U.S. ENVIRONMENTAL PROTECTION AGENCY

NEW YORK BIGHT WATER QUALITY

SUMMER OF 1994

ENVIRONMENTAL SERVICES DIVISION
REGION 2
NEW YORK, NEW YORK 10278

NEW YORK BIGHT WATER QUALITY

SUMMER OF 1994

Prepared By: United States Environmental Protection Agency
Region 2 - Surveillance and Monitoring Branch
Edison, New Jersey 08837

Helen Grebe 12/15/95
Helen Grebe, Environmental Scientist

ABSTRACT

The purpose of this report is to disseminate technical information gathered by the Environmental Services Division of the U.S. Environmental Protection Agency (EPA), Region 2, during the 1994 New York Bight Water Quality Monitoring Program. The monitoring program was conducted using the EPA helicopter, and a U.S. Fish and Wildlife Service helicopter for sample collection and floatable surveillance. The monitoring period was from May 15 to September 15 of 1994. The monitoring program consisted of four separate parts, as follows:

1. Beach network - 26 Long Island beach stations and 44 New Jersey beach stations sampled for bacteriological analysis once a week,

2. Phytoplankton network - phytoplankton samples along the New Jersey coast and in Raritan Bay, Sandy Hook Bay, Barnegat Bay, Great Egg Harbor, and Delaware Bay collected bimonthly,

3. Perpendicular network - 11 transects (2 New York Bight and 9 New Jersey coast stations) extending 16 nautical miles east from the New Jersey coast sampled three to four times during the sampling season for dissolved oxygen and temperature, and

4. Floatable surveillance network - helicopter flights around the New York/New Jersey Harbor Complex conducted 6 days a week during the summer months.

Bacteriological data indicated that fecal coliform densities at the Long Island and New Jersey beach stations were well within the acceptable Federal guidelines and State limits for primary contact recreation (a geometric mean of 200 fecal coliforms/100ml). A total of 319 samples along the Long Island coast, and 622 samples along the New Jersey coast, were collected for fecal coliform and enterococcus analyses. All individual fecal coliform densities along the Long Island and New Jersey coasts were below the States' bathing water quality standard of 200 fecal coliforms/100ml. The recommended EPA criterion for enterococci in marine waters is a geometric mean

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II

DATE: MAR 1 9 1996

SUBJECT: New York Bight Report - 1994

FROM: Helen Grebe, Environmental Scientist
Ambient Monitoring Section

TO: Addressees

Enclosed for your information is a copy of our most recent New York Bight report entitled "New York Bight Water Quality, Summer of 1994".

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Enclosure

of 35 enterococci/100ml. Individual enterococcus densities did not exceed 35 enterococci/100ml along the Long Island coast. Except for one occasion, individual enterococcus densities did not exceed 35 enterococci/100ml along the New Jersey coast. Based on fecal coliform and enterococcus data, Long Island and New Jersey coastal waters are of excellent quality.

Dissolved oxygen levels were generally good along the New Jersey and New York Bight perpendiculars. Bi-monthly average dissolved oxygen concentrations remained above 6.5 mg/l. Individual dissolved oxygen values remained above the "lethal if prolonged" guideline of 2 - 3 mg/l. Dissolved oxygen values have remained higher than those of 1985 when, in mid to late summer, approximately 1600 square miles of ocean bottom off New Jersey were plagued with dissolved oxygen concentrations considered stressful for aquatic life, for extended periods of time.

During the summer of 1994, phytoplankton blooms and chlorophyll a levels were highest in the intercoastal bays of New Jersey. Red algal blooms were predominant in Raritan and Sandy Hook Bays through mid August. Most beaches along New Jersey were affected by blooms of short duration more often in 1994, than in 1993. The green tide, caused by *Gyrodinium aureolum*, which occurred along the southern New Jersey coast in 1984 and 1985, did not recur in 1994.

There were no beach closures due to wash-ups of floatable debris in 1994. This was largely due to the initiation of a Short-Term Action Plan aimed at addressing floatable debris in the New York/New Jersey Harbor Complex. The action plan is a cooperative monitoring and response effort on the part of various federal, state and local government agencies.

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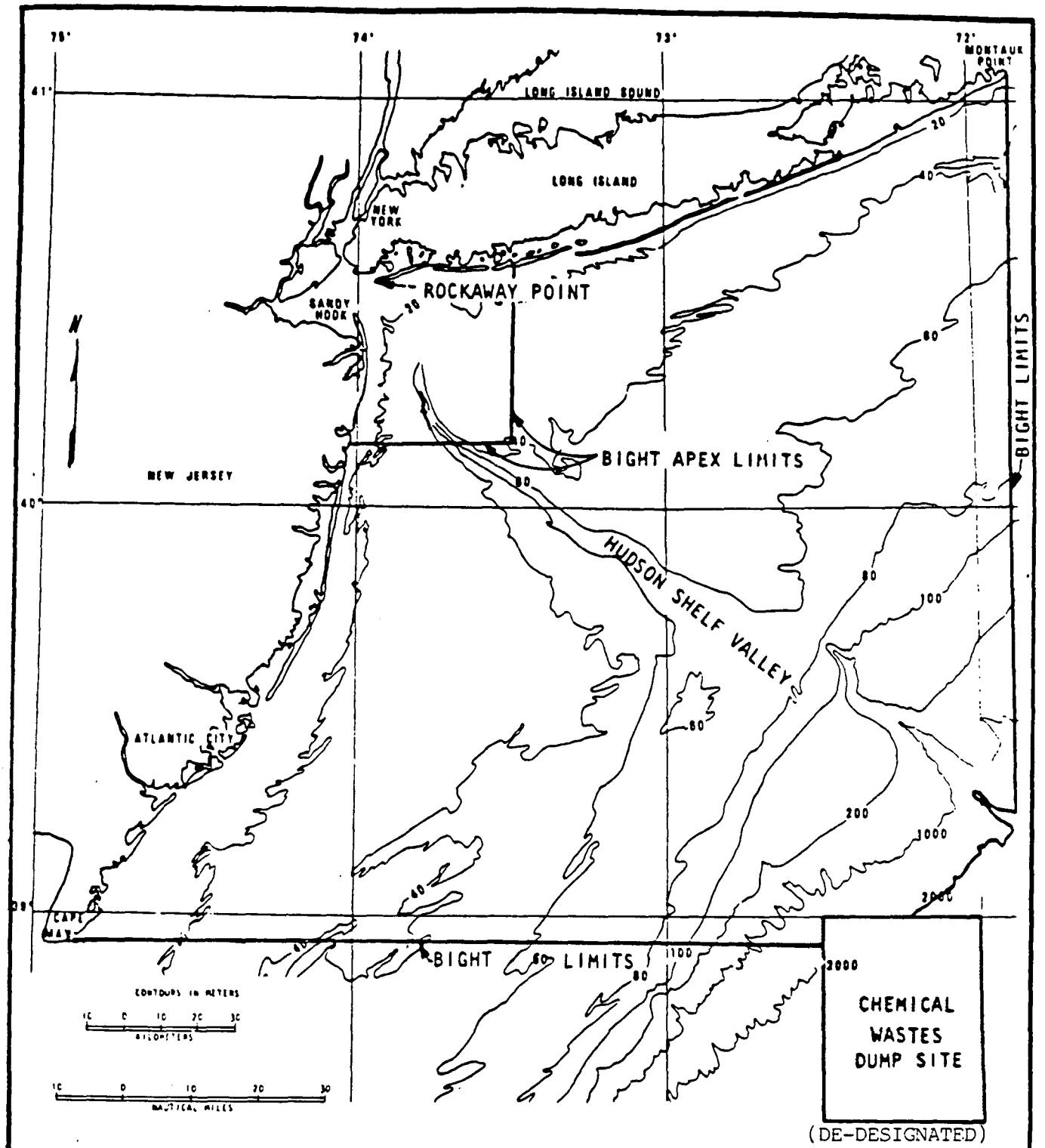
I. INTRODUCTION

The Environmental Services Division of the U.S. Environmental Protection Agency has prepared this report to disseminate environmental data for the New York Bight Apex, the New York/New Jersey Harbor Complex, 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 2000 meter contour line, and the southwest by Cape May. Figure 1 shows the limits of the New York Bight. The New York Bight Apex, which contains the de-designated sewage sludge, acid waste, and cellar dirt disposal sites, and the active dredged material disposal site, is shown in Figure 2. The New York/New Jersey Harbor Complex, for purposes of this report, is defined as the Arthur Kill, Newark Bay, Kill Van Kull, southern portions of the East and Hudson Rivers, Verrazano Narrows, Gravesend Bay, the Coney Island coastline to the mouth of Jamaica Bay, and Upper and Lower New York Harbors. The New York/New Jersey Harbor Complex is shown in Figure 3.

This report is the twentieth in a series and reflects the monitoring period from May 15 to September 15 of 1994. The New York Bight Water Quality Monitoring Program is EPA's response to its mandated responsibilities as defined under the Marine Protection, Research and Sanctuaries Act of 1972, the Water Pollution Control Act Amendments of 1972 and 1977, and the Water Quality Act of 1987.

II. HISTORY OF THE NEW YORK BIGHT MONITORING PROGRAM

Since its initiation in 1974, the New York Bight Water Quality Monitoring Program has been modified several times to be more responsive to the needs of the general public, the states, the counties, and EPA; and to concentrate on specific areas of concern during the critical summer period. Many changes occurred after the summer of 1976, when anoxic



THE NEW YORK BIGHT

Figure 1

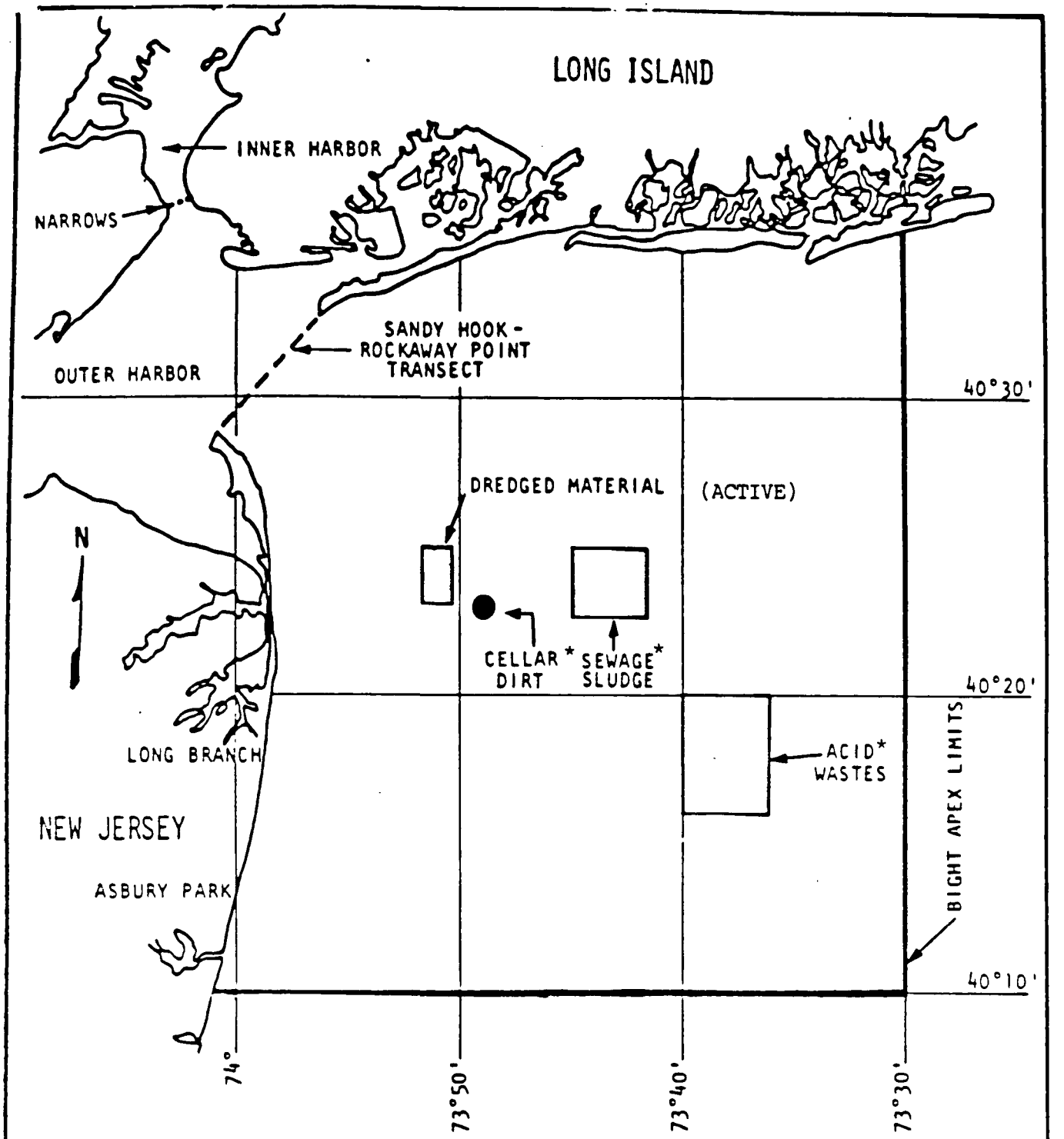
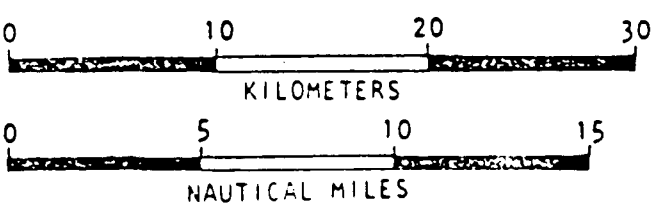


Figure 2

BIGHT APEX AND EXISTING DUMP SITES

* = DE-DESIGNATED



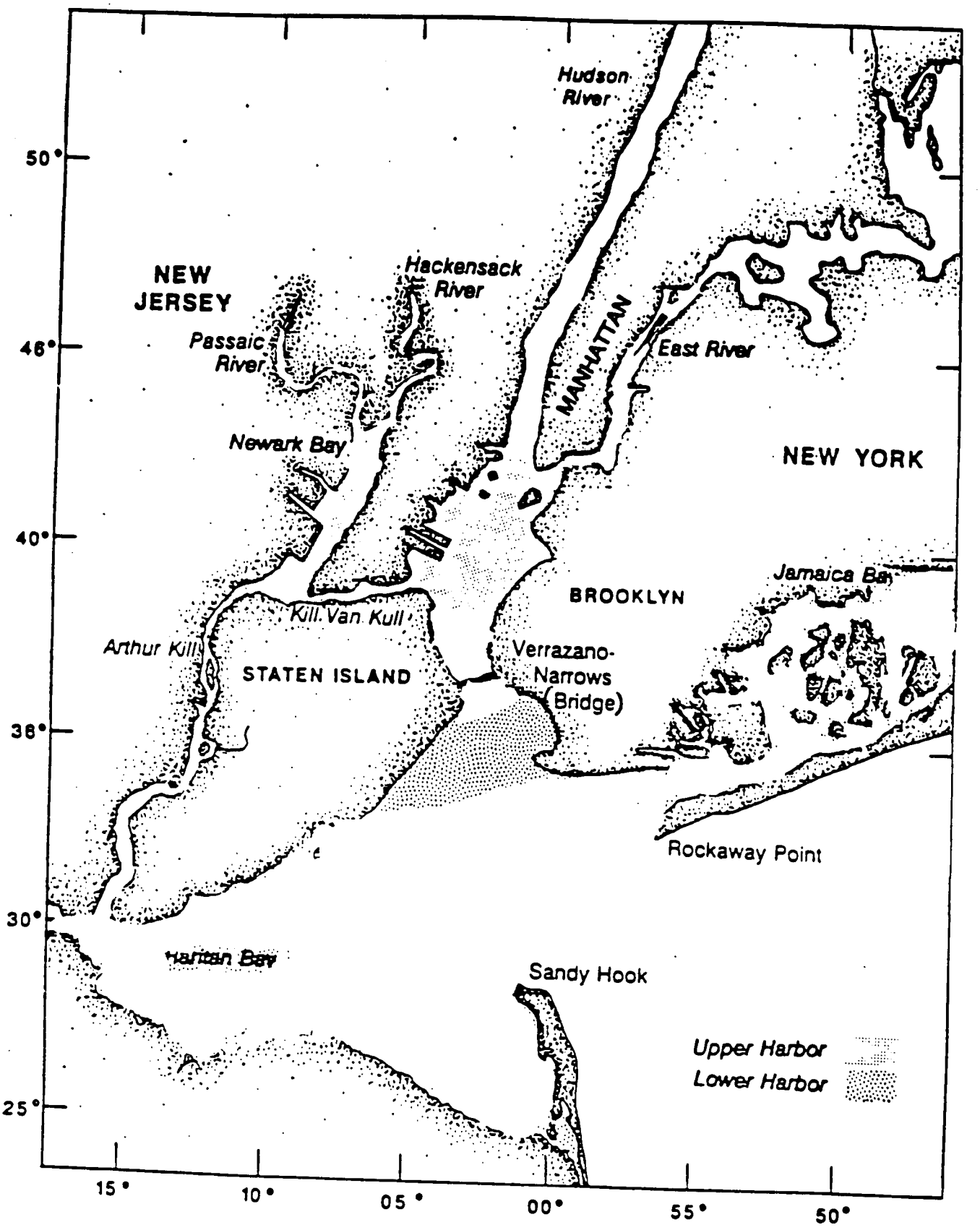


Figure 3 Map of New York/New Jersey Harbor Complex

conditions caused a fishkill in the Bight and an unusually heavy wash-up 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, investigate the origins of these crises, and direct any decisions regarding protection of the Bight's water quality.

In 1986, the monitoring program was modified to intensify sampling activities along the southern New Jersey beaches. During mid to late summer in 1985, beaches along the southern New Jersey coast were affected by algal blooms, which caused "green tide", and high bacterial counts which resulted in beach closings. To improve monitoring coverage, four additional beach stations between Long Beach Island and Wildwood were sampled weekly for phytoplankton. In addition, bacteria samples were collected weekly rather than bimonthly along the southern New Jersey beaches. However, since 1985, extensive phytoplankton blooms of long duration have not occurred along the New Jersey coast. As a result, beginning in 1993 and continuing in 1994, the frequency of phytoplankton monitoring decreased from once a week to bimonthly. Weekly bacteriological samples continue to be collected.

In August 1987, a 50-mile slick of garbage washed ashore along mid to southern New Jersey. In 1988, several miles of Long Island beaches were plagued with garbage wash-ups, including medical debris. This precipitated the need to develop a response network to prevent future beach closures due to floatables. As a result, EPA along with the New York State Department of Environmental Conservation, New York City Department of Environmental Protection, New York City Department of Sanitation, U.S. Army Corps of Engineers, New Jersey Department of Environmental Protection and Energy, and the U.S. Coast Guard developed the "Short Term Action Plan for Addressing Floatables Debris in the New York Bight" (USEPA, 1989). The Short Term Action Plan establishes a monitoring and response network to locate and coordinate cleanup operations

for slicks found in the New York/New Jersey Harbor Complex. The intent was to prevent slick materials from escaping the harbor and potentially stranding on regional beaches. The nucleus of the plan consists of daily helicopter floatable observation flights of the New York/New Jersey Harbor Complex, a command/communication center, and the cleanup of floatable debris by the U.S. Army Corps of Engineers or the New York City Department of Environmental Protection.

In 1992, in response to a changing environment, i.e., the cessation of sewage sludge dumping, monitoring for dissolved oxygen in the New York Bight Apex has been modified. The following stations were not sampled in 1992, 1993 or 1994: the Long Island perpendiculars, the Manasquan Inlet perpendicular, most New York Bight Apex stations, and New Jersey perpendicular stations 3 and 7 nautical miles off the coast. Four New York Bight Apex stations were retained, and four new ones added. The New York Bight Apex stations now extend east off the New Jersey Coast, approximately 4, 8, 12, and 16 nautical miles offshore. New Jersey perpendicular stations were sampled at 1, 5, 9, 12, and 16 nautical miles off the coast, in 1992, 1993 and 1994. The new sampling scheme was developed to document the extent of low dissolved oxygen concentrations off the New Jersey coast.

Frequency of dissolved oxygen monitoring has also been changed. In past years, monitoring for dissolved oxygen occurred every week throughout the summer. In 1992, 1993 and 1994, dissolved oxygen monitoring occurred 3 to 4 times during the summer season focusing around historically low periods.

III. SAMPLING AND SURVEILLANCE PROCEDURES

During the period of May 15 through September 15, 1994, water quality monitoring and surveillance activities were carried out using the EPA Huey helicopter, and a Fish and Wildlife Service helicopter. The EPA Huey helicopter was especially designed for water sampling, while the Fish and Wildlife Bell Jet Ranger was used for floatable surveillance flights. The monitoring program is composed of three separate sampling networks and one floatable surveillance network. Table 1 outlines the 1994 monitoring program. It includes station groups, frequency of sampling, parameters analyzed, sample depth, and mode of transportation.

The beach station network was sampled to gather bacteriological water quality information for the protection of human health. Samples were collected weekly starting one week before Memorial Day up until Labor Day. Twenty-six Long Island coast stations and 44 New Jersey coast stations were sampled once a week for fecal coliform and enterococcus bacteria densities. At beach stations, samples were collected just offshore in the surf zone, while the helicopter hovered over the surface. Sampling was accomplished by lowering a 1-liter Kemmerer sampler approximately 1 meter below the water surface. The sample was transferred to a sterile plastic container, iced and subsequently transported (within 6 hours) to the Edison Laboratory for fecal coliform and enterococcus analyses. The results of the bacteriological data for 1994 are contained in Appendix A.

