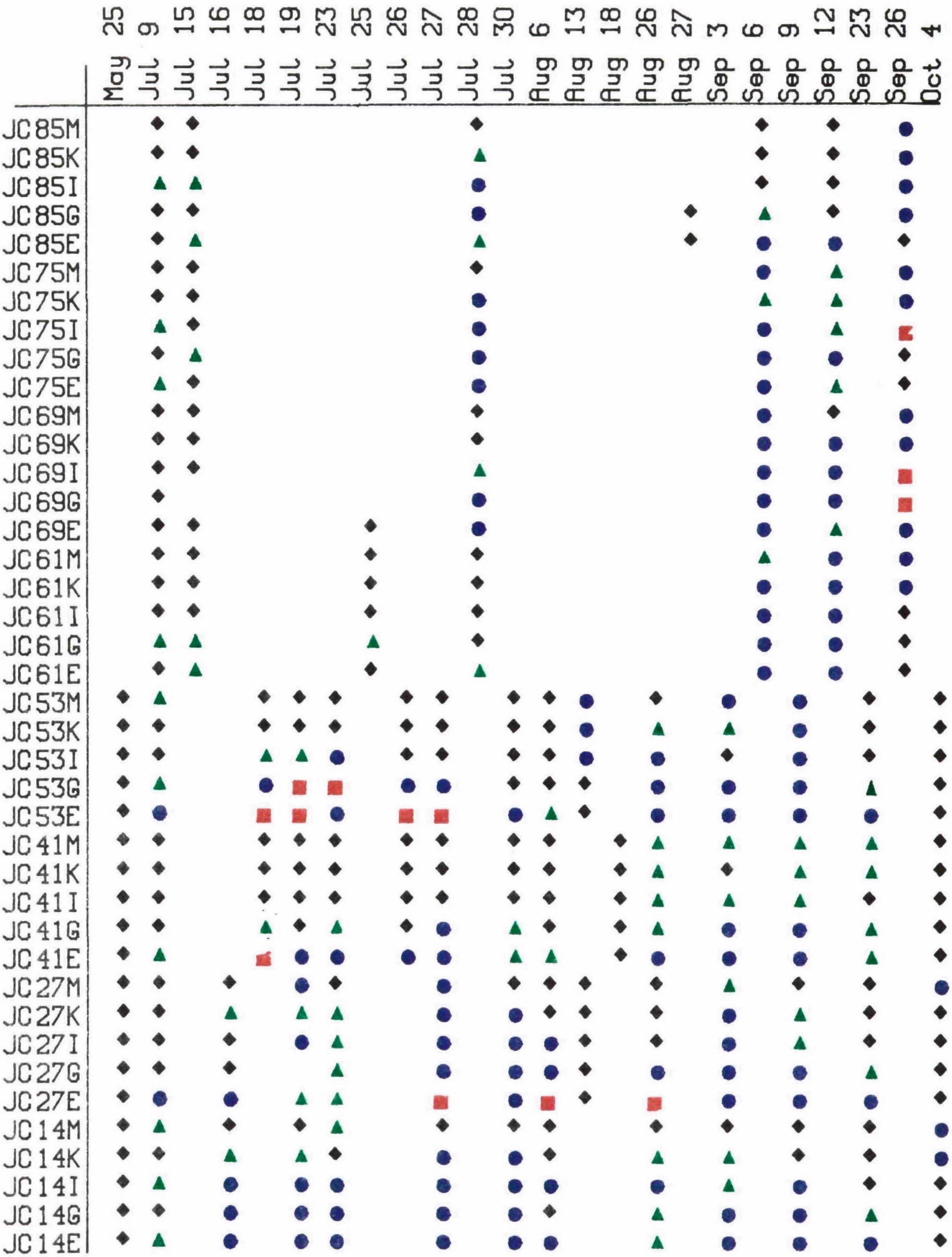
NEW JERSEY COAST BOTTOM DISSOLVED OXYGEN, 1983. SEMIMONTHLY AVERAGES OF ALL NORTHERN (JC14–JC53) AND SOUTHERN (JC61–JC85) PERPENDICULAR STATIONS.

TABLE 07

Dissolved Oxygen Distribution (Bottom Values)

New Jersey Coast Perpendiculars

1983



KEY: ◆ - > 5 mg/l ▲ - 4-5 mg/l ● - 2-4 mg/l ■ - 0-2 mg/l

FIGURE 13

Dissolved Oxygen Concentration Profiles

New Jersey Coast

July 1983

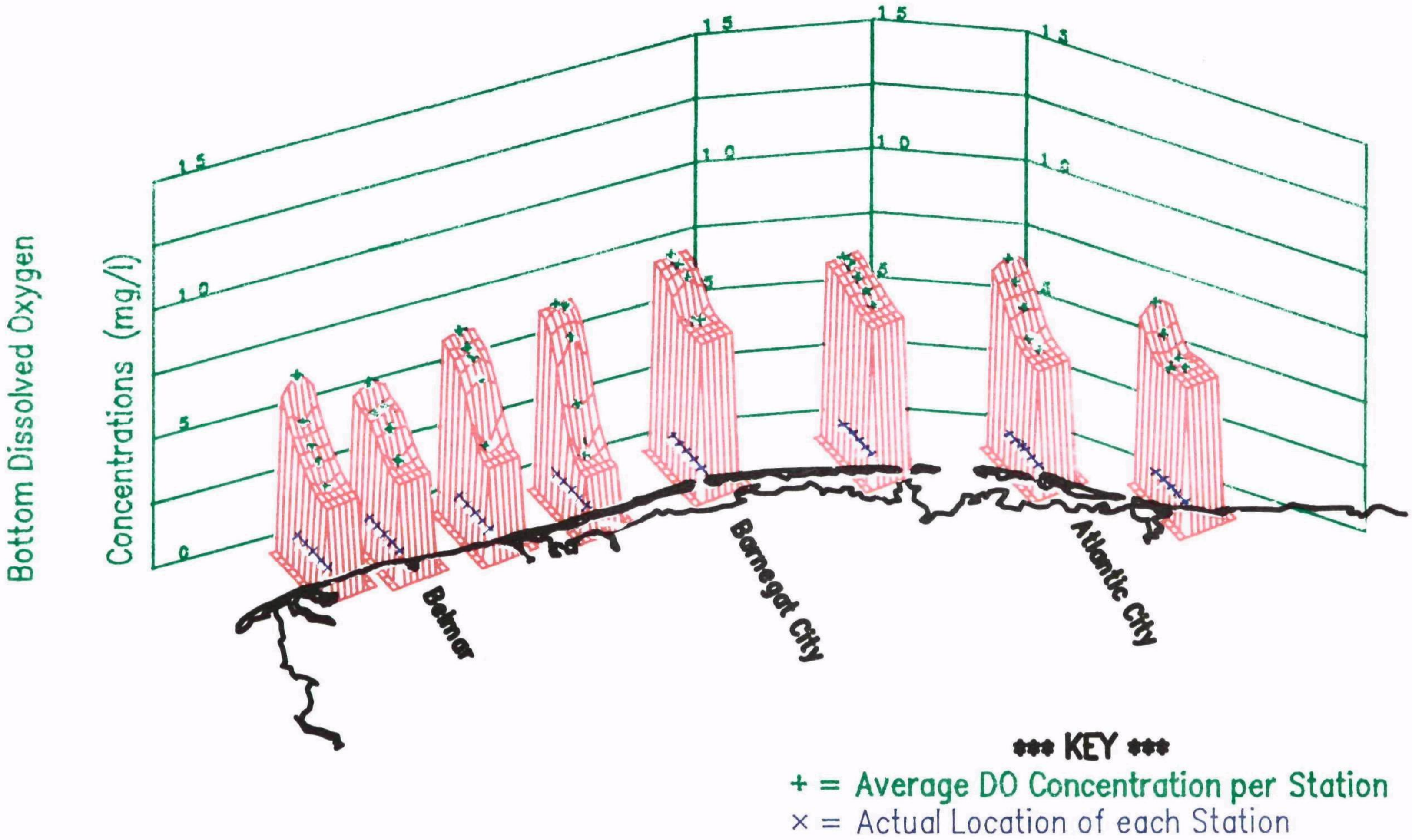


FIGURE 14

Dissolved Oxygen Concentration Profiles

New Jersey Coast

August 1983

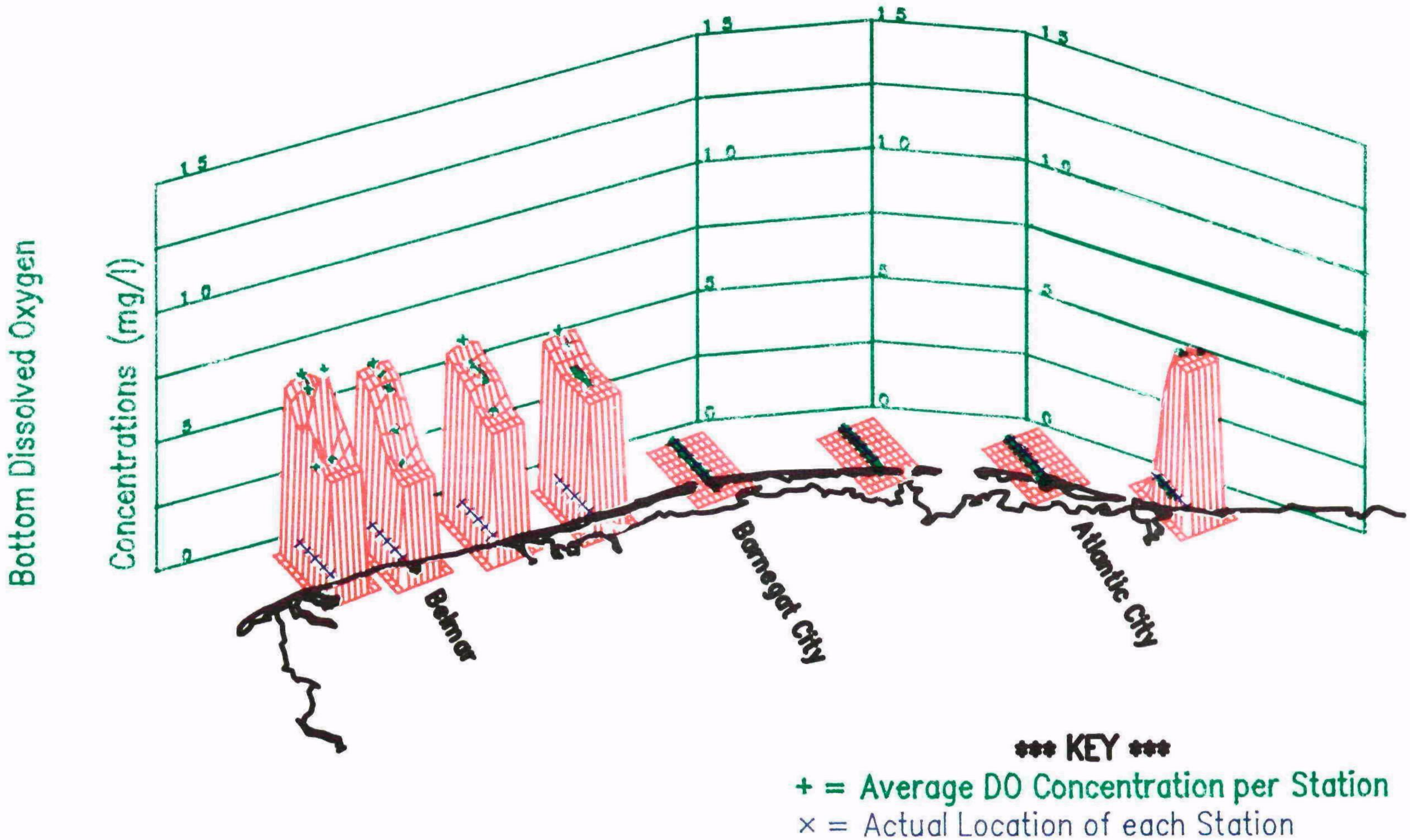
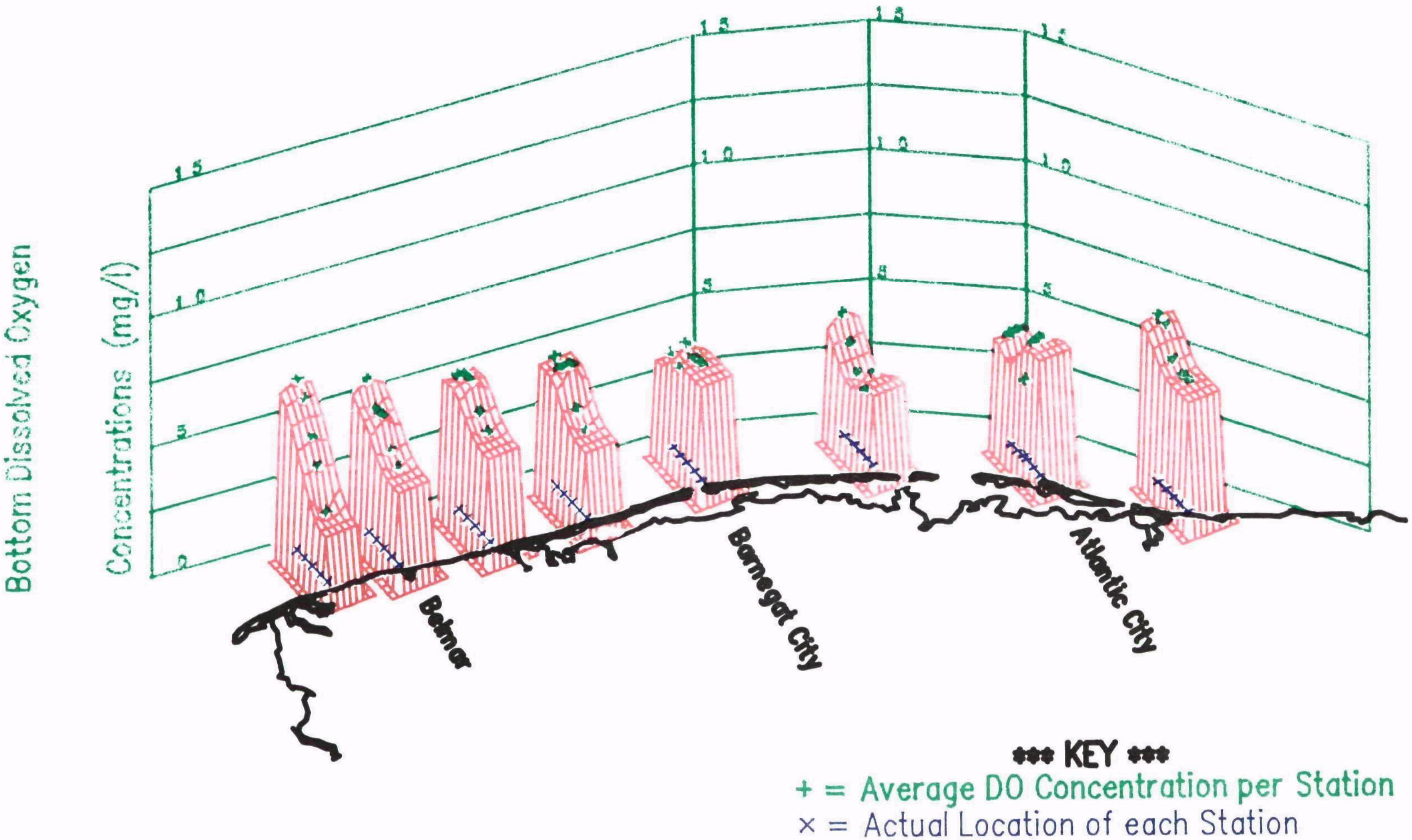


FIGURE 15

Dissolved Oxygen Concentration Profiles

New Jersey Coast

September 1983



reversed in September, Figure 15, and the DO again increased with distance from shore.

