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List of specific record(s):

Biological Survey of Newark Bay Shoal Areas and Adjacent Kill Van Kull and Arthur Kill Channels. By Lawler, Matusky and Skelly Engineers, Inc. Prepared for the Port Authority of New York and New Jersey. 1996.

**THE PORT AUTHORITY OF NY & NJ**

Daniel D. Duffy  
*FOI Administrator*

August 6, 2012

Ms. Erika Denkenberger  
ARCADIS  
6723 Towpath Rd., P.O. Box 66  
Syracuse, NY 13214

Re: Freedom of Information Reference No. 13365

Dear Ms. Denkenberger:

This is a response to your July 27, 2012 request, which has been processed under the Port Authority's Freedom of Information Code (the "Code", copy attached) for a copy of the Biological Survey of Newark Bay Shoal Areas and Adjacent Kill Van Kull and Arthur Kill Channels prepared for the PA by Lawler, Matusky and Skelly engineers, Inc.

Material responsive to your request and available under the Code can be found on the Port Authority's website at <http://www.panynj.gov/corporate-information/foi/13365-O.pdf>. Paper copies of the available records are available upon request.

Please refer to the above FOI reference number in any future correspondence relating to your request.

Very truly yours,



Daniel D. Duffy  
FOI Administrator

Attachment

**THE PORT AUTHORITY OF NEW YORK AND NEW JERSEY**

**BIOLOGICAL SURVEY OF NEWARK BAY SHOAL AREAS  
AND KILL VAN KULL AND ARTHUR KILL CHANNELS**

December 1996

*LMSE-96/0531 + 459/053*

**LAWLER, MATUSKY & SKELLY ENGINEERS LLP**  
Environmental Science & Engineering Consultants  
One Blue Hill Plaza  
Pearl River, New York 10965

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## CHAPTER 1

### EXECUTIVE SUMMARY

Biological surveys were conducted monthly from April 1995 to March 1996 at four Newark Bay shoal stations. In addition, two deepwater channel stations - one in the Arthur Kill and another in the Kill Van Kull - were evaluated. The sampling program focused on the collection and analysis of fish, ichthyoplankton, macroinvertebrates (blue crabs), epibenthos, and benthos. Water quality measurements taken with biological samples included dissolved oxygen (DO), salinity/conductivity, and water temperature.

A total of 3691 fish representing 27 species were collected in 72 bottom trawls completed during the study. Twenty-two species and 3226 individuals were collected in 48 bottom trawls conducted in Newark Bay shoal areas. The project sites (Newark Bay Southwest [NBSW] and Newark Bay Northwest [NBNW]) resulted in the collection of 21 species and 2581 individuals. The two Newark Bay reference stations (Newark Bay Northeast [NBNE] and Newark Bay Southeast [NBSE]) resulted in the collection of 14 species and 645 individuals.

Bay anchovy was the dominant species collected (2700 individuals), accounting for 73% of the total. Bay anchovy was followed in abundance by striped bass (231 individuals, 6% of the total), winter flounder (217 individuals, 6% of the total), Atlantic silversides (135 individuals, 4% of the total), and grubby (88 individuals, 2% of the total). The remaining 22 species were represented by 320 individuals and made up 9% of the total catch.

Several fish species showed seasonal usage of the Newark Bay shoal areas, including striped bass (late spring), winter flounder (mid-summer), bay anchovy (summer to early fall), bluefish (early fall), and Atlantic silversides (early to mid-fall).

Length-frequency analysis of the six most abundant fish species collected in shoal areas indicated catches consisted predominantly of individuals in one or two age classes. Striped bass were mostly one- and two-year old fish. Winter flounder were young-of-year (YOY) and one-year-old fish. Summer flounder were mostly one-year-old fish and bluefish were all YOY. Atlantic silverside included adults and YOY, and bay anchovy were mostly adult fish.

A total of 90,702 fish eggs, larvae, and juveniles were collected, representing 16 species. The dominant species, accounting for 90.2% of the ichthyoplankton collected, was bay anchovy (81,845 collected); most were eggs collected from the Newark Bay shoal areas. Bay anchovy was followed in abundance by tautog eggs (3.0%), weakfish eggs (2.1%), goby larvae (2.0%),

and silver hake eggs (1.0%). Newark Bay stations contributed more eggs, larvae, and juveniles than did the channel stations.

A total of 3629 blue crabs were collected in the bottom trawls; most (88%) were collected from Newark Bay shoal stations.

A total of 2,359,349 epibenthic invertebrates were represented in 72 epibenthic sled samples. The dominant species were copepods, with 1,760,309 representing 74.6% of the total. They were followed in abundance by crab larvae, including blue crab zoea (246,717, representing 10.4% of total), Gammaridae (amphipods) (120,846, representing 5.1% of the total), *Neomysis americanus* and other mysid shrimp (91,729, representing 3.9% of the total), Caridaie larvae and adults (60,793, representing 2.6% of the total), and *Leukon americanus* (40,465, representing 1.7% of the total). Bay and channel stations contributed about equal numbers to the collections of epibenthic invertebrates.

A total of 16,991 benthic invertebrates were collected in shoal and river stations. The collections were dominated by *Streblospio benedicti* (51.8%), followed in abundance by *Sabellaria vulgaris* (13.1%), *Scoloplus* sp. (9.3%), *Mulinia lateralis* (5.1%), and Paraonidae (4.9%). Channel collections contained more organisms per area by a ratio of over 5:1, resulting largely from collections of the polychaetes *Streblospio benedicti* and *Sabellaria vulgaris*, which were more abundant in channel stations by a ratio of over 7:1.

Newark Bay water quality followed typical seasonal patterns, with temperatures ranging from a low of 1.5°C during winter to 24°C during summer; DO ranged from 5 to 7 mg/l during the summer to 13.5 mg/l during winter; and salinity fluctuated from a high of 21 ppt in December to a low of 3 ppt during January. Water quality in the channel area followed similar patterns.

Observations of other vertebrate species indicated some usage of the Newark Bay shoals by cormorants, gulls, and waterfowl (ducks and geese). No wading birds, shorebirds, raptors, or terns were observed using the project area during biological sampling. Channel areas were used mainly as movement corridors for gulls and cormorants and were generally not used as resting or foraging areas.

## CHAPTER 2

### INTRODUCTION

#### 2.1 INTRODUCTION

This report summarizes biological and water quality data collected from Newark Bay shoal areas and from deeper-water migratory corridors in the Arthur Kill and Kill Van Kull channels, which must be used by marine species to enter the Bay. The results of monthly surveys and a description of the data collected are included. The program was primarily a reconnaissance study of Newark Bay; therefore, statistical analysis or conclusions regarding the environmental conditions of the Bay were not conducted. To supplement the data, state and Federal agencies were contacted for information on the presence of threatened and endangered species (TES) and other significant resources and a literature search and review of past studies was conducted.

#### 2.2 BACKGROUND

Lawler, Matusky & Skelly Engineers LLP (LMS), under contract to the Port Authority of New York/New Jersey (PA), conducted an environmental survey of Newark Bay from April 1995 through March 1996. The primary objective of the study was to describe the seasonal presence and abundance of fish, ichthyoplankton, macrobenthos, epibenthos, and benthos populations present in the shallow areas of Newark Bay. The shoal areas of the Bay were evaluated to obtain baseline information for the proposed construction/operation of confined disposal facilities (CDFs) in the shallows adjacent to Port Elizabeth and Port Newark. The biological community may be directly or indirectly affected (negatively or positively) by the CDF project because of certain life history parameters, seasonal use or nonuse of the project area, and/or by habitat preferences.

#### 2.3 PROCEDURES

Field data were used to describe existing environmental conditions and species assemblages. The survey concentrated on shoal areas generally less than 1.5 to 1.8 m (5 to 6 ft) deep at mean low water (MLW). The biological data collected included fish, ichthyoplankton, macrobenthos, epibenthos, and benthos. Water quality data included dissolved oxygen (DO), temperature, salinity, and conductivity. Incidental observations of wildlife using Newark Bay habitats were made during scheduled surveys. A literature search was conducted for recent (since 1964) data on the area. Resource agencies were contacted for information on TES and significant habitats.

## 2.4 STUDY OBJECTIVES

The objectives of the study described in this report were to:

- Retrieve and prepare a summary of data characterizing Newark Bay aquatic resources based on studies that have sampled Newark Bay biota and water quality during the last 30 years.
- Sample fish, benthic, and epibenthic resources monthly in the Newark Bay shoal areas and at two potential migratory corridors leading to the Bay. Describe the aquatic resources of the Bay based on this sampling program.
- Provide a link between earlier studies conducted in the Arthur Kill by sampling Goethals Bridge West (GBW), which was sampled during the March 1994 to February 1995 Staten Island Bridges Program (SIBP).
- Collect information on water temperature, DO, and salinity/conductivity on a monthly schedule in conjunction with biological sampling.
- Describe existing physical conditions of the Bay and migratory corridors leading to the Bay based on the data collected.
- Contact state and Federal agencies for information on TES and significant resources of the Bay and summarize this information.
- Determine species or groups of species that may be affected either negatively or positively by activities taking place on the shoal areas of the Bay.

## 2.5 REPORT FORMAT

Following this introduction (Chapter 2), a detailed description of the methods used in the surveys is provided in Chapter 3. Results of the surveys are described in Chapter 4. A summary of the life history of selected species or groups of similar species is provided in Chapter 5.