The phytoplankton sampling network was sampled to monitor phytoplankton assemblages and red tide blooms in New Jersey coastal waters and bays. Water samples for phytoplankton identification and quantification, and chlorophyll analysis, were collected eight times during the summer season. Sample analyses were completed by the New Jersey Department of Environmental Protection (NJDEP). The samples were collected

Table 1

Outline of the 1994 Monitoring Program

Station Group	Frequency	Parameter	Sample Depth	Mode of Transportation
Long Island Beaches (Rockaway Pt. to Shinnecock Inlet)	26 stations/ week	Fecal Coliform Enterococcus	one meter below the surface	EPA Huey Helicopter
New Jersey Beaches (Sandy Hook to Cape May)	44 stations/ week	Fecal Coliform Enterococcus	one meter below the surface	EPA Huey Helicopter
New Jersey Phytoplankton Station Network	bi-monthly	Phytoplankton Chlorophyll a	just below the surface	EPA Huey Helicopter
New Jersey and New York Bight Apex Perpendicular Station Network (Sandy Hook to Hereford Inlet)	53 stations 11 transects sampled three times/ season	Dissolved Oxygen and Temperature	one meter below the surface, one meter above the ocean floor	EPA Huey Helicopter
NY/NJ Harbor Overflight	6 days/ week	observations	surface water	F&WL Jet Ranger

as close to the surface as possible, using a 1-liter Kemmerer sampler. A 500 ml dark brown plastic bottle was filled for phytoplankton and chlorophyll a analyses, and preserved by cooling to 4^0C. The NJDEP picked up the phytoplankton samples at our Edison laboratory within 24 hours of collection. At the laboratory, the NJDEP removed an aliquot of sample for chlorophyll analysis. The results of NJDEP's analyses are contained in Appendix B.

The perpendicular station network was established to gather surface and bottom dissolved oxygen values during the critical summer period. The perpendicular station network consists of 11 transects extending east from the New Jersey coast. Two transects extended east from Northern New Jersey in the New York Bight Apex, with 4 stations in each transect; and 9 transects extended east from the remainder of the New Jersey coast, with 5 stations in each transect. The transects cover the inner Bight from Sandy Hook to Hereford Inlet, New Jersey. Samples were collected for dissolved oxygen and temperature. 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. Samples were taken at 1 meter below the surface and 1 meter above the ocean floor. After collection, the water sample was transferred to a biochemical oxygen demand bottle for dissolved oxygen 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. The samples were held for less than 6 hours before returning to the laboratory, where 2 ml of sulfuric acid were added, and the samples were titrated with 0.0375N sodium thiosulfate.

The floatable surveillance network encompassed overflights of the New York/New Jersey Harbor Complex. The networks' objective was to improve water quality by removing floatable

debris from the water column, thereby, preventing the debris from stranding on regional beaches or shore lines. The overflights consisted of flying a helicopter 50 to 300 feet above the water, 6 days/week from May 15 to September 15. Approximate size or dimension, contents, relative density, location, possible sources and time of sighting of significant floatable debris were recorded. The information was reported to a central communication response network, specifically established to coordinate cleanup efforts. Cleanup efforts were conducted by the Corps of Engineers or the New York City Department of Environmental Protection as necessary.

IV. LOCATION OF SAMPLING STATIONS AND OBSERVATION POINTS

Beach Stations

A total of 70 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 for a total of 26 stations (LIC 01-LIC 28). Sample station locations, nomenclature, and descriptions are given in Table 2 and Figure 4. There are 44 New Jersey coast stations, beginning at Sandy Hook extending south to Cape May Point (JC 01A-JC 99). These stations are described and identified in Table 3 and in Figures 5 and 6.

The results of the bacteriological data are contained in Appendix A.

Phytoplankton Stations

Phytoplankton samples were collected eight times during the summer season along the New Jersey coast and in Raritan Bay, Sandy Hook Bay, and Barnegat Bay. The stations were as follows:

RB 05	JC 30	JC 65	JC 91
RB 15	JC 33	JC 75	BB 02
RB 51	JC 57	JC 83	DB 1
JC 11	JC 63	JC 87	

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

Table 2

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

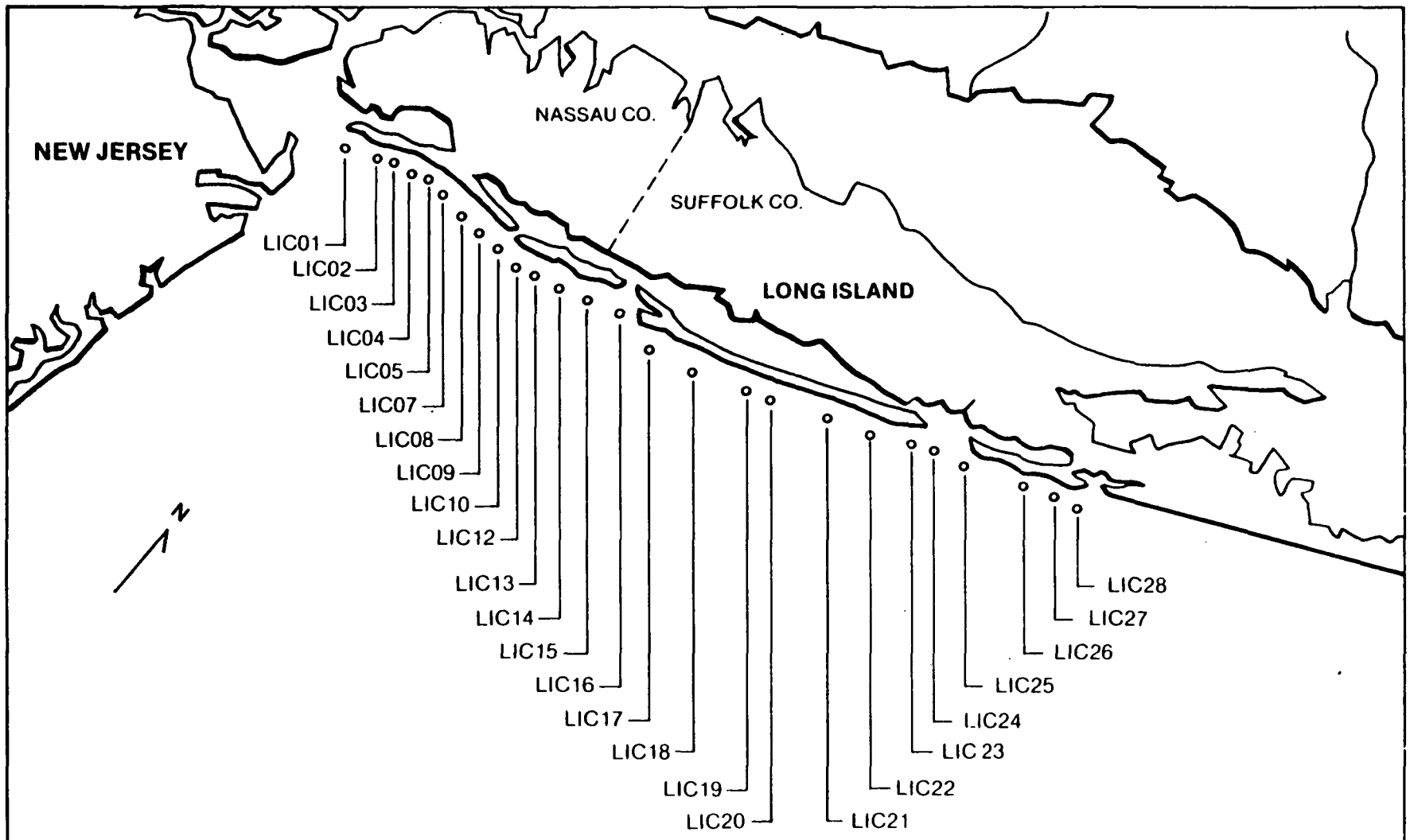


FIGURE 4
LONG ISLAND COAST STATION LOCATIONS

Table 3

New Jersey Coast Station Locations

Station No.	Location
JC 01A	Sandy Hook, 1.2 km south of tip
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 13	Long Branch, Chelsea Avenue
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 26	Shark River Inlet
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 35	One block north of Manasquan Inlet
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

Table 3 (continued)

Station No.	Location
JC 53	Seaside Heights, between the amusement piers
JC 55	Island Beach State Park, off white building north of Park Headquarters
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
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 74	Absecon Inlet
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

Table 3 (continued)

Station No.	Location
JC 89	Avalon, off beige building on the beach
JC 92	Hereford Inlet
JC 93	Wildwood, off northern amusement pier
JC 95	Two mile beach, opposite radio tower
JC 96	Cape May Inlet
JC 97	Cape May, off white house with red roof on the beach
JC 99	Cape May Point, opposite lighthouse

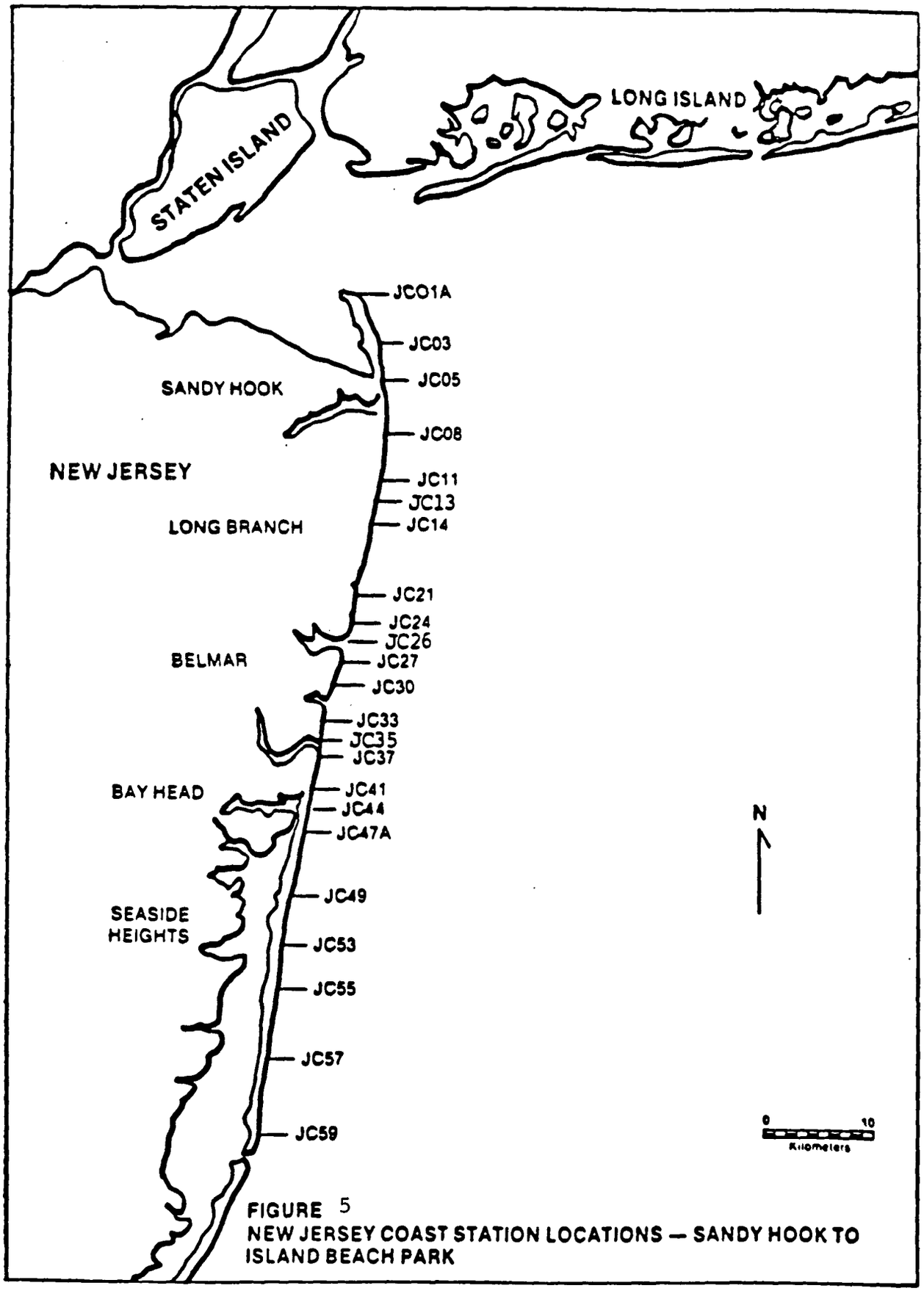


FIGURE 5
NEW JERSEY COAST STATION LOCATIONS — SANDY HOOK TO ISLAND BEACH PARK

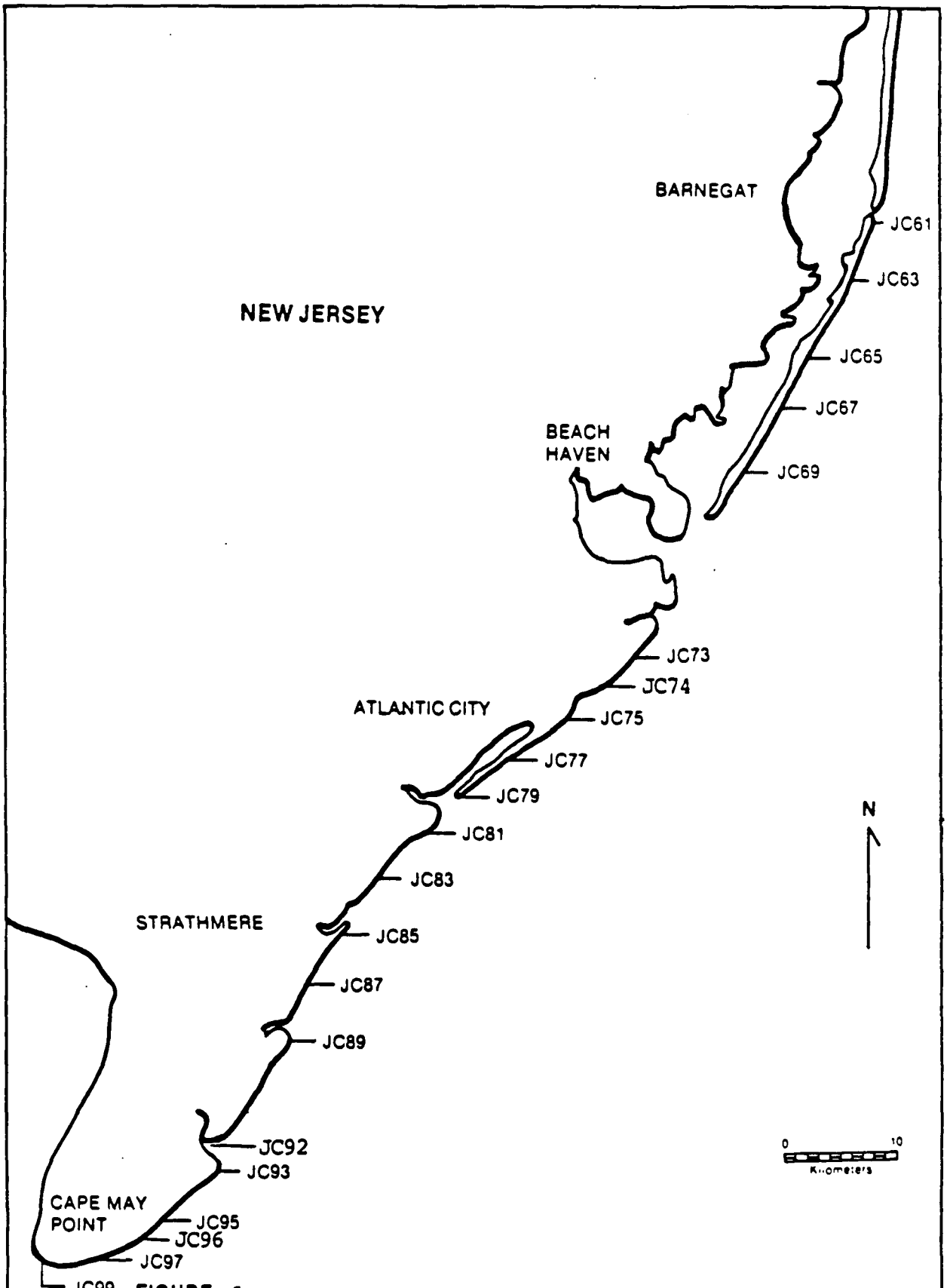


FIGURE 6
NEW JERSEY COAST STATION LOCATIONS — BARNEGAT TO CAPE MAY POINT

Perpendicular Stations

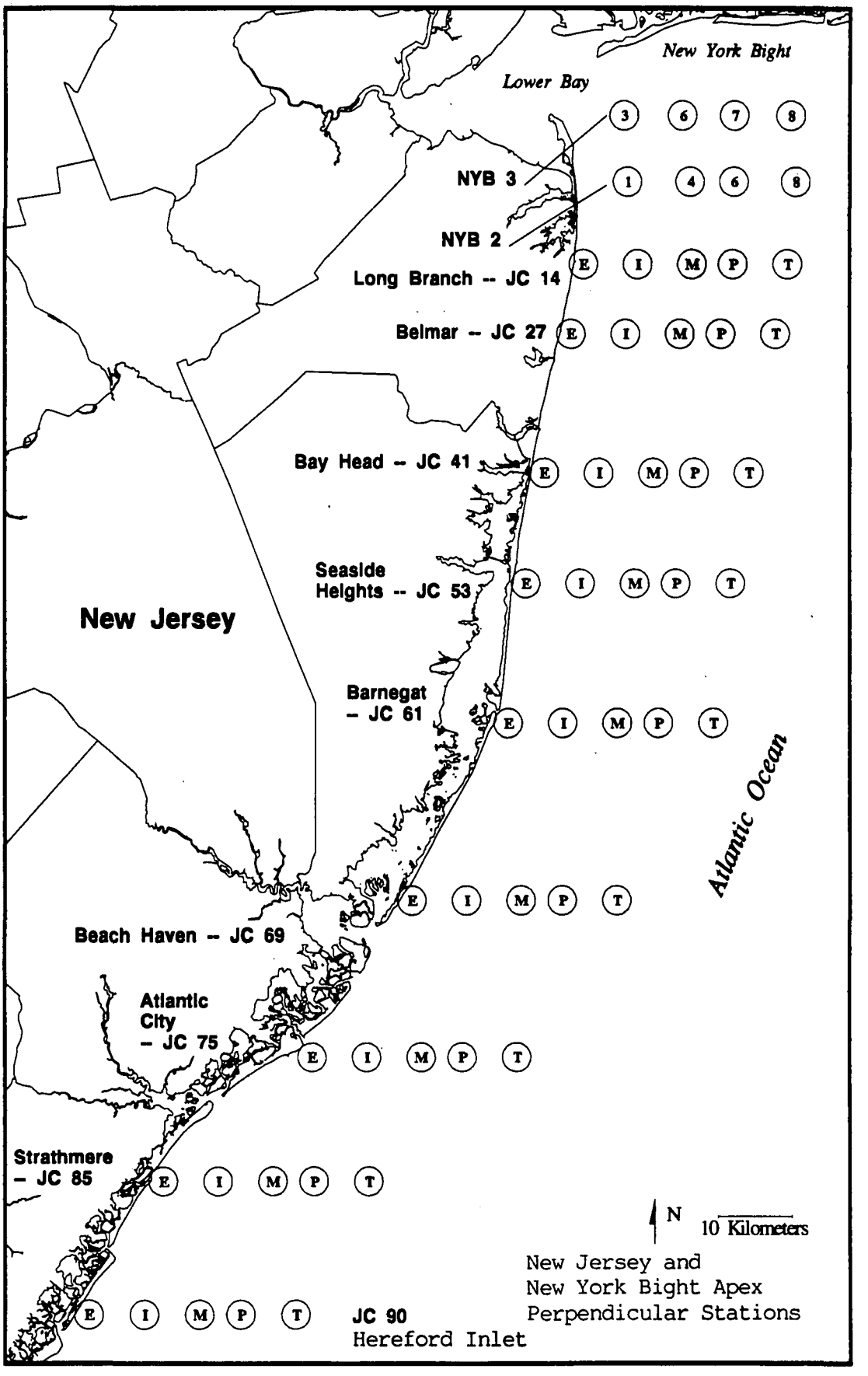
The perpendicular station network consists of 11 transects extending east from the New Jersey coast. Nine New Jersey coast (JC) perpendicular transects extend east from Long Branch to Hereford Inlet, and two New York Bight (NYB) Apex perpendicular transects extend east from the northern and southern ends of Sandy Hook. New Jersey coast perpendicular stations start at 1 nautical mile (nm) and extend east to 16 nm offshore. In 1992, 1993 and 1994 perpendicular transects from Long Branch to Hereford Inlet were sampled at 1, 5, 9, 12, and 16 nm offshore. The Hereford Inlet (JC90) perpendicular transect was established in 1992. Two New York Bight Apex perpendicular transects were established in 1992. The stations on each transect are approximately 4, 8, 12, and 16 nm off the northern and southern end of Sandy Hook. Four of the eight stations sampled are part of the original ocean monitoring program and have historical data dating back to 1973.

The perpendicular station locations are plotted in Figure 7.