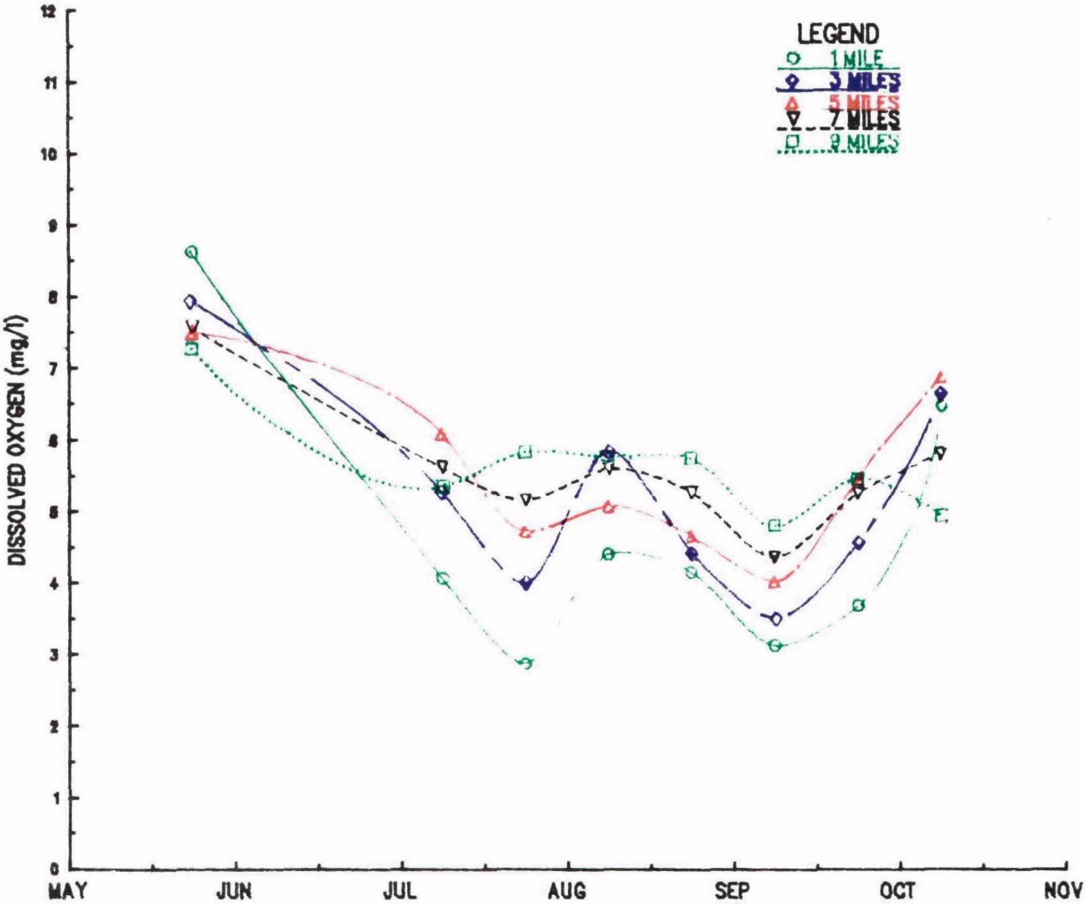
There were 486 samples collected along the New Jersey perpendiculars between May 25 and October 4, 1983 and analyzed for dissolved oxygen. Of these, 139 samples, or 28.6 percent, were below 4 mg/l.

Figure 16 compares the shore to seaward distribution of dissolved oxygen values along the northern New Jersey perpendiculars. This graph shows the following:

- As in previous years, with the exception of 1982, a dissolved oxygen "double minima" occurred along the New Jersey coast. Dissolved oxygen lows were recorded in late July, 1, 3, 5 and 7 miles off the coast, followed by an improvement in early August with a subsequent second minima occurring in early September. This year the "double minima" was not observed 9 miles off the coast.
- With the exception of the DO average 3 miles off the coast in early August, throughout July, August, and September the northern New Jersey perpendicular stations that are 1 and 3 miles offshore had average dissolved oxygen values approximately 1 - 2 mg/l less than the stations 5, 7 and 9 miles offshore. In general, the lower DO values found at the nearshore stations may be attributed to the influence of river runoff, treatment plant effluent, inlet dredged material disposal sites, and the Hudson Estuary system on the water along the New Jersey coast.

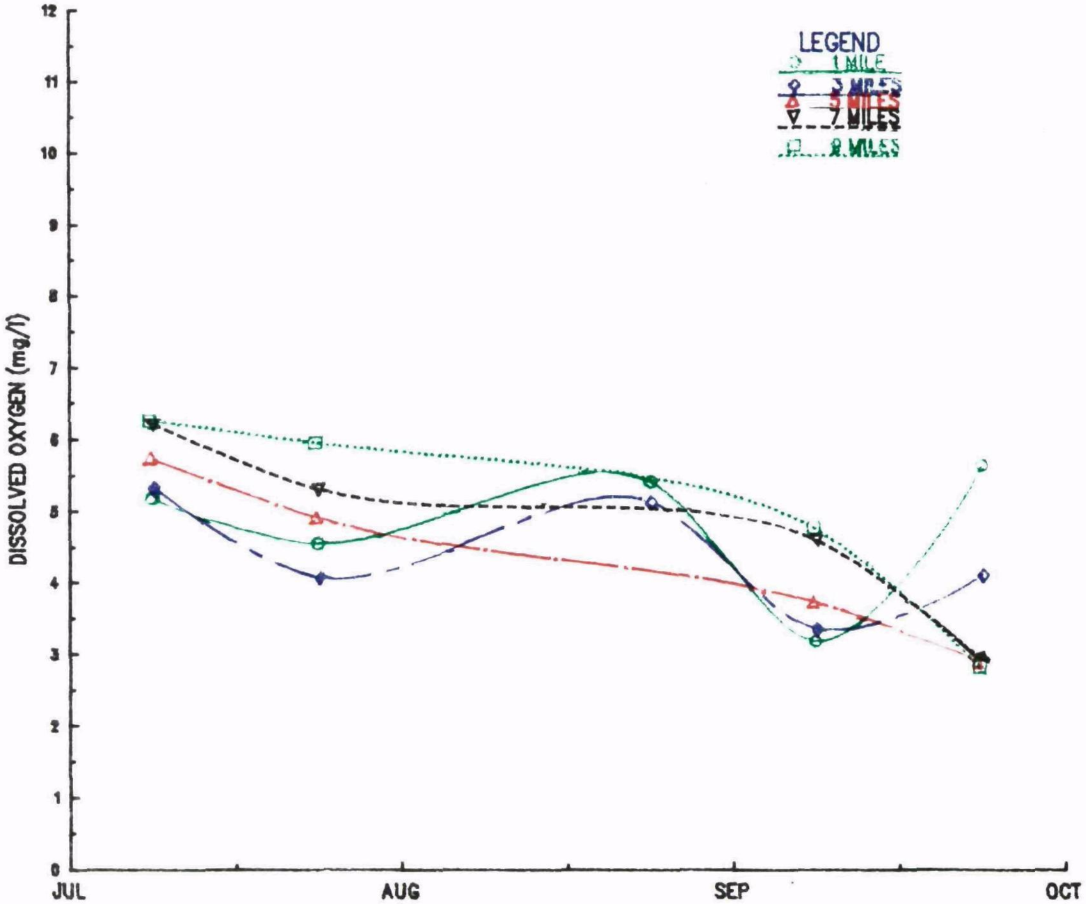
Figure 17 compares the shore to seaward distribution of dissolved oxygen values along the southern New Jersey perpendiculars. The stations 5, 7, and 9 miles off the coast had dissolved oxygen values between

FIGURE 16



SHORE–TO–SEAWARD DISTRIBUTION OF BOTTOM DISSOLVED OXYGEN, 1983
SEMIMONTHLY AVERAGES OF ALL NORTHERN PERPENDICULAR STATIONS (JC14–JC53), AT FIXED DISTANCES FROM SHORE.

FIGURE 17



SHORE–TO–SEAWARD DISTRIBUTION OF BOTTOM DISSOLVED OXYGEN, 1983
SEMIMONTHLY AVERAGES OF ALL SOUTHERN PERPENDICULAR STATIONS
(JC61–JC85), AT FIXED DISTANCES FROM SHORE.

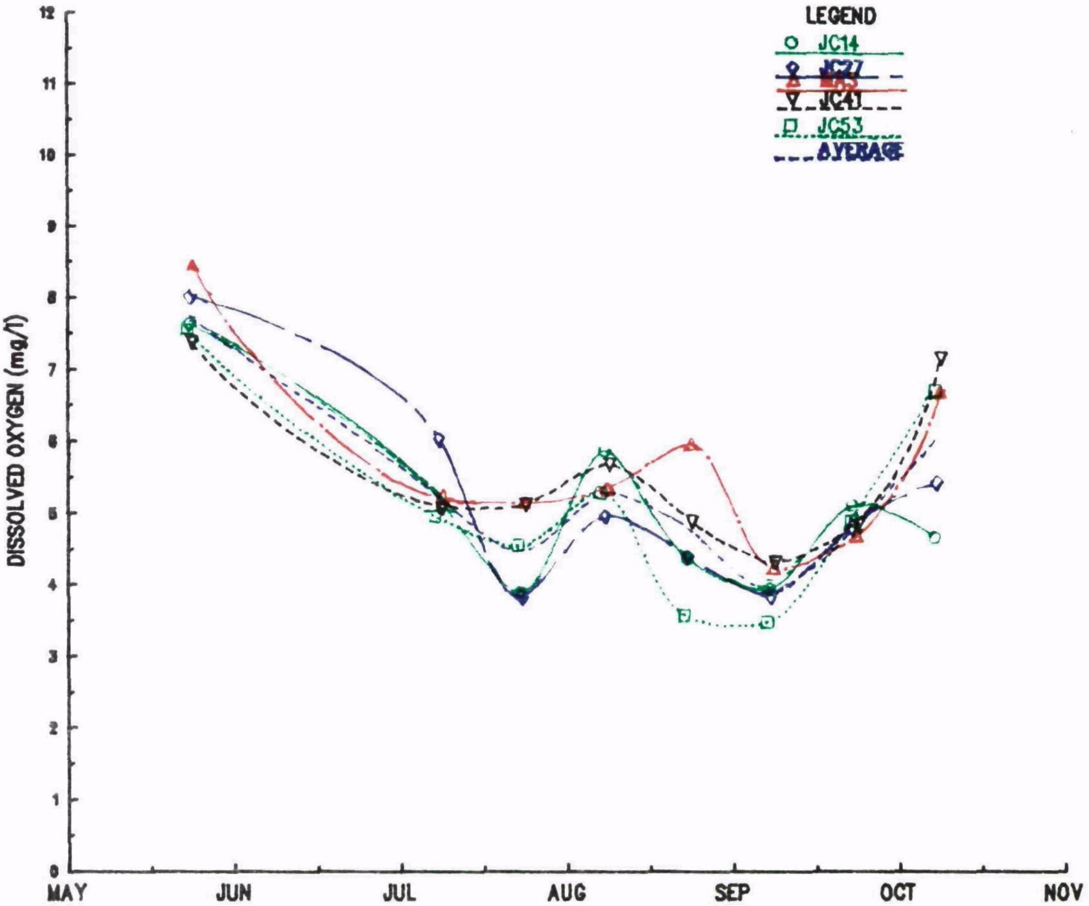
5.5 and 6.5 mg/l in early July which fell slowly throughout the summer to about 3.0 mg/l in late September. The stations 1 and 3 miles off the coast exhibited the "double minima" with the lowest values occuring in early September followed by a recovery in late September. The stations 1 and 3 miles off the coast had dissolved oxygen averages of approximately 5.5 mg/l in early July, which fell to about 4.5 mg/l in late July, rose to 5.5 to 6.0 mg/l in late August, fell to about 3.0 mg/l in early September and recovered in late September.

Figure 18 illustrates the DO values for the northern perpendiculars in 1983 as compared to an overall average. JC 27, MAS, JC 41, and JC 53 clearly show the "double minima" phenomenon. JC 14 shows a minima in late July, another in early September and a third in early October. The recovery for the JC 14 perpendicular was not documented.

Figure 19 gives the same plot for the southern perpendiculars. All perpendiculars, with the exception of JC 85 show a slow downward trend from early July through early September. JC 85 perpendicular exhibits a 2.0 mg/l drop from early September to late September. The only southern perpendicular to show signs of a fall recovery in late September was JC 61.

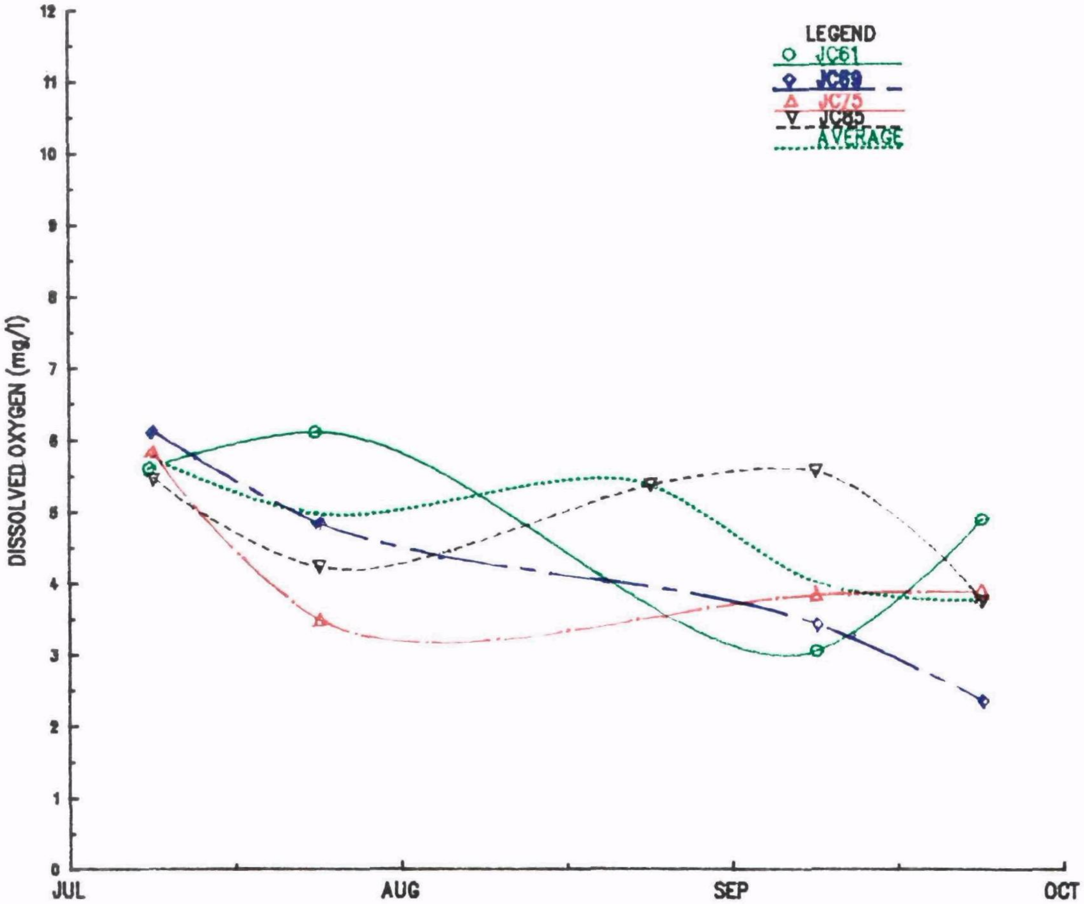
Figures 20, 21, 22, and 23 show the number of dissolved oxygen observations on each perpendicular over the last 5 years which, during June, July, August and September, were below a level of 4 mg/l. June has consistently had high dissolved oxygen values. There were no values below 4 mg/l in June over the last 5 years, Figure 20. 1983 had the greatest number of dissolved oxygen values below 4 mg/l during July, Figure 21. The JC 14 perpendicular had 20 observations below 4 mg/l. August 1983 dissolved oxygens, Figure 22, were slightly better than average, while September 1983 dissolved oxygens, Figure 23, were the lowest in the last five years.