## CHAPTER 3

### MATERIALS AND METHODS

#### 3.1 DESCRIPTION OF STUDY AREA

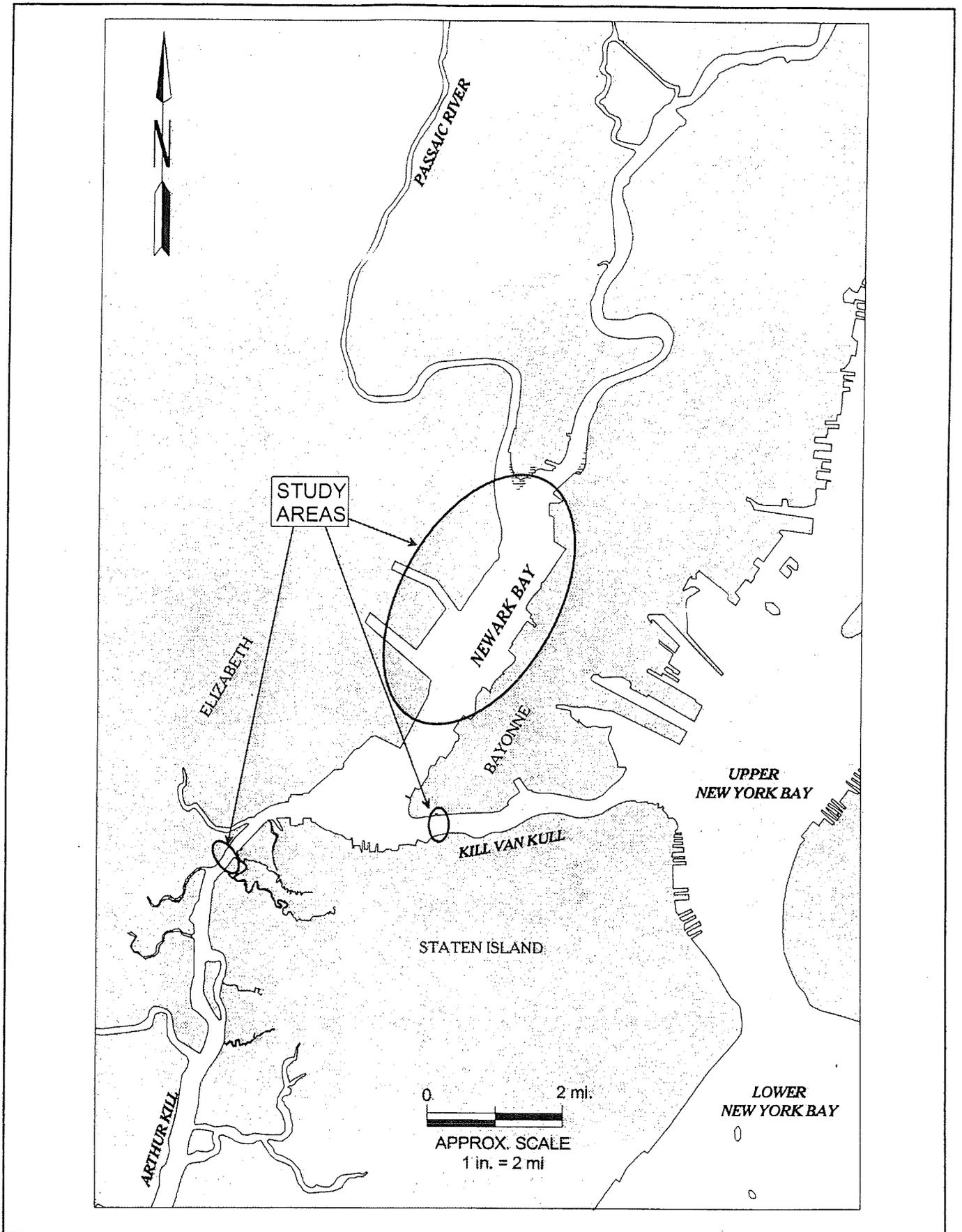
Newark Bay is part of the Hudson-Raritan Estuary. Located completely within the state of New Jersey, the Bay has a northeast-southwest orientation and is bordered by the Arthur Kill/Kill Van Kull to the south, the confluence of the Passaic and Hackensack rivers to the north, the City of Bayonne to the east, and the Cities of Elizabeth and Newark to the west. *Newark Bay has been extensively modified by dredging and filling since the mid-1800s and serves as a major shipping port.* Several navigation channels provide access to the Bay and its port facilities. The eastern, or Bayonne, shore consists primarily of residences, with limited industrial complexes, while the western shore is dominated by the extensive containership facilities of the Elizabeth-Port Authority Marine Terminal and Port Newark. Wetlands are present on the western shore north and south of Ports Newark and Elizabeth.

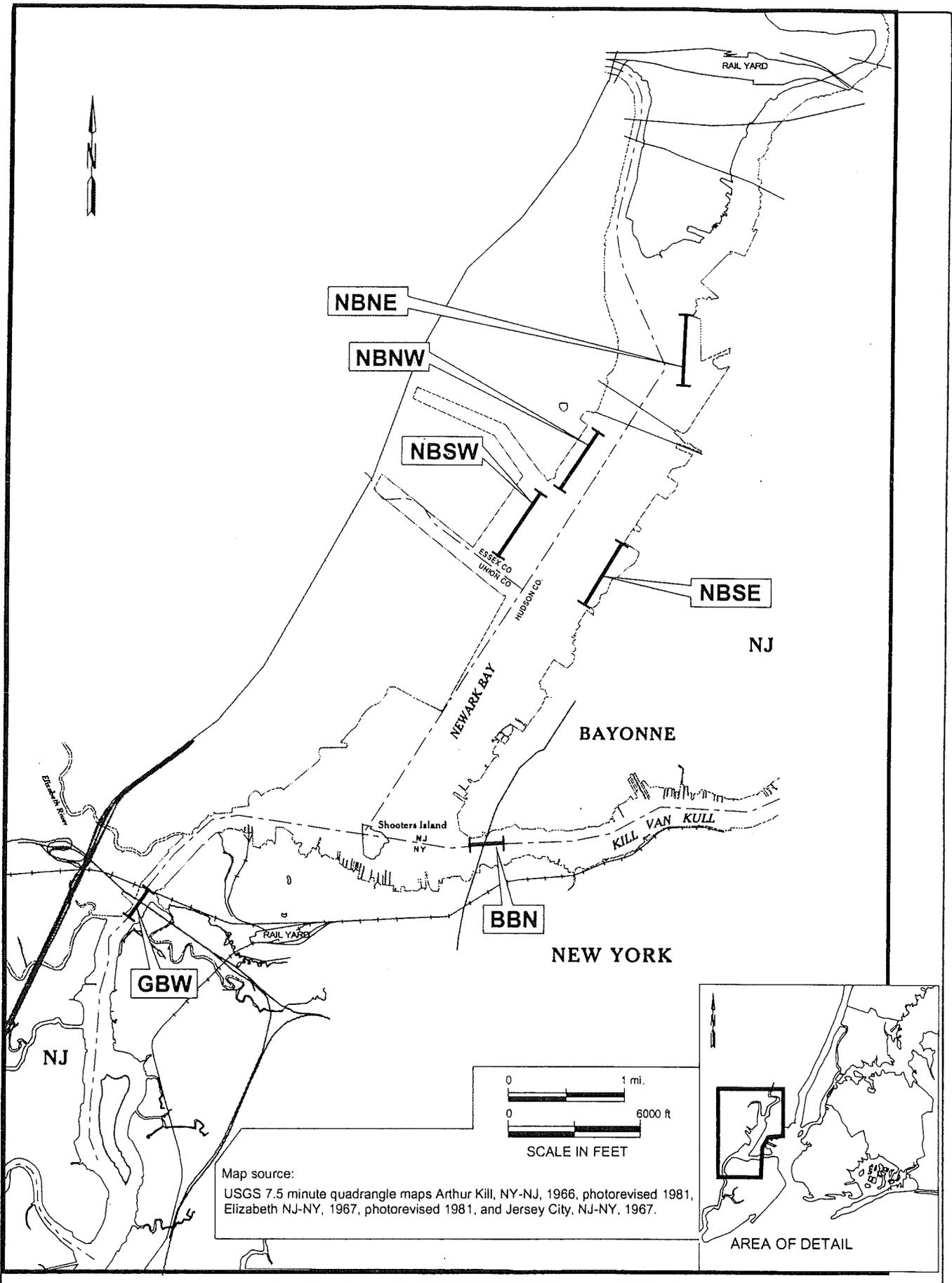
Newark Bay is rectangular in shape, approximately 8.9 km (5.5 miles) long and varying in width from 1.0 to 2.0 km (0.6 to 1.2 miles) (Figure 3-1). The surface area of the Bay is approximately 8.9 km<sup>2</sup> (5.5 square miles), with the widest section of the Bay opposite Port Newark, and the narrowest section opposite Port Elizabeth. With the exception of the maintained shipping channels, turning basins, and docking facilities, Newark Bay is very shallow, having extensive shallow areas dominating the eastern half. The mean tidal range in the Bay is 0.87 m (2.8 ft). Maximum flood and ebb tidal currents are 0.4 m/sec (1.2 ft/sec).