New York/New Jersey Harbor Complex

A complete overflight of the New York/New Jersey Harbor Complex included the following waterways: the Arthur Kill; Newark Bay, as far north as the New Jersey Turnpike Bridge; the Kill Van Kull; the Upper New York Harbor; the Hudson and East Rivers as far north as Central Park, New York; the Verrazano Narrows; Gravesend Bay; the shoreline of Coney Island as far east as the Marine Parkway Bridge; and the Lower New York Harbor, see Figure 3.

Figure 7



New Jersey and
New York Bight Apex
Perpendicular Stations

V. 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. 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 4^0C to 10^0C while dissolved oxygen values are between 8 and 10 mg/l 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 cooler bottom water is

effectively isolated from the upper layer by a 10^0C 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 cause 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 8 depicts a representative history of dissolved oxygen concentration in the general ocean area off of New Jersey, New York, and New England.

Dissolved Oxygen Criteria

The dissolved oxygen levels necessary for survival and/or reproduction vary among biological species. Sufficient data have not been accumulated to assign definitive limits or lower levels of tolerance for each species at various growth stages. Rough guidelines are available for aquatic species for purposes of surveillance and monitoring. These are as follows:

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

These criteria are consistent with biological information

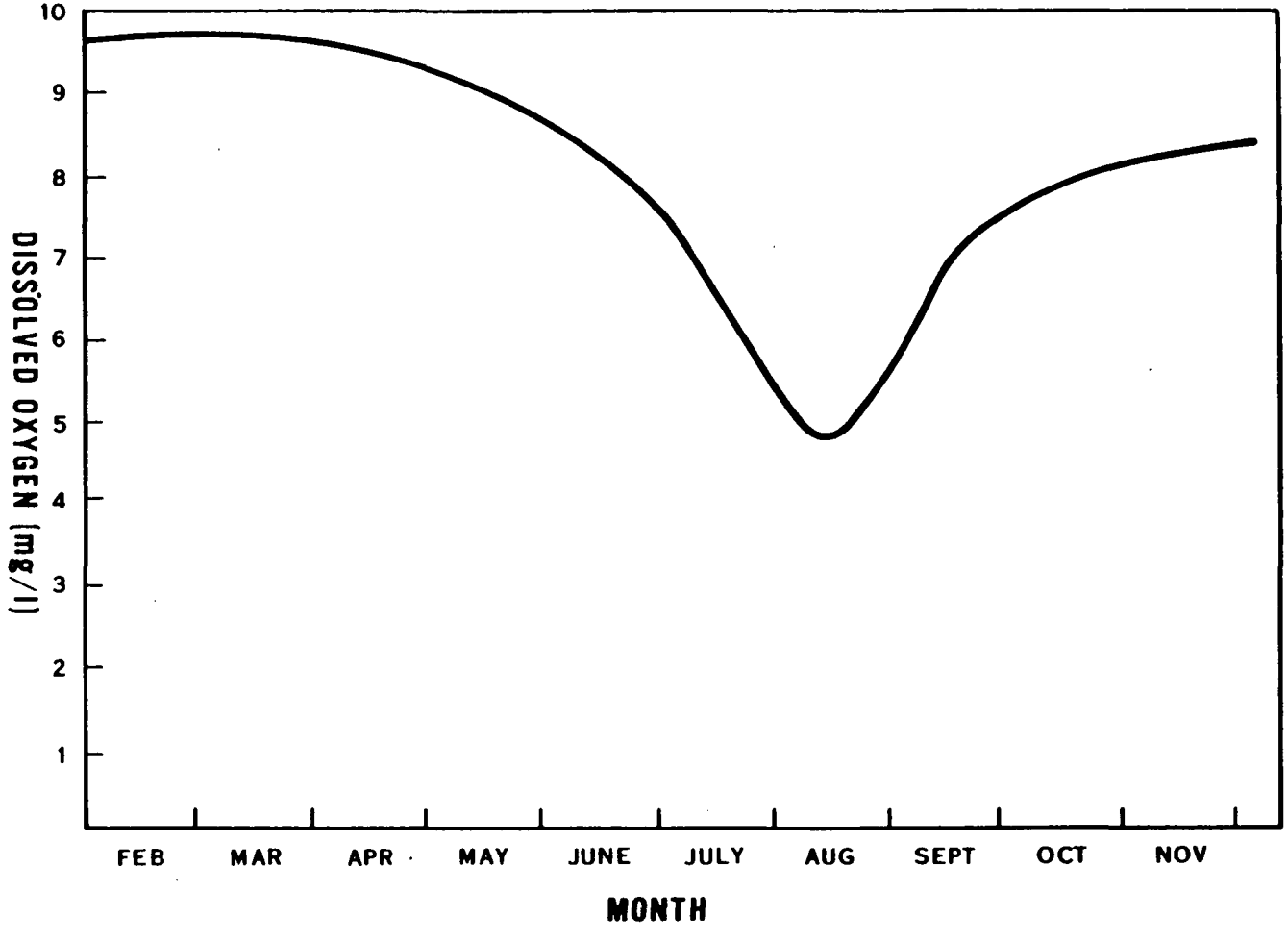


FIGURE 8
GENERALIZED ANNUAL MARINE DISSOLVED OXYGEN CYCLE OFF THE NORTHEAST U.S. (FROM NOAA)

recorded in the New York Bight over the past 15-20 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 fishkills and benthic organism mortality.

Surface Dissolved Oxygen - 1994

During the 1994 sampling period, July 25 through August 26, a total of 57 surface samples were collected for dissolved oxygen analysis. The upper water column, as in past years, appeared to be completely mixed with dissolved oxygen levels at or near saturation. Therefore, no further discussion on surface dissolved oxygen will be presented in this report.

Bottom Dissolved Oxygen - 1994

New York Bight Apex Perpendiculars

New York Bight Apex perpendicular stations, (NYB21, 24, 26, 28 and NYB33, 36, 37, 38) were sampled 3 times during the 1994 sampling period. A total of 24 bottom samples were collected for dissolved oxygen. Only two samples were below the "healthy" guideline of 5.0 mg/l. These two values were:

Station	Date	Dissolved Oxygen
NYB24	8/15/94	4.8 mg/l
NYB24	8/25/94	4.5 mg/l

Based on these data, dissolved oxygen remained well above the guidelines considered stressful to aquatic life.

New Jersey Coast Perpendiculars

Figure 9 illustrates the 1994 bi-monthly average of bottom dissolved oxygen concentrations for the New Jersey coast perpendiculars. The dissolved oxygen averages remained above 6.4 mg/l, from late July to late August.

Table 4 summarizes the bottom dissolved oxygen values for

Figure 9

New Jersey Perpendiculars, 1994

Bi-Monthly Average of Bottom Dissolved Oxygen Concentrations

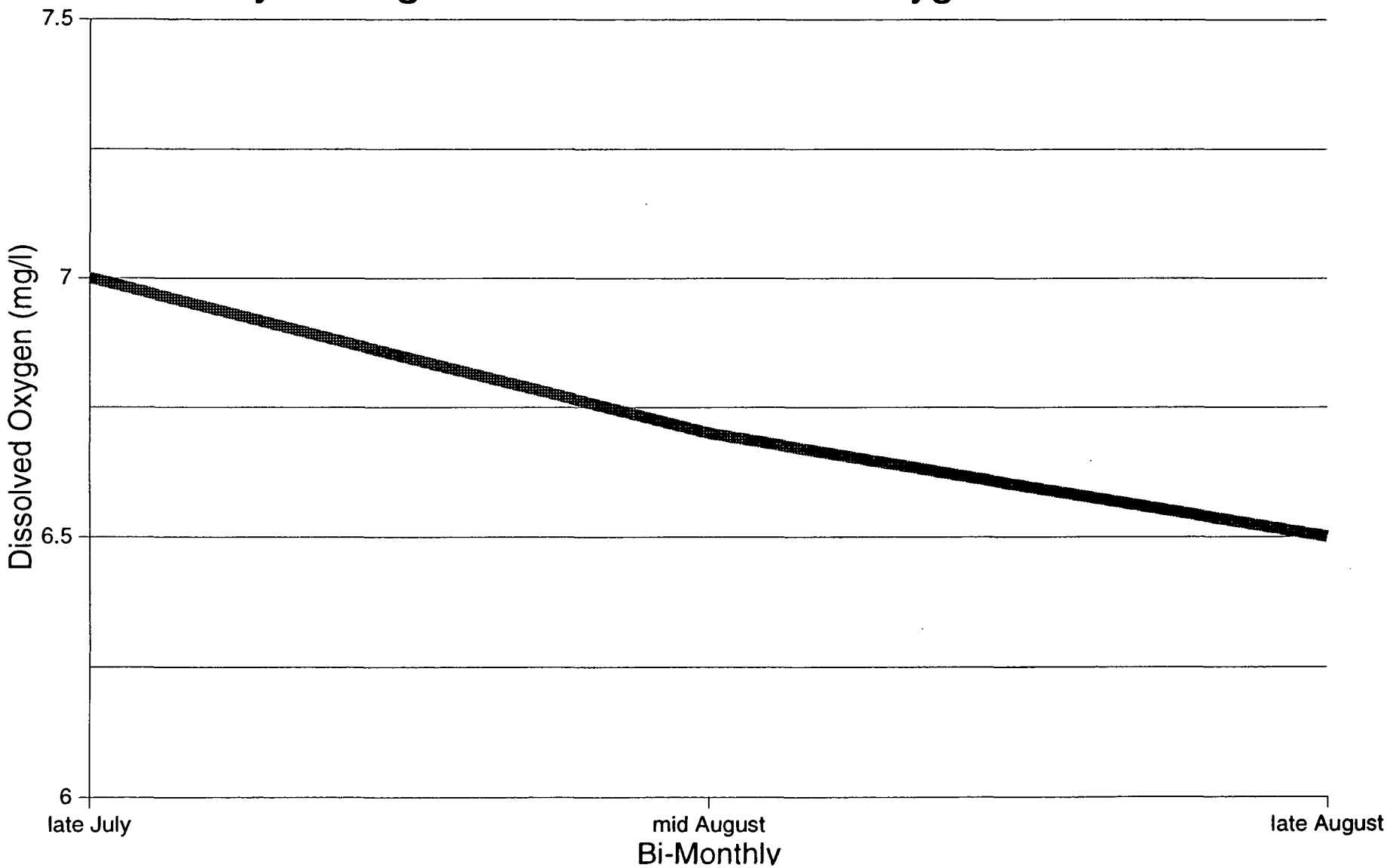


Table 4
1994 NJ Dissolved Oxygen Distribution (Bottom Values)

	Jul25	Jul29	Aug15	Aug19	Aug25	Aug26
JC14E	*		*		*	
JC14I	*		*		*	
JC14M	*		*		*	
JC14P	*		*			
JC14T			*			
JC27E	*		X		*	
JC27I	*		*		*	
JC27M			*		*	
JC27P			*			
JC27T			*			
JC41E			▼		*	
JC41I			*		*	
JC41M			*		*	
JC41P			*			
JC41T			*			
JC53E			*		*	
JC53I			*		*	
JC53M			*		*	
JC53P						
JC53T						
JC61E		*		*		*
JC61I		*		*		*
JC61M		*		*		*
JC61P		*		*		
JC61T		*		*		
JC69E		*		*		*
JC69I		*		*		*
JC69M				*		*
JC69P				*		
JC69T				*		
JC75E				▼		*
JC75I				*		*
JC75M				*		*
JC75P				*		
JC75T				*		
JC85E				*		*
JC85I				*		*
JC85M				*		*
JC85P				*		
JC85T				*		
JC90E				*		*
JC90I				*		*
JC90M				*		*
JC90P				*		
JC90T				*		

KEY: *=≥ 5mg/l ▼=5-4mg/l X=4-3mg/l ▉=3-2mg/l 0=< 2mg/l

Table 4 summarizes the bottom dissolved oxygen values for the New Jersey coast perpendiculars. Of the 83 samples collected, only three values were below the "healthy" guideline of 5 mg/l. The three values were as follows:

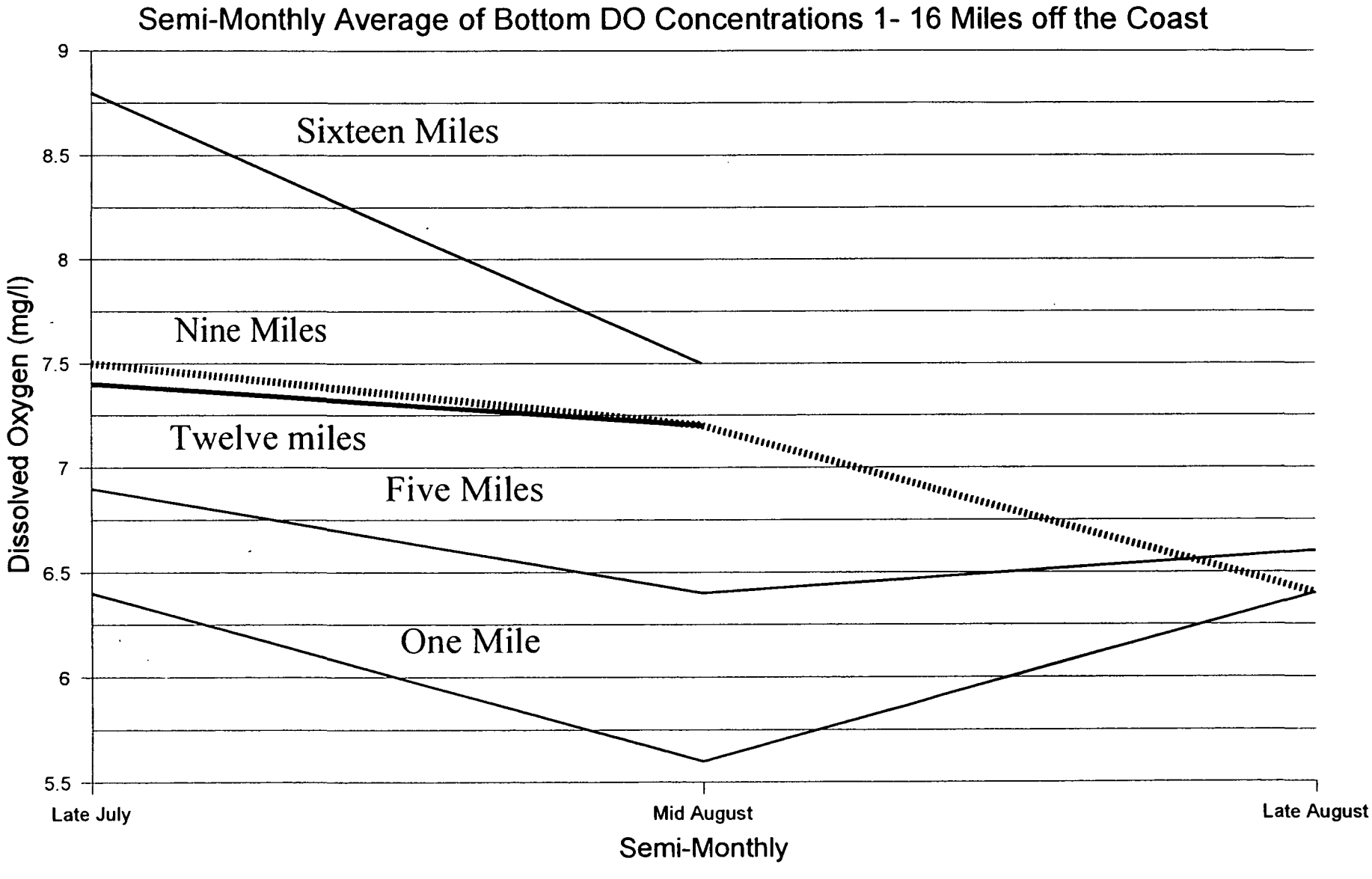
Station	Date	Dissolved Oxygen
JC27E	8/15/94	3.5 mg/l
JC41E	8/15/94	4.2 mg/l
JC75E	8/19/94	4.8 mg/l

Figure 10 compares the shore to seaward distribution, (or distance off the coast) of average dissolved oxygen concentrations along the New Jersey coast perpendicular transects. Generally the dissolved oxygen values increased with distance offshore. The dissolved oxygen concentrations for stations 9 and 12 nautical miles off the coast were essentially identical from late July to in mid August. In late August, the dissolved oxygen concentrations for stations 1, 5, and 9 nautical miles off the coast were essentially the same, within 0.5 mg/l of each other.

The pattern of increasing dissolved oxygen with increasing distance off shore has been observed over the past several years. The lower values at the nearshore stations are attributed to the influence of river discharges, treatment plant effluents, stormwater runoff, benthic oxygen demand from inlet dredged material disposal sites, and the plume from the Hudson-Raritan River Estuary system.

Figure 10

New Jersey Perpendiculars, 1994



Dissolved Oxygen Trends

Figure 11 compares the bi-monthly average of bottom dissolved oxygen concentrations of the New Jersey and New York Bight Perpendiculars, for 1992, 1993 and 1994. All average values are above 5.0 mg/l, with the lowest value, 5.3 mg/l, occurring in late August of 1992. In late July of 1994, the dissolved oxygen concentrations are 0.8 mg/l higher than the 1992 values, and 0.7 mg/l lower than the 1993 value. In late August of 1994, the dissolved oxygen concentrations are 1.2 mg/l higher than the 1992 values, and 0.4 mg/l lower than the 1993 value.

Figure 12 displays the three year bi-monthly average dissolved oxygen concentrations along the New Jersey perpendiculars 1 to 16 nautical miles off the coast, for 1992, 1993 and 1994. Generally the dissolved oxygen values increased with distance offshore. Stations 9, 12, and 16 nautical miles off the coast are consistent with the normal dissolved oxygen sag curve (Figure 8), with low dissolved oxygen values ranging from 6.4 to 6.7 mg/l, occurring in late August. Stations 1 and 5 nautical miles off the coast show low dissolved oxygen values of 5.4 mg/l in late August, and 5.5 mg/l in mid August, respectively. Stations 1 and 5 nautical miles off the coast average dissolved oxygen concentrations are 1 - 2 mg/l lower than stations 9, 12, and 16 nautical miles off the coast.

Dissolved oxygen data have been collected from 1979 through 1993 at 28 stations that are common with the 1994 database. Figures 13 and 14 display minimum dissolved oxygen values per station, that occurred during the sampling periods of 1979 through 1985, and 1986 through 1993, respectively. The data have been divided into pre/post 1985, due to the stressed dissolved oxygen values recorded in 1985. Minimum dissolved oxygen values recorded between 1979 and 1985 showed 48 percent occurring in 1985. Minimum dissolved oxygen values recorded between 1986 and 1993 showed 45 percent occurring in 1990. Twenty-six (93 percent) of the 28 minimum values recorded