FIGURE 18



NORTH–SOUTH BOTTOM DISSOLVED OXYGEN DISTRIBUTION FOR NORTHERN NEW JERSEY, 1983.
SEMIMONTHLY AVERAGES ALONG PERPENDICULARS JC14–JC53, COMPARED TO OVERALL AVERAGE.

FIGURE 19



NORTH–SOUTH BOTTOM DISSOLVED OXYGEN DISTRIBUTION FOR SOUTHERN NEW JERSEY, 1983. SEMIMONTHLY AVERAGES ALONG PERPENDICULARS JC61–JC85, COMPARED TO OVERALL AVERAGE.

FIGURE 20

Dissolved Oxygen Concentrations
Below 4 mg/l
New Jersey Coast
June

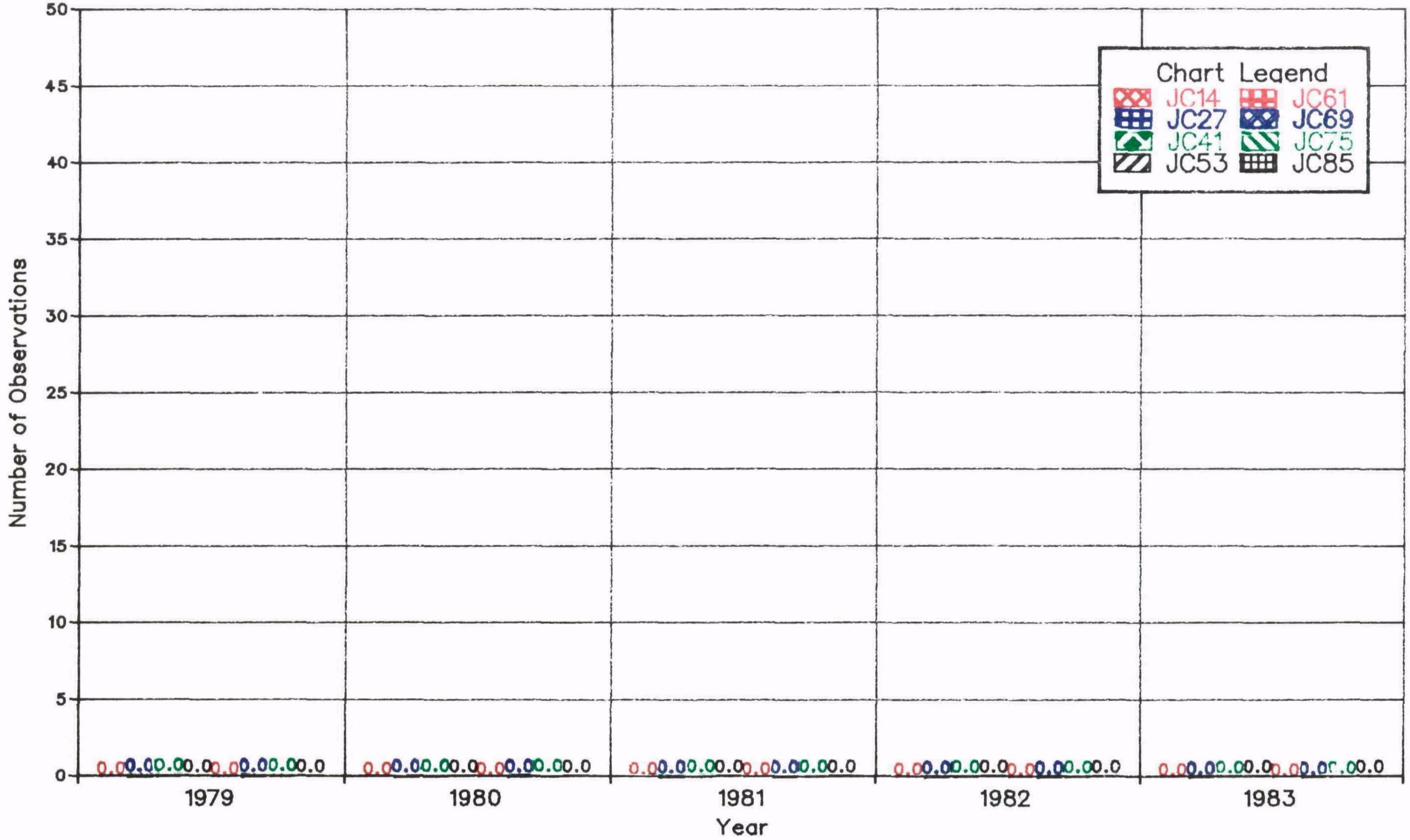


FIGURE 21

Dissolved Oxygen Concentrations
Below 4 mg/l
New Jersey Coast
July

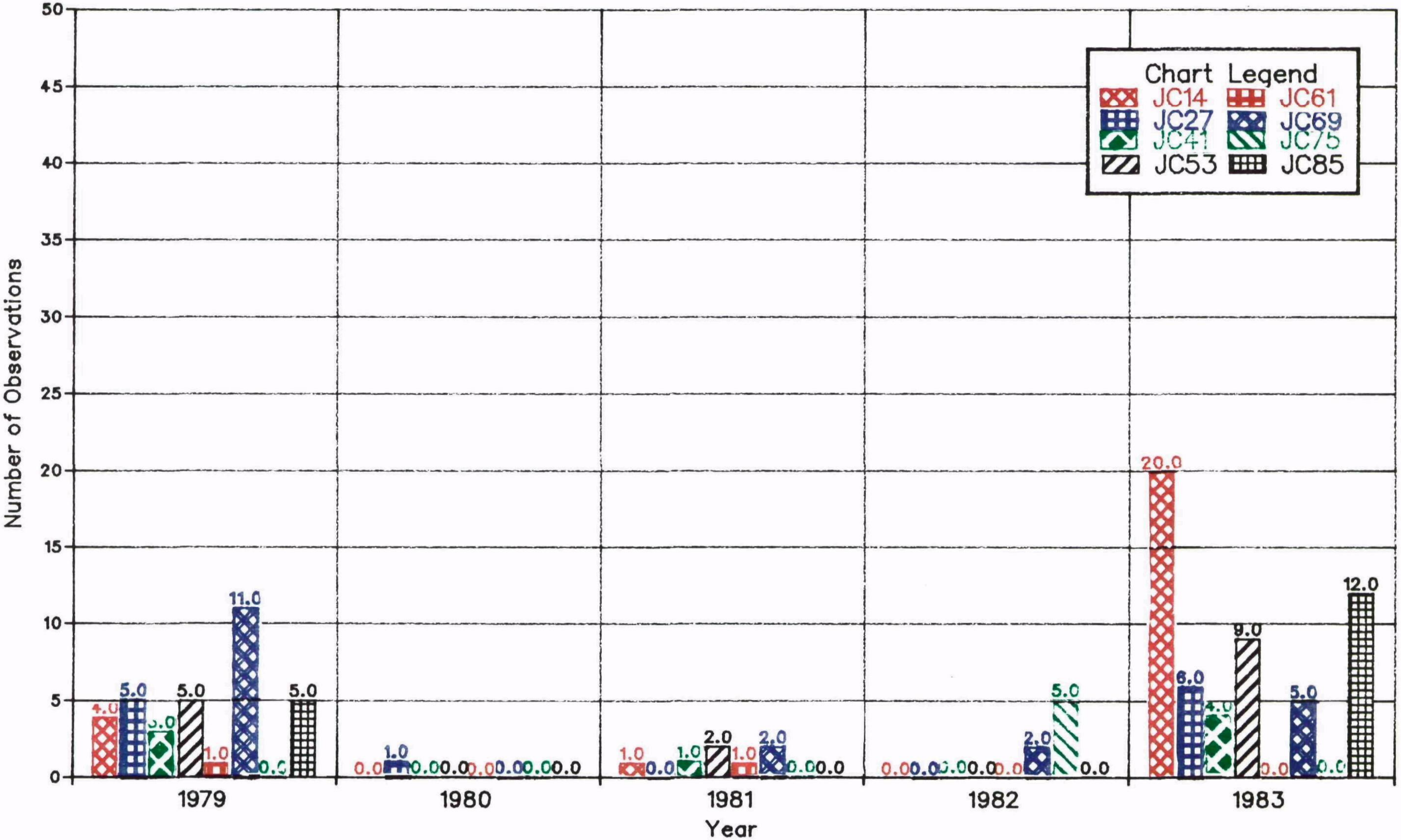


FIGURE 22

Dissolved Oxygen Concentrations
Below 4 mg/l
New Jersey Coast
August

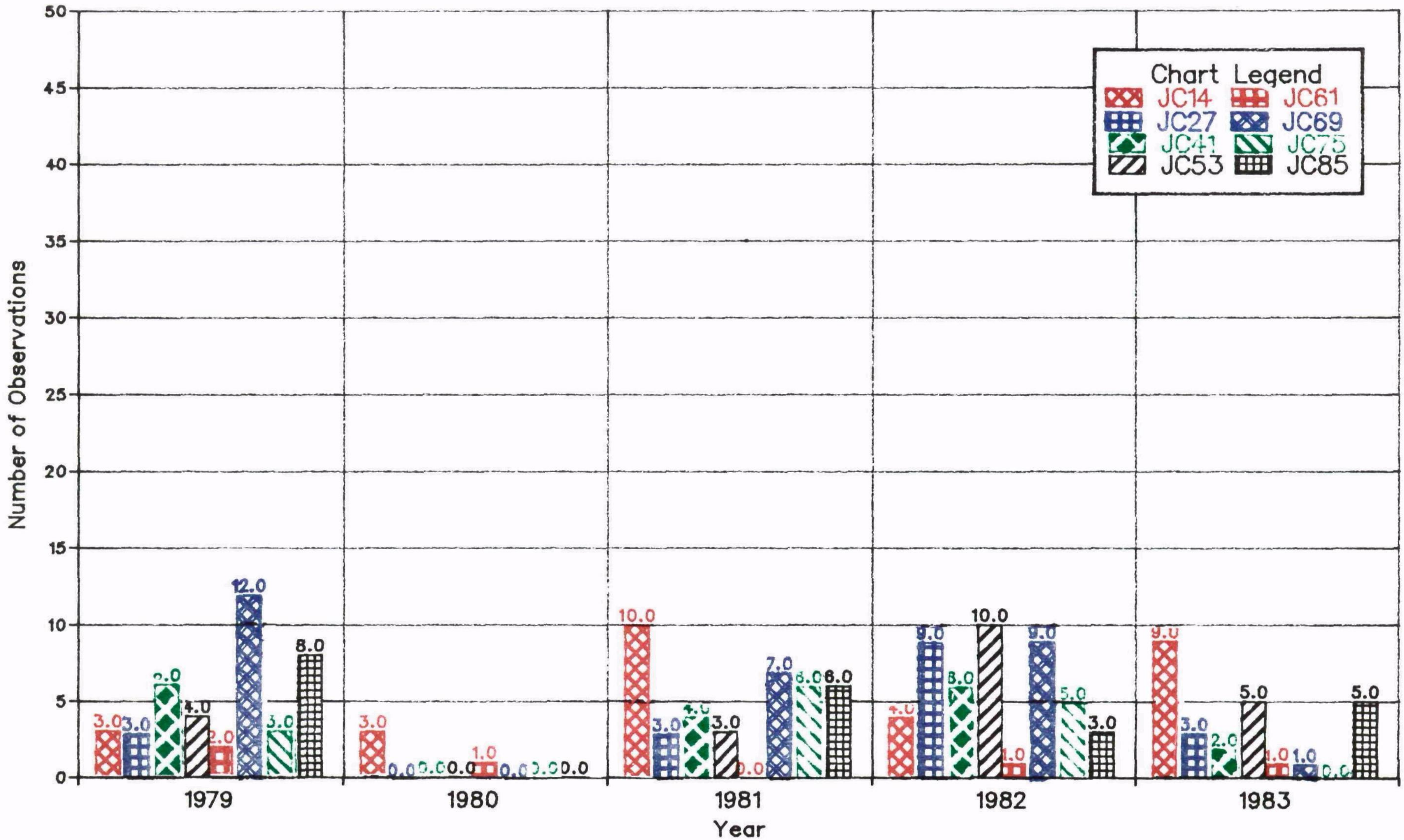
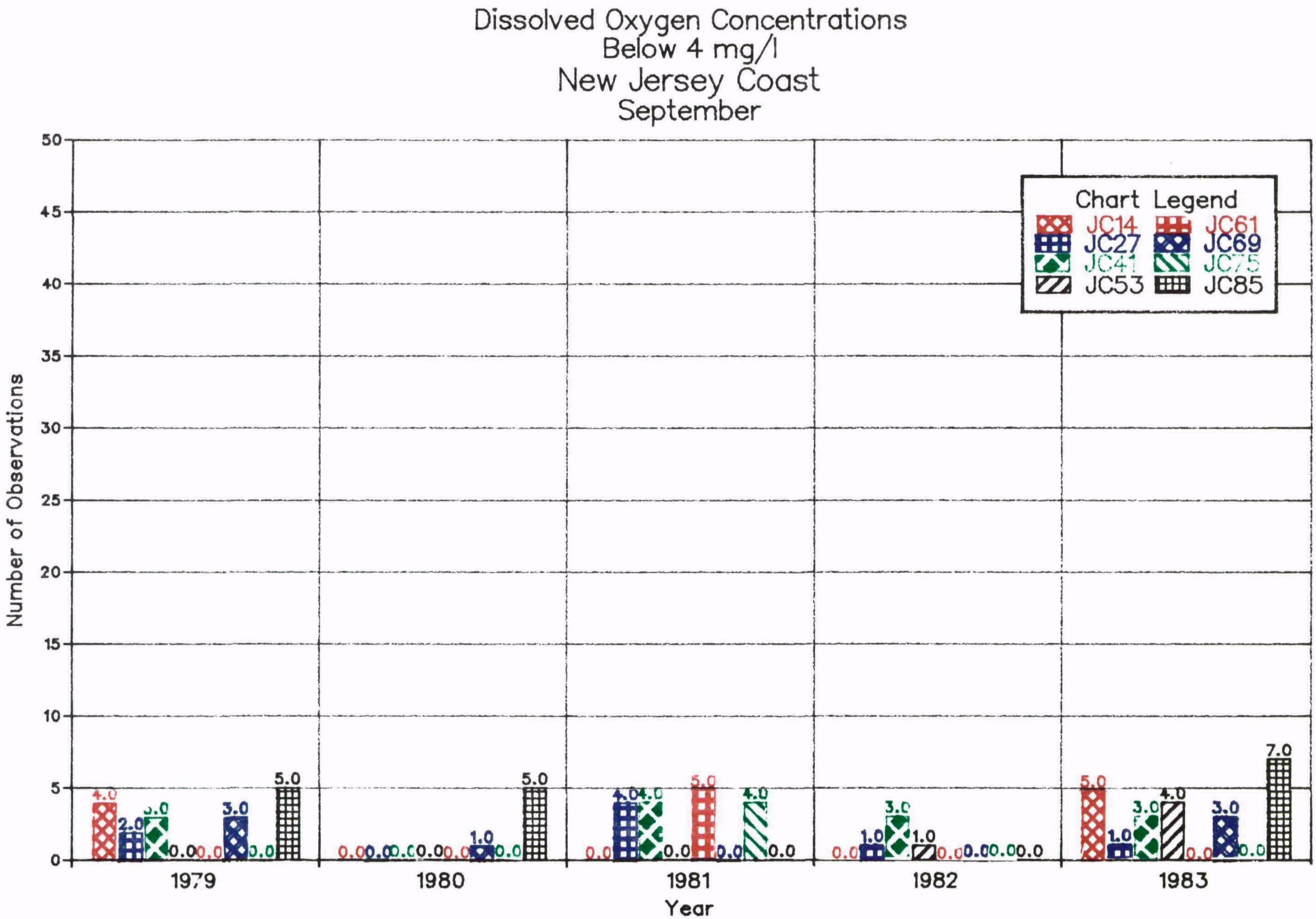