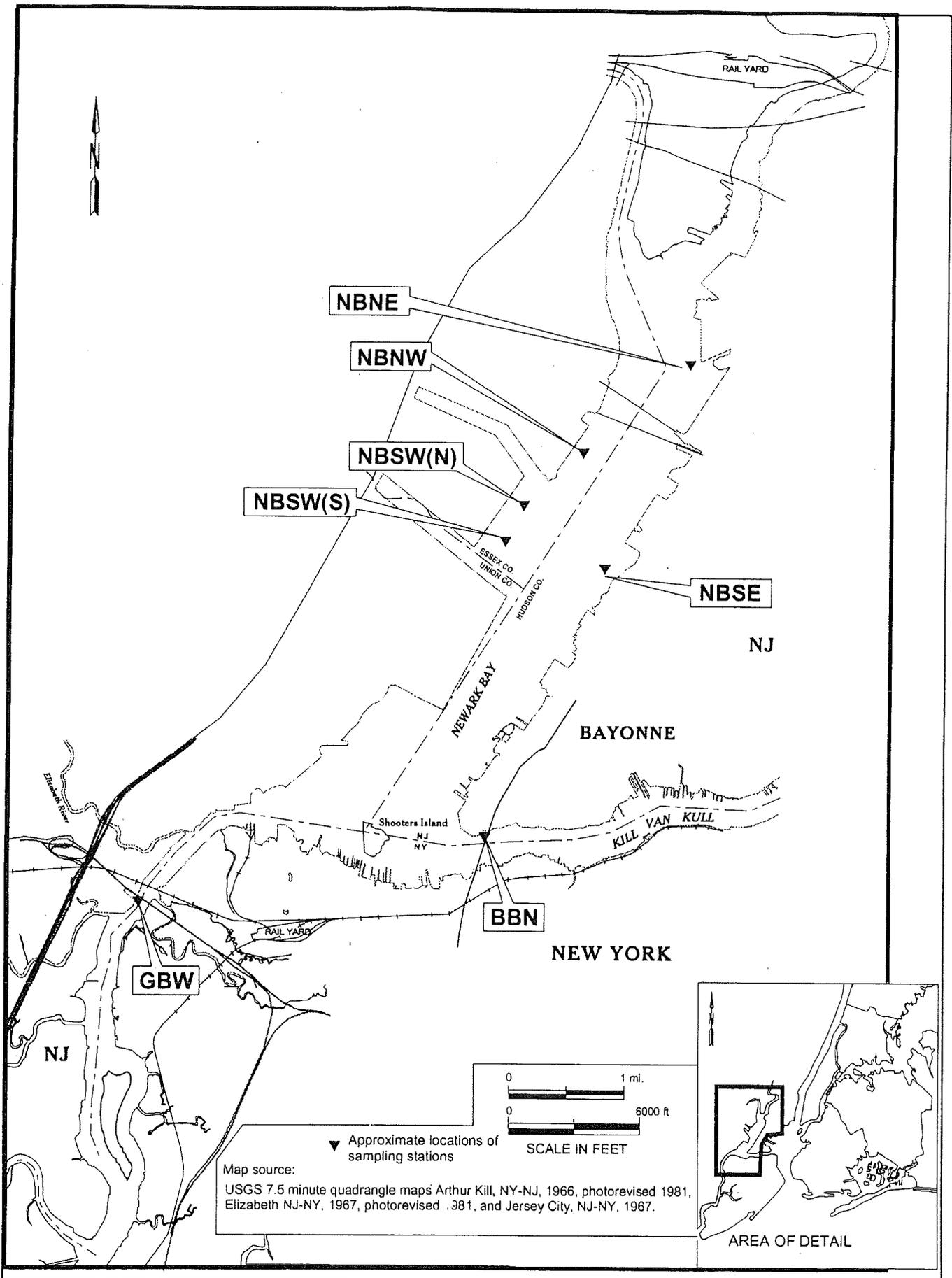
#### 3.2 SAMPLING STATION DESCRIPTIONS

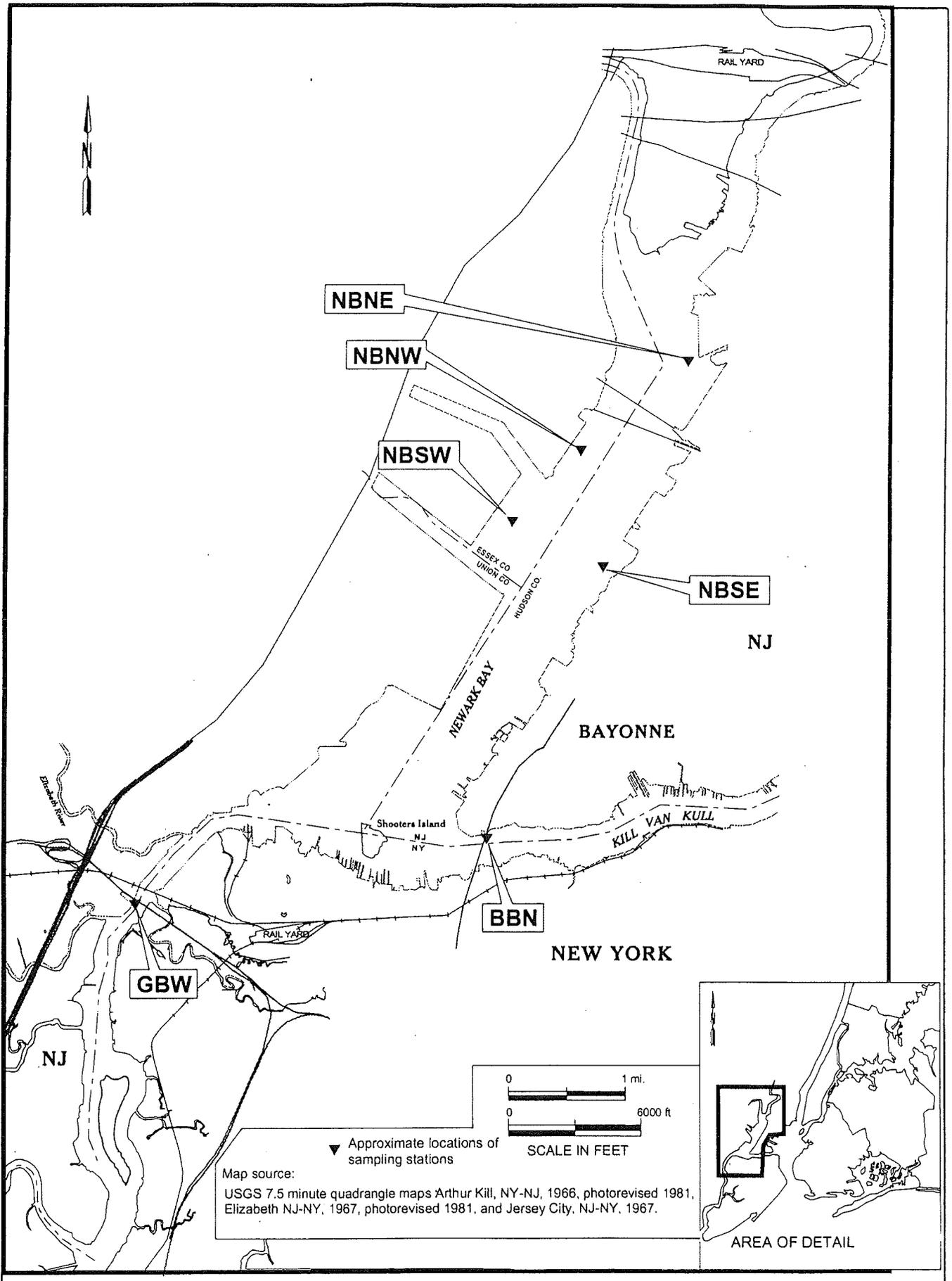
Fish, ichthyoplankton, macrobenthos, epibenthos, benthos, and water quality samples were collected in Newark Bay shoal areas and at two deepwater stations (one in the Kill Van Kull and one in the Arthur Kill) (Figures 3-2 through 3-4). Details of each sampling station are presented below:

- Newark Bay Southwest (NBSW) is located on the western shoals between Port Elizabeth Channel to the south, Port Newark Channel to the north, Port Newark Pierhead Channel to the west, and Newark Bay Middle Reach to the east. Recorded water depths at the station varied between 0.9 and 1.5 m (3 and 5 ft) at MLW. National Oceanic and Atmospheric Administration (NOAA) charts indicate water depths of 0.2 to 0.9 m (0.5 to 3 ft) MLW in the area.









- Newark Bay Northwest (NBNW) is located on the western shoals between Port Newark Channel to the south, New Jersey Turnpike Bridge to the north, and the western shore of Newark Bay off Port Newark; it is just east of Newark Bay North Reach Channel. Water depth at the station varied between 0.9 and 1.5 m (3 and 5 ft) MLW. NOAA charts indicate water depths of 0.6 to 0.9 (2 to 3 ft) MLW in this area.
- Newark Bay Northeast (NBNE) is located on the eastern side of Newark Bay above the Conrail alignment and east of the confluence of the Passaic and Hackensack rivers. Water depths at the station varied between 0.9 and 1.5 m (3 and 5 ft) MLW. NOAA charts indicate water depths of 0.3 to 0.6 m (1 to 2 ft) MLW.
- Newark Bay Southeast (NBSE) is located on the eastern side of Newark Bay, opposite NBSW and just south of Hudson County Park. Water depths at the station varied from 0.9 to 1.5 m (3 to 5 ft) MLW. NOAA charts indicate water depths of 0.3 to 0.9 m (1 to 3 ft) MLW in this area.
- Bayonne Bridge North (BBN) is located in the Kill Van Kull under the northern end of the Bayonne Bridge. Water depths at the station varied from 12.8 to 13.4 m (42 to 44 ft) MLW.
- Goethals Bridge West (GBW) is located on the western side of the Arthur Kill just south of the Goethals Bridge. Water depths at the station varied from 11.6 to 12.2 m (38 to 40 ft) MLW.

### 3.3 SAMPLING METHODOLOGIES

#### 3.3.1 Trawls

Trawls were conducted using a flat-bottom otter trawl with a 9.1-m (30-ft) head rope. The trawl was towed on the bottom against the tidal current at a speed of 150 cm/sec (4.9 ft/sec) relative to the bottom. The trawl was set off the stern of a 12.8-m (42-ft) research vessel. The trawl duration at Newark Bay stations was 10 min, and channel trawls were 3 min in duration. Trawls as short as 8 min in the Bay and as short as 2 min in the channel were deemed acceptable if the trawl came in quickly and in good condition after a hang down.

<b>LOCATION</b>	<b>SAMPLE DEPTH</b>	<b>DIRECTION</b>	<b>DURATION (min)</b>
NBSW(S)	Bottom	North-Northeast or South-Southwest	10
NBNW(N)	Bottom	North-Northeast or South-Southwest	10
NBSE	Bottom	North-Northeast or South-Southwest	10
NBNE	Bottom	North or South	10
BBN	Bottom	East or West	3
GBW	Bottom	Northeast or Southeast	3

Trawl samples were processed in the field immediately following each collection to ensure that fish and blue crabs could be released alive at the location where they were captured. All fish and invertebrates collected were identified and enumerated, and fish were measured to the nearest mm (total length). Trawl data from each collection were recorded on a field data sheet (Figure 3-5) designed for computer viewscreen entry.