Figure 11

NJ & NYB Perpendiculars, 1992, 1993, & 1994

Semi-Monthly Average of Bottom Dissolved Oxygen Concentrations

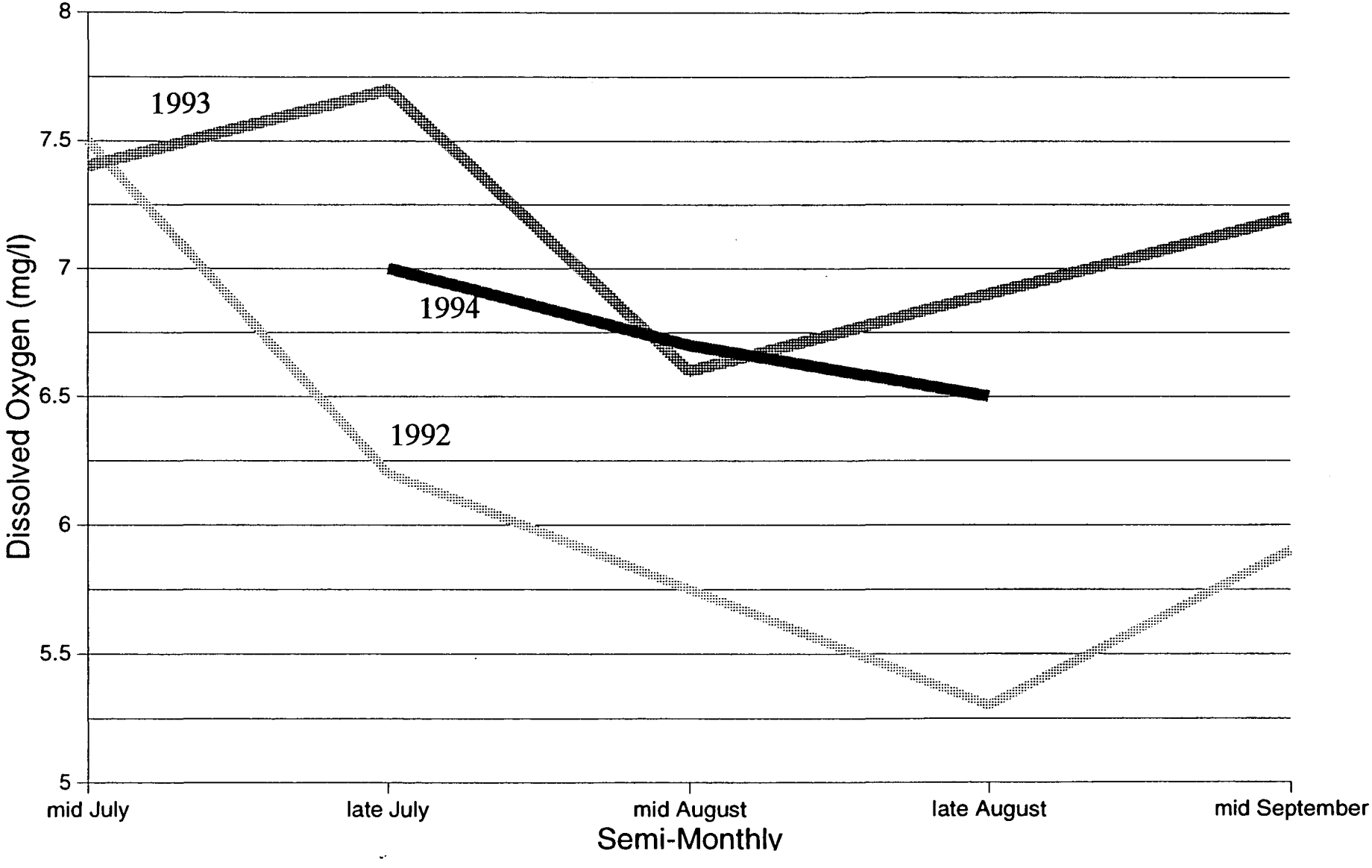


Figure 12

NJ Perpendiculars Bottom DO Concentrations 1 - 16 Miles Off the Coast

Three Year Semi-Monthly Average, 1992, 1993, and 1994

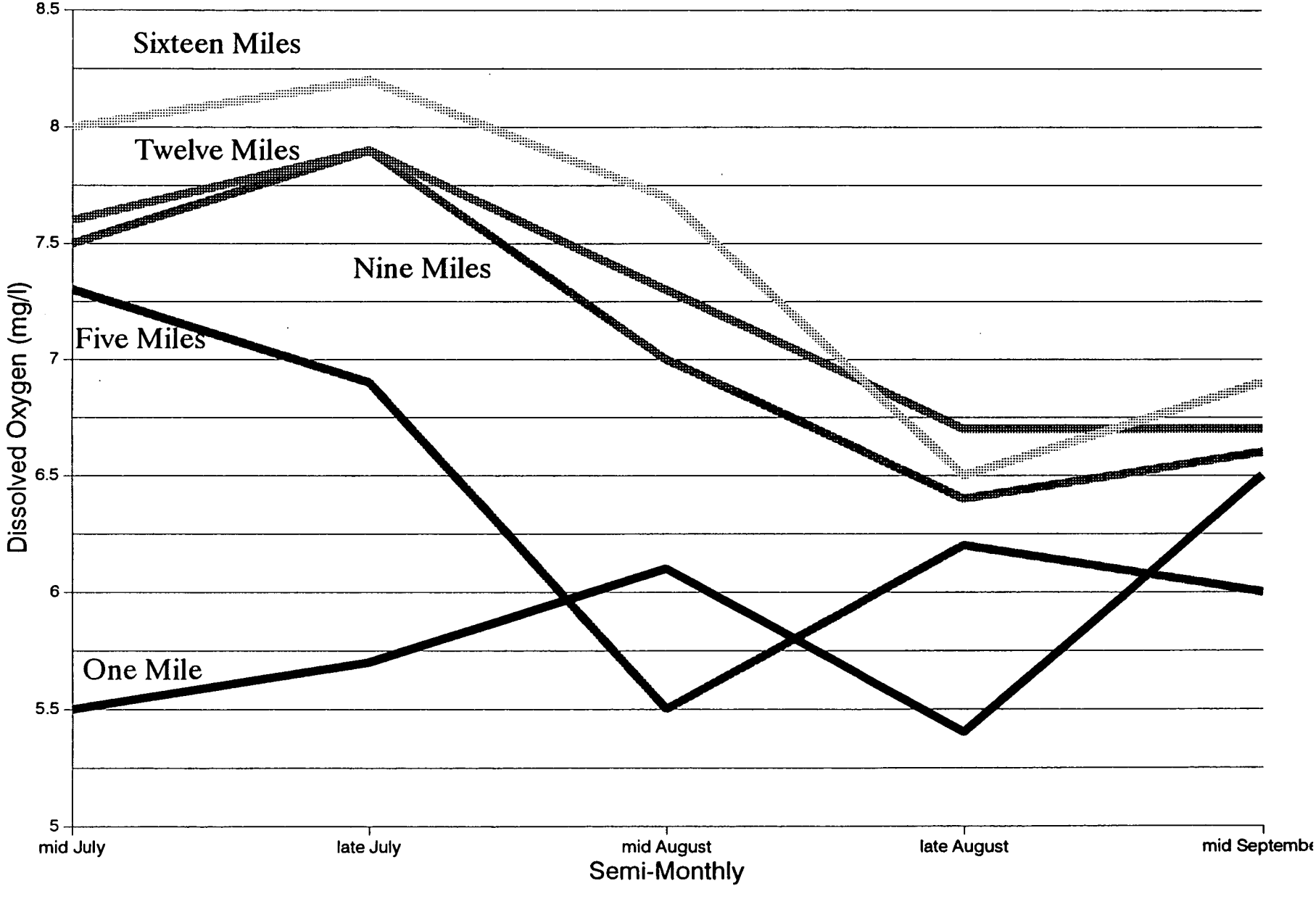
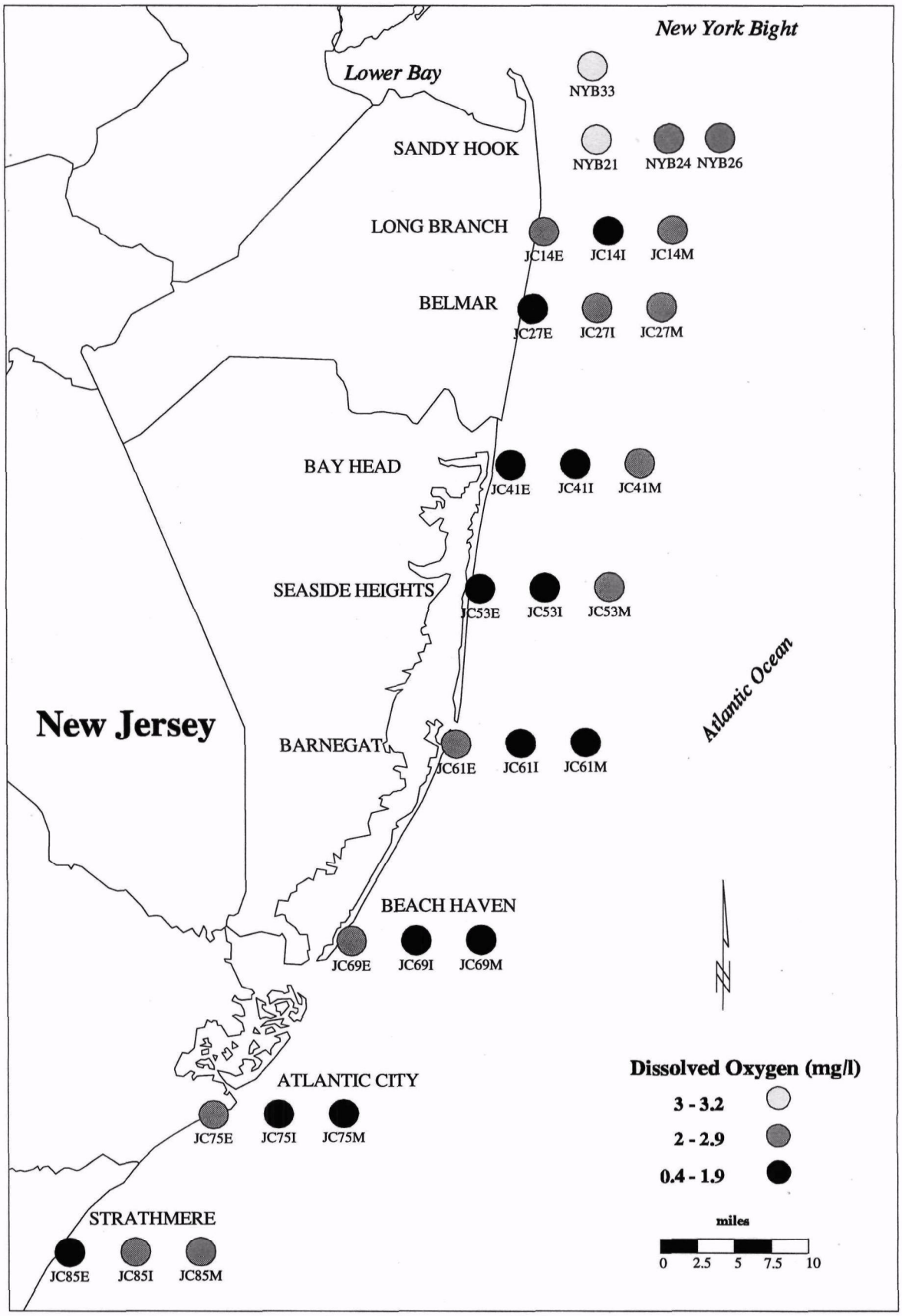
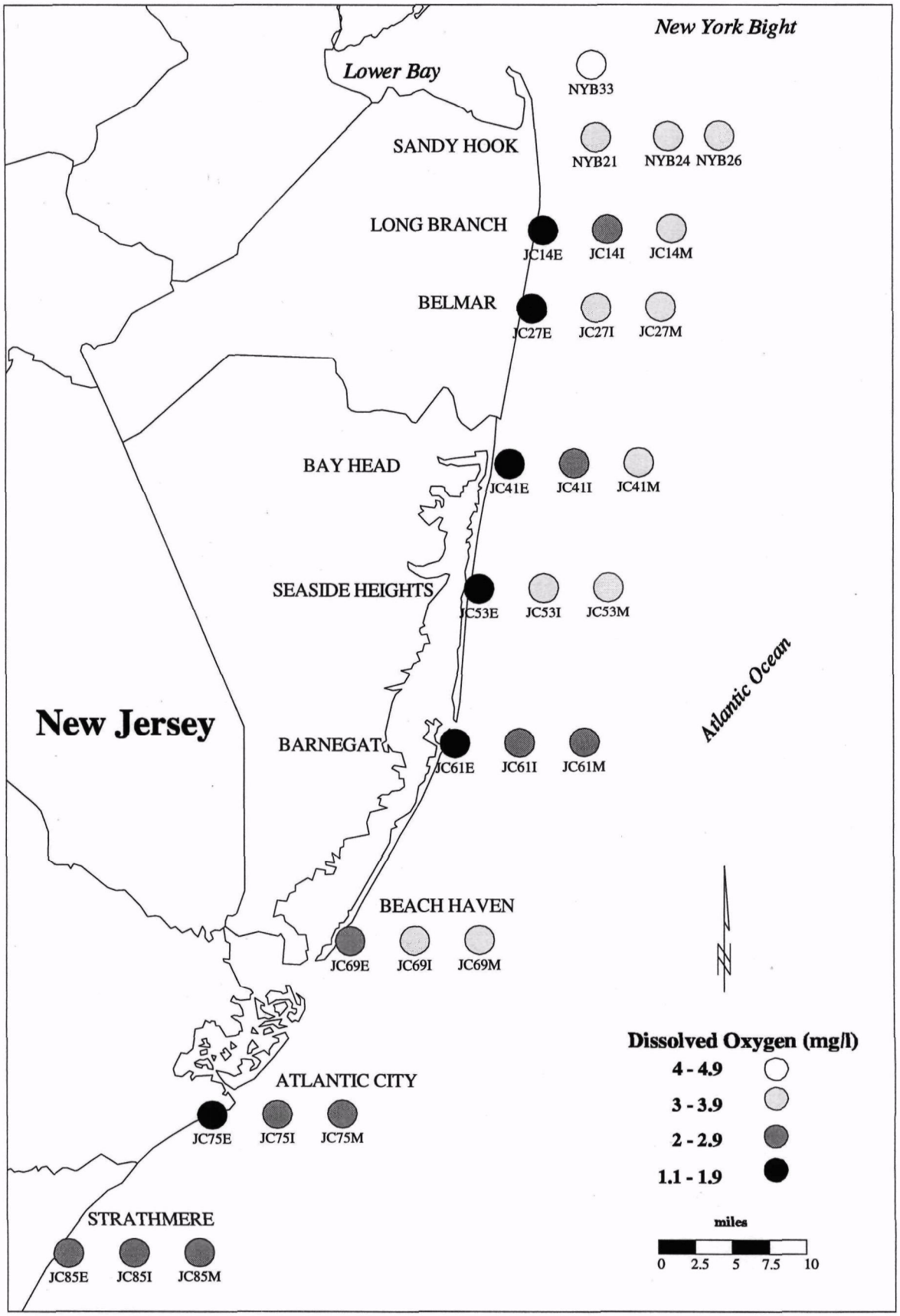


Figure 13



Minimum Bottom Dissolved Oxygen Values for New Jersey and New York Bight Apex Perpendiculars, Summers of 1979 to 1985

Figure 14



Minimum Bottom Dissolved Oxygen Values for New Jersey and New York Bight Apex Perpendiculars, Summers of 1986 to 1993

between 1979 and 1985, (Figure 13) were below the "lethal if prolonged" guideline of 3 mg/l. In comparison, 16 (57 percent) of the 28 minimum values occurring between 1986 and 1993, (Figure 14) were below the "lethal if prolonged" guideline of 3 mg/l. No individual dissolved oxygen values, in 1994, were below the "lethal if prolonged" guideline of 3 mg/l.

The prolonged depressed dissolved oxygen levels in 1985 were attributed to the decomposition of the organisms responsible for the numerous algal blooms that occurred, the lack of meteorological events favoring reaeration, such as substantial winds and storm activity, and the presence of a strong thermocline. The low dissolved oxygen levels in 1990 were not as widespread or persistent as those encountered in 1985.

Since 1985, dissolved oxygen values have shown significant improvement with few values below 3 mg/l. This improvement may be partially attributed to the increased storm activity in subsequent years, promoting reaeration; and the absence of a significant green tide event.

During the summer of 1994, fewer algal blooms were observed, strong winds prevailed, water temperature remained low, and there were numerous storms promoting reaeration. Based on these facts and the data collected, New Jersey coastal waters were of excellent quality in 1994.

VI. FLOATABLES OBSERVATIONS AND DISCUSSION

Purpose

During the summer of 1989, the USEPA initiated surveillance overflights of the New York/New Jersey Harbor Complex in response to the Short Term Action Plan for Addressing Floatable Debris. This Action Plan, which is part of the New York Bight Restoration Plan, was developed by an Interagency Floatable Task Force in an effort to prevent the occurrence of beach closures due to floatable debris, as occurred in previous years. Overflights of the New York/New Jersey Harbor Complex for floatable surveillance continued through 1994. All floatable observations were reported to either the Army Corps of Engineers, or the New York City Department of Environmental Protection. Cleanups were conducted as necessary.

In 1994, a joint effort by the Interagency Floatable Task Force, resulted in the acquisition of a new vessel to be owned and operated by New York City Department of Environmental Protection for collection of floatables debris in designated New York waterways. As a result, surveillance of the New York/New Jersey Harbor increased to include the following New York waterways (or add-on sites): the southern portions of the Hudson and East Rivers, Gravesend Bay, the coastline of Coney Island, and the mouth of Jamaica Bay.

The following information specifically relates to the 1994 aerial surveillance of floatables and/or slick lines in the New York/New Jersey Harbor Complex. From May 15 to September 15, 1989 - 1994, the New York/New Jersey Harbor Complex was surveyed for floatables, six days a week, weather permitting. For comparison reasons, data from 1989, 1992, 1993 and 1994 will be presented.

Criteria for Reportable Floatables

For cleanup purposes, the Short Term Action Plan defined a "slick" as an aggregation of floating debris of indefinite width and a minimum length of approximately 400 meters. Using this as a guideline, all slicks have been divided into the following five categories (from largest to smallest):

Major: any slick over 1600 meters in length;

Heavy: 800 meters to 1600 meters

Moderate: 400 meters to 800 meters;

Light: any slick under 400 meters;

Dispersed: any area that contains a significant amount of floatables, but no defined slick.

A slick under the categories of Light or Dispersed is usually difficult to detect and maintain a sighting for purposes of an efficient cleanup.

The categories of slicks are subjective. All floatable observations have been placed in one of the five categories according to the slick's estimated dimensions, relative density and other recorded observations. Any slick not meeting the length requirements that has a relatively heavy density or extensive width can be moved up a category; as any slick with a relative light density or broken pattern can be moved down a category.

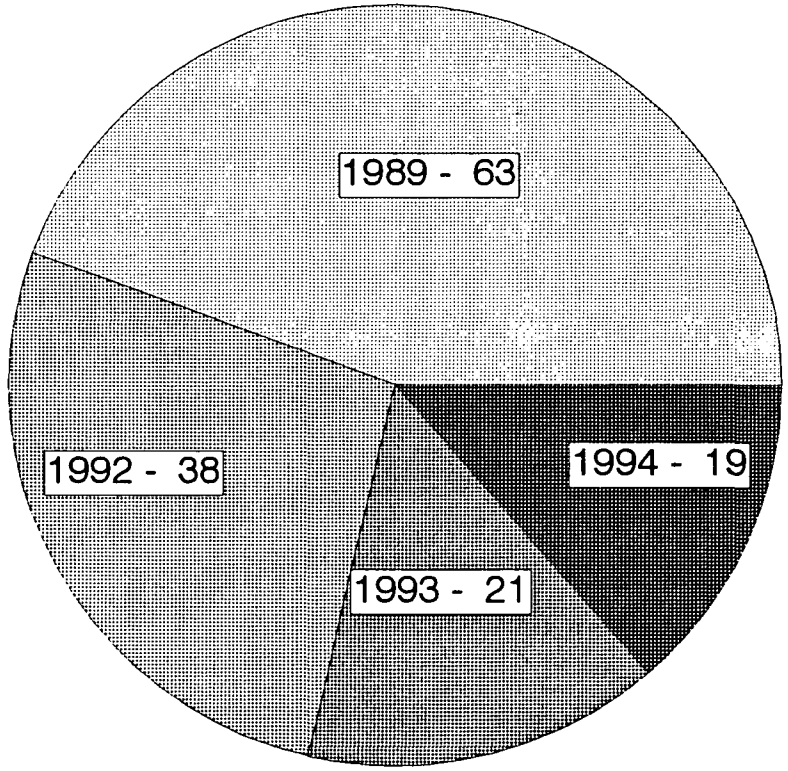
Trends

Figure 15 displays the total number of slicks observed in the New York/New Jersey Harbor Complex divided into two categories: 1) slicks meeting cleanup requirements - major, heavy, and moderate, and 2) slicks not meeting cleanup requirements - minor and dispersed slicks. The sighting of slicks meeting cleanup requirements has decreased steadily since 1989. In 1989, 63 slicks were observed which met the cleanup requirements; in 1992, 38 slicks were observed; in 1993, 21 slicks were observed; and in 1994, 19 slicks were observed, see Pie Chart 1, Figure 15. Of the 19 slicks that

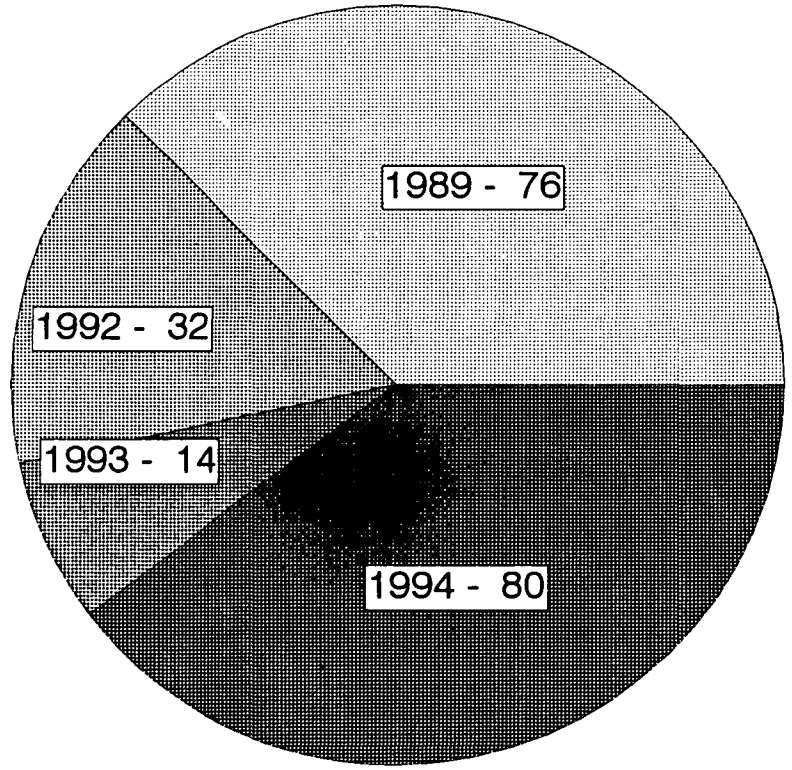
Figure 15

Total Number of Slicks Observed in the NY/NJ Harbor Comlpex
May 15 - September 15, 1989, 1992, 1993, and 1994

Pie 1
Slicks Meeting Cleanup Requirements



Pie 2
Minor and Dispersed Slicks



were observed which met the cleanup requirements in 1994, 4 slicks occurred at the add-on sites. The sightings of minor and dispersed slicks have decreased from 1989 to 1993, but increased in 1994, see Pie Chart 2, Figure 15. Of the 80 minor and dispersed slicks observed in 1994, 29 slicks (or 36 percent) were observed at the add-on sites. Figure 16 presents the total number of slicks observed by each size category for each year. As in Figure 15, slicks meeting cleanup requirements steadily decreased from 1989 to 1994, however, slicks not meeting cleanup requirements decreased from 1989 to 1993, but increased in 1994.