FIGURE 23



Dissolved Oxygen Concentrations
Below 4 mg/l
New Jersey Coast
September
Chart Legend
JC14
JC61
JC27
JC69
JC41
JC75
JC53
JC85
Number of Observations
0
5
10
15
20
25
30
35
40
45
50
1979
1980
1981
1982
1983
Year

Dissolved Oxygen Trends

Figure 24 shows the five year average, made up of the average of all semimonthly averages, for the northern New Jersey perpendicular stations. The DO starts off at approximately 8 mg/l in late May and drops at a fairly constant rate to approximately 5 mg/l in late July. It remains at 5 mg/l until late August when it drops to 4.5 mg/l in early September. Throughout the remainder of September and into October the DO begins to recover, rising quite rapidly in October.

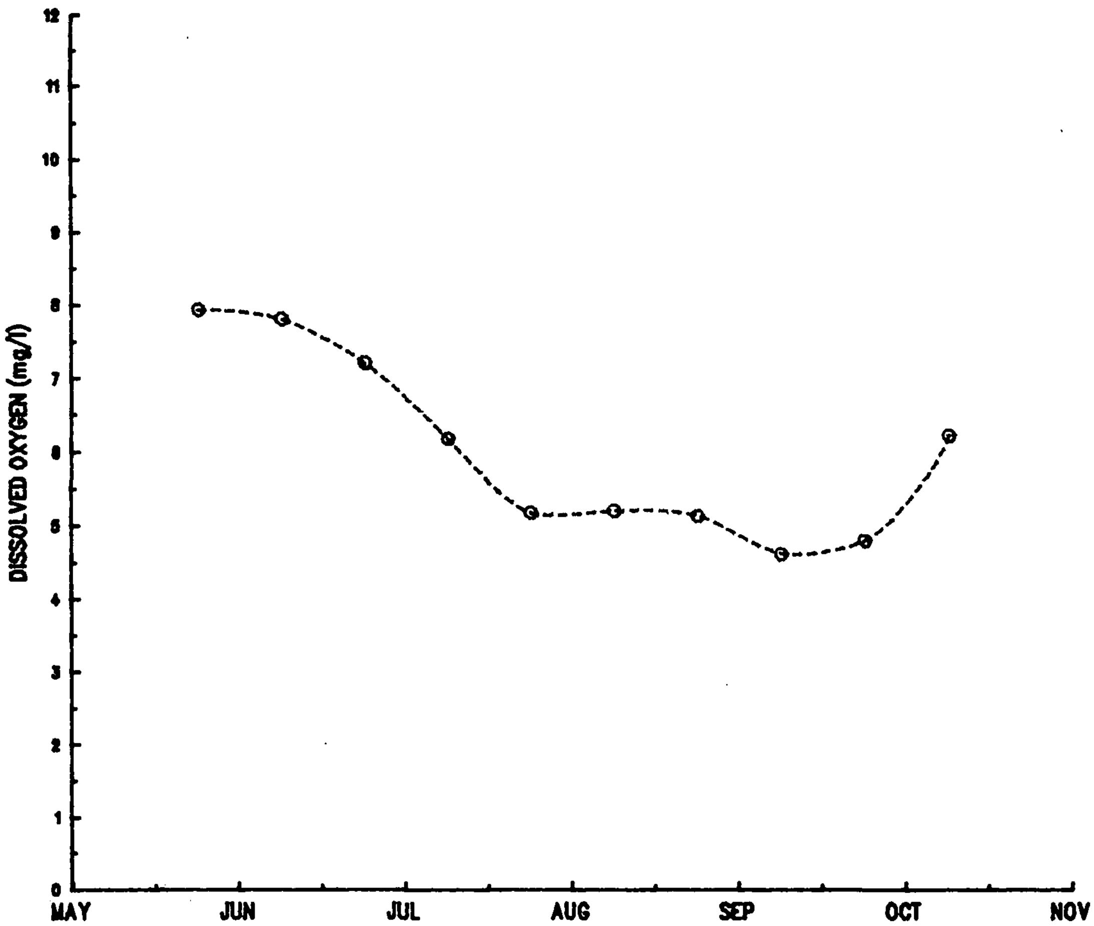
Figure 25 shows the five year average, made up of the average of all semimonthly averages, for the southern New Jersey perpendicular stations. The DO starts off in June at approximately 8.5 mg/l and drops fairly rapidly to about 5.5 mg/l in early July. It remains between 5.0 and 5.5 mg/l until early September when it drops to about 4.5 mg/l. It rises steadily through September and into October.

Figures 26, 27 and 28 illustrate the five year trends in dissolved oxygen for Northern New Jersey perpendiculars, Southern New Jersey perpendiculars and New York Bight Stations, respectively.

Figure 26 shows a dissolved oxygen "double minima" occurring in 1979, 1980, and 1983 with an initial low occurring in late July followed by a small recovery and then a second low in early to mid September. In 1981 and 1982 there was one low occurrence each in early August, 1981 and early September, 1982.

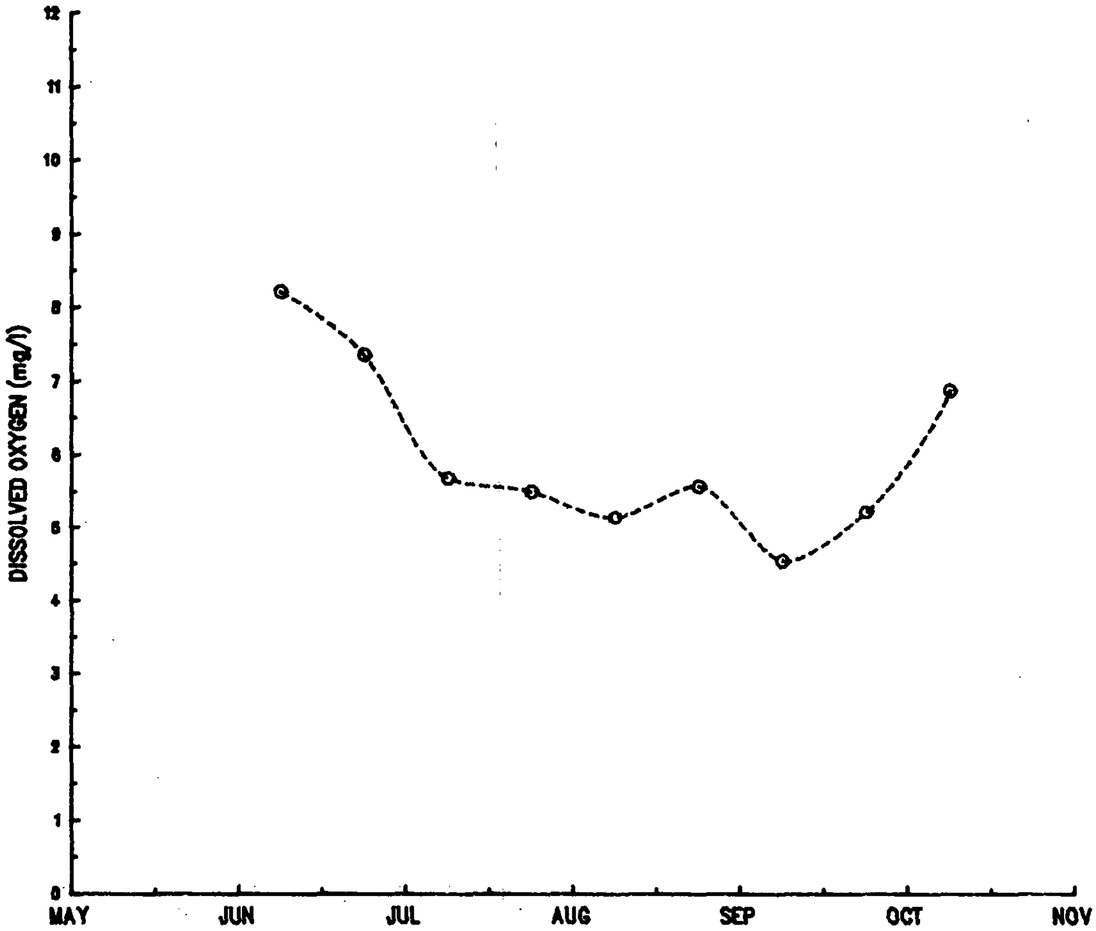
In 1983 along the southern New Jersey perpendiculars, Figure 27, the average DO started at about 6.0 mg/l in early July and dropped to about 4.0 mg/l in late September. Figure 27 shows no obvious trends over the years.

FIGURE 24



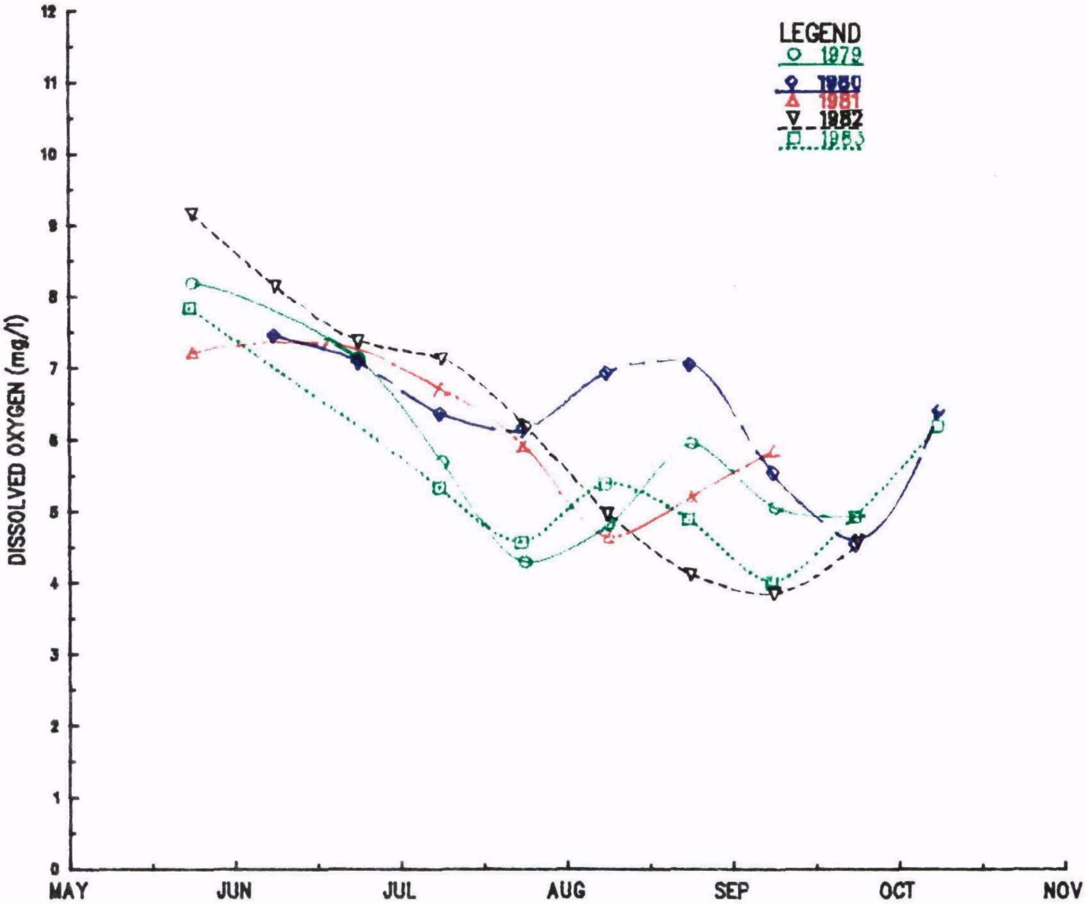
NORTHERN NEW JERSEY COAST BOTTOM DISSOLVED OXYGEN, FIVE YEAR AVERAGE OF THE INDIVIDUAL SEMIMONTHLY AVERAGES, 1979 TO 1983