Trawl catches were converted to catch per 10 min, which allowed comparison of stations where the trawl was not towed for 10 min with stations that were towed for the full 10 min.

### 3.3.2 Epibenthic Sled

Epibenthic sled tows were conducted with a 505-micron (0.02-in.) mesh, square-mouth plankton net measuring 0.5 m (1.64 ft) on a side (net mouth area = 0.25 m<sup>2</sup> [0.67 ft<sup>2</sup>]) and 2.5 m (8.2 ft) long. The sled was towed on the bottom at approximately 100 cm/sec (3.3 ft/sec), with the net approximately 20 cm (8.0 in.) above the bottom. A velocity meter was mounted in the mouth of the net to permit the calculation of water filtered through the net. The net was set off the stern of a 12.8 m (42-ft) research vessel. All tows were 5 min in duration at the stations identified below:

**FIGURE 3-5  
TRAWL, EPIBENTHIC SLED, AND  
WATER QUALITY FIELD DATA SHEET**

<b>TRAWL FIELD DATA SHEET</b>									
SURVEY NAME:					JOB No.:			SHEET OF	
<b>I. GENERAL INFORMATION</b>									
Date:		Invt No.:			Crew:		Boat:		
Station:		Station Depth:			Net Depth:		Gear:		
<b>II. TOW INFORMATION</b>									
Surface Velocity (cm/sec):		Tow Velocity (cm/sec): Optimum: _____ Actual: _____				Tow Direction:			
START Time:		END Time:			Duration: Minutes: _____ Seconds: _____		Hungdown: <input type="checkbox"/> YES <input type="checkbox"/> NO		
G.O. Probe Number:		G.O. Probe Readout Number:		Trawl Status: <input type="checkbox"/> VALID <input type="checkbox"/> INVALID		Snag Catch:			
<b>III. OBSERVATIONS</b>									
Air Temperature (deg C):		Wind Direction:			Wind Speed (mph)		Wave Height (ft)		
Sky:		Precipitation:			Water Color/Odors:		Tide:		
Vegetation:							Amount (circle) LIGHT    MODERATE    HEAVY		
Invertebrates:									
Vertebrates (other than fish):									
<b>IV. CHEMISTRIES</b>									
METERS USED:		Temperature:                      QC (Initial)		Conductivity/Salinity:                      QC (Initial)		Dissolved Oxygen (DO):                      QC (Initial)			
DEPTH (m)	TEMPERATURE (°C)		CONDUCTIVITY			SALINITY		DO	
	Original	QC	Bottle #	Field (µ/cm)	Cor. (µ/cm@25)	(‰)	Bottle #	Results (ppm)	QC (ppm)
<b>V. CATCH ESTIMATES</b>									
<b>VI. LENGTH ESTIMATES</b>									
<b>VII. COMMENTS</b>									
<b>VIII. CREW CHIEF SIGNATURE</b>									
Date:							Number of Sample Bags:		

LOCATION	SAMPLE DEPTH	TOW DIRECTION	DURATION (min)
NBSW	Bottom	North-Northeast or South-Southwest	5
NBNW	Bottom	North-Northeast or South-Southwest	5
NBSE	Bottom	North-Northeast or South-Southwest	5
NBNE	Bottom	North or South	5
BBN	Bottom	East or West	5
GBW	Bottom	Northeast or Southwest	5

The sled-mounted net was brought in at the end of the tow and washed down from the outside using onboard pumps. The sample was concentrated in the cod-end bucket. The bucket was removed and the contents washed into a 1-l plastic sample container, which was then filled to the midpoint with water, labeled, and preserved with 10% buffered formalin, resulting in a 5% solution of buffered formalin. Epibenthic sled data were recorded on a field data sheet (Figure 3-5).

In LMS' Nyack, New York, laboratory, epibenthic sled samples were sorted for ichthyoplankton and invertebrates using bottom-illuminated glass sorting pans with grids. All ichthyoplankton and invertebrates were removed and identified to the lowest possible taxon using 10- to 30-power binocular dissecting scopes and appropriate keys and reference specimens. Enumerations, including whole animals and heads of incomplete animals, were made and recorded on the laboratory data sheets. The sorted organisms were preserved and stored.

Collection information was reduced to number per 1000 m<sup>3</sup> using the following formula:

$$\text{Numbers of organisms/1000 m}^3 = 25806.452 \div \text{velocity meter revolutions} \times \text{number of organisms}$$

### 3.3.3 Benthic Grab

Benthic grab samples were taken with a 22.9-cm x 22.9-cm (9-in. x 9-in.) Ponar sampler at the stations identified below:

LOCATION	SAMPLE DEPTH	BENTHIC GRAB SITE
NBSW(S)	5 to 8 cm into bottom sediment	South end of trawl transect
NBSW(N)	5 to 8 cm into bottom sediment	North end of trawl transect
NBNW	5 to 8 cm into bottom sediment	Center of trawl transect
NBSE	5 to 8 cm into bottom sediment	Center of trawl transect
BBNE	5 to 8 cm into bottom sediment	Center of trawl transect
BBN	5 to 8 cm into bottom sediment	Center of trawl transect
GBW	5 to 8 cm into bottom sediment	Center of trawl transect

The sample was considered valid if the jaws were completely closed and the grab was 75% full. Sediment temperature and physical descriptions, including color, composition, texture, and odor, were recorded on field data sheets (Figure 3-6). The sample was washed through a U.S. Standard No. 18 (1-mm mesh) sieve, placed in a labeled plastic jar, mixed with 5% buffered formalin containing Rose Bengal stain, and transported to the laboratory for analysis.

In the LMS laboratory, the field label was verified against the field data sheet and the sample was placed in a U.S. Standard No. 18 (1-mm mesh) sieve and gently rinsed to separate organisms from fine sediments. The material that remained on the sieve was transferred to a bottom-illuminated glass sorting pan with grids. The organisms were sorted into groups and enumerated. Only whole organisms or parts of organisms with heads were counted; all identifiable fragments were saved. Empty bivalve and gastropod shells were discarded. Groups of sorted, enumerated organisms were identified to the lowest possible taxon and enumerated. Organisms such as barnacles and hydroids, which are not quantitatively sampled with the Ponar grab, were identified but not counted.

Organism counts were reported as number per 0.05 m<sup>2</sup> (0.54 ft<sup>2</sup>), which corresponds to the sample area of the Ponar grab sampler.

### 3.3.4 Field Observations

Observations of wildlife in the project area were made during monthly surveys at times when the survey crew was on site. Therefore, observations were opportunistic and not conducted specifically for wildlife at optimum times. Most observations were of birds; binoculars were



used for confirming identification and activity. Species and numbers were recorded when possible on the trawl field data sheet (Figure 3-5).

### 3.3.5 Water Quality

Water quality samples were taken immediately after each trawl was completed. Sample collection information was recorded on the trawl field data sheet (Figure 3-5). DO measurements were taken with a YSI Model 51A DO meter, with whole-water samples collected for quality control (QC) and at times when the meter was not calibrating properly. Whole-water samples were routinely taken during each monthly field survey as a QC check on the meter. The Winkler method was used to analyze the preserved whole-water samples for DO. Conductivity was taken with a YSI SCT meter; conductivities were recorded as microsiemens(s)/cm at 25°C. Salinity was calculated from conductivity by the following formula:  $\text{Salinity} = (-100) \times \log_e(1 - \text{Conductivity at } 25^\circ\text{C} \div 178500)$ . Temperature was taken with a YSI meter and was checked against a calibrated thermometer. If YSI temperatures differed by more than 0.1°C the calibrated thermometer was used to record temperatures.

## 3.4 LITERATURE SEARCH

An extensive computerized literature search was conducted followed by several focused searches. The following subjects, key words, and locations were used in the computerized literature search for the period 1964 through 1995. The dates of available literature in databases are included below; only National Technical Information Services (NTIS) and Ocean Abstracts included literature covering the entire 30 year period of record.

### *Databases Searched*

NTIS: 1964-1995 June

BIOSIS Previews: 1969-1995 May

Pollution Abstracts: 1979-1995 July

Oceanic Abstracts: 1964-1995 June

Aquatic Science and Fish Abstracts: 1978-1995 April

Enviroline: 1979-1995 April

Enviroline: 1979-1995 April

Zoological Record Online: 1978-1995

***Locations Searched:***

Newark Bay  
New York/New Jersey Estuary  
Hudson Raritan Estuary  
Hudson River  
Kill Van Kull  
Arthur Kill  
Hackensack River  
Raritan River

***Subjects Searched/Key Word:***

Vertebrates  
Mammals  
Birds  
Waterfowl  
Reptiles  
Turtle  
Amphibians  
Fish  
Invertebrates  
Benthos  
Epibenthos  
Endangered Species  
Threatened Species  
Special Concern Species  
Rare Species  
Water Quality  
Sediment Quality  
Pollution

Titles were searched first; those with potential information were queried for abstract, author, date, and publication. Relevant articles were searched for additional literature useful for the Newark Bay Study. Articles determined useful were acquired from the LMS library or through interlibrary loans.

### **3.5 AGENCY FILE SEARCH**

At the beginning of the project, state and Federal agency file searches were requested. The New Jersey Department of Environmental Protection (NJDEP), the U.S. Fish and Wildlife Service (USF&WS), and the National Marine Fisheries Service (NMFS) were queried for occurrence records for TES, significant habitats, and other information on fish and wildlife resources of Newark Bay, Arthur Kill, and Kill Van Kull. Copies of letters sent out and responses from agencies in the form of letters, tables, and other information are discussed in Chapter 4, and are included in Appendix E.

## CHAPTER 4

### RESULTS

Results for the monthly trawl (fish and blue crabs), epibenthic sled (ichthyoplankton and epibenthos), benthic grab (benthic invertebrates), and water quality samples (temperature, conductivity, salinity, and DO) are presented in the following sections. In addition, the results of the literature review, the agency file search, and incidental field observations are detailed below.