Figure 17 shows the total number of slicks reported corresponding to one of six locational divisions of the New York/New Jersey Harbor Complex, and the total number of slicks observed at the add-on sites. The sighting of slicks generally decreased in the Verrazano Narrows, the Kill Van Kull, and the Lower New York Harbor. The sighting of slicks in the Upper New York Harbor, Newark Bay, and the Arthur Kill decreased from 1989 to 1993, but increased in 1994.

Figure 18 displays the total number of slicks observed at the add-on sites divided by the size categories. Gravesend Bay had the greatest number of slicks observed, ten slicks. The greatest number of slicks observed meeting the cleanup requirements, two slicks, occurred at the Hudson River.

Since 1989, there has been a significant reduction of floatable slicks requiring cleanups. The reduction of slicks can be directly attributed to the initiation of beach and litter cleanup activities, such as the Short Term Action Plan, the Clean Streets/Clean Beaches campaign, and Operation Clean Shores. The Clean Streets/Clean Beaches campaign commenced in 1992 by a coalition of metropolitan-area public and private groups. The campaign stresses public education on the link between street and beach litter. Operation Clean Shores, a program utilizing prisoners, was initiated by the New Jersey

Figure 16

Total Number of Slicks Observed in the New York/New Jersey Harbor Complex

By Size Category in 1989, 1992, 1993, and 1994

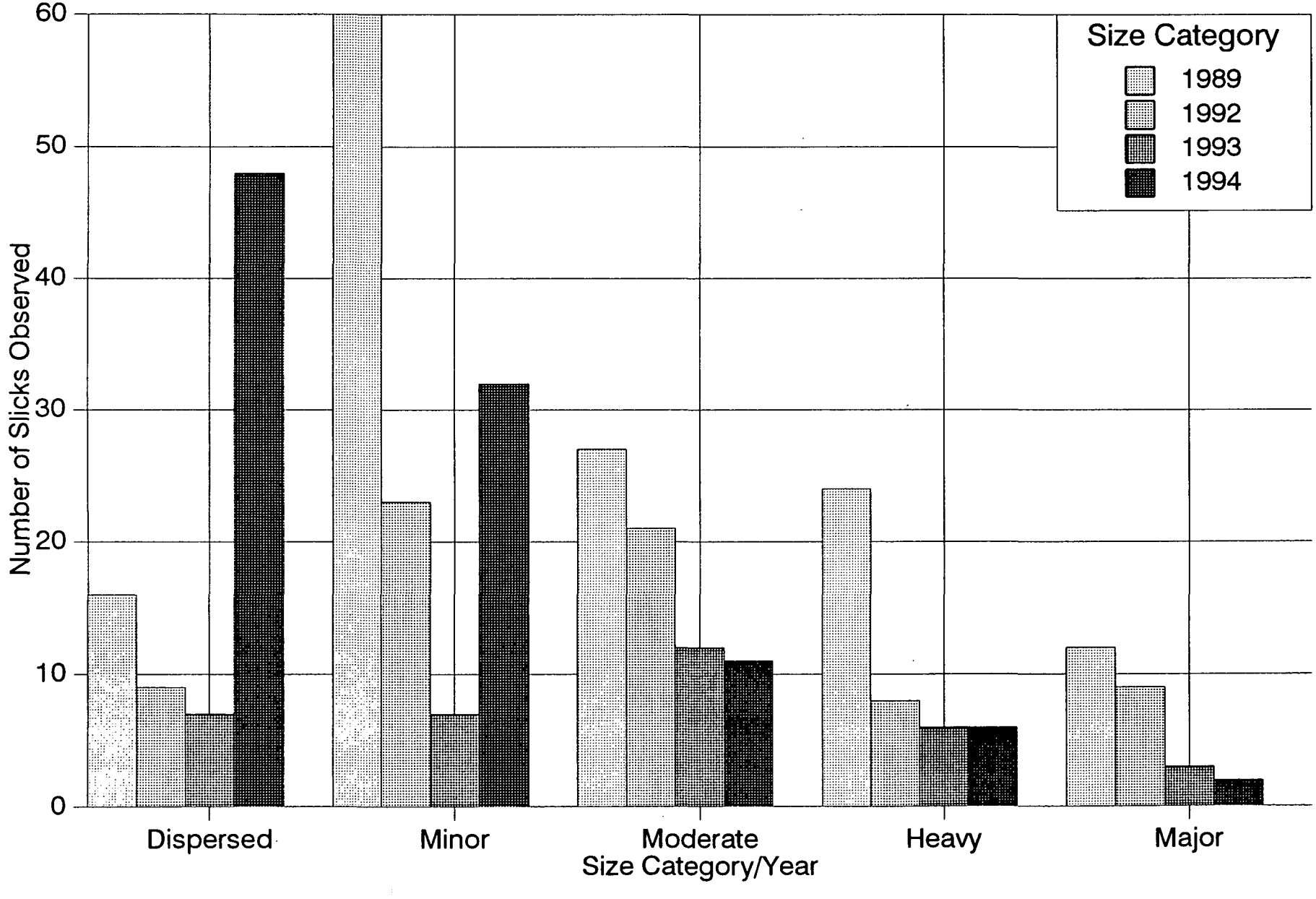


Figure 17

Total Number of Slicks Observed in the New York/New Jersey Harbor Complex

By Locational Subdivision in 1989, 1992, 1993, and 1994

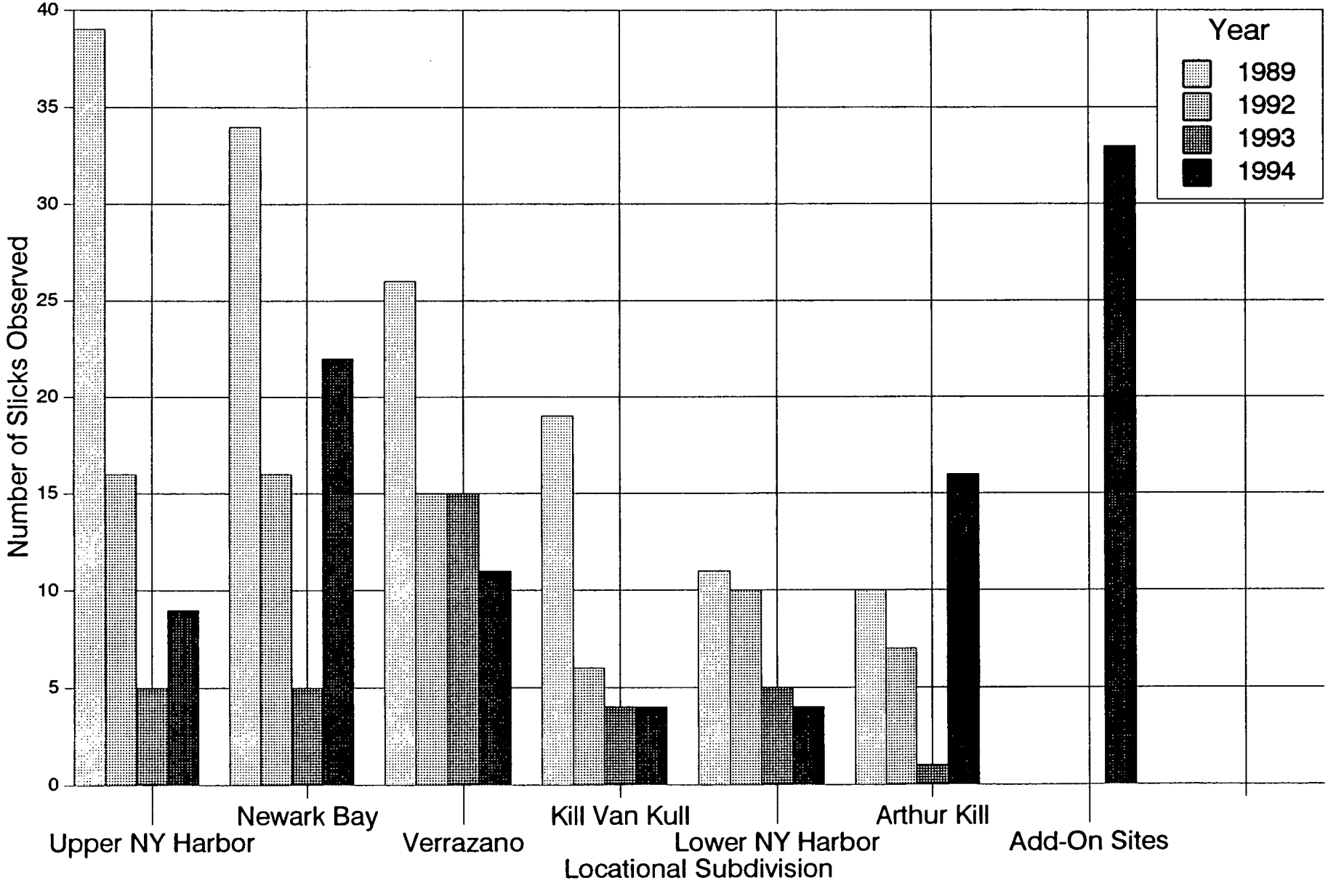
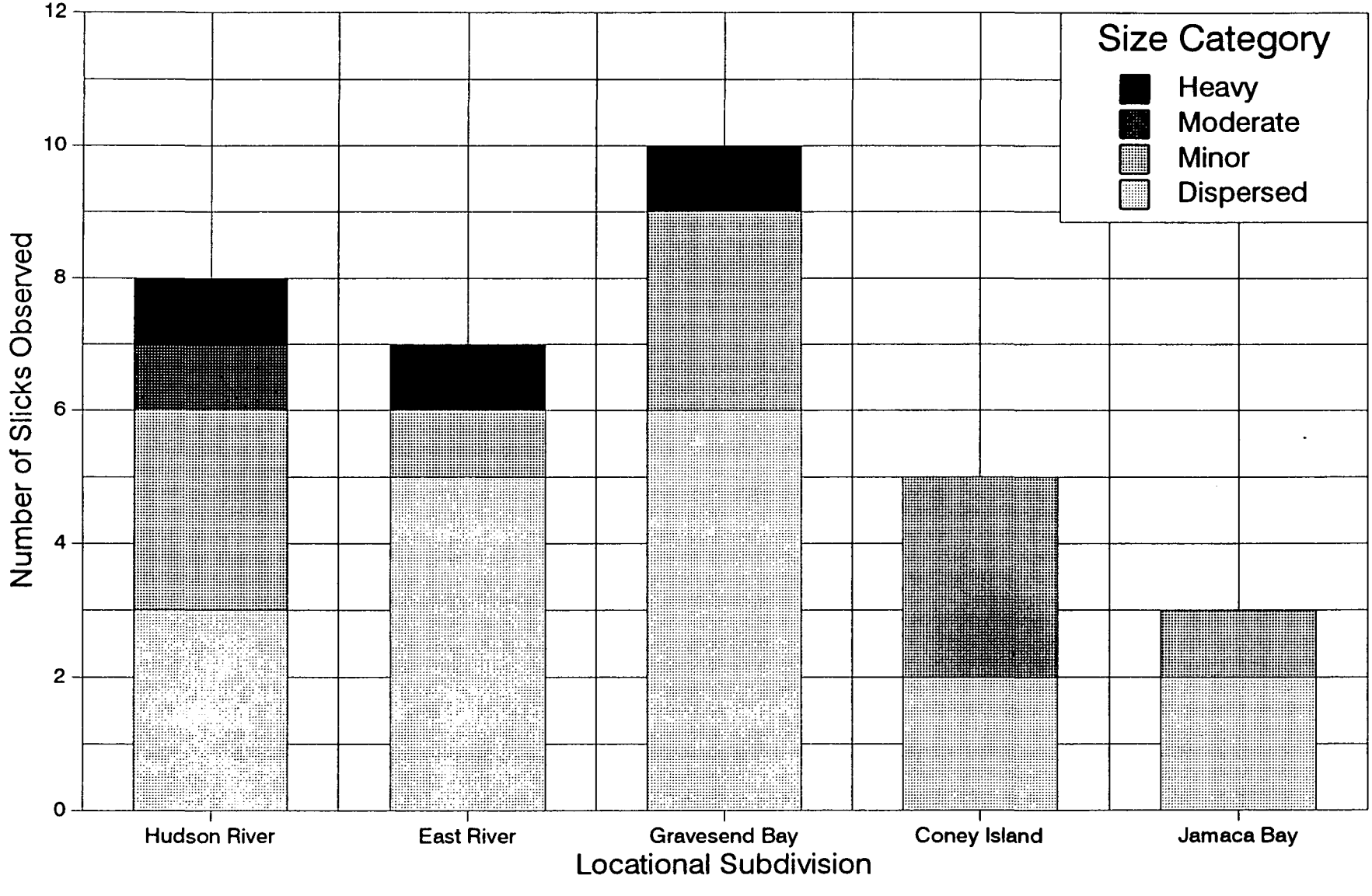


Figure 18

Total Number of Slicks Observed at Add-On Sites, 1994

Divided by Size Categories



Department of Environmental Protection and Energy in 1989 to remove floatable debris from impacted shorelines. Increasing the program from seasonal to year-round, and with the cooperation from participating municipalities, 11.6 million pounds of floatables were removed in 1992, 11.5 million pounds in 1993, and approximately 8 million pounds in 1994. Removal of floatables from impacted shorelines prevents the material from resuspending into the water column and washing up on other shorelines or bathing beaches.

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APPENDIX A

Microbiological Water Quality

New York Bight Summer 1994

MICROBIOLOGICAL WATER QUALITY

NEW YORK BIGHT

SUMMER 1994

Introduction

A study of the density* of fecal coliform and enterococcus organisms was conducted in 1994 as part of the continuing annual monitoring of the nearshore waters off the Long Island and New Jersey coasts.

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 the 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 (1).

Investigations have shown that agents of bacterial disease, enteropathogenic/toxigenic *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella*, *Salmonella*, and *Shigella* are excreted in large numbers in the feces of infected individuals, and are thus potentially present in sewage. Members of the genera *Salmonella* & *Shigella* are not indicator but legitimate intestinal pathogens. *Clostridium perfringens*, a pathogen, which are present as normal flora in man, and warm-blooded animals, are also excreted in large numbers (2). It is common practice to use an indicator organism to detect fecal contamination because of the ease of isolating and quantitating certain microorganisms on membrane filters. Elaborate procedures are usually required for the detection of most pathogens in mixed populations. When numerous indicator organisms are present, the likelihood of pathogens being found is far greater.

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 indicator 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 fecal coliform per 100 ml, nor shall more than 10% of the total samples during any 30-day period exceed 400 fecal coliforms per 100 ml. The rationale for the limits was developed using data collected from studies at the Great Lakes (Michigan) and the Inland River (Ohio) which showed an epidemiological detectable health effect at levels of 2300-2400 coliforms/100 ml. Subsequent investigations conducted on the Ohio River suggested that fecal coliforms represent 18% of

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* Bacterial density in this study is referred to as the number of fecal coliforms and enterococci per 100 ml of water.

the total coliforms. This would indicate that detectable health effects may occur at a fecal coliform level above approximately 400/100 ml. A limit of 200 fecal coliforms per 100 ml would therefore provide a quality of water which should exceed that which would cause a detectable health effect (3).

New York State, for its primary contact recreational coastal waters, adopted the standard of 200 fecal coliforms/100 ml, provided that the log mean is not exceeded during 5 successive sets of samples. New Jersey also has the standard of 200 fecal coliforms/100 ml. By 1978, most of the states adopted the fecal coliform indicator with geometric mean limits at 200 fecal coliforms/100 ml.

Fecal Coliform Indicator Bacteria

Fecal coliforms comprise all of the coliform bacteria that ferment lactose at 44.5 ± 0.2°C. This group, according to traditional theory, more accurately reflects the presence of fecal discharges from warm-blooded animals. As an indicator, fecal coliforms 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.

Enterococcus Group: Indicator Bacteria

Enterococci are a subgroup of the fecal streptococci. The occurrence of fecal streptococci in water indicates fecal contamination from warm-blooded animals. One is able to pinpoint the source of fecal contamination (such as human, equine, bovine, avian) by identifying the species utilizing biochemical tests. The enterococcus group includes the following species: *Enterococcus faecalis; Enterococcus faecalis, subspecies liquefaciens; Enterococcus faecalis, subspecies zymogenes;* and *Enterococcus faecium*. *Enterococcus faecalis*, one of the group D streptoccal species, grows in broth containing 6.5% NaCl, hydrolyzes arginine and utilizes pyruvate (4-6). *Enterococcus faecium* grows in 6.5% NaCL broth, hydrolyzes arginine, but does not utilize pyruvate. *Streptococcus bovis* does not grow in 6.5% NaCl broth, does not hydrolyze arginine, and does not utilize pyruvate. These are the three most common species of group D streptococci found as pathogens in human infection. *Enterococcus durans* is isolated occasionally, and *Streptococcus equinus* is found rarely (7).

The taxonomy and nomenclature of the streptococci have undergone major changes over the past few years. Primarily on the basis of the results of DNA-DNA hybridization studies two new genera, *Enterococcus* and *Lactococcus* have been proposed to accommodate the fecal group D and lactic group N streptococci respectively (8).

EPA has recently published the results of two research projects which compared the relationship between illnesses associated with bathing in recreational waters and ambient densities of several indicator organisms (9). One study was performed on marine bathing beaches and one on freshwater beaches. Studies at marine and fresh water bathing beaches indicated that gastroenteritis is directly related to the quality of the bathing water and that enterococci is a better indicator of water quality than fecal coliforms (1,3).

EPA has issued a criteria guidance document recommending enterococci and *Escherichia coli* for inclusion into state water quality standards for the protection of primary contact recreational uses in lieu of fecal coliforms. The EPA (1986) recommended criterion for enterococci for marine waters is 35/100 ml. This information was published in the Federal Register on March 7, 1986.

Materials and Methods

Marine water samples were collected by helicopter from May to September 1994. The samples were collected using a Kemmerer sampler and transferred to 500 ml sterile, wide-mouthed plastic containers, and then transported in an ice chest to the Region 2 Edison laboratory for analysis.

Fecal coliform determinations were conducted according to the membrane filtration (MF) procedures described in *Standard Methods*, 18th edition, 1992 (4) and *Microbiological Methods for Monitoring the Environment, Water and Wastewater,* (5) Enterococci determinations were conducted according to the MF procedure described by Levin (10), and DuFour (11), using the modified mE media. Confirmation of enterococci colonies were conducted following procedures outlined in *Microbiological Methods for Monitoring the Environment, Water and Wastewater,* (5).

Results and Discussion

Fecal Coliform - New Jersey

Along the New Jersey Coast, fecal coliform densities equal to or greater than 50/100 ml occurred on four occasions at station JC-14 (Long Branch, off of the foot of S. Bath Avenue), JC-53 (Seaside Heights, between the amusement piers), JC-92 (Hereford Inlet) and JC-96 (Cape May Inlet). Refer to Tables 1 & 2 and Figure 1 for specific data.

Fecal Coliform - Long Island

Fecal coliform densities greater than 50/100 ml did not occur. The maximum density of 48/100 ml occurred at station LIC-18 (Great South Beach). Refer to Table 3 and Figure 2 for specific data.

Enterococci - New Jersey

Enterococci densities exceeding the criteria of 35/100 ml (3) occurred on one occasion at Station JC-92 (Hereford Inlet). Refer to Tables 4 & 5 and Figure 3 for specific data.

Enterococci - Long Island

Enterococci densities exceeding the criteria of 35/100 ml did not occur. The maximum density of 12/100 ml occurred at station LIC-04 (Rockaway, off of the foot of B92 Road). Refer to Table 6 and Figure 4 for specific data.

For the majority of New Jersey and Long Island Coastal Station low fecal coliform geometric mean densities per 100 ml were observed.

New Jersey had higher maximum peaks on specific dates than in prior years. This profile is visually presented in the geometric mean value of fecal coliform densities in Figres 1 and 2.

Geometric mean densities for enterococci along the New Jersey and Long Island Coastal Stations were somewhat lower. These profiles are visually evident in Figures 3 and 4.

Numerous studies addressing the disappearance of fecal coliform and enterococci in marine waters show extremely varied results. Bacterial survival is affected by numerous physical and biological parameters (12).