FIGURE 25



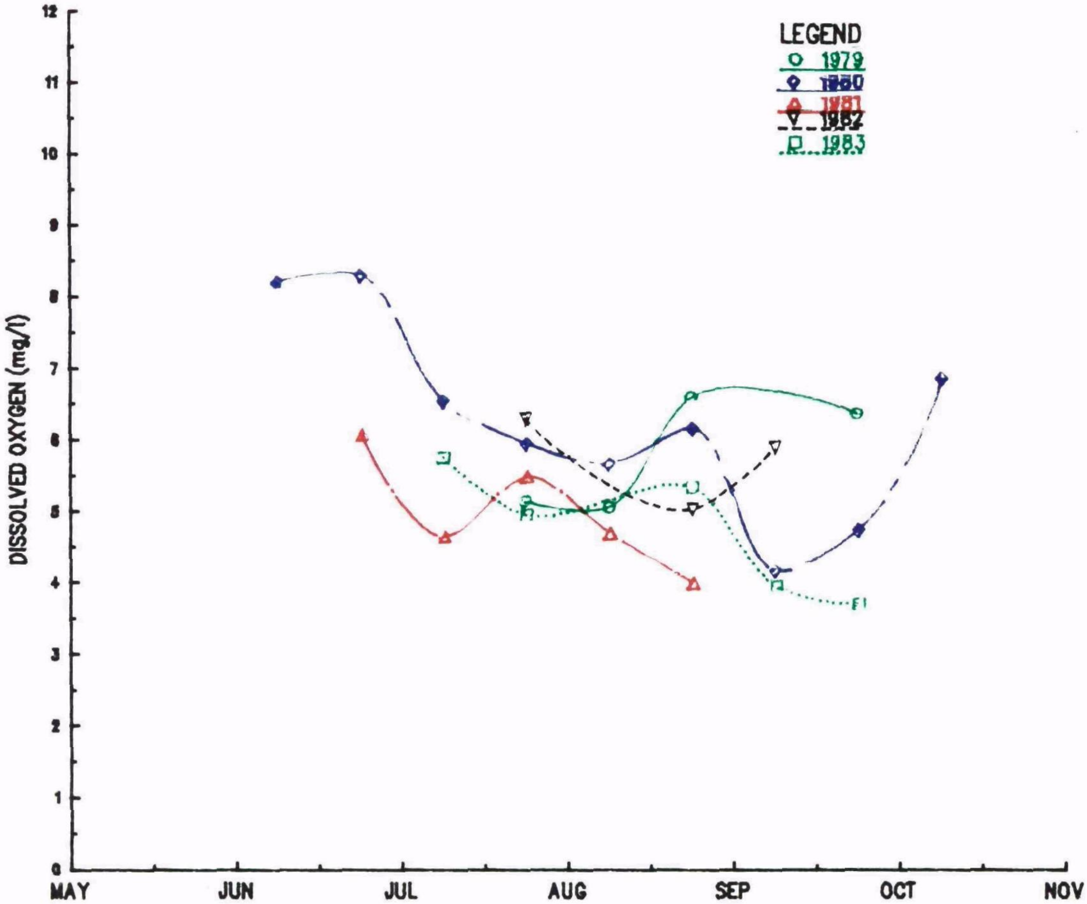
SOUTHERN NEW JERSEY COAST BOTTOM DISSOLVED OXYGEN, FIVE YEAR AVERAGE OF THE INDIVIDUAL SEMIMONTHLY AVERAGES, 1979 TO 1983

FIGURE 26



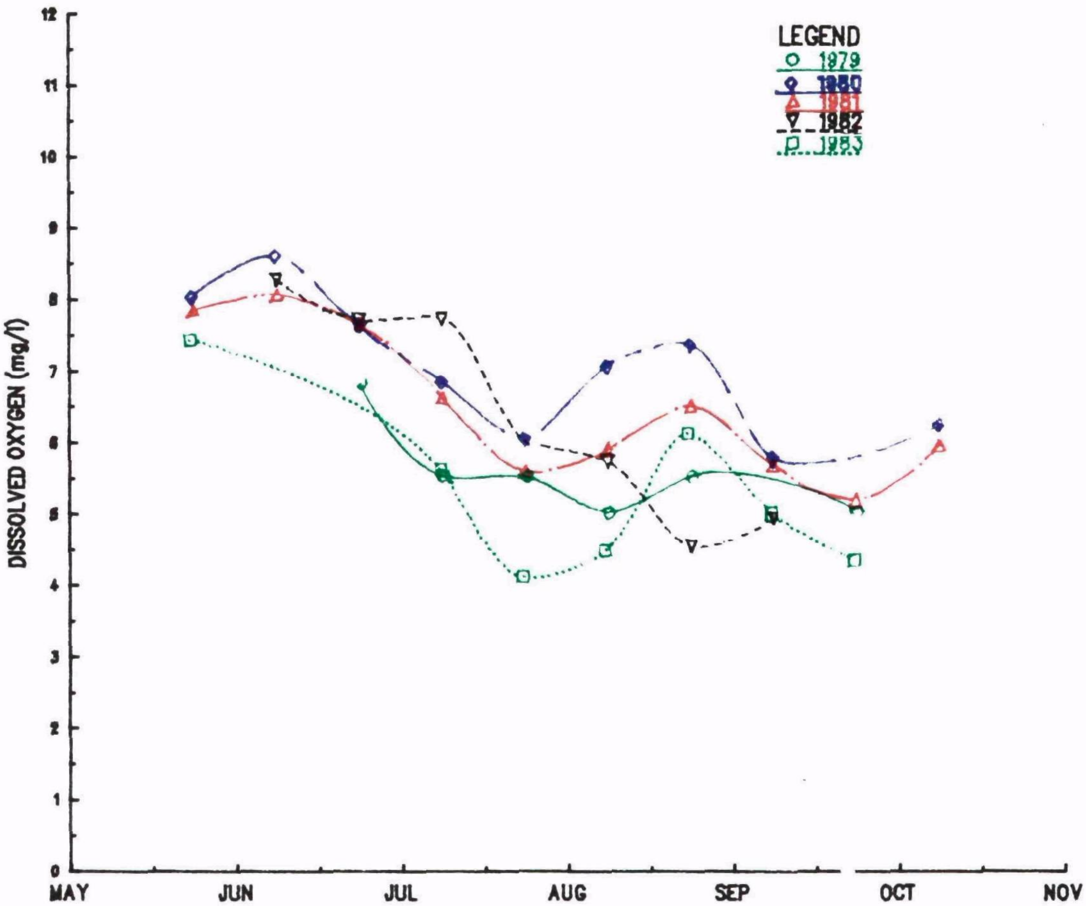
NORTHERN NEW JERSEY COAST BOTTOM DISSOLVED OXYGEN, 1979–1983 COMPARISON. SEMIMONTHLY AVERAGES OF ALL JC14–JC53 PERPENDICULAR STATIONS.

FIGURE 27



SOUTHERN NEW JERSEY COAST BOTTOM DISSOLVED OXYGEN, 1979–1983 COMPARISON. SEMIMONTHLY AVERAGES OF ALL JC61–JC85 PERPENDICULAR STATIONS.

FIGURE 28



NEW YORK BIGHT BOTTOM DISSOLVED OXYGEN, 1979–1983 COMPARISON.
SEMIMONTHLY AVERAGE OF ALL NEW YORK BIGHT STATIONS.

In Figure 28 a comparison of all New York Bight stations is shown for the years 1979-1983. The 1983 semimonthly DO average is approximately 1 mg/l lower than in the previous four years except for late August when it is just about average. The "double minima" is evident for 1980, 1981, and 1983. The fall recovery is not documented in 1983.

V. BACTERIOLOGICAL RESULTS

New Jersey

Table 8 presents a summary of the fecal coliform data collected along the coast of New Jersey between June 2, 1983 and October 5, 1983. The geometric mean for each station is plotted in Figure 29. The State standard for primary contact recreation along the New Jersey Coast is a geometric mean of 50 fecal coliforms/100 ml based on five or more samples analyzed within a 30 day period. Due to the low values found and the relatively small number of samples collected, only one geometric mean was calculated for each station over the entire summer. The highest geometric mean, 2.9, is at station JC 81 at Ocean City. Station JC 93 at Wildwood and JC 01A at Sandy Hook had geometric means of 2.8 and 2.5, respectively. All of the geometric means are very low. Figure 29 clearly shows that the New Jersey coastal stations are well below the bacteriological standard. Based on fecal coliform data, New Jersey coastal waters have excellent water quality.

Throughout the summer sampling period, a total of 442 samples were collected for fecal coliform analysis along the New Jersey Coast. Of the 442 samples, four or approximately one percent were above 50 fecal coliforms/100 ml. These samples were:

Station	Date Sampled	Fecal Coliform/100ml
JC 01A	6/02/83	100
JC 14	8/31/83	53
JC 30	8/11/83	96
JC 75	7/21/83	152

The causes for the elevated densities at stations JC 14 and JC 30 are unknown. The cause of the high value at JC 75 is probably poorly treated sewage from the Atlantic City Sewage Treatment Plant. The cause of the elevated value at JC 01A is probably poorly treated sewage from New York Harbor or Raritan Bay.

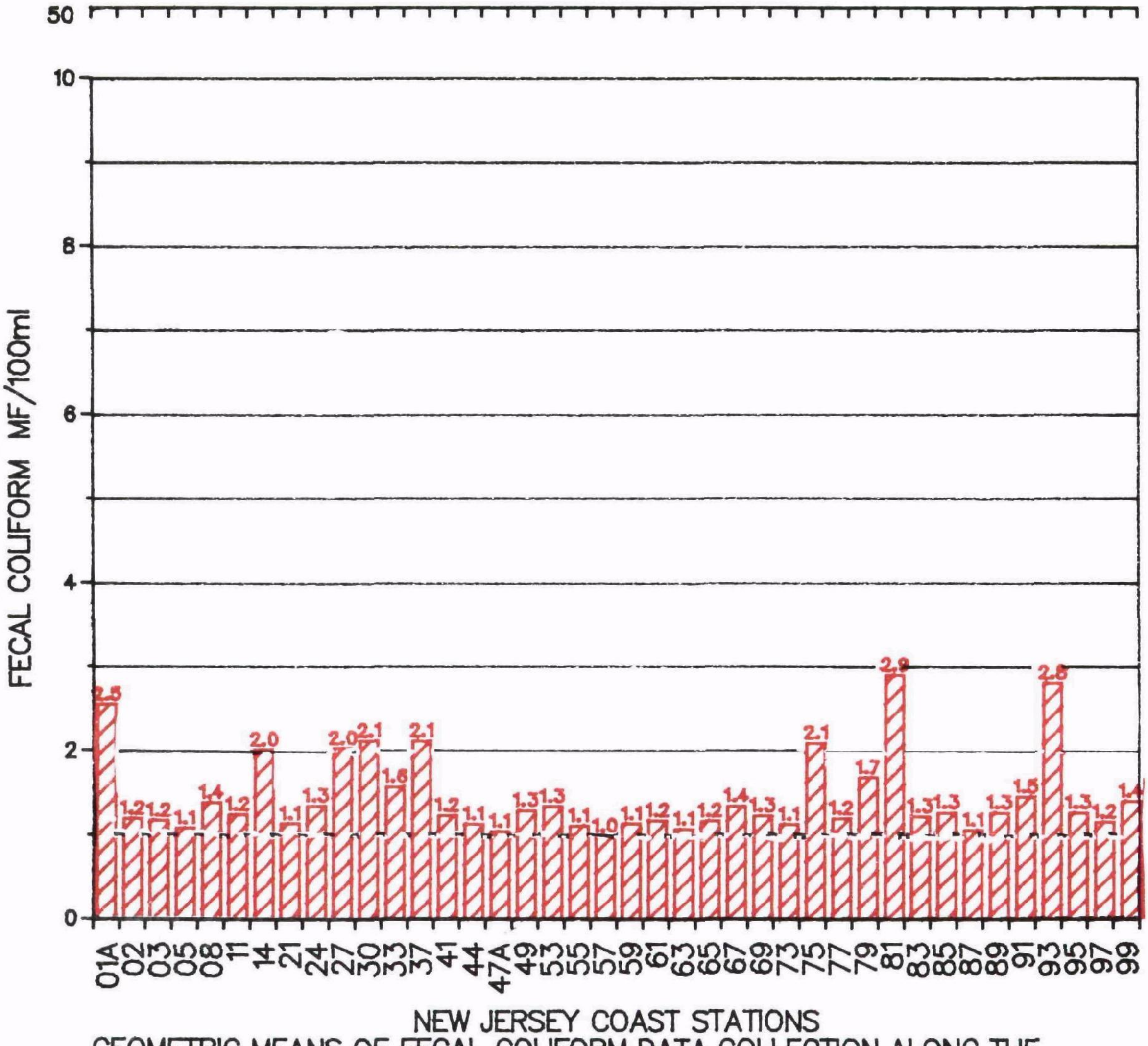
TABLE 8

Summary of bacteriological data
collected along the New Jersey coast
June 2, 1983 through October 5, 1983

Station	Number of Samples Collected	Maximum Value Fecal Coliform/100 ml	Geometric Mean Fecal Coliform/100 ml
JC01A	14	100	2.5
JC02	14	4	1.2
JC03	14	3	1.2
JC05	14	3	1.1
JC08	14	24	1.4
JC11	14	7	1.2
JC14	14	53	2.0
JC21	14	3	1.1
JC24	14	8	1.3
JC27	14	16	2.0
JC30	14	96	2.1
JC33	14	36	1.6
JC37	14	35	2.1
JC41	14	20	1.2
JC44	14	3	1.1
JC47A	14	2	1.1
JC49	14	5	1.3
JC53	14	11	1.3
JC55	14	5	1.1
JC57	14	1	1.0
JC59	8	3	1.1
JC61	8	2	1.2
JC63	8	2	1.1
JC65	8	4	1.2
JC67	8	6	1.4
JC69	8	6	1.3
JC73	8	3	1.1
JC75	10	152	2.1
JC77	8	5	1.2
JC79	8	18	1.7
JC81	8	18	2.9
JC83	8	3	1.3
JC85	8	4	1.3
JC87	8	2	1.1
JC89	8	2	1.3
JC91	8	12	1.5
JC93	8	13	2.8
JC95	8	2	1.3
JC97	8	2	1.2
JC99	8	3	1.4

FIGURE 29

STANDARD



GEOMETRIC MEANS OF FECAL COLIFORM DATA COLLECTION ALONG THE COAST OF NEW JERSEY, JUN 2, 1983 TO OCT 5, 1983.
(ACTUAL VALUES PRINTED ABOVE BARS)