#### 4.1 BIOLOGICAL PROGRAM

##### 4.1.1 Trawls

A total of 3691 fish representing 27 species were collected in 72 bottom trawls completed during the study (Table 4-1). Twenty-two species (3226 individuals) were collected in 48 bottom trawls conducted in Newark Bay shoal areas, and 13 species (465 individuals) were collected at the two channel stations (24 trawls). The sampling stations located in the immediate vicinity of the proposed CDFs (NBSW and NBNW) resulted in the collection of 21 species (2581 individuals) in 24 trawls. The two Newark Bay reference stations (NBNE and NBSE) resulted in the collection of 14 species (645 individuals) in 24 trawls. The deepwater station located at GBW resulted in 10 species and 350 individuals in the 12 trawls conducted. The effort at the BBN station collected 11 species (115 individuals) in the 12 trawls conducted.

The results indicate higher species richness and diversity at the stations in the vicinity of the proposed Newark Bay Confined Disposal Facility (NBCDF) (project station) than at the Newark Bay reference stations and the Kill Van Kull and Arthur Kill channel stations. Seven species were unique to project stations; numbers collected ranged from one to 13 individuals.

Fish collections were dominated by bay anchovy, with 2700 individuals (73% of the total fish collected); they were followed in abundance by striped bass (231 individuals, 6% of the total), winter flounder (217 individuals, 6% of the total), Atlantic silversides (135 individuals, 4% of the total), and grubby (88 individuals, 2% of the total) (Table 4-1). The remaining 22 species, with 320 individuals, made up 9% of the total catch.

Numbers of fish collected varied by general location (Table 4-1). A total of 2342 (87%) of the bay anchovy were collected from the project stations, 335 (12%) were from reference sites, and 23 (1%) were from channel sites. Thirty-five percent of the striped bass were collected at

**TABLE 4-1**  
**NUMBER OF FISH AND BLUE CRABS COLLECTED**  
**BASED ON TEN MINUTE TRAWLS**

Station Appx. Depth at MLW	No. Individuals Collected					Bay Total	No. Individuals Collected Channel Sites BBN 42-44'	Reference Sites NBSE 3-5'	NBNE 3-5'	Channel Total	No. Individuals Collected Channel Total	Channel (%)	Total All Trawls	Total (%)
	Project Sites NBSW 3-5'	NBNW 3-5'	Reference Sites NBSE 3-5'	NBNE 3-5'	Bay Total									
<b>Species Collected</b>														
<b>30 ft Bottom Trawl</b>														
<i>Alewife</i>		1			1	0.03							1	0.03
<i>American shad</i>	3	10			13	0.40							13	0.35
<i>Atlantic croaker</i>	2				2	0.06							2	0.05
<i>Atlantic herring</i>	1	3			4	0.12							4	0.11
<i>Atlantic silverside</i>	4	23	9	99	135	4.18							135	3.66
<i>Atlantic tomcod</i>	1			1	2	0.06	10		43	53	11.46		55	1.50
<i>Bay anchovy</i>	1,002	1,340	138	197	2,677	82.97	20		3	23	5.01		2,700	73.14
<i>Blueback herring</i>	1	2			3	0.09							3	0.08
<i>Bluefish</i>	10	21	2	12	45	1.39							45	1.22
<i>Butterfish</i>							3			3	0.54		3	0.07
<i>Creville jack</i>	1	1		2	4	0.12							4	0.11
<i>Cunner</i>							5			5	1.07		5	0.14
<i>Gizzard shad</i>			1		1	0.03							1	0.03
<i>Grubby</i>							43		45	88	18.80		88	2.37
<i>Northern puffer</i>		1			1	0.03							1	0.03
<i>Northern kingfish</i>	6	8	1		15	0.46							15	0.41
<i>Northern pipefish</i>	1		2	5	8	0.25							8	0.22
<i>Scup</i>							5			5	1.07		5	0.14
<i>Spot</i>							3		3	6	1.25		6	0.16
<i>Spotted hake</i>		1	2	4	7	0.22	5		43	48	10.28		55	1.49
<i>Striped anchovy</i>		1			1	0.03							1	0.03
<i>Striped bass</i>	37	43	4	97	181	5.60	10		40	50	10.74		231	6.24
<i>Summer flounder</i>	13	2	7	7	29	0.91							29	0.79
<i>Weakfish</i>	1	1	1	4	7	0.22	8		3	11	2.33		18	0.48
<i>White perch</i>		2	1	6	9	0.28	5		27	32	6.80		41	1.10
<i>Windowpane</i>	1				1	0.03				7	1.43		8	0.21
<i>Winter flounder</i>	23	15	27	16	81	2.50			136	136	29.19		217	5.87
<i>Number of species</i>	16	17	12	12	22		11		10	13			27	
<i>Total number (individuals) *</i>	1,106	1,475	195	450	3,226	100.00	115		350	465	100.00		3,691	100.00
<i>Percent of total fish</i>	29.97	39.96	5.28	12.19			3.13		9.48					100.00
<i>Blue crab *</i>	729	972	736	777	3,214		83		332	415			3,629	100.00
<i>Percent of total crabs</i>	20.09	26.78	20.28	21.41			2.29		9.15					100.00

\* Numbers are rounded.

Stations NBSW and NBNW, 44% were from reference sites, and 22% were from channel stations. Eighteen percent of the winter flounder were from project sites, 20% were from reference sites, and 63% were from channel sites. All the Atlantic silversides were collected at shoal sites: 20% from project sites and 80% from reference sites. Grubby were collected only from channel sites.

Bay anchovy dominated the Newark Bay shoal area collections (2677 individuals, 83% of the total), followed by striped bass (181 individuals, 6% of the total), Atlantic silversides (135 individuals, 4% of the total), winter flounder (81 individuals, 2% of the total), and bluefish (45 individuals, 1% of the total) (Table 4-1).

A total of 350 fish were collected at the GBW station; most (39% of the total) were winter flounder (136 individuals), followed by grubby (45 individuals, 13% of the total), Atlantic tomcod (43 individuals, 12% of the total), spotted hake (42 individuals, 12% of the total), and striped bass (40 individuals, 11% of the total) (Appendix A). A total of 115 fish were collected at the BBN station. Grubby dominated collections with 42 individuals (37% of the total), followed by bay anchovy with 20 individuals (17% of the total), Atlantic tomcod (10 individuals, 9% of the total), striped bass (10 individuals, 9% of the total), and weakfish (eight individuals, 7% of the total).

Blue crabs were the only large macroinvertebrate collected in trawls. Most (89%) of the 3629 blue crabs were collected from Newark Bay shoal stations (Table 4-1). A total of 1701 blue crab were collected at project stations (NBSW and NBNW), 1513 blue crab were collected at the Newark Bay reference stations (NBSE and NBNE), and 415 blue crab were collected in the two channel stations (BBN and GWB). The results indicate a higher use of the Newark Bay shoals than channel stations.

The results obtained in this study were compared to other studies conducted in the same general area (Will and Houston 1988; NOAA 1995). The methods and equipment used in these programs were similar to those used in this study. The use of similar gear and methods produces data that can be used to compare catch per unit of effort (CPUE) with data collected from other areas. All fish and blue crab collections were converted to catch per 10-min trawl. There was one limiting factor to comparability in the gear used and its associated efficiency: the LMS 1995-96 study used a 9.8-m (32-ft) trawl, while NOAA used a 9.8-m (32-ft) trawl in the channels and a 4.9-m (16-ft) trawl in the shallows. The 4.9-m (16-ft) trawl would sample a smaller area in 10 min than would the 9.8-m (32-ft) trawl, and therefore CPUE is expected to be lower by over 50% for the smaller trawl.

Generally, the abundance, seasonality, habitat, and size of fish species and blue crabs followed similar patterns at the shallow Newark Bay stations (Appendices A, B and C). The six most common fish species collected in Newark Bay and blue crabs are discussed below:

- **Bay anchovy (*Anchoa mitchilli*)** was the most common fish species collected at Newark Bay shallow stations and was uncommon at channel stations (Appendix A). Most bay anchovy moved into the Newark Bay shallows in late June and moved out by October. Bay anchovy were most abundant at the project area stations NBSW and NBNW and were an order of magnitude less common at the two reference stations (NBSE and NBNE) (Appendix A). No bay anchovy were collected from December through April. Length-frequency data indicate that most bay anchovy collected were adults; few juvenile fish were collected (Appendix B).

Bay anchovy abundance in the shoal areas was similar during both the 1993-94 survey (NOAA 1995) and the 1995-96 LMS study. CPUE increased from 40-50 in July, to 100-200 in August, to 200+ to 400+ in September, and then decreased rapidly to 0 in late October (Appendix C). Bay anchovy were uncommon in the channel areas, with a peak CPUE of 28 in June, followed by CPUE of 0 to 1 through November.

Juveniles were observed in trawl catches during May and June; however, their numbers cannot be quantified because most pass through the mesh in the body of the trawl Appendix B. Mature adults over 40 mm (Vonglitois et al. 1987) were present from May through October. Other published studies show similar seasonal trends (NOAA 1995).

- **Striped bass (*Morone saxatilis*)** was the second most common fish species collected at Newark Bay shallow stations and the fifth most common species collected at channel stations. Striped bass were common at Newark Bay stations during April to July and in October. Station NBNE had the most striped bass, while station NBSE had the least striped bass (Appendix A).

Striped bass were noticeably uncommon during August and September and during November to March. Striped bass were collected more frequently during the winter months in the deep waters of the Arthur Kill and Kill Van Kull. Length-frequency data indicate the majority of striped bass collected were yearling fish that fit length intervals for known-age Hudson River Striped Bass (LMS 1995). YOY fish were also present as were a few two-year-old fish from 300 to 360 mm (12 to 14 in.) in total length (Appendix B).

The abundance, life stages, and seasonality of striped bass collected during the present study were similar to those of striped bass collected in Newark Bay shallows during other studies (Will and Houston 1988, NOAA 1995). Appendix C includes seasonal data and abundance of striped bass (predominately yearling fish) collected during recent surveys of shallow and deep stations. Neither of the

figures include data from Will and Houston (1988), which combines shallow and deep stations.