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TABLE 1
FECAL COLIFORM DENSITIES > 50 PER 100ML
NEW JERSEY COAST STATIONS
SUMMER 1994

OBS.	STATION	DATE	VALUE
1	JC14	080394	60
2	JC53	081794	56
3	JC92	062294	70
4	JC96	081094	78

TABLE 2
GEOMETRIC MEANS OF FECAL COILFORM DENSITIES
NEW JERSEY COAST STATIONS
SUMMER 1994

OBS	STATION	GEO MEAN	MINIMUM	MAXIMUM	N
1	JC01A	1.22106	0	20	15
2	JC03	1.27880	0	20	15
3	JC05	1.00000	0	1	15
4	JC08	1.14870	0	4	15
5	JC11	1.74110	0	16	15
6	JC13	1.35566	0	12	15
7	JC14	1.55056	0	60	15
8	JC21	1.18017	0	3	15
9	JC24	1.32991	0	24	15
10	JC26	2.48214	0	24	15
11	JC27	1.31951	0	16	15
12	JC30	1.00000	0	1	15
13	JC33	1.29444	0	24	15
14	JC35	1.09682	0	2	15
15	JC37	1.72774	0	11	14
16	JC41	1.10409	0	4	14
17	JC44	1.04729	0	2	15
18	JC47A	1.00000	0	1	15
19	JC49	1.19786	0	5	15
20	JC53	3.76698	0	56	15
21	JC55	1.00000	0	1	15
22	JC57	1.00000	0	1	15
23	JC59	1.09682	0	4	15
24	JC61	1.00000	0	1	15
25	JC63	1.09682	0	4	15
26	JC65	1.14912	0	7	14
27	JC67	1.04729	0	2	15
28	JC69	1.07599	0	3	15
29	JC73	1.14778	0	6	13
30	JC74	1.30551	0	4	13
31	JC75	1.57889	0	20	12
32	JC77	1.47142	0	7	11
33	JC79	1.00000	0	1	13
34	JC81	1.23773	0	4	13
35	JC83	1.21064	0	4	13
36	JC85	1.23773	0	8	13
37	JC87	1.23860	0	20	14
38	JC89	1.21064	0	4	13
39	JC92	1.99325	0	70	13
40	JC93	1.21064	0	4	13
41	JC95	1.21064	0	12	13
42	JC96	3.64612	0	78	13
43	JC97	1.05477	0	2	13
44	JC99	1.00000	0	1	12

FIGURE 1

GEOMETRIC MEANS OF FECAL COLIFORM DENSITIES
NEW JERSEY COAST STATIONS
SUMMER 1994

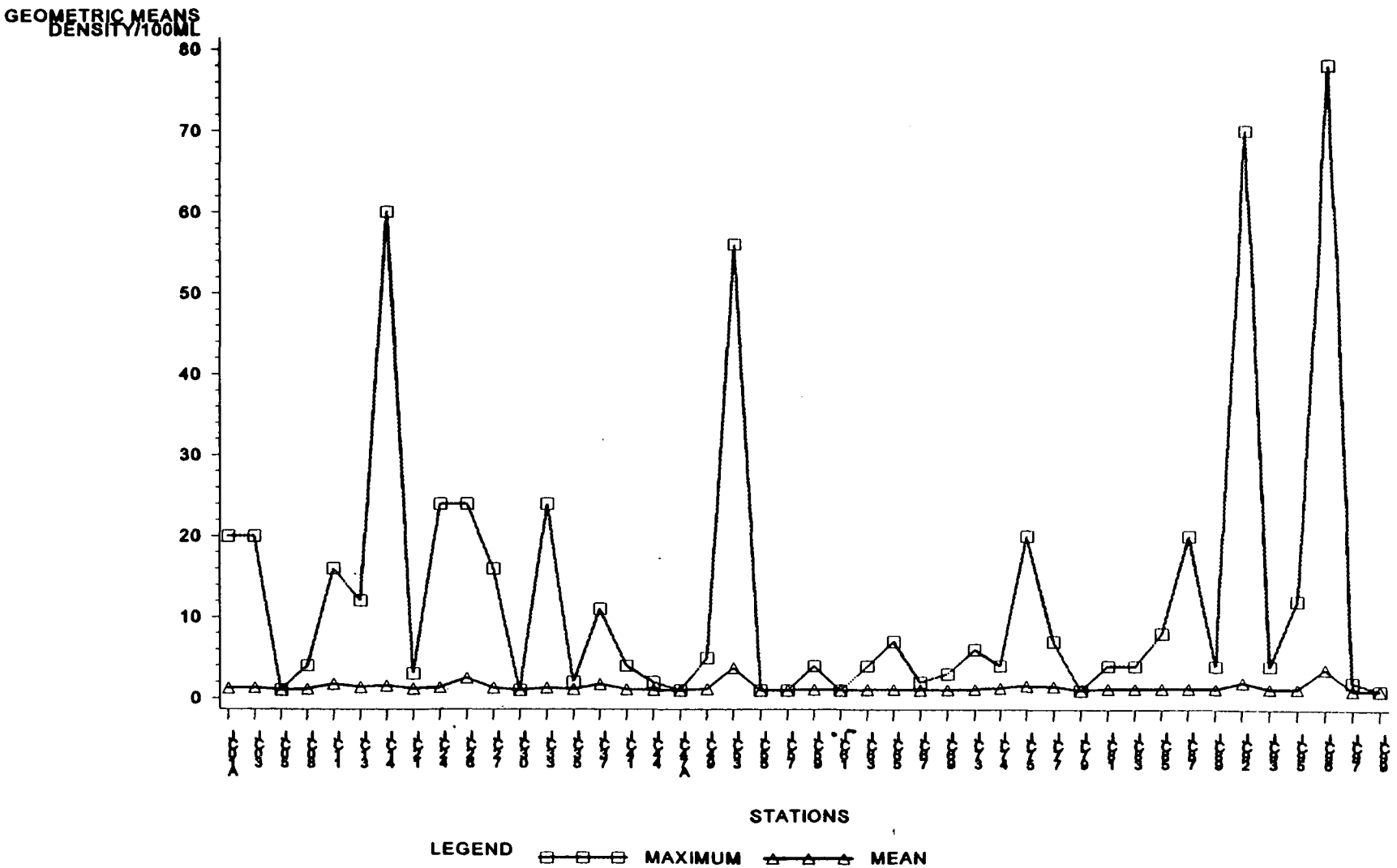


TABLE 3
GEOMETRIC MEANS OF FECAL COLIFORM DENSITIES
LONG ISLAND COAST STATIONS
SUMMER 1994

OBS	STATION	MEAN	MINIMUM	MAXIMUM	N
1	LIC01	1.27694	0	8	13
2	LIC02	1.11253	0	4	13
3	LIC03	1.11253	0	4	13
4	LIC04	2.12412	0	20	13
5	LIC05	1.00000	0	1	13
6	LIC07	1.05477	0	2	13
7	LIC08	1.11253	0	4	13
8	LIC09	1.64195	0	12	12
9	LIC10	1.75675	0	6	12
10	LIC12	1.00000	0	1	12
11	LIC13	1.05946	0	2	12
12	LIC14	1.00000	0	1	12
13	LIC15	1.00000	0	1	12
14	LIC16	1.00000	0	1	12
15	LIC17	1.00000	0	1	12
16	LIC18	1.38071	0	48	12
17	LIC19	1.00000	0	1	12
18	LIC20	1.18921	0	4	12
19	LIC21	1.46281	0	8	12
20	LIC22	1.25992	0	8	12
21	LIC23	1.25992	0	4	12
22	LIC24	1.20094	0	9	12
23	LIC25	1.18921	0	4	12
24	LIC26	1.00000	0	1	12
25	LIC27	1.05946	0	2	12
26	LIC28	1.00000	0	1	12

FIGURE 2

GEOMETRIC MEANS OF FECAL COLIFORM DENSITIES
LONG ISLAND COAST STATIONS
SUMMER 1994

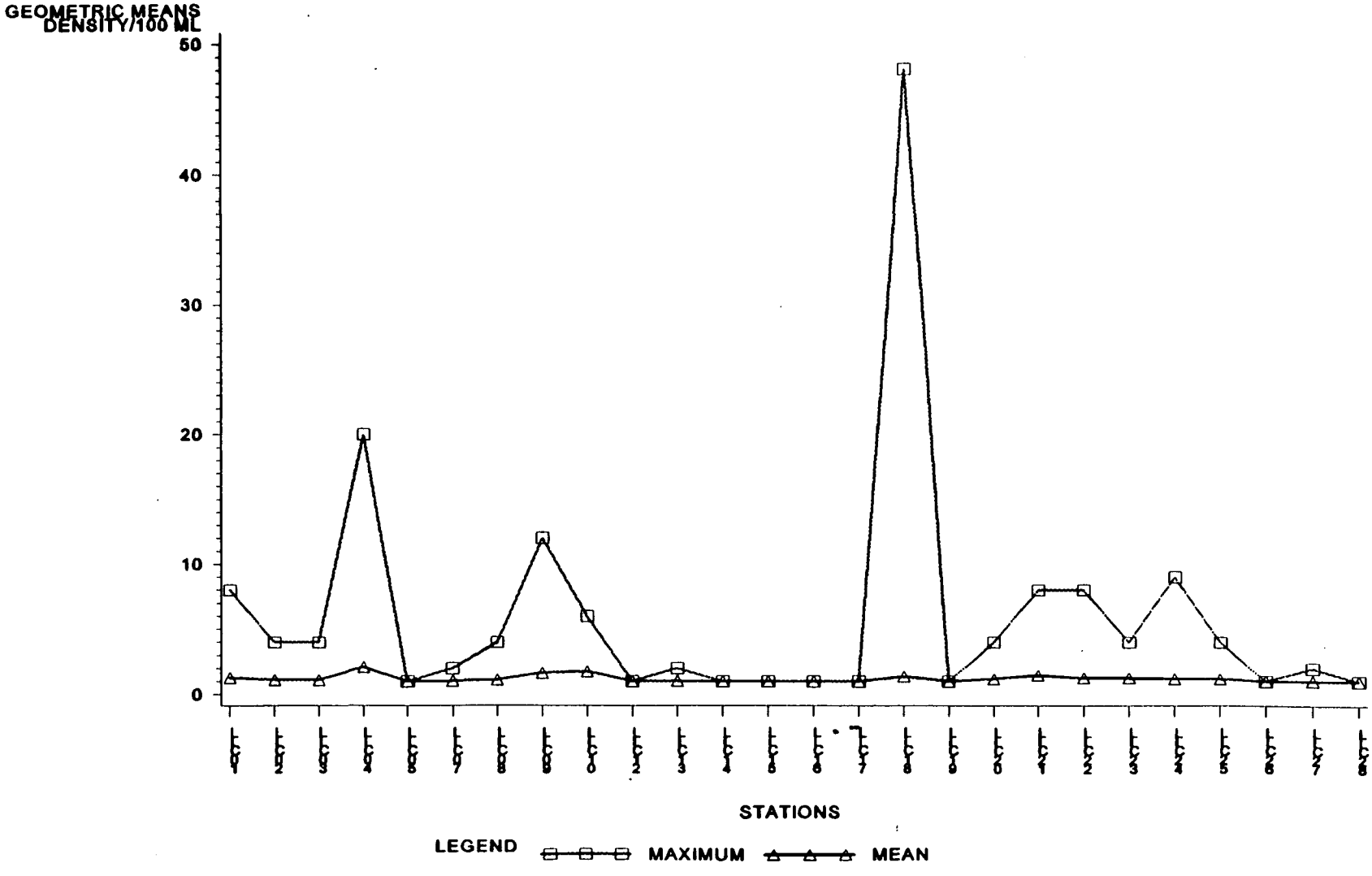


TABLE 4

ENTEROCOCCUS DENSITIES > 35 PER 100ML
NEW JERSEY COAST STATIONS
SUMMER 1994

OBS	STATION	DATE	VALUE
1	JC92	062294	36

TABLE 5
GEOMETRIC MEANS OF ENTEROCOCCUS DENSITIES
NEW JERSEY COAST STATIONS
SUMMER 1994

OBS	STATION	GEO MEAN	MINIMUM	MAXIMUM	N
1	JC01A	1.04729	0	2	15
2	JC03	1.00000	0	1	15
3	JC05	1.09682	0	4	15
4	JC08	1.00000	0	1	15
5	JC11	1.00000	0	1	15
6	JC13	1.04729	0	2	15
7	JC14	1.04729	0	2	15
8	JC21	1.00000	0	1	15
9	JC24	1.00000	0	1	15
10	JC26	1.31951	0	16	15
11	JC27	1.11326	0	5	15
12	JC30	1.14870	0	4	15
13	JC33	1.04729	0	2	15
14	JC35	1.09682	0	4	15
15	JC37	1.16013	0	4	14
16	JC41	1.10409	0	4	14
17	JC44	1.00000	0	1	15
18	JC47A	1.00000	0	1	15
19	JC49	1.04729	0	2	15
20	JC53	1.28297	0	7	15
21	JC55	1.00000	0	1	15
22	JC57	1.11326	0	5	15
23	JC59	1.00000	0	1	15
24	JC61	1.14870	0	4	15
25	JC63	1.00000	0	1	15
26	JC65	1.00000	0	1	14
27	JC67	1.00000	0	1	15
28	JC69	1.00000	0	1	15
29	JC73	1.05477	0	2	13
30	JC74	1.13179	0	5	13
31	JC75	1.67277	0	20	12
32	JC77	1.10503	0	3	11
33	JC79	1.00000	0	1	13
34	JC81	1.21064	0	12	13
35	JC83	1.05477	0	2	13
36	JC85	1.14778	0	3	13
37	JC87	1.16013	0	4	14
38	JC89	1.14778	0	3	13
39	JC92	1.71136	0	36	13
40	JC93	1.14778	0	3	13
41	JC95	1.05477	0	2	13
42	JC96	2.02455	0	25	13
43	JC97	1.00000	0	1	13
44	JC99	1.09587	0	3	12

FIGURE 3

GEOMETRIC MEANS OF ENTEROCOCCUS DENSITIES NEW JERSEY COAST STATIONS SUMMER 1994

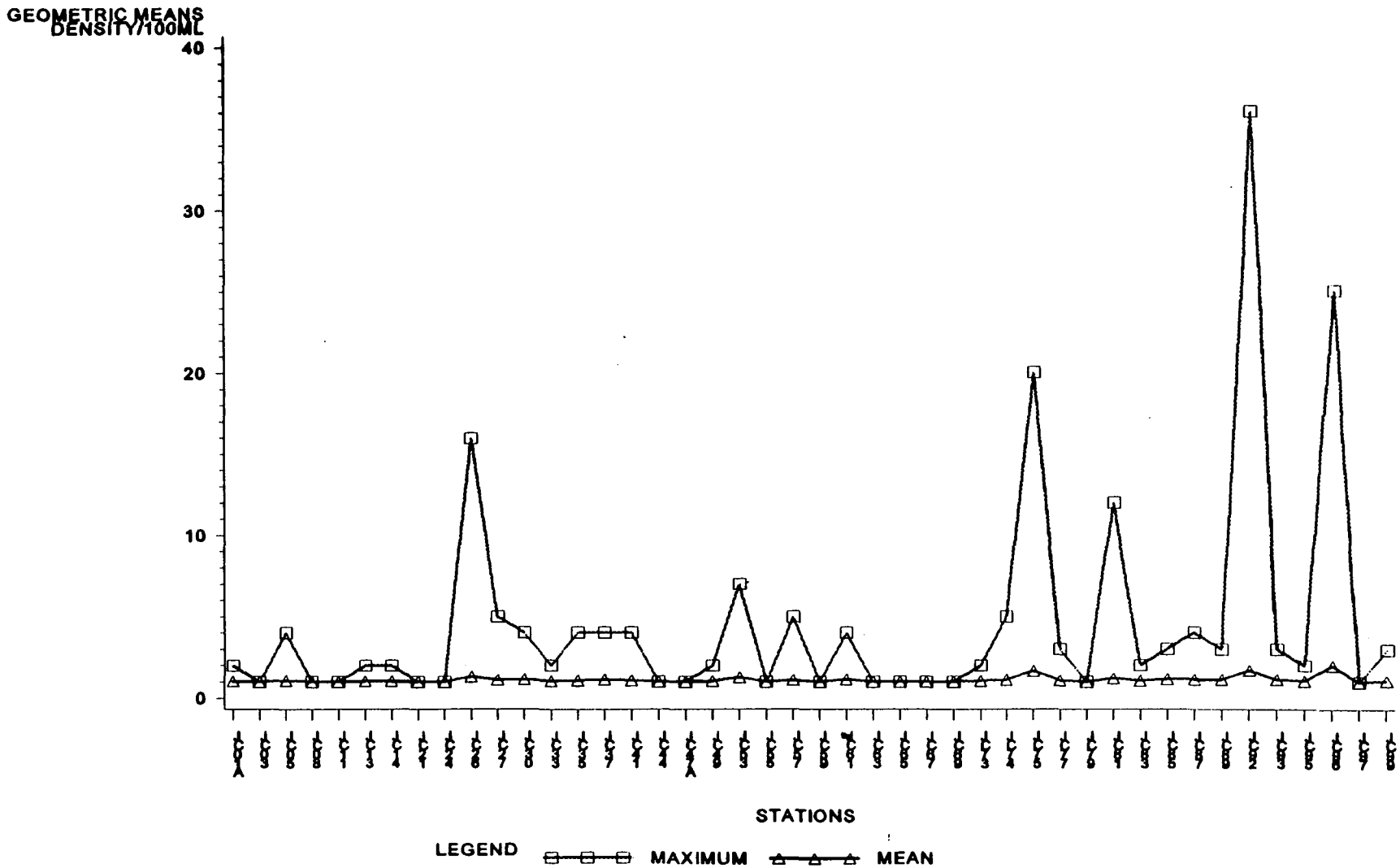
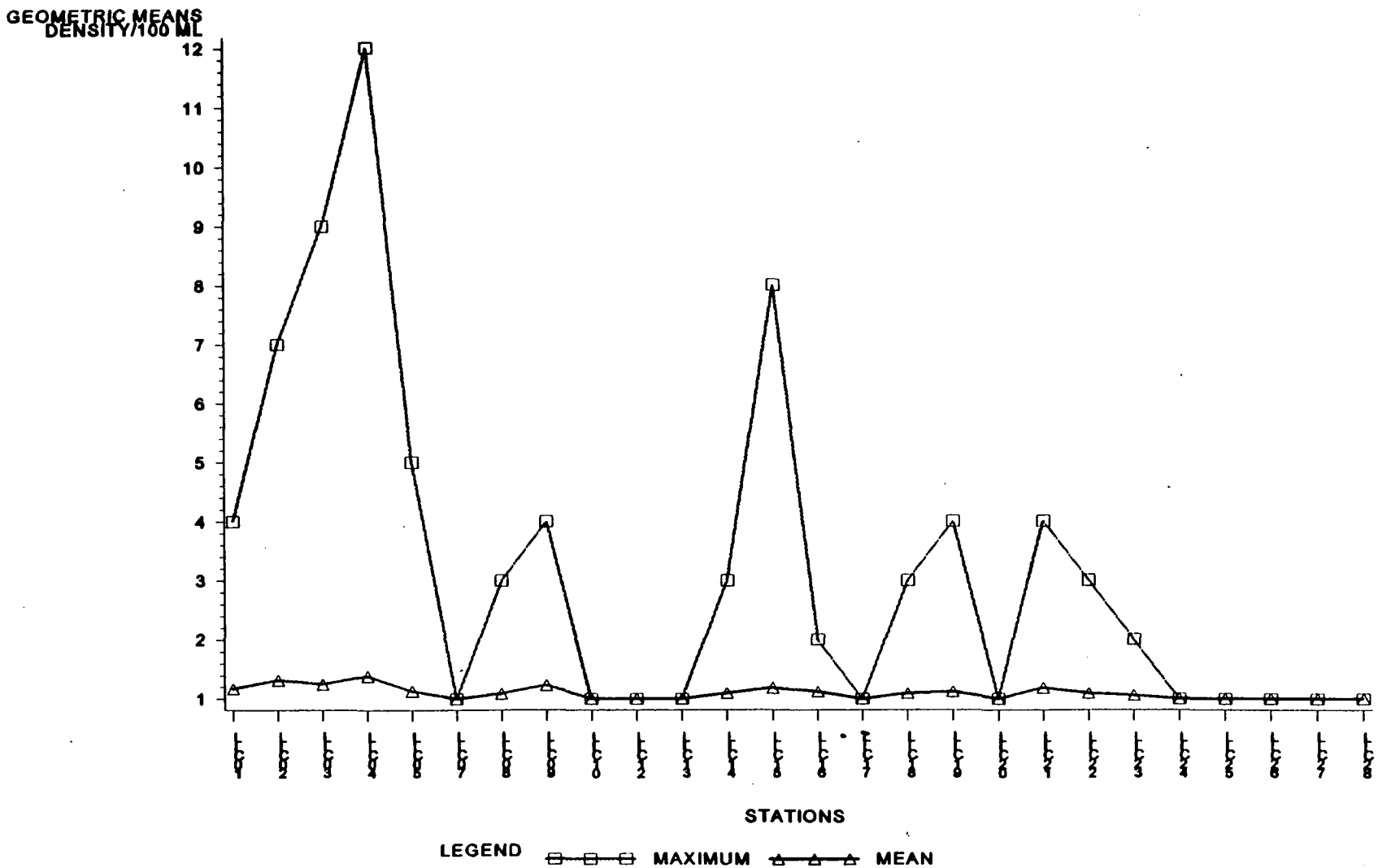


TABLE 6
GEOMETRIC MEANS OF ENTEROCOCCUS DENSITIES
LONG ISLAND COAST STATIONS
SUMMER 1994

OBS	STATION	MEAN	MINIMUM	MAXIMUM	N
1	LIC01	1.17346	0	4	13
2	LIC02	1.31454	0	7	13
3	LIC03	1.24899	0	9	13
4	LIC04	1.38854	0	12	13
5	LIC05	1.13179	0	5	13
6	LIC07	1.00000	0	1	13
7	LIC08	1.08818	0	3	13
8	LIC09	1.23008	0	4	12
9	LIC10	1.00000	0	1	12
10	LIC12	1.00000	0	1	12
11	LIC13	1.00000	0	1	12
12	LIC14	1.09587	0	3	12
13	LIC15	1.18921	0	8	12
14	LIC16	1.12246	0	2	12
15	LIC17	1.00000	0	1	12
16	LIC18	1.09587	0	3	12
17	LIC19	1.12246	0	4	12
18	LIC20	1.00000	0	1	12
19	LIC21	1.18921	0	4	12
20	LIC22	1.09587	0	3	12
21	LIC23	1.05946	0	2	12
22	LIC24	1.00000	0	1	12
23	LIC25	1.00000	0	1	12
24	LIC26	1.00000	0	1	12
25	LIC27	1.00000	0	1	12
26	LIC28	1.00000	0	1	12

FIGURE 4

GEOMETRIC MEANS OF ENTEROCOCCUS DENSITIES LONG ISLAND COAST STATIONS SUMMER 1994



APPENDIX B

Summary of Phytoplankton Blooms and Related Conditions in New Jersey Coastal Waters

Summer of 1994

NJ Department of Environmental Protection and Energy
Division of Science and Research
CN 422, Trenton, NJ 08625-0422

WATER MONITORING MANAGEMENT
James Mumman, Administrator

October 1995

ANNUAL SUMMARY OF PHYTOPLANKTON BLOOMS AND RELATED CONDITIONS IN NEW JERSEY COASTAL WATERS SUMMER OF 1994

Water Monitoring Method Prepared By:

Paul Olsen

Project Manager

Paul Olsen
Bureau of Water Monitoring
Biomonitoring Unit

ANNUAL SUMMARY OF PHYTOPLANKTON BLOOMS AND RELATED CONDITIONS IN NEW JERSEY COASTAL WATERS SUMMER OF 1994

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
DIVISION OF SCIENCE AND RESEARCH
OFFICE OF WATER MONITORING MANAGEMENT
BUREAU OF WATER MONITORING
BIOMONITORING UNIT

ANNUAL SUMMARY OF PHYTOPLANKTON BLOOMS AND RELATED CONDITIONS IN NEW JERSEY COASTAL WATERS SUMMER OF 1994

I N T R O D U C T I O N

The New Jersey Department of Environmental Protection (DEP) each summer monitors phytoplankton assemblages and red tide blooms in its coastal waters and major estuaries with regard to water quality conditions. This information, obtained cooperatively with the US Environmental Protection Agency (EPA) Region II, is summarized for the 1994 season. These results complement the dissolved oxygen and sanitary bacteriological data also gathered during their annual New York Bight Water Quality Survey [1] and the Coastal Cooperative Monitoring Program (CCMP) involving DEP and the shore county health agencies [2].