Long Island

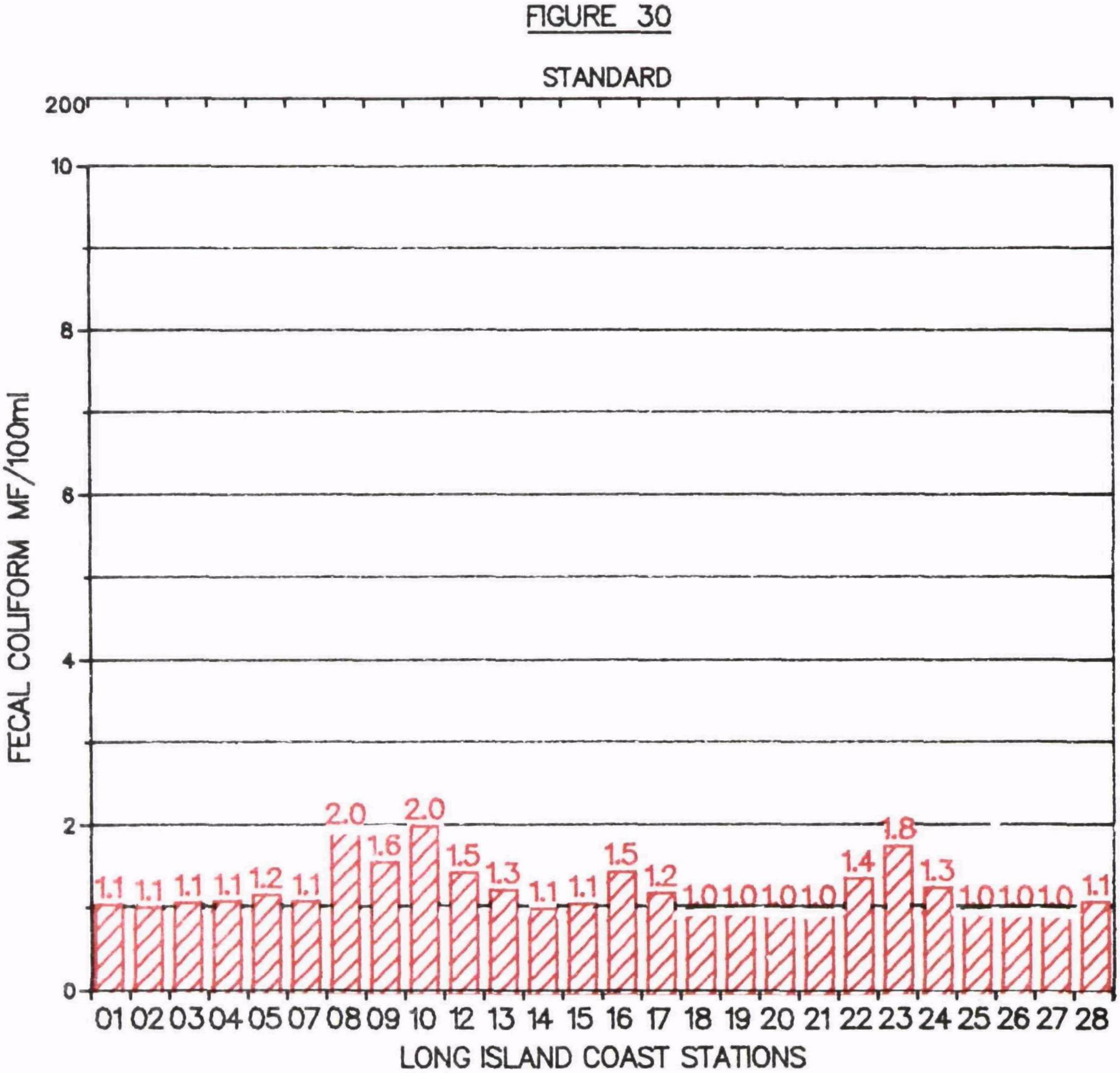
Table 9 presents a summary of the fecal coliform data collected along the coast of Long Island from May 18, 1983 through September 27, 1983. The geometric mean for each station is plotted in Figure 30. The State standard for primary contact recreation along the Long Island coast is 200 fecal coliforms/100 ml. This value is a monthly geometric mean of five or more samples. Only five samples were collected all summer at stations LIC 17-28, therefore this portion of the graph represents a geometric mean of only five data points at each station. As with the New Jersey data, due to the low values found and the relatively small number of samples collected, only one geometric mean was calculated for each station over the entire summer. The highest geometric mean is 2.0, which occurred at stations LIC 08 and 10. Station LIC 10 also had the highest geometric mean in 1980, 1981, and 1982. LIC 10 is under the direct influence of any poorly treated sewage that may flow out of Jones Inlet. From Figure 30, it is apparent that the standard is not approached. Based on bacteriological data, the New York coastal waters along Long Island are of excellent quality.

A total of 242 samples were collected during the summer along the coast of Long Island and analyzed for fecal coliform bacteria. The highest density found all summer, 28 fecal coliforms/100 ml, was at station LIC 10. This value is well below the State standard.

TABLE 9

Summary of bacteriological data collected along the coast of Long Island May 18, 1983 through September 27, 1983

Station	Number of Samples Collected	Maximum Value Fecal Coliform/100 ml	Geometric Mean Fecal Coliform/100 ml
LIC01	13	3	1.1
LIC02	13	2	1.1
LIC03	13	4	1.1
LIC04	13	5	1.1
LIC05	13	3	1.2
LIC07	13	5	1.1
LIC08	13	10	2.0
LIC09	13	16	1.6
LIC10	13	28	2.0
LIC12	13	11	1.5
LIC13	13	12	1.3
LIC14	13	2	1.1
LIC15	13	4	1.1
LIC16	13	10	1.5
LIC17	5	3	1.2
LIC18	5	1	1.0
LIC19	5	1	1.0
LIC20	5	1	1.0
LIC21	5	1	1.0
LIC22	5	6	1.4
LIC23	5	5	1.8
LIC24	5	4	1.3
LIC25	5	1	1.0
LIC26	5	1	1.0
LIC27	5	1	1.0
LIC28	5	2	1.1



GEOMETRIC MEANS OF FECAL COLIFORM DATA COLLECTION ALONG THE COAST OF LONG ISLAND, MAY 18, 1983 TO SEP 27, 1983. (ACTUAL VALUES PRINTED ABOVE BARS)

New York Bight Apex

During the summer of 1983 a total of 348 samples were collected in the inner New York Bight for fecal coliform analysis. The stations sampled were the 20 inner NYB series stations, the LIC 09 and LIC 14 perpendicular stations, and the JC 14 and JC 27 perpendicular stations. Of the 348 samples collected, three had fecal coliform densities in excess of 50 fecal coliforms/100 ml. This represents 0.9 percent of the samples. There is no fecal coliform standard for the New York Bight Apex waters. The value of 50 fecal coliforms/100 ml was chosen for use in comparison with previous years. In 1978, 1979, 1980, 1981, and 1982 the percentage of samples having counts above 50/100 ml was 3.3, 2.3, 0.4, 0.7, and 2.1, respectively. The three high values found this past summer were:

Station	Date Collected	Sample Depth (feet)	Fecal Coliform/ 100ml of sample
NYB 26	7/27/83	076	138
NYB 26	8/03/83	076	100
NYB 45	7/13/83	088	108

These elevated counts at stations NYB 26 and NYB 45 were probably due to recent disposal of sewage sludge in the sewage sludge dump site.

A further discussion of the bacteriological data prepared by the EPA Regional laboratory which includes a discussion of the standards, indicator bacteria, materials and methods, and results is presented in Appendix B.

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10. U.S. Environmental Protection Agency; "New York Bight Water Quality Summer of 1980", Environmental Services Division, Region II, Edison, New Jersey, January 1982.

11. U.S. Environmental Protection Agency; "New York Bight Water Quality Summer of 1981", Environmental Services Division, Region II, Edison, New Jersey, January 1983.

12. U.S. Environmental Protection Agency; "New York Bight Water Quality Summer of 1982", Environmental Services Division, Region II, Edison, New Jersey, May 1984.

APPENDIX A

SUMMARY OF

PHYTOPLANKTON DYNAMICS AND BLOOM INCIDENCE

IN NEW JERSEY COASTAL WATERS

SUMMER OF 1983

New Jersey Department of Environmental Protection
Division of Water Resources
Bureau of Monitoring and Data Management
Biological Services Unit

SYNOPSIS

Weekly during summer, phytoplankton are again analyzed by the NJDEP in conjunction with EPA's annual helicopter survey of water quality conditions in the New York Bight. Our sampling scheme includes stations in the New Jersey northern estuarine and coastal area where red tides caused by phytoflagellate blooms tend to recur (see Figure 1). We are concerned about the unaesthetic qualities as well as effects possibly toxic to humans or lethal to fish. Background, methods and references pertinent to this program are given in previous reports.

During 1983, red tides were not prominent around Sandy Hook where early summer blooms of *Olisthodiscus luteus* have occurred in recent years. A profusion of species, including a few responsible for past red tides, was seen at various locations. During the last two seasons, we saw an increase over the previous few years in the number of significant blooms along the ocean front southward from Sandy Hook. In 1982 most of these occurred in the northern half of Monmouth County; while, in 1983, most were in the southern half. A few events, most notably the July bloom in the Belmar vicinity of *Prorocentrum micans* (one of the few suspected toxic species in our area) are reported independently of the routine sampling effort.

1983 HIGHLIGHTS

Phytoplankton results for 1983 are given in Tables I and II; nutrients, in Table III. Other significant events are summarized in Table IV.

The diatom, Thalassiosira nordenskioldii, generally maintained dominance in late spring. Also abundant during this period, Cyclotella sp. (a similar form) may actually be a smaller phase in the life cycle of T. nordenskioldii. Some species normally dominant in winter and spring, particularly Skeletonema costatum and Asterionella glacialis, may have peaked before sampling commenced in June. Diatom blooms detected within the routine sampling scheme occurred typically at the Raritan Bay and Sandy Hook stations (see Table II).

Although several phytoflagellate species attained dominant or bloom proportions, major red tides were not observed in the above vicinity to the extent seen in recent years. However, Olisthodiscus luteus, a species which has been responsible for red tides (non-toxic) here in early summer, was dominant in the June samples from the estuary (RB32 and 15). We also detected a dominance of several associated phytoflagellates (primarily Cryptomonas and Rhodomonas sp.) at the estuarine stations in June and early July.

A gap in routine sampling occurred with the helicopter deployed for maintenance between June 16 and July 14. A visible bloom of O. luteus (100,000 cells/ml in one sample) was reported on June 21/22 by personnel of the National Marine Fisheries Service lab. at Sandy Hook. This bloom apparently never reached significantly beyond Sandy Hook Bay. In a separate incident, orange-colored water with associated vegetable odors was reported June 24-27 in the surf from Spring Lake to Sea Girt. Examination of a sample taken by the Monmouth County Health Department revealed a profusion of species with O. luteus and Katodinium rotundatum dominant.

Resumption of sampling by the helicopter on July 13, revealed blooms of Prorocentrum micans from one-half mile off Asbury Park into the surf at Belmar. The previous night, fishermen on the Long Branch Pier reported irritation caused by a yellow substance on their lines. Boat samples taken on July 15 by the Monmouth County Health Department revealed no viable blooms in the vicinity; however, many dead cells of P. micans were found off the Belmar surfline, while this and other samples contained a brown flocculent material. During this time, irritation to bathers caused Belmar officials to temporarily close the beachfront.

Routine samples taken from the helicopter July 14 through the 29th found an abundance or dominance of several phytoflagellates at coastal stations southward to JC57 (Table II). Notable here were other potential red tide species, such as K. rotundatum and Peridinium trochoideum as well as P. micans. Certain diatoms, particularly Cerataulina pelagica and S. costatum also gained dominance during mid to late July. Another data gap was seen between July 29 and August 19 however, no major phytoflagellate blooms were reported during this period.

In late summer, several incidents of brown or discolored water occurred which were apparently not associated with red tides. On July 28-30, brownish water was sighted in the ocean from Sea Bright to Seaside Heights and off Atlantic City. This may have been associated with an onwelling of cooler ocean waters which brought a radical drop in surf temperatures (from about 75° to 60°F) along much of the New Jersey coastline around this time. A few diatom and flagellate species, primarily *S. costatum* and *Gymnodinium splendens*, respectively, were prominent at some routine stations during this period. Through August a few separate incidents of dirty water, with some associated phytoplankton species, were reported from the Ocean County and Cape May County surf.

On August 21-22 a dense area of brownish dirty water was sighted off Asbury Park to Spring Lake. This gave rise to some citizen complaints, including one videotape account which was sent to the Governor (now in custody of this Division) claiming it was untreated sewage. A sample by EPA, taken off Allenhurst, revealed a significant concentration of diatoms (several species abundant) along with organic detritus.

Some late summer peaks of various flagellates, a few diatoms (notably *Phaeodactylum* sp.) and chlorophytes (*Nannochloris* sp.) typically took place in Raritan and Sandy Hook Bays. By September, at the end of the routine monitoring period, diatoms regained prominence. Dominants included *Leptocylindrus* sp., *S. costatum*, and *Thalassiosira gravida*.

EVALUATION

Red tides caused by phytoflagellate blooms have been documented in annual occurrence in Lower New York Bay and adjacent New Jersey estuarine and coastal waters for over 20 years. Nutrients for their growth are in ample supply in these waters, especially in the estuarine complex. The NJDEP has formally monitored blooms and phytoplankton dynamics here since 1974. Several species have been responsible but, in recent years, the most dramatic events have been dominated by Olisthodiscus luteus. Most have been benign in nature.

These blooms typically orginate in the Raritan Bay sector in June following spring diatom flowerings (usually not visible) and early spring flow and nutrient peaks from the Raritan River. Hydrographic patterns in the area allows phytoplankton densities to build up along the south shore of the estuary into Sandy Hook Bay, and then to wash around the Hook into the ocean. Coriolis forces cause the estuarine plume to curl back in toward the beach, and from there it spreads southward along the shore. This effect can be augmented by the discharge of the Hudson River which usually peaks in late spring (after the Raritan) and, from Ambrose Channel, also curls to its right and along the N.J. shore. Often we see a peak in phytoflagellate activity in the ocean in early summer following that in the estuary. Blooms tend to spread out or become patchy southward of Sandy Hook, and they can be sustained by localized nutrient sources such as inlets, storm drains and sewerage outfalls.

In the past few seasons, blooms of O. luteus have not been of the intensity or duration seen in some previous years. Significant blooms of other species dominant in the past, such as Prorocentrum micans and Katodinium rotundatum (dinoflagellates) or a mixture of several species, have occurred. In 1983 (and '82) blooms occurred along the Monmouth County oceanfront apparently separately from any activity in the bay. The more noteworthy events of 1983 occurred along the southern half (Long Branch to Spring Lake); while, in 1982, more were observed in the northern (Sea Bright to Long Branch) sector.

Various effluents or nutrient sources are located in both segments. Local health jurisdiction for Monmouth County is split between a few different agencies. This area warrants more attention and closer coordination in future monitoring efforts.

Since blooms may localize, or may materialize or disappear within one or a few days, they often go undetected in routine sampling. Therefore, we rely on other sources such as the local health agencies, lifeguards or citizen complaints. We encourage anyone witnessing a possible bloom (water discolored yellowish or greenish to deep red or brown) to take a sample in a clean bottle and notify authorities immediately.

Often a brown, flocculent or stringy mass (bloom remnants) is all that is found after a bloom is reported. Other species, including diatoms, may thrive on the decomposing mass, further compounding a condition which resembles sewage. This may be concentrated at the shoreline by onshore breezes or dissipated by stronger winds. Upwelling of bloom remnants or other decomposing organic matter can occur from currents washing inshore or out of the bays, depending on certain weather or oceanographic conditions. Several of these events are reported each season from northern to southern reaches of the New Jersey shore.

In 1983, the bloom of *Prorocentrum micans* in the lower Monmouth sector was reminiscent of a more extensive and persistent bloom of that species here in 1968 (and again in 1972). These blooms caused superficial irritation and respiratory discomfort to bathers, along with diminished aesthetic value of the beaches and consequent economic losses. A possible role in fish mortality was also seen in several localized incidents, primarily via anoxia when the cells decomposed. The latter occurred on a large or massive scale only in 1976, caused by a different species (*Ceratium tripos*). This was an offshore phenomenon separate from the inshore red tides.