Striped bass were abundant in Newark Bay deepwater stations in November 1993 and from February to April 1994 (NOAA 1995); numbers were low during May, June, August, September, and October 1993 and moderate during July and December 1993 and January 1994. During studies conducted in the lower Hudson River from 1979 through 1984, Hudson River striped bass were found to use deeper interpier and channel areas during the winter months (LMS 1983, 1984a).

- **Atlantic silversides (*Menidia menidia*)** was the third most common fish species collected at Newark Bay shallow stations; none were collected at the deeper channel stations. Atlantic silversides moved into the Newark Bay shallows during September and moved out after November (Appendix A). No Atlantic silversides were collected at shallow stations from December through August. Atlantic silversides were adults and juvenile fish that fit length intervals for known-age silversides published for Massachusetts (Conover and Ross 1982) (Appendix B).

Atlantic silversides were present in shoal areas during the late summer and fall of the 1993-94 and 1995-96 studies (Appendix C). During 1995-96 they were absent during winter through mid-summer; however, during the 1993 to 1994 survey low numbers were collected during the winter but were not collected during spring to late summer. No Atlantic silversides were collected from channel areas during the 1993-94 study (NOAA 1995).

- **Winter flounder (*Pleuronectes americanus*)** was the fourth most common fish species collected at Newark Bay shallow stations and was the most common species at GBW; however, none were collected at the BBN station. For the Newark Bay stations more were collected at the NBSW and NBSE stations than at the NBNW and NBNE stations. Winter flounder were collected every month of the study but were most common during June to July and September (Appendix A).

Winter flounder collections included mostly YOY and a few one-year-old fish. These fish fit into length ranges for known-age fish published by Haas and Rechsiek (1995) for Narragansett Bay, Rhode Island. Two older fish were collected in April; these fish were 305 and 365 mm (12 and 14 in.) in total length, respectively.

Winter flounder were present in the Newark Bay shoal area through most of the year, absent only during the December and January sampling efforts in the 1995-96 study. NOAA (1995) found winter flounder were absent in February to March 1994 (a time during the following year when their numbers were increasing) (Appendix C). Winter flounder numbers in the Bay were low throughout the winter and high during spring through early fall in both studies. NOAA catches were generally greater than LMS catches in shoal areas despite

the use of a smaller trawl. This may indicate a preference for the shoal edges (where sampling was conducted in the NOAA study) over the center of the shoal areas (where sampling was conducted during this study). Channel catches (Appendix C) were highest during the summer and fall, with a noticeable decline in numbers collected in late summer, early fall, and through the winter to late spring (NOAA 1995).

- **Bluefish (*Pomatomus saltatrix*)** was the fifth most common fish species collected at Newark Bay. No bluefish were collected from the deeper river stations in the Arthur Kill or Kill Van Kull. Bluefish moved into Newark Bay in August, peaked in September, and were gone by November (Appendix A). Most bluefish were collected from the project stations, especially station NBNW.

Bluefish were represented mostly by YOY fish ranging from 110 to 230 mm (4.3 to 9.1 in.) in total length (Appendix C). These fish fit YOY length ranges published in McBride et al. (1995) for Narragansett Bay, Rhode Island.

Bluefish were present in shoal areas during the late summer to early fall of the 1993-94 and 1995-96 studies (Appendix F). Bluefish were absent from early fall through early spring during both studies. Few bluefish were collected in channel areas of the Bay during the 1993-94 studies; of these, all were collected during the summer and early fall periods (NOAA 1995).

- **Summer flounder (*Paralichthys dentatus*)**, a commercially and recreationally important bottom fish, was the sixth most common species collected at shoal areas during the study. All were collected at the shallow Newark Bay stations; none were collected at the Arthur Kill or Kill Van Kull stations. Summer flounder were present in the Bay from May to September; none were collected during the period November through April (Appendix A).

Summer flounder were mostly one-year-old fish fitting length intervals published by Powell (1982), some larger fish ranging in size from 325 to 345 mm (13 to 14 in.) in total length were probably two-year-old fish. One smaller fish approximately 125 mm (5 in.) was probably a YOY.

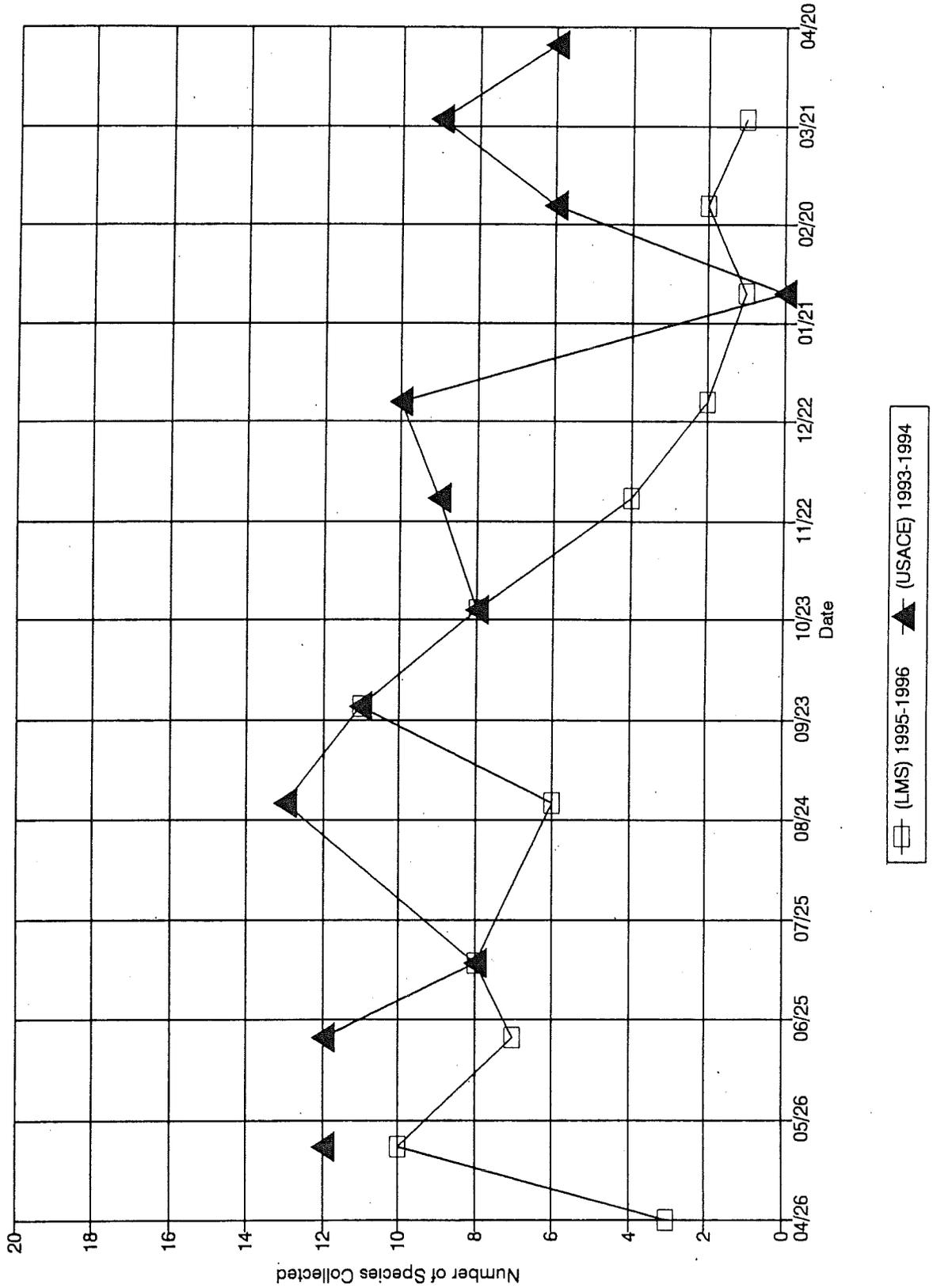
Summer flounder were present in shoal areas of Newark Bay during late spring through early fall of the 1993-94 and 1995-96 studies (Appendix C). Summer flounder were absent from late September through April during the 1993-94 studies and from October through April in this study. Summer flounder were collected in greater numbers in the channel stations from April to September during 1993-94; none were collected from October to March (Appendix C).

- **All fish.** Species richness (the total number of fish species collected each month in trawls in Newark Bay shallows) was generally similar on a seasonal basis for both the NOAA study conducted during 1993-94 and the LMS study conducted during 1995-96 (Figure 4-1). The 1995-96 study generally collected fewer species in the shoal areas than did the 1993-94 study. Higher species richness in the shoal areas of the Bay were reached during late spring to early fall, when

FIGURE 4-1

# Newark Bay Aquatic Sampling Studies

Species Richness in Shoal Areas of Newark Bay



an average of over eight species were collected by LMS and 11 species were collected by NOAA. The number of species were lowest during winter (January) when one species was collected by LMS and no species was collected by NOAA. More species of fish were collected in the channels during 1993 and 1994, reaching peaks of 22 to 24 species from April through November; lows of 14 to 15 species were noted during mid-winter (Figure 4-2).

The numbers of fish collected in Newark Bay shoal areas was highest during September and lowest from October through March for both the LMS 1995-96 and NOAA 1993-94 studies (Figure 4-3). During late fall and winter, average collections approached 10 fish or less per 10-min trawl effort. NOAA collections in the channel areas were larger during this same period. Channel catches reached a peak of about 340 fish per 10-min trawl in October and never fell below an average of 80 fish per 10-min trawl through the winter (Figure 4-4). In the table below the common fish species recorded in Newark Bay are listed along with their rank based on numbers collected for the three latest studies (NOAA 1995; Will and Houston 1988; this study [LMS 1996]). Three species - bay anchovy, winter flounder, and striped bass - were among the six most common species during all studies. Atlantic tomcod was among the top three species in all studies except the 1995-1996 (LMS 1996) survey.