Routine helicopter surveillance and sample collections in coastal waters of the New York Bight commenced in 1977 following the massive offshore *Ceratium tripos* bloom, which was associated with oxygen depletion and consequent widespread fish mortalities [3]. Prior to this, beginning in 1973, the NJDEP and the National Marine Fisheries Service (NMFS) Sandy Hook Laboratory conducted an intensive phytoplankton survey of the New Jersey northern estuarine and coastal area [4]. Red tides caused by a few species of phytoflagellates have been recurrent in this region since the early 1960's. The blooms often extended from the Hudson-Raritan estuary southward along the N.J. coast, sometimes as far as Shark River or beyond. The blooms have been associated with hypertrophication in the region [5]. Adverse effects were usually only aesthetic in nature, albeit occasional fish kills via hypoxia, or complaints by bathers of minor irritation, did result. *Gonyaulax tamarensis,* causative species of paralytic shellfish poisoning within the northwestern Atlantic region, has been found in New Jersey, but only in very low concentrations [6]. A history of bloom events in New Jersey waters, and the phytoplankton species involved, is given in previous reports [1].

The dinoflagellate green tides of 1984-85, caused by *Gyrodinium* cf *aureolum* [7], were the first serious blooms along the southern New Jersey coast. Also in 1985, yellowish - brown water caused by the chlorophyte, *Nannochloris atomus,* became conspicuous in the Barnegat Bay system and has recurred each subsequent summer [8]. Following these events, routine surveillance was expanded southward from Island Beach to Cape May. In more recent years, major phytoflagellate red tides have been confined primarily to the Hudson-Raritan estuary; the dominant species has been *Katodinium rotundatum*. These have usually occurred in early summer followed by blooms of several diatom species both in the major estuaries (with the exception of Barnegat Bay) and, to a lesser degree, along the New Jersey coast [1].

M E T H O D S

The current survey encompasses the entire New Jersey coastal region including the major estuaries at the northern and southern extremes. Fourteen stations selected from the USEPA New York Bight, N.J. beach network (Figure 1) were sampled for phytoplankton concurrently with bacteriological sampling. In 1994, due to personnel limitations, samples were collected only seven times, in the following sequence: late May (pre-Memorial Day) - eight sites including all of those in Raritan/Sandy Hook Bay and the NJ coast south to Island Beach; mid June (about the equinox) - same as late May; early July (pre July 4th)- twelve estuarine and coastal locations, complementing the full sampling range to Cape May, including RB56A, 51A and 15 in Raritan/Sandy Hook Bay, all coastal locations in Figure 1, Barnegat Bay and Delaware Bay; mid July - eight sites, including three in Raritan/Sandy Hook Bay (RB56A, 51A and 15) and five coastal locations south to Cape May County (JC11, 33, 57, 75, 83); end of July/start of August-same as mid July; mid August-same as mid July; early September (pre Labor Day) - same as pre-July 4th.

Field collections via helicopter were made as in previous years by members of the USEPA, Region II Monitoring and Surveillance Branch (Edison NJ). Samples were taken at a one meter depth using a Kemmerer sampler. Coastal stations were sampled just outside the surf zone. Water aliquots for phytoplankton species composition/chlorophyll a remained iced, to be analyzed within 48 hours of collection. All procedures were in accordance with DEPE standard field methods [9]. Phytoplankton identification, cell counts, and chlorophyll a analysis were performed according to Standard Operating Procedures (SOP) of the DEP Aquatic Biomonitoring Laboratory.

RESULTS AND DISCUSSION

1994 Highlights

May 25 - June 15:	Blooms of diatoms from Raritan Bay through Sandy Hook Bay to the northern Monmouth County coast; *Asterionella glacialis* dominant; *Skeletonema costatum,* flagellate *Chroomonas amphioxiea,* chlorophytes *Chlorella* sp. and *Nannochloris atomus* abundant; *S. costatum* and *C. amphioxiea* present in significant numbers along the coast of Ocean County.
June 15 - June 29:	Mixed blooms of flagellates and chlorophytes from Raritan and Sandy Hook Bays, extending along the Monmouth County coast; flagellates *Eutreptia lanowii* (a euglenoid) and *Tetraselmis* sp. abundant; diatoms *Cyclotella* sp. and *Thalassoiosira nordenskioldii* abundant in Raritan Bay, *Cerataulina pelagica* common from there along the coast to southern Monmouth County; a few diatom species and *N. atomus* present along the Atlantic - Cape May County oceanfront; a diversity of species in Delaware Bay, both diatoms and flagellates; *Phaeodactylum tricornutum* and the chlorophyte *N. atomus* dominant; diatoms *Thalassiosira* sp, *Pleurosigma* sp, and *Gyrodinium* sp (a dinoflagellate) abundant.
June 29 - September 1:	Blooms of *N. atomus* ongoing in Barnegat Bay; diatoms *Nitzschia* sp., *Cylilndrotheca closterium*, and the flagellate *Calycomonas ovalis*, abundant; greenish-brown water discoloration observed.
July 13 - August 3:	Mixed blooms, primarily of diatoms, from Raritan to Sandy Hook Bay, *S. costatum, T. nordenskioldii, Chaetoceros sp,* and the euglenoid *E. lanowii* dominant; other flagellates *Euglena* sp. and *Olisthodiscus luteus*, and chlorophytes abundant; resultant water discoloration reported.

August 17 - September 1: Blooms of the diatom, *Thalassiosira gravida* in Raritan and Sandy Hook Bays extending to the northern Monmouth County coast; *T. nordenskioldii*, *S. costatum* and flagellates *E. lanowii* and *Chroomonas* spp. abundant there and, to a lesser degree, southward to Ocean County; *Euglena* sp. and *Katodinium rotundatum* (a dinoflagellate) abundant along the Atlantic and Cape May County coast, with several diatom species also present; in Delaware Bay, again an abundance and diversity of diatom species with a bloom of *N. atomus* and presence of several flagellate species.

Phytoplankton Species Composition

A list of major phytoplankton species for the 1994 season, with notes on occurrence and distribution, is presented in Table 1; spatial and temporal succession of dominant species are included. Species considered dominant occurred often in cell concentrations greater than 10^3 ml^{-1}. Blooms occurred when densities of one or more dominants approached or exceeded 10^4 cells ml^{-1}; concentrations of this magnitude tend to impart visible coloration to the water, i.e. cause "red tide". Red tides in this region historically have been attributed to blooms of phytoflagellates, especially *Olisthodiscus luteus, Katodinium rotundatum* and *Prorocentrum* spp. In recent years, however, blooms of diatom species, most notably *Skeletonema costatum* and *Thalassiosira* spp., have been responsible for brownish water discoloration, with resultant accumulations of brown floc following bloom collapse. Additionally, the euglenoid flagellate *Eutreptia lanowii* has also attained dominant status. The most intense red tides in recent years have been in Raritan-Sandy Hook Bay, especially stations RB56A and 51A. In 1994 these occurred during the June 15-August 13 period. The densest cell concentration, with concomitant red to brown water, were detected on the August 13 sampling date; dominant species included diatoms *S. costatum*, *Chaetoceros* spp and *Thalassiosira* spp (maximum 2-2.5 X 10^4 ml^{-1}) and *E. lanowii* (max. 2.5 X 10^4 cells ml^{-1}). For *Nannochloris*, because of its minute size (<5um) the criterion for blooms (10^5 ml^{-1}) is an order of magnitude higher than for the other species. Although *N. Atomus* has been abundant throughout the region, especially in Raritan-Sandy Hook Bay, in recent years its densities in Barnegat Bay (to >10^6 ml^{-1}) have well exceeded those in the other areas.

Biomass Measurements

As opposed to species differential cell counts, chlorophyll a measurements are reflective of total phytoplankton biomass. In 1994, seasonal variation, as well as highest levels, again were greatest in the major estuaries at northern and southern extremes of the New Jersey coast (Table 2, Figures 2 & 3). This is attributed in part to tidal fluctuations, but more so to the intense bloom pulses in these estuaries. Delaware Bay again had the highest overall value, 107 mgl^{-1} on August 31, 1995, attributable to its normal diversity of diatoms, chlorophytes and flagellates. Barnegat Bay again sustained moderately high chlorophyll a levels, around 20 mgl^{-1} in summer due to the persistence of *N. atomus*. Although cell densities have been considerably greater in Barnegat Bay than in the other estuaries, the minute size of the dominant species (<5*um*) represents considerably less biomass than the dominant species in other areas. Mean chlorophyll a levels for the entire season are shown for each station in Figure 3. Overall, values for 1994 were slightly higher than those for 1993. In the coastal region, certain sites (especially in Monmouth and Atlantic - Cape May Counties) reflected estuarine influence, having somewhat higher chlorophyll values than the others.

Environmental Factors

Given the ample nutrient supply of the inner New York Bight (5,10), it is surprising that major phytoflagellate blooms have not been more frequent in recent years, particularly in coastal areas (the last being in 1985). For the past few summers, major red tides have been confined principally to the Hudson - Raritan estuary; these have occurred primarily in early summer, preceded and often followed by blooms of diatom species (1). In view of the fact that diatoms are normally dominant during the cooler months, the mid-summer shift from flagellate to diatom dominance (as occurred in recent years) may have been weather-induced. This is supported by the fact that the same diatom species were abundant simultaneously in both the estuary and adjacent coastal waters. Most of the phytoflagellate species encountered are characteristically indigenous to the estuarine areas. The abundance of diatoms in the bays, however, may reflect a contribution from ocean waters via wind and tidal currents. The nearshore waters of the New York Bight are subject to considerably greater turbulence and slower warming than the sheltered estuaries and embayments. Sustained southwesterly or northeasterly winds can promote upwelling or downwelling (respectively), and thus water column mixing, along the New Jersey coast (10). National Weather Service regional data indicates that conditions such as these have persisted in varying degrees during the past several summers. Conversely, flagellate blooms, or red tides, in the coastal waters have typically developed under conditions of quiescence and warmth, which promote water column stratification; likewise, the same

conditions have prolonged the blooms in the estuaries and bays (1,7,10). Diligent monitoring of current meteorological and oceangraphic data (i.e. wind direction and velocity, precipitation and sunlight, water column temperature and salinity), thus could aid considerably in prediction of red tide blooms in areas where they have historically occurred.

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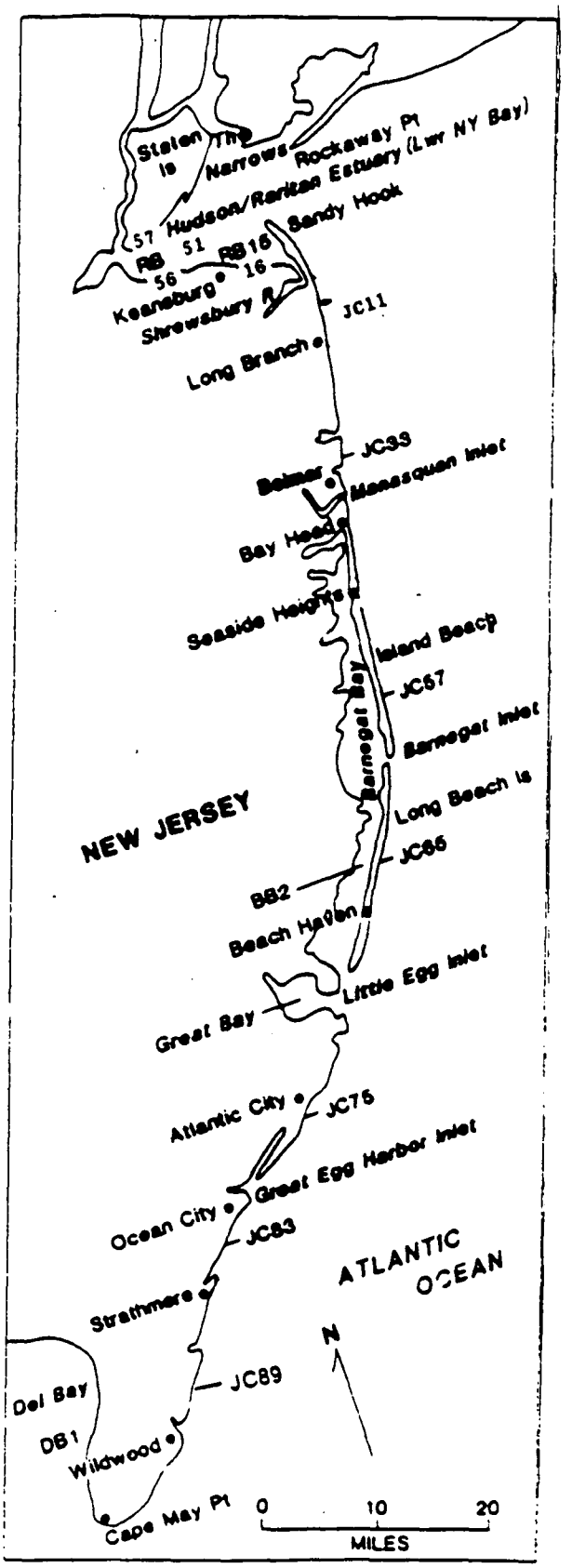
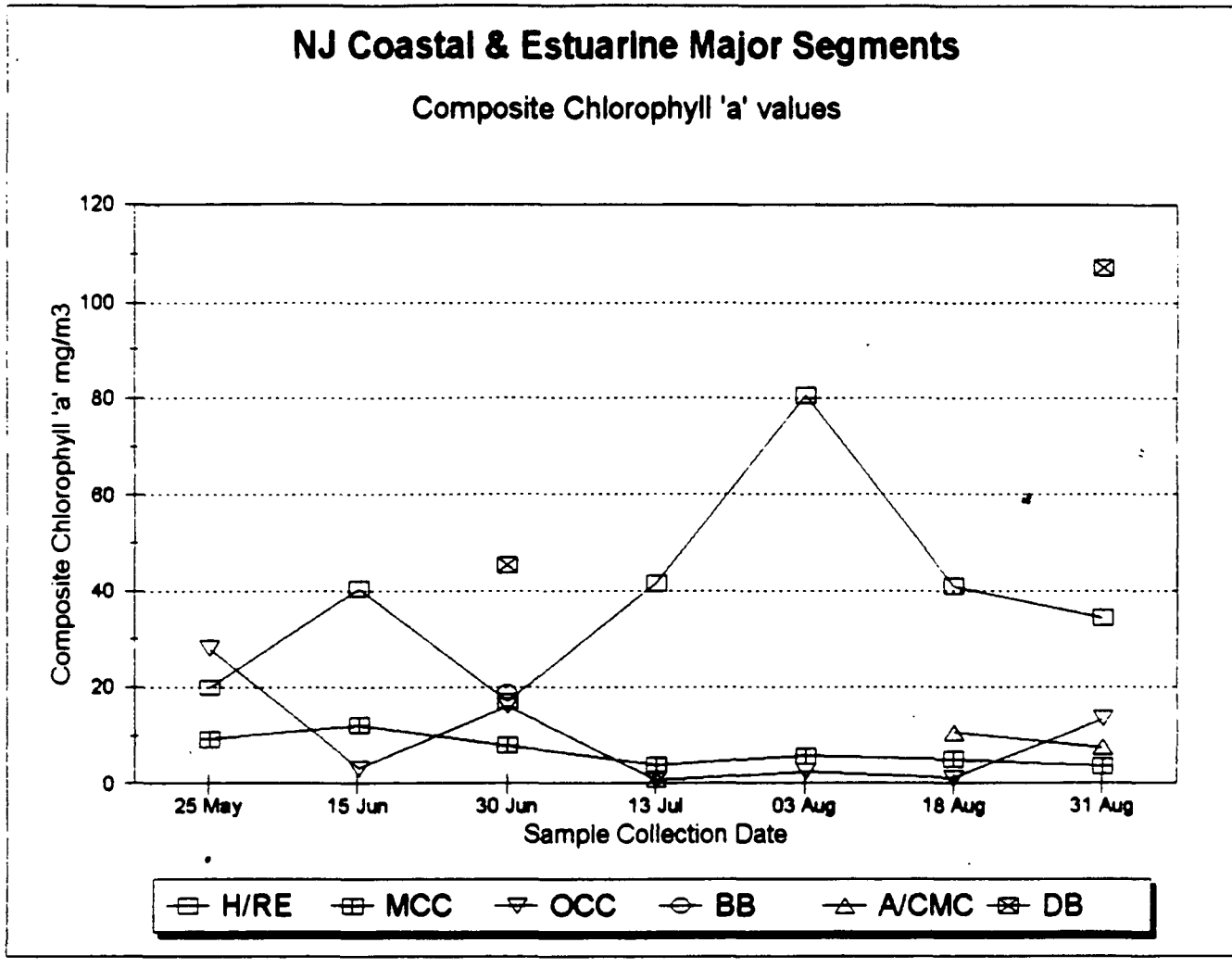


Figure 1. New Jersey coast station locations, Sandy Hook to Cape May.

Figure 2. Seasonal changes in Chlorophyll 'a' concentrations for the 1994 NJ coastal and estuarine phytoplankton survey. Lines represent composite values for major segments of the survey region.



H/RE - Hudson/Raritan Estuary (RB57,56A,51A,16,15)
MCC - Monmouth County coast (JC11,33)
OCC - Ocean County coast (JC57,65)
BB - Barnegat Bay (BB02)
A/CMC - Atlantic/Cape May Counties coast (JC75,83,89,92)
DB - Delaware Bay (DB01)

Figure 3. Mean Chlorophyll 'a' values for NJ coastal and estuarine stations north to south for the 1994 season.