Our red tides thus far have not been of the variety which causes acute toxicity to humans (particularly via ingestion of shellfish), such as occurs in New England. *Gonyaulax tamarensis*, causative agent of paralytic shellfish poisoning (PSP), has not been found to any significant degree in any of our New Jersey monitoring programs. The proximity of this, however, along with the other adverse effects, are major reasons why we continue to monitor.

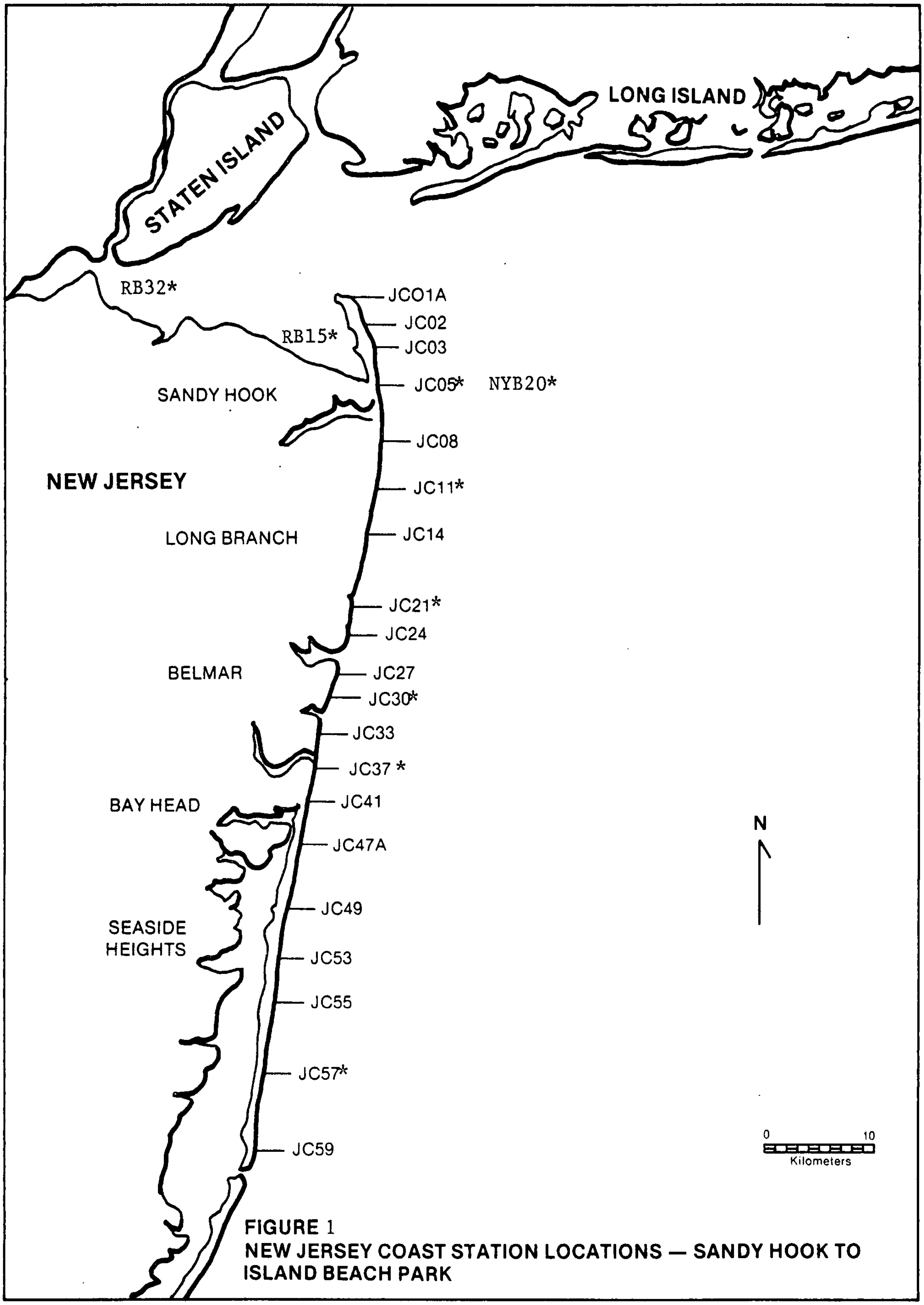

FIGURE 1
NEW JERSEY COAST STATION LOCATIONS — SANDY HOOK TO ISLAND BEACH PARK

* Stations where phytoplankton samples were collected

TABLES I and II

Major phytoplankton species found in the 1983 survey. Those seasonally dominant (+) often attained cell densities greater than 1000/ml. (10,000 for Nannochloris). Those abundant (-) appeared frequently, usually in lower numbers, though occasionally in dominant or bloom proportions. Visibility of a bloom is related to cell size and density, all those listed except Nannochloris sp. being greater than 5 µm. In Table II, blooms (*) occurred when concentrations at some observed point exceeded 10,000 cells/ml (100,000 for N. atomus).

TABLE I

Diatoms

Leptocylindrus danicus (-)	Cerataulina pelagica (+)
L. minimus (-)	Chaetoceros sp. (-)
Skeletonema costatum (+)	Rhizosolenia sp.
Cyclotella sp. (+)	Guinardia flaccida
Thalassiosira gravida (+)	Thalassionema nitzschioides
T. nordenskioldii (+)	Pheodactylum tricornutum (-)
Coscinodiscus sp.	Asterionella glacialis (-)
Biddulphia sp.	
Eucampia zoodiacus	

Dinoflagellates

Prorocentrum micans (-)	Heterocapsa triquetra (-)
P. minimum (+)	Oblea rotunda
P. scutellum	Peridinium trochoideum (-)
Exuviaella sp.	P. aciculiferum
Dinophysis acuta	Gonyaulax diegensis
Gymnodinium sp. (-)	
G. splendens (-)	
Katodinium rotundatum (+)	

Other Phytoflagellates

Olisthodiscus luteus (+)	Euglena sp.
Calycomonas gracilis (+)	E. proxima (-)
C. ovalis (+)	Eutreptia sp.
Chrysochromulina sp. (-)	E. viridis (-)
Chroomonas sp. (+)	Pyramimonas sp. (-)
Rhodomonas amphioxiea (+)	P. grossii (-)
R. minuta	P. micron (+)
Cryptomonas sp. (-)	Bipedinomonas sp. (-)

Chlorophytes

Chlorella sp. (-)	Nannochloris atomus (+)

TABLE II

1983 [redacted]	Succession of Dominant Phytoplankton Species	Sampling Location								
		RB 32	RB 15	NYB 20	JC 05	JC 11	JC 21	JC 30	JC 37	JC 57
Ju[redacted] 2	Skeletonema costatum		-	+						
	Thalassiosira (Cyclotella)sp		+	-	-	-				
	T. nordenskioldii		*	*	*	+	+			
	Asterionella glacialis				+					
	Olisthodiscus luteus		+		-				+	
	Calycomonas ovalis		+		+				+	
	Cryptomonas sp.		*							
	Nannochloris atomus	+	-	+	+	+	-	-	+	-
June 7	S. costatum				*				-	
	Thalassiosira (Cyclotella)sp	+	+	-	+					
	T. nordenskioldii	*	*	+	*	+	-	-		-
	A. glacialis				+					
	Prorocentrum minimum	-	+	-	-					
	O. luteus	+	-	-	-	-	-		-	
	Cryptomonas sp.		+							
	N. atomus	+	+	-	+	-	-	-	+	
Ju[redacted]e 16	T. nordenskioldii	+	*	+	+	+	+			
	P. minimum	+	+	-	-					-
	O. luteus	+	+		-	-	-	-	-	
	Chroomonas sp.		+	+			-	-	-	
	Chlorella sp.				*	+	+	+		-
	N. atomus	+	+	-	+	-	-	-	-	-
Ju[redacted] 14	Cerataulina pelagica			+	+	+	+	+	+	
	Prorocentrum micans			-	-	-	-	-	+	+
	Peridinium trochoideum				-		-		+	+
	Rhodomonas amphioxiea	+	*					+		
	Euglena/Eutreptia sp.		+					-		
	Pyramimonas/Chlorella sp.	+	-		-	+		+	+	+
	N. atomus	+	+	-	+					
Ju[redacted] 21	S. costatum		+	+	+	+	-			
	Thalassiosira gravida		+	-	-					
	C. pelagica	-	+	+						
	Katodinium rotundatum				-		+	+	+	-
	Peridinium trochoideum		-		-	+		-		
	Rhodomonas amphioxiea	+								
	Pyramimonas/Chlorella sp.	+		-			—			+
	N. atomus	+	+	-	-			+	+	+
July 29 [redacted]	Leptocylindrus sp.	+								
	S. costatum	+	*	*	*					
	T. gravida		+		-		-			
	Gymnodinium splendens			-	+					
	K. rotundatum			-	+				-	-
	Calycomonas gracilis	-		+	-					
	Chroomonas sp.	-		+	-					
	Pyramimonas micron			-	-			-	-	-
A[redacted]g. 19	S. costatum								+	
	Gymnodinium splendens	-			-		-	-	-	
	Calycomonas sp.			+						
	Rhodomonas sp.	-	-	-	+	-	-			-
	Pyramimonas micron	+		+	-	+	-	-		-
	Chlorella sp.									
	N. atomus	+	-	+			-		+	-

TABLE II (Continued)

1983	Succession of Dominant Phytoplankton Species	RB 32	RB 15	NYB 20	JC 05	JC 11	JC 21	JC 30	JC 37	JC 57
Aug. 26	Leptocylindrus sp.	+		+	-					
	T. gravida		+		-		-	-		
	C. pelagica			+	+	+		+		
	Rhodomonas sp.	*	+	-	+		+	-		
	Cryptomonas sp.	*	+		-			-		
	N. atomus	*	+	-	+			+		
Aug. 31	S. costatum				+					
	C. pelagica		+	-	-	-	-			
	P. tricornutum		+	+		-	-		-	
	K. rotundatum	+			-				-	
	Peridinium sp.	-	+	-	-					
	O. luteus		-		+	+				
	Calycomonas gracilis	-	+	+	-		-			
	Chrysochromulina sp.		+	+	-	-		-		
	Rhodomonas/Chroomonas sp	+	+	+		+		+	+	
	Euglena/Eutreptia sp	+	+		-	-	-	+		
	Pyramimonas/Tetraselmis sp.		+	-	-		-		-	
	N. atomus/Chlorella sp.	+	+	+	+	+	-	+	+	
Sept.	Leptocylindrus danicus								+	
	S. costatum	+	+	-	+	+	-	+	+	
	T. gravida	+	+	-	-	+	-	-	+	
	Chaetoceros sp.	-	-				-	+		
	Chroomonas sp.	+	+			-		-		
	N. atomus	+	+		+	+	-			

TABLE III

Nutrient Data for the 1983 Phytoplankton Survey
NH_3+NH_4 / NO_2 + NO_3 (mg/l)

Date	RB 15	RB 32	NYB 20	JC 05	JC 11	JC 21	JC 30	JC 37	JC 57
June 2	.08/.28	.57/.42	<.02/.22	<.02/.21	<.02/.15	<.02/.02	<.02/<.02	<.02/.02	<.02/.03
7	.03/.06	.43/.48	.03/.03	<.02/.05	.20/.05	.09/.04	.05/.03	.05/.03	.06/.03
16	.03/.11	.21/.16	.04/.07	- -	.03/.02	.03/<.02	.05/.03	.04/.03	.03/<.02
July 21	.11/.04	.33/.19	<.02/<.02	.09/.03	.25/.03	<.02/.02	<.02/.02	.05/.03	<.02/.04
Aug. 4	.11/.05	.12/.17	<.02/<.02	<.02/<.02	<.02/<.02	<.02/<.02	.04/.03	<.02/<.02	<.02/<.02
16	.60/.16	.87/.37	.11/.08	.14/.08	.11/.06	.12/.05	.13/.05	.14/.06	.10/.07
31	16/.19	.83/.39	.12/.13	.08/.11	.06/.07	.14/.07	.14/.07	.09/.07	.19/.07
Sept. 15	<.02/.13	.82/.33	- -	.06/.08	.34/.07	.05/.02	.03/<.02	<.02/<.02	- -
23	.02/.05	1.1/.34	<.02/<.02	.06/<.02	.09/<.02	.09/.02	.09/.02	.04/<.02	<.02/<.02
Oct. 5	.77/.33	1.4/.50	.33/.17	.39/.19	.59/.10	.16/.04	.16/.03	.10/.05	- -

TABLE IV

Blooms and Similar Events Reported Independently of Routine Sampling in 1983.

Date	Location	Observation	Note
June			
21-22	Sandy Hook Bay	Red Tide in bay to tip of hook reported by NOAA Sandy Hook Marine Lab.	O. luteus dominant 100,000 /ml (one sample)
24-27	Spring Lake to Sea Girt surf	Orange colored water and strong odor reported via Monmouth County Health Department.	Several species; O.luteus + K. rotundatum dominant
July			
12-13	Long Branch Pier	Yellow substance on fishing lines,	causing irritation.
13	Asbury Park to Belmar	Red Tide sighted by helicopter one half mile off Asbury to beach at Belmar.	P. micans dominant up to 13,000/ml.
14	Avon to Spring Lake	Brown flocculent material to 1000 yds. off, Monmouth Co. Health Dept. from Coast Guard Boat.	Bloom remnants. Belmar Beach closed because of irritation to bathers.
18	Ocean City	Blooms (?) reported; several Press calls.	Unconfirmed.
19	Long Beach Island	Blooms (?) reported; several Press calls.	Unconfirmed.
21	Long Branch and Point Pleasant	Brown, foamy substance seen from helicopter	Bloom remnants.
28-30	Sea Bright to Seaside Heights; Atlantic City	Brownish water sighted from helicopter; colder water reported along shore.	Radical drop in surf temperatures (75°-60°F).
August			
3	Avalon	Possible red tide reported by Cape May Co. H.D.	Detritus in sample.
4	Pt. Pleasant	Bloom reported by Ocean Co. H.D.	Several species & detritus.
6-8	Beach Haven to Atlantic City	Brown water reported by helicopter	
	Seaside, Normandy	dirty water reported in surf	Detritus in samples.
21-22	Allenhurst to Spring Lake	Brownish water to 1000 yds off; resident sends videotape of unaesthetic conditions to DEP	Diatoms and one dino-flagellate dominant + detritus.
26	Ocean City	Brown foam in surf at 48th St.	Unconfirmed.

APPENDIX B

Microbiological Water Quality

New York Bight

Summer 1983

INTRODUCTION

A study of the density* of fecal coliform (FC) organisms was conducted in 1983 as part of the continuing annual monitoring of the near shore waters off the Long Island and New Jersey Coast. Monitoring at selected stations in the New York Bight was also conducted.

By determining the bacteriological water quality one can estimate potential health risks associated with the presence of sewage pollution. Epidemiological studies have attempted to assess incidence of illness with bathing in water containing fecal contamination. Evidence exists that there is a relationship between bacterial water quality and transmission of certain infectious diseases (Cabelli, V.J., et al, 1979,1980).