**OCCURRENCE RANK OF MOST COMMON FISH SPECIES COLLECTED  
IN RECENT STUDIES**

Species	Shoal Stations (LMS 1995-96)	Shoal Stations (NOAA 1993-94)	Channel Stations (NOAA 1993-94)	Shoal and Channel (Will & Houston 1988)
Bay anchovy	1	1	8	2
Striped bass	2	4	1	6
Winter flounder	3	5	5	3
Atlantic silverside	4	6	NC	C
Bluefish	5	8	42	10
Summer flounder	6	7	12	C
Atlantic herring	12	2	26	NC
Atlantic tomcod	16	3	2	1
Weakfish	14	13	3	NC
White perch	9	9	4	8
Spotted hake	11	25	6	5
Rainbow smelt	NC	28	7	NC
Atlantic menhaden	NC	NC	15	4

FIGURE 4-2

# Newark Bay Aquatic Sampling Studies

USACE 1993-1994 Species Richness in Channel Areas of Newark Bay

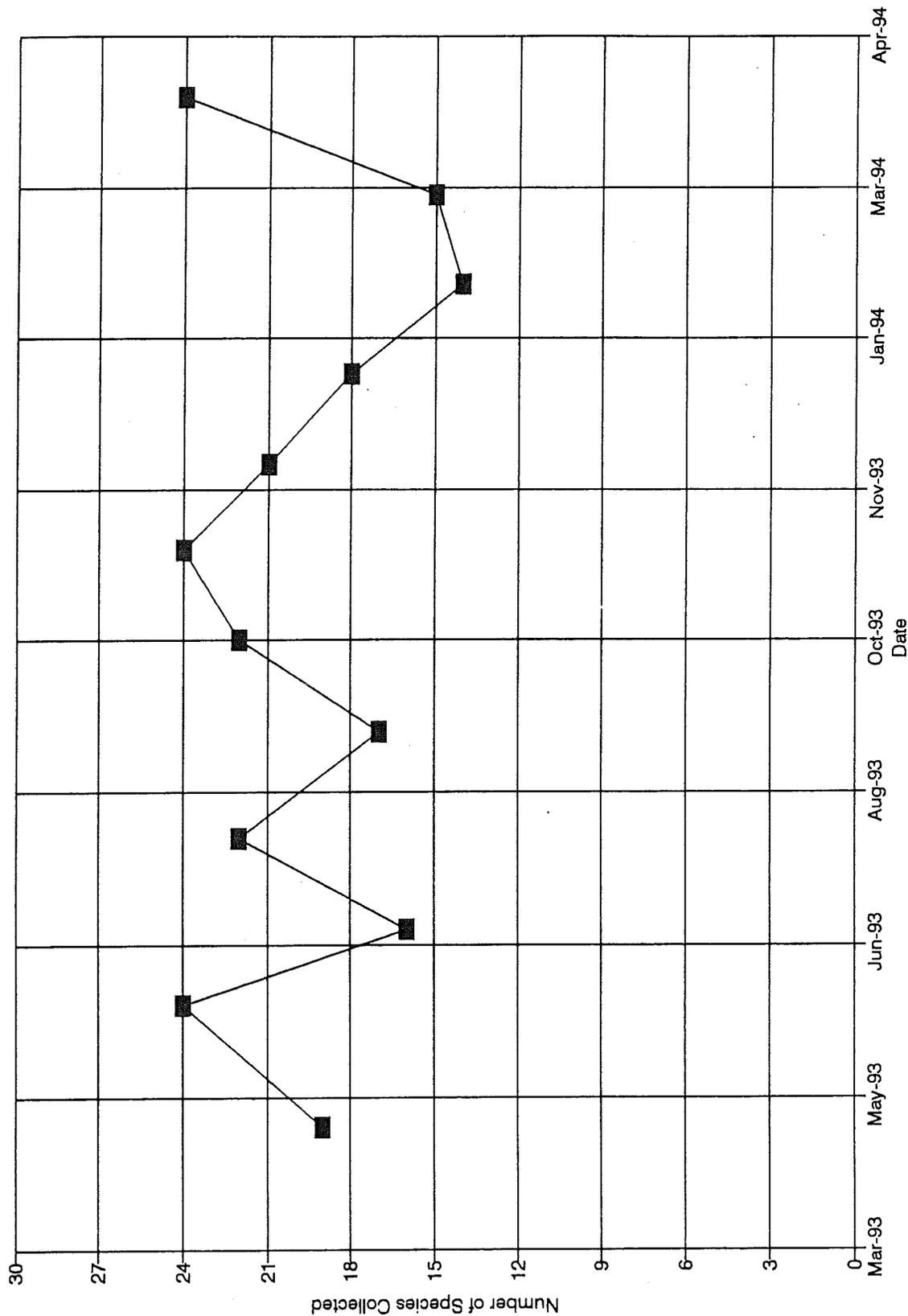


FIGURE 4-3

# Newark Bay Aquatic Sampling Studies

Monthly Fish Totals in Shoal Areas of Newark Bay

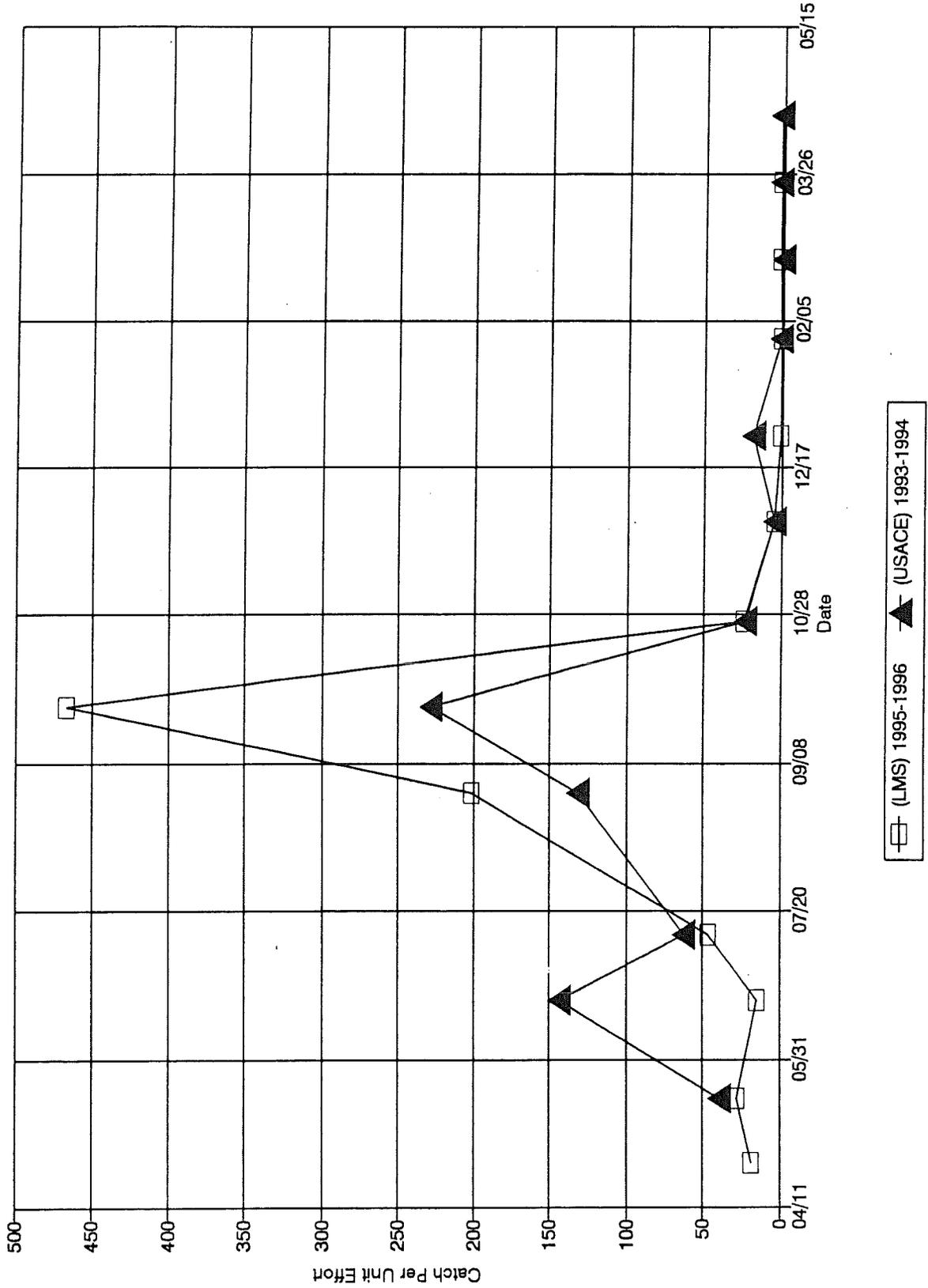
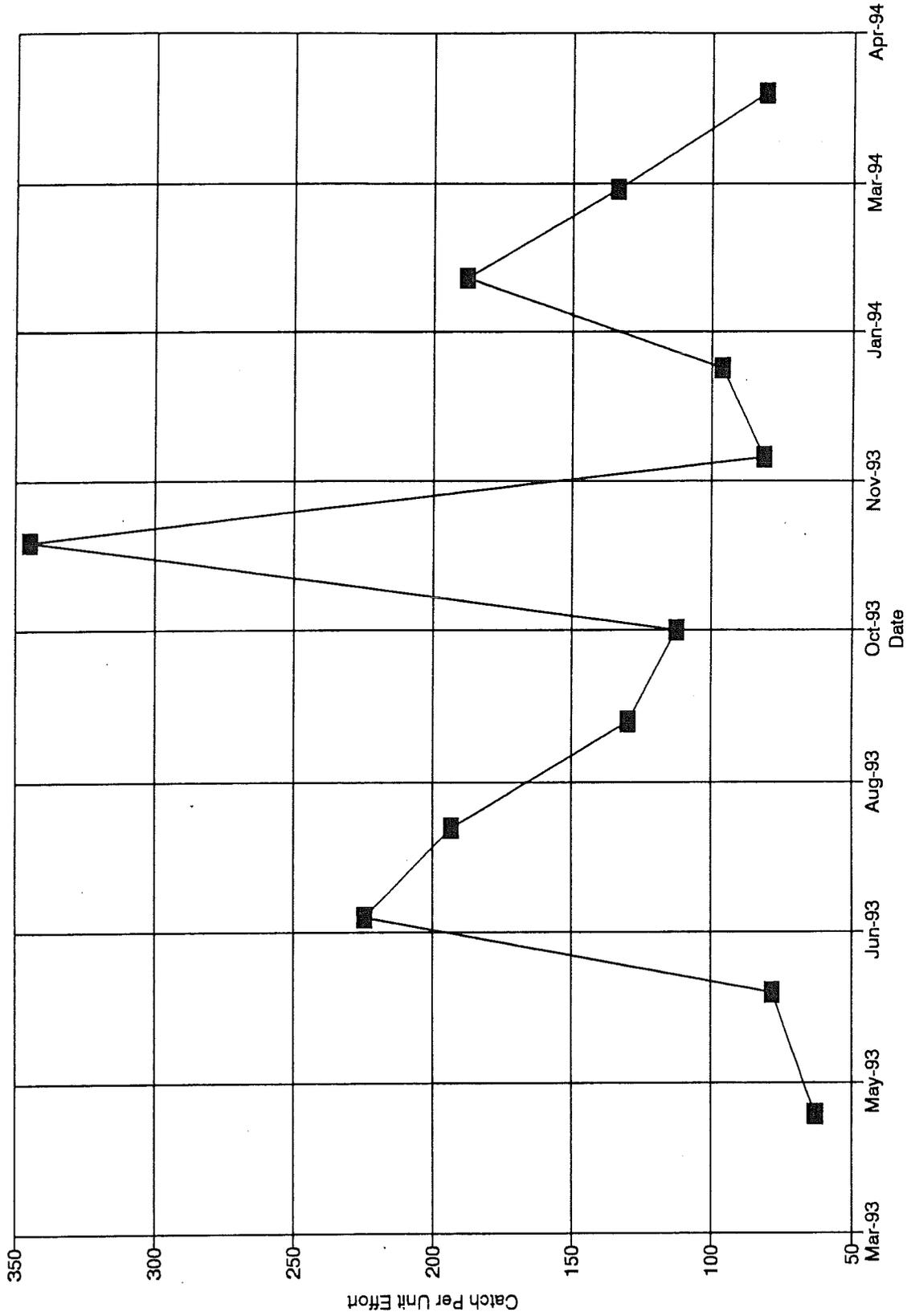