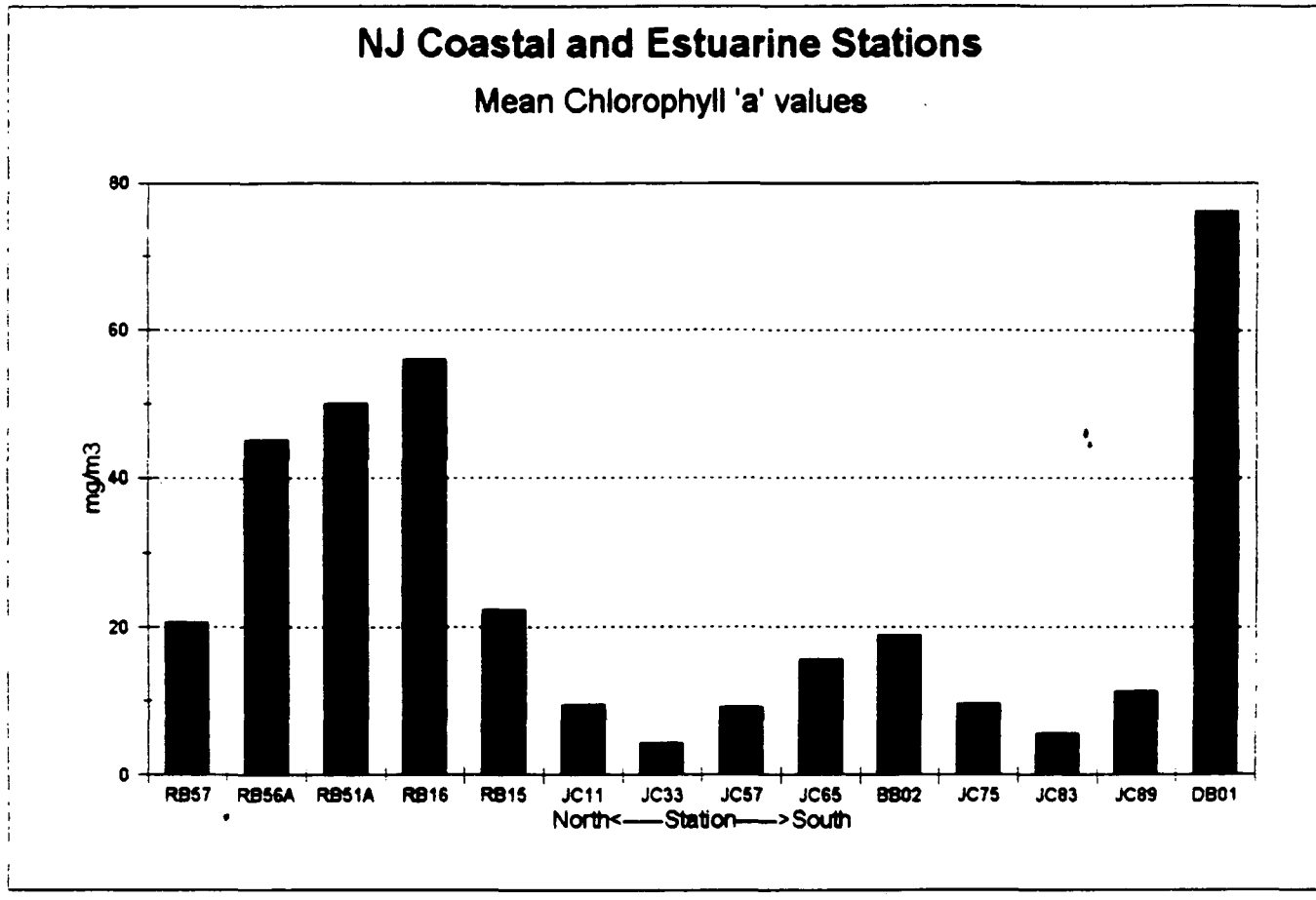


Table 1. Major phytoplankton species found in the 1994 New Jersey coastal and estuarine survey with notes on occurrence and distribution. An asterisk (*) denotes species which were dominant or abundant, exceeding cell concentrations of $10^3 ml^{-1}$ at some time during the sampling period. Two asterisks (**) denote species which bloomed, approaching or exceeding 10^4 cells ml^{-1}. For Nannochloris, because of its minute size (1.5-3.0 µm), these criteria are incrased by a factor of ten. Other species listed occurred commonly, although not usually in in abundance. Spatial and temporal distribution of dominants is included; for genera with more than one species on the list, a capital letter following the name indicates the species which attained dominance.

Diatoms

Leptocylindrus danicus[3](A)
L. minimus[3](B)
Skeletonema costatum**[5]
Cyclotella sp.*[2,5]
Thalassiosira sp.[5]
T. gravida**[5](A)
T. nordenskioldii**[5](B)
Eucampia zoodiacus
Cerataulina pelagica*[3]
Chaetoceros spp.**[5]
Rizosolenia sp. (setigera)[3]
Asterionella glacialis**[5]
Guinardia flaccida
Ditylum brightwelli
Navicula sp.
Pleurosigma sp.
Nitzschia sp.*
N. seriata (A)
Phaeodactylum tricornutum*[2]
Cylindrotheca closterium*[2]

Dinoflagellates

Prorocentrum minimum[1,5]
P. triestinum (redfieldi)[1,5]
Dinophysis acuta[3]
Gymnodinium spp.[2]
Gyrodinium spp.[2,5]
Katodinium rotundatum*[1,5]
Heterocapsa triquetra[2,5]
Oblea rotunda
Protoperidinium sp.[3]
P. trochoideum
Ceratium spp.[3]

Other Phytoflagellates

Olisthodiscus luteus*[1,5]
Calycomonas ovalis[4]
Chrysochromulina sp.[2]
Pyramimonas spp.[2]
Tetraselmis sp.[2]
Euglena sp.*(proxima)*[2]
Eutreptia lanowii**[5](A)
E. viridis[2](B)
Cryptomonas sp.[5]
Chroomonas amphioxiea*[5](A)
C. minuta*[2](B)
C. vectensis[2](C)

Nonmotile Coccoids

Chlorella spp.*[2]
Nannochloris atomus**[2,4]

Footnotes:
1 - historically responsible for red tides in the region
2 - primarily estuarine
3 - primarily coastal
4 - most predominate in Barnegat Bay
5 - most abundant in Raritan/Sandy Hook Bay and adjacent NJ coastal waters

Table 1. (continued)

LOCATION		SAMPLING DATES			
		spring May 25	early summer June 15,29	midsummer July 13,August 3	late summer August 17,September 1
North					
Raritan Bay	RB57	Skeletonema*	Cyclotella*	Skeletonema**	Thalassiosira A**B*
	RB56A	Asterionella**	Thalassiosira B*	Thalassiosira A,B*	Skeletonema
		Chroomonas A*	Cerataulina	Chaetoceros**	Eutreptia A*
	RB51A	Chlorella*	Olisthodiscus	Euglena*	Chroomonas A*B*C
		Nannochloris*	Eutreptia A**	Eutreptia A**B	Nannochloris**
			Chlorella*	Olisthodiscus*	
			Nannochloris**	Chlorella*	
				Nannochloris*	
Sandy Hook Bay	RB16A	Skeletonema	Cerataulina	Skeletonema*	Thalassiosira A**B*
		Asterionella**	Asterionella	Thalassiosira A,B**	Skeletonema
	RB15	Cerataulina	Tetraselmis*	Chaetoceros	Calycomonas
		Chroomonas A	Eutreptia A**	Olisthodiscus	Chlorella
		Chlorella	Chlorella	Calycomonas	
			Nannochloris*	Nannochloris*	
Monmouth County coast	JC11	Asterionella*	Cyclotella	Thalassiosira B*	Thalassiosira A*,B
		Chroomonas A	Cerataulina	Skeletonema*	Cerataulina
			Tetraselmis	Asterionella*	Rhizosolenia
	JC33		Eutreptia	Chroomonas	Nitzschia A
			Chlorella	Chlorella	Chroomonas
Ocean County coast	JC57	Skeletonema	Leptocylindrus A	Thalassiosira B	Leptocylindrus
		Chroomonas A	Ceratium	Chroomonas	Rhizosolenia
	JC65		Nannochloris	Chlorella	Nitzschia A
					Eutreptia
					Chroomonas A
Barnegat Bay	BB2		Nitzschia*		
			Cylindrotheca		
			Calycomonas		
			Nannochloris**		
Atlantic County coast	JC75				Skeletonema
					Euglena*
					Eutreptia A
					Katodinium*
Cape May County coast	JC83		Skeletonema	Skeletonema	Leptocylindrus A
			Thalassiosira		Skeletonema
	JC89		Nitzschia		Nitzschia A
			Nannochloris		Katodinium*
Delaware Bay capeshore	DB1		Leptocylindrus B		Thalassiosira*
			Thalassiosira*		Skeletonema
			Navicula		Nitzschia*
			Pleurosigma*		Olisthodiscus
			Phaeodactylum*		Cryptomonas
			Gyrodinium*		Nannochloris**
			Nannochloris**		
South					

Table 2. Chlorophyll 'a' (mg/m3) for the 1994 NJ coastal and estuarine phytoplankton survey.

	25 May	15 Jun	30 Jun	13 Jul	03 Aug	18 Aug	31 Aug	Mean
H/RE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39.26
RB57	2.99	38.08						20.54
RB56A	28.74	35.78	28.65	31.77	115.48	47.69	27.85	45.14
RB51A		48.21	6.78	70.69	85.84	25.53	62.67	49.95
RB16	35.21	76.83						56.02
RB15	13.20	2.95	15.78	22.17	40.53	49.21	12.52	22.34
MCC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.76
JC11	14.73	22.74	7.42	6.92	4.26	6.22	3.02	9.33
JC33	3.68	1.42	8.27	0.75	7.12	3.81	4.27	4.19
OCC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.27
JC57	28.01	3.09	11.77	0.77	2.48	1.07	16.13	9.05
JC65			20.48				10.58	15.53
BB			[illegible]					18.91
BB02			18.91					18.91
A/CMC			[illegible]	[illegible]		[illegible]	[illegible]	7.82
JC75			20.90	0.37		14.92	1.68	9.47
JC83			6.24	1.49		6.03	8.27	5.51
JC89			10.18				12.35	11.27
DB			[illegible]				[illegible]	76.22
DB01			45.31				107.12	76.22

H/RE - Hudson/Raritan Estuary (RB57,56A,51A,16,15)
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APPENDIX C

Daily Floatables Observations

for the Summers of 1994

Daily Floatable Observations, 1994

May 15 - June 3, 1994

The New York Harbor Complex was monitored for floatables a total of seventeen times during the period of May 16 - June 3, 1994.

The New York Harbor was clear of significant floatables on May 16, 17, 18, 20, 27, 30, 31, and June 1, 2, and 3.

On May 19, two small patches of floatables were reported in the Hudson River and under the Verrazano Bridge.

On May 21, a light density slick, 2000 feet by 5 feet, consisting of plastic and reeds, was reported east of Pralls Island.

Scattered floatables consisting of large wood and plastic, were reported throughout Newark Bay with a heavy concentration around Bergens Point, on May 23. Light scattered Debris was reported in the Arthur Kill. A one mile slick line of scattered floatables, large wood and plastic, was reported north of the Holland Tunnel in the middle of the Hudson River, on May 23.

On May 24, a heavy amount of scattered floatables were reported in the Arthur Kill, the Kill Van Kull, Newark Bay, Upper New York Harbor, and the Hudson River. The heaviest concentration occurred in the Middle of Newark Bay near green buoy #3 running North for approximately 1 mile. The floatables consisted mostly of large wood, plastic, and timbers. The Army Corps of Engineer vessel's the Hayward and the Driftmaster, were observed cleaning up slicks in the Kill Van Kull and the Upper New York Harbor.

On May 25, a slick approximately 200 meters in length, was reported in Newark Bay, and scattered debris was reported in the Lower New York Harbor.

On May 26, large slicks were reported in the south east end of Newark Bay and the east side of the Narrows, off Brooklyn and just north of the Verrazano Bridge. Both slicks were of moderate density, approximately one and a half miles long, and consisted of large wood, plastic, timbers and scum. Scattered debris was reported in the Arthur Kill and Gravesend Bay.

On May 28, a slick approximately 100 feet long, consisting mostly of reeds and some plastic was reported in the Verrazano Narrows.

June 4 - June 10, 1994

The New York Harbor Complex was monitored for floatables a total of six times during the period of June 4 - June 10, 1994.

The New York Harbor was clear of significant floatables on June 4, and 9.

Scattered debris was reported in Newark Bay, on June 6; and in the Upper New York Harbor, on June 7.

On June 8, floatables were sighted at red buoy 6 in Newark Bay. The slick was of moderate density and approximately 100 feet long and 50 feet wide. The slick consisted of wood, plastic, and scum. One mile north of the Verrazano Bridge in the middle of the Harbor was a 100 ft. x 50 ft. patch. The patch was very dense and consisted of large wood pieces, plastic, and other scattered debris.

On June 10, floatables were sighted in the Narrows west of red buoy 20A and one mile north of the Verrazano Bridge. The slick was 5 feet wide and 1/4 mile long. The slick consisted of wood, plastics, and scum.

June 11 - June 17, 1994

The New York Harbor Complex was monitored for floatables a total of five times during the period of June 11 - June 17, 1994.

On June 11, a slick was reported just north of the Verrazano Bridge. It was approximately 200 meters long and 3 meters wide consisting of plastics, wood, and grass.

On June 13, west of Pralls Island, scattered debris was reported approximately 1/2 mile long and 1 meter wide. Northeast of the Verrazano bridge oil was sighted along the shoreline.

On June 14, oil was sighted in the Arthur Kill from red buoy 36 to the ships graveyard. Oil was also sighted in the New York Harbor at green buoy 3.

On June 15, floating timbers were seen under the Verrazano Bridge. In Gravesend Bay light scattered debris was reported approximately 1/4 mile offshore.

On June 17, in the Verrazano Narrows and in the Gravesend Bay area light patches of scattered debris was reported highly dispersed.

June 18 - June 24, 1994

The New York Harbor Complex was monitored for floatables a total of five times during the period of June 18 - June 24, 1994.

Light scattered debris was reported in the Arthur Kill and Jamaica Bay, on June 20.

Light dispersed floatables covering one half a mile was reported in the Hudson River and Jamaica Bay, on June 21.

On June 22, scattered debris was reported in Newark Bay and the Hudson River.

On June 23, in Newark Bay a light dispersement of wood planks and logs was seen between red buoys 6 and 8. The slick was approximately one mile long beginning at the mouth of the Bay. The East River contained a light slick consisting of wood and plastic. The slick went from the Brooklyn Bridge to the Manhattan Bridge. Scattered debris was reported in the Kill Van Kull.

On June 24, there was a slick in the Arthur Kill 1/4 mile long containing wood, plastic, and grass. Across from the Freshkills Landfill was an oil slick approximately 1/2 mile long which also contained logs and branches. A slick was reported in Newark Bay, approximately 1 and 1/4 miles long, starting at red buoy 6 and extending to a 1/4 mile past red buoy 8. The slick contained large logs, planks, tree stumps, grass and plastic and consisted of four dense patches. The largest patch was 20 feet long and 5 feet wide. Also in Newark Bay just west of the Bayonne Bridge was a small, medium density slick consisting of wood and grass. It was about 200 feet in length.

June 25 - July 1, 1994

The New York/New Jersey Harbor Complex was monitored for floatables a total of five times during the period of June 25 - July 1, 1994.

The New York/New Jersey Harbor was clear of significant floatables on June 28, and July 1.

On June 27, an oil sheen approximately 1/4 mile long was reported in the East River northwest of the Willamsburg Bridge.

On June 29, scattered debris was reported in the Arthur Kill and Gravesend Bay.

On June 30, a slick approximately 200 yards long and 5 feet wide was reported north of the Goethals Bridge. It consisted of household debris, reeds and wood.

July 2 - July 8, 1994

The New York Harbor Complex was monitored for floatables a total of seven times during the period of July 2 - July 8, 1994.

The New York Harbor was clear of significant floatables on July 2, 3, 4, and 6.

On July 5, on the north side of the Upper Harbor a light slick consisting of scattered wood, plastic, and paper was reported. A large patch was reported just south of Governor's Island.

On July 7, at the mouth of Newark Bay extending from green buoy 5 to red buoy 2, was a scattered slick consisting of reeds, wood, sticks, and plastic. In the middle of the Kill Van Kull was a 1/4 mile long slick consisting of wood, reeds, and paper. One quarter mile off of the Brooklyn shore in the Verrazano Narrows was a mile long moderately dense slick consisting of wood, reeds, paper, and plastic.

On July 8, in the Newark Bay between red buoy 6 and red buoy 8 was a 75 meter long slick consisting of several wood planks logs and scattered debris. In the Verrazano Narrows a 100 meter long slick around red buoy 22 consisting of wood, paper, and plastic, was reported.

July 9 - July 15, 1994

The New York Harbor Complex was monitored for floatables a total of six times during the period of July 9 - July 15, 1994.

The New York Harbor was clear of significant floatables on July 11, 12 and 14.

On July 9, a slick was reported in the southern portion of Newark Bay. The slick was approximately 200 yards long and 5 - 10 feet wide. It consisted of reeds, wood, and household debris. In the Upper New York Harbor, just west of Governor's Island, a 200 yard slick was reported consisting of reeds, wood, and household debris. Scattered debris was reported in the Arthur Kill.

On July 13, scattered pieces of paper and plastic were reported at green buoy 3 south of Governor's Island. In Gravesend Bay, light scattered debris was reported shoreward of buoy A.

On July 15, a light slick was reported in Gravesend Bay near yellow buoy A. It was approximately 500 feet long consisting of wood, plastic, and paper.

July 16 - July 22, 1994

The New York/New Jersey Harbor Complex was monitored for floatables a total of six times during the period of July 16 - July 22, 1994.

The New York/New Jersey Harbor was clear of significant floatables on July 22.

Minor dispersed floatables were reported in the Arthur Kill, Newark Bay, East River, and Lower New York Harbor, on July 16.

On July 18, a half mile long oil sheen in the mouth of the Arthur Kill was reported. A light density slick approximately 200 ft long near red buoy 16, in Newark Bay, was reported.

On July 19, a light density slick, west of the Bayonne Bridge, containing wood, paper, and plastic was reported. In the Hudson River south of the Holland tunnel a 50 foot long medium density slick, containing wood, plastic, and paper, was reported.

On July 20, scattered debris was reported in the Upper New York Harbor, were a Corps of Engineers vessel was on sight.

On July 21, in the Arthur Kill a light density oil sheen was reported beginning just south of the Fresh Kills landfill extending to Pralls Island. In the Kill Van Kull a light density 150 foot long slick, containing wood, paper, and plastic, was reported. A light density slick 100 feet long, was reported one half mile north of the Verrazano Bridge. Scattered Debris was reported in the East River.

Incidents

NJDEP reported floatables washing ashore on the New Jersey coast from Asbury to Barnegat, early in the week. NJDEP accompanied the EPA helicopter crew, including two Discovery Students, and video taped parts of the coast, on Wednesday, July 20. A small amount of floatables was observed scattered in the surf zone, throughout the coast. No floatables were observed on the beach.

An oil spill was reported in the Delaware River in Gloucester County New Jersey, just south of the Philadelphia airport, on Wednesday, July 20. The oil had spread into a sheen covering 50 percent of the river for approximately 2 miles north and south of the tanker. A cleanup crew was on sight. The EPA helicopter crew took pictures for ERRD.

July 23 - July 29, 1994

The New York/New Jersey Harbor Complex was monitored for floatables a total of six times during the period of July 23 - July 29, 1994.

The New York/New Jersey Harbor was clear of significant floatables on July 23 and 26.

Small amounts of scattered debris was reported in Newark Bay, on July 25; in the Upper Harbor on July 28; and in the Arthur kill on July 27, 28, and 29.

July 30 - August 5, 1994

The New York/New Jersey Harbor Complex was monitored for floatables a total of six times during the period of July 30 - August 5, 1994.

The New York/New Jersey Harbor was clear of significant floatables on July 30, and August 1 and 5.

On August 2, a slick was reported on the northwest side of Governor's Island approximately 200 feet long and 3 feet wide. It consisted of wood and plastic. Garbage was seen washing ashore at Coney Island. It was moderately dispersed and consisted of household debris and plastic.

On August 3, light scattered debris was reported in Gravesend Bay and off Coney Island shoreline.

On August 4, a light slick consisting of household debris, paper and plastics was reported at Coney Island. It was approximately 300 yards long and 2 feet wide.

August 6 - August 12, 1994

The New York/New Jersey Harbor Complex was monitored for floatables a total of six times during the period of August 6 - August 12, 1994.

The New York/New Jersey Harbor was clear of significant floatables on August 9, 10, 11, and 12.

Minor dispersed floatables were reported in Jamaica Bay, the Kill Van Kull, and off Coney Island shoreline, on August 6.

On August 8, in the Arthur Kill, a 1/2 mile light slick extending south of red buoy 30 containing wood and paper was reported. Also in the Arthur Kill a light density slick between red buoy 30 and red buoy 32 containing wood and paper was reported. In Newark Bay a slick containing wood and paper beginning at red buoy 2 extending to green buoy 7 was reported. On the northwest side of Governors Island densely scattered debris, approximately 1 1/2 miles long, consisting of wood, paper, and plastic was reported. In the Verrazano Narrows a dense slick consisting of wood, paper, and plastic approximately 300 yards long was reported.

August 13 - August 19, 1994

The New York/New Jersey Harbor Complex was monitored for floatables a total of six times during the period of August 13 - 19, 1994.

The New York Harbor was clear of significant floatables on August 15, 16, 18, and 19.

On August 13, a moderately dense slick, approximately one mile long, was reported in Gravesend Bay. The slick consisted of plastic and wood. Dispersed floatables were reported in the East River.

Scattered debris was reported in Newark Bay and the Hudson River, on August 17.

August 20 - 26, 1994

The New York/New Jersey Harbor Complex was monitored for floatables a total of five times during the period of August 20 - 26, 1994.

The New York Harbor was clear of significant floatables on August 24 and 26.

On August 20, a heavy density slick, approximately one mile long, was reported in the middle of Newark Bay. The slick consisted of plastic, tires, scum, and wood.

Light dispersed floatables were reported in Gravesend Bay, on August 23 and 25.

August 26 - September 9, 1994

The New York/New Jersey Harbor Complex was monitored for floatables a total of fourteen times during the period of August 26 - September 9, 1994.

The New York Harbor was clear of significant floatables on August 26, 27, 29, and September 1, 2, 3, 4, 5, 8, and 9.

Scattered debris was reported off the coastline of Coney Island, on August 30; and in the Upper New York Harbor, on August 31.

On September 6, a light density slick, approximately 60 yards by 10 yards, was reported along the Bayonne side of Newark Bay. Slicks approximately one half and one quarter mile long were reported in the Hudson River and the Upper Harbor. Scattered debris was reported in the East River, Gravesend Bay, and off the coastline of Coney Island. All slicks consisted of plastic, leaves, scum, and wood.

An oily sheen, approximately 500 feet by 20-50 feet, was reported just south of the Fresh Kills Landfill in the ship graveyard, on September 7. Several patches of oil sheen were reported 100 yards north of the graveyard. Light scattered debris was reported in the Verrazano Narrows.

Small slicks, approximately 50 - 60 meters, were reported in Newark Bay and the Upper New York Harbor, on September 9.

All oil sheens were reported to the US Coast Guard. All floatables were reported to the Army Corps of Engineers or the New York City Department of Environmental Protection. Cleanups were conducted as necessary.

Floatable observation flights will continue on a lunar cycle schedule - the day of and two days after a new or full moon event.