A fecal coliform bacterial guideline for primary contact recreational waters was recommended by the U.S. Environmental Protection Agency (USEPA) in 1976 and subsequently adopted by most of the states. The EPA standard stated that fecal coliforms should be used as the indicators to evaluate the suitability of recreational waters, and recommended that fecal coliforms, as determined by MPN or MF procedure and based on a minimum of not less than five samples taken over not more than a 30 day period, shall not exceed a log mean of 200/100 ml, nor shall more than 10% of the total samples during any 30 day period exceed 400/100 ml. Rationale for the limits was developed using data collected from studies at Great Lakes, Michigan and the Inland River, Ohio which showed an epidemiological detectable health effect at levels of 2300-2400 coliforms/100 ml. Later work done on the Ohio River suggested that fecal coliforms represent 18% of the total coliforms. This would indicate that detectable health effects may occur at a fecal coliform level of approximately 400/100 ml limit, providing for a quality of water which should be better than that which would cause a health effect.

New York State, for its primary contact recreational coastal waters, has adopted the log mean of 200 fecal coliforms/100 ml. New Jersey, however, chose to adopt more stringent limits. For their coastal primary contact recreational waters, a log mean of 50 fecal coliforms/100 ml was established. By 1978, most of the states adopted the fecal coliform indicator with geometric mean limits at 200/100 ml.

Fecal Coliform Indicator Bacteria

Fecal coliforms comprise all of the coliform bacteria that ferment

*Bacterial density in this study is referred to as the number of fecal coliform organisms per 100 ml of water.

lactose at 44.5 ± 2°C. This group according to traditional thinking, more accurately reflects the presence of fecal discharges from warm-blooded animals. As indicators, the bacteria have the advantage of being less subject to regrowth in polluted waters. Their increased specificity to fecal sources made them the choice over other coliform organisms.

For more detailed information about this bacterial group, please refer to the following:

1. Standard Methods 15th ed., 909C (F.C.)
2. Microbiological Methods for Monitoring the Environment, Water and Wastes. EPA-600/8-78-017, Sect. C, p. 124.
3. Bergey's Manual of Determinative Bacteriology. 8th Ed. 1974. p. 290, members of the Enterobacteriaceae, p. 295, Escherichia coli.

Materials and Methods

Marine water samples were collected by helicopter on a weekly sampling schedule from May to October 1983. Samples were collected using a Kemmerer sampler, transferred to a 500 ml sterile wide-mouth plastic container, and then returned to the Region II Edison laboratory for analysis.

Fecal coliform determinations were conducted according to the membrane filter (MF) methodology contained in Standard Methods, 15th edition, 1980 and Microbiological Methods for Monitoring the Environment, EPA 600/8-78-017.

Results and Discussion

Along the New Jersey Coast, fecal coliform (FC) densities greater than 50/100 ml were only observed at four stations (Table 1). The observations were made at JC-01A (Sandy Hook, 1.2 km south of the tip), JC-14 (Long Branch), JC-30 (Spring Lake), and JC-75 Atlantic City). For the majority of New Jersey Coastal Stations, low FC densities were observed (see Table 2). This profile is visually presented in the geometric mean values of FC densities in Figure 1.

Fecal coliform densities along the Long Island Coast were even lower. Fecal coliform densities greater than 50/100 ml were not detected. Geometric mean FC densities were all less than 1.4 (Table 3 and Figure 2).

The New York State standard for primary contact recreation waters states that the monthly geometric mean of 5 or more samples shall not exceed 200 fecal coliform/100 ml. Geometric mean values for all stations were two orders of magnitude less than this standard.

New York Bight

The distribution of fecal coliform densities >50/100 ml in the New York Bight is shown in Table 4. The geometric mean densities of fecal coliforms found in the Bight are presented in Table 5. Station NYB-26 is located in the center of the sewage sludge disposal site. Samples at this site were taken at a depth of 76 feet and had a fecal coliform counts of 138 and 100 on two occasions. Station NYB-45 which is approximately 1 mile northwest from the sewage sludge site had a fecal coliform count of 108. Samples at this site were taken at a depth of 74 feet (Tables 4 & 5). The fecal coliform counts obtained at these stations are a likely result of deposition of sewage sludge at the sewage sludge dump site. Fecal coliform indicator organisms are sometimes more numerous in the sediments and off the bottom suggesting greater survival after sedimentation. (Van Donsel, et al, 1971.; Rittenburg et al, 1958). The high count observed at Station NYB-45, outside the dump site proper, may be attributed to movement of sewage sludge into the Christiensen Basin. Such movement has been suggested by Cabelli (1980) to explain the distribution of Clostridia species in the New York Bight apex.

Data presented in this report affirms that waste emanating from the upper New York Bay flows in an east-south easterly direction down through the Narrows and into Lower New York Bay. Previous studies by the FWPCA also support these flow patterns (FWPCA, 1967).

REFERENCES

1. Standard Methods for the Examination of Water and Wastewater, 15th Ed., American Public Health Association, Washington, D.C. (1981)

2. Microbiological Methods for Monitoring the Environment, Water and Wastes, EPA-600/8-78-017 (1978).

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7. Cabelli, V.J. et al. (1979). Relationship of Microbial Indicators to Health Effects at Marine Bathing Beaches. American Journal of Public Health.

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9. FWPCA. 1967. Report on the Quality of the Interstate Waters of the Lower Passaic River and Upper and Lower Bays of N.Y. Harbor. FWPCA, Nov. 1969.

TABLE 1

BACTERIAL DENSITIES >50 PER 100 ML
NEW JERSEY BEACH STATIONS
SUMMER 1983

STATION	DATE	DENSITY
JC01A	830602	100
JC14	830831	53
JC30	830811	96
JC75	830721	152

TABLE - 2

GEOMETRIC MEANS OF BACTERIAL DENSITIES
NEW JERSEY BEACH STATIONS
SUMMER 1983

STATION	MEAN	MINIMUM	MAXIMUM	N
JC01A	2.19279	0	100	14
JC02	0.43694	0	4	14
JC03	0.48599	0	3	14
JC05	0.41421	0	3	14
JC08	0.48348	0	24	14
JC11	0.41421	0	7	14
JC14	1.37478	0	53	14
JC21	0.38545	0	3	14
JC24	0.56737	0	8	14
JC27	1.57855	0	16	14
JC30	1.32519	0	96	14
JC33	0.62880	0	36	14
JC37	1.37316	0	35	14
JC41	0.24292	0	20	14
JC44	0.31853	0	3	14
JC47A	0.19422	0	2	14
JC49	0.51121	0	5	14
JC53	0.49855	0	11	14
JC55	0.13653	0	5	14
JC57	0.05076	0	1	14
JC59	0.54221	0	3	8
JC61	0.31607	0	2	8
JC63	0.25103	0	2	8
JC65	0.22284	0	4	8
JC67	0.59553	0	6	8
JC69	0.27537	0	6	8
JC73	0.29684	0	3	8
JC75	1.53631	0	152	10
JC77	0.48774	0	5	8
JC79	1.07374	0	18	8
JC81	2.41255	0	18	8
JC83	0.62239	0	3	8
JC85	0.66828	0	4	8
JC87	0.14720	0	2	8
JC89	0.64645	0	2	8
JC91	0.72390	0	12	8
JC93	2.81426	0	13	8
JC95	0.50980	0	2	8
JC97	0.56508	0	2	8
JC99	0.76923	0	3	8

TABLE - 3

GEOMETRIC MEANS OF BACTERIAL DENSITIES
LONG ISLAND BEACH STATIONS
SUMMER 1983

STATION	MEAN	MINIMUM	MAXIMUM	N
LIC01	0.23773	0	3	13
LIC02	0.21064	0	2	13
LIC03	0.32811	0	4	13
LIC04	0.21064	0	5	13
LIC05	0.54591	0	3	13
LIC07	0.27694	0	5	13
LIC08	1.36876	0	10	13
LIC09	1.24464	0	16	13
LIC10	1.38646	0	28	13
LIC12	0.55077	0	11	13
LIC13	0.39812	0	12	13
LIC14	0.21064	0	2	13
LIC15	0.19378	0	4	13
LIC16	0.64774	0	10	13
LIC17	0.31951	0	3	5
LIC18	0.14870	0	1	5
LIC19	0.14870	0	1	5
LIC20	0.00000	0	0	5
LIC21	0.31951	0	1	5
LIC22	0.47577	0	6	5
LIC23	0.97435	0	5	5
LIC24	0.37973	0	4	5
LIC25	0.00000	0	0	5
LIC26	0.14870	0	1	5
LIC27	0.31951	0	1	5
LIC28	0.24573	0	2	5

TABLE - 4

BACTERIAL DENSITIES >50 PER 100 ML
NEW YORK BIGHT STATIONS
SUMMER 1983

STATION	DATE	DENSITY	DEPTH
NYB26	830727	138	B
NYB26	830803	100	B
NYB45	830713	108	B

TABLE - 5

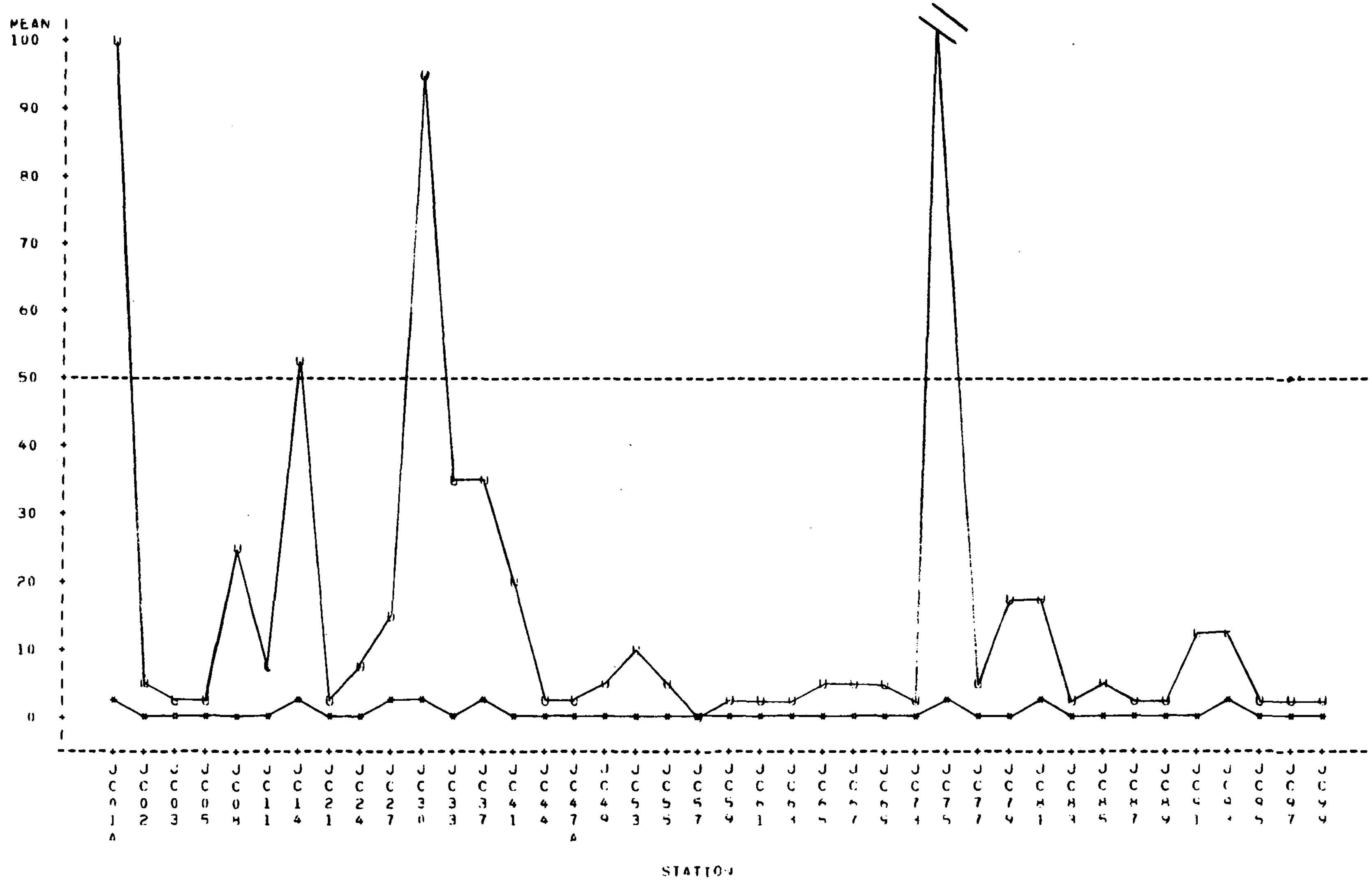
GEOMETRIC MEANS OF BACTERIAL DENSITIES
NEW YORK BIGHT STATIONS
SUMMER 1983

STATION	DEPTH	MEAN	MINIMUM	MAXIMUM	N
NYB20	B	0.0000	0	0	7
NYB21	B	0.0000	0	0	7
NYB22	B	0.0000	0	0	7
NYB23	B	0.0000	0	0	7
NYB24	B	0.9195	0	7	7
NYB25	B	0.9622	0	6	7
NYB26	B	15.1757	0	138	7
NYB27	B	0.2190	0	3	7
NYB32	B	0.1487	0	1	5
NYB33	B	0.1487	0	1	5
NYB34	B	0.0000	0	0	5
NYB35	B	0.3797	0	4	5
NYB40	B	0.0000	0	0	6
NYB41	B	0.0000	0	0	7
NYB42	B	0.1699	0	2	7
NYB43	B	0.4860	0	3	7
NYB44	B	2.7688	0	19	7
NYB45	B	10.9476	1	108	7
NYB46	B	0.6189	0	8	6
NYB47	B	0.0000	0	0	6
NYB20	S	0.1041	0	1	7
NYB21	S	0.0000	0	0	7
NYB22	S	0.1041	0	1	7
NYB23	S	0.0000	0	0	7
NYB24	S	0.0000	0	0	7
NYB25	S	0.0000	0	0	7
NYB26	S	0.7170	0	10	7
NYB27	S	0.0000	0	0	7
NYB32	S	1.2581	0	12	4
NYB33	S	0.6438	0	3	5
NYB34	S	0.0000	0	0	5
NYB35	S	0.1487	0	1	5
NYB40	S	0.0000	0	0	6
NYB41	S	0.0000	0	0	7
NYB42	S	0.0000	0	0	7
NYB43	S	0.0000	0	0	7
NYB44	S	0.1041	0	1	7
NYB45	S	0.0000	0	0	7
NYB46	S	0.7426	0	27	6
NYB47	S	0.1225	0	1	6

FIGURE - 1

GEOMETRIC MEANS OF BACTERIAL DENSITIES
NEW JERSEY BEACH STATIONS
SUMMER 1983

PLOT OF MEAN*STATION SYMBOL USED IS *
PLOT OF MAXIMUM*STATION SYMBOL USED IS U



NOTE: 1 OBS HAD MISSING VALUES OR WERE OUT OF RANGE

FIGURE - 2

GEOMETRIC MEANS OF BACTERIAL DENSITIES
LONG ISLAND BEACH STATIONS
SUMMER 1983

PLOT OF MEAN*STATION SYMBOL USED IS *
PLOT OF MAXIMUM*STATION SYMBOL USED IS U