FIGURE 4-4

# Newark Bay Aquatic Sampling Studies

USACE 1993-1994 Monthly Fish Totals in Channel Areas of Newark Bay



- **Blue crab (*Callinectes sapidus*)**, a commercially and recreationally important species, was very common in Newark Bay. Of the 3629 blue crabs collected, 3214 (89%) were collected in shoal areas of Newark Bay. Most blue crabs were collected from May through October, with peak CPUE in the Bay reaching 227 blue crabs per 10-min trawl in July. Blue crabs were not collected from November to March.

Blue crabs were present in shoal areas of Newark Bay during April to October in this study and from June through October in the 1993-1994 study. CPUE peaked in July during both studies, with peaks of 227 crabs per 10-min trawl during this study and a peak in July of 1993-94 of 25 crabs per 10-min trawl. The smaller trawl used during the 1993-94 survey would naturally catch fewer crabs, but this peak is significantly lower even if adjusted for trawl size. Crabs were collected in channel stations of Newark Bay during 1993-1994; a peak catch of 200 crabs per 10-min trawl was found in July. Crabs were present in the channel areas of Newark Bay throughout the year. Numbers were lowest from December through April (Appendix F).

#### 4.1.2 Epibenthic Sled

4.1.2.1 *Ichthyoplankton*. A total of 90,702 fish eggs, larvae, and juveniles were collected during the study (Table 4-2). Of these, 86,936 (95.8% of the total ichthyoplankton) were eggs, 3531 (3.9% of the total) were larvae, and 235 (0.3% of the total) were juvenile fish.

#### Eggs

Of the 86,935 eggs collected during the study, most were eggs of the numerically dominant bay anchovy (80,723 eggs, 92.9% of the total) collected during June and July (Appendix D). They were followed in abundance by tautog (2755 eggs, 3.2% of the total), all collected in May; weakfish (1896 eggs, 2.2% of the total), present from April through June; silver hake (876 eggs, 1.0% of the total), collected in July; and Labridae (448 eggs, 0.5% of the total), collected in June and July.

Most eggs (82,376 eggs, 94.8% of the total) were collected from the shoal areas of Newark Bay (Table 4-2). Bay anchovy eggs (80,723) were collected predominately from Newark Bay shoal areas (78,732 eggs, 97.5% of the total); the remainder (1991 eggs, 2.5% of the total) were collected from channel stations. Silver hake and Labridae eggs were found at both shoal and channel areas. Weakfish collections indicate a slight preference for shoal stations over channel areas, while tautog collections indicate a slight preference for channel stations. No preference could be discerned for summer flounder; slightly more eggs were collected in the channel areas but numbers were very low. Other species collected were represented by only a few individuals, and preferences for either habitat type was not discernable.

TABLE 4-2

**ICHTHYOPLANKTON SAMPLING RESULTS BY STATION AND STATIONS COMBINED  
NUMBERS PER 1000 CUBIC METER**

APRIL 1995 - MARCH 1996

Station	Project Sites			No. Individuals Collected Reference Sites			Bay		No. Individuals Collected Channel Sites	Channel BBN	GBW	Channel Total	Total All Sites	Total (%)
	NBSW	NBNW	NBSE	NBNE	Total	Bay	Total	(%)						
<b>ICHTHYOPLANKTON</b>														
<b>EGGS</b>														
Bay anchovy	16,583	4,998	25,980	31,171	78,732	95.58	1,903	88	1,991	43.65	80,723	92.85		
Silver hake	283	370	41	694	0.84	182	182	182	182	3.99	876	1.01		
Weakfish	380	659	279	1,599	1,476	1.79	288	132	420	9.22	1,896	2.18		
Labridae	197	190	52	438	0.53	11	11	11	11	0.23	448	0.52		
Tautog	133	469	152	140	894	1.09	607	1,254	1,862	40.82	2,755	3.17		
Cunner					0	0.00		10	10	0.21	10	0.01		
Summer flounder		58	11		69	0.08	86	86	86	1.88	155	0.18		
Winter flounder	54			19	73	0.09			0	0.00	73	0.08		
Total collected	17,630	6,742	26,422	31,582	82,375	100.00	3,076	1,484	4,561	100.00	86,936	100.00		
<b>LARVAE</b>														
Bay anchovy	151	146	684	65	1,046	34.49	32	44	76	15.27	1,122	31.77		
Silversides					0	0.00		20	20	4.01	20	0.57		
Northern pipefish		14	14		28	0.92	11	11	11	2.14	39	1.10		
Grubby		43			43	1.42	165	39	204	40.89	247	6.99		
American sand lance		12			12	0.39	15	15	15	3.01	27	0.76		
Gobiidae	171	167	1,015	337	1,690	55.72		117	117	23.37	1,806	51.15		
Summer flounder			14		14	0.46			0	0.00	14	0.40		
Windowpane					0	0.00		10	10	1.96	10	0.28		
Winter flounder		93		107	200	6.60	37	10	47	9.34	247	6.98		
Total collected	322	475	1,727	509	3,032	100.00	260	239	499	100.00	3,531	100.00		
<b>JUVENILE</b>														
Northern pipefish		20	42	108	170	91.20	12	11	23	47.93	193	82.28		
Weakfish				0	0	0.00		11	11	22.52	11	4.64		
Naked goby		16		16	16	8.80		14	14	29.55	31	13.07		
Total collected	0	36	42	108	186	100.00	12	36	48	100.00	235	100.00		

## **Larvae**

A total of 3531 larvae were collected; most (1806 larvae; 51.1% of the total) were goby larvae, collected during June to September (Appendix D). They were followed in abundance by bay anchovy (1122 larvae, 31.8% of the total), collected mostly in July; winter flounder (247 larvae, 7.0% of the total), collected in April and May; and grubby (246 larvae, 7.0% of the total), collected in March and April.

Of the 3531 larvae collected during the study, most (3034 larvae, 85.9% of the total) were collected from shoal areas (Table 4-2). Bay anchovy, northern pipefish, and goby collections indicate a slight preference for shoal areas. Grubby were slightly more common at channel stations, and winter flounder were present at both channel and shoal areas. Other species collected were represented by only a few individuals and preference for either habitat type was usually not discernible.

## **Juveniles**

Three juvenile fish species were collected: northern pipefish (193 individuals, 82.3% of the juveniles collected), naked goby (31 individuals, 13.1%), and weakfish (11 individuals, 4.6%). Northern pipefish and naked goby were collected from shoal and channel stations; weakfish were only collected at the GBW channel station.

## **Other Ichthyoplankton Studies**

Three other ichthyoplankton studies were conducted in the Newark Bay area. Ichthyological Associates, Inc. (Anselmini 1974), collected ichthyoplankton in Newark Bay; however, the results were not available. Ecological Analysts, Inc. (Versar 1989), collected ichthyoplankton in the Bay and Hackensack River; however, the data were combined for report purposes and Newark Bay data could not be separated out. NOAA (1995) conducted ichthyoplankton surveys in Newark Bay in 1993 and 1994; eggs and larvae of 21 species were collected during the study. The species collected and dominance rank are provided in the table below along with the results from this study.

### Occurrence Rank of Most Common Ichthyoplankton Species Collected in Recent Studies

Species	Present Study 1995-1996	NOAA (1995) 1993-1994	Versar (1989) 1986
Bay anchovy	1	1	1
Tautog (Labridae)	2	6	2
Weakfish	3	NC	8
Goby	4	2	6
Silver hake	5	NC	NC
Winter flounder	7	3	5
Grubby	8	4	NC
Northern pipefish	9	5	3
Cunner (Labridae)	6	7	2
<i>Menidia</i> sp.	NC	NC	3
<i>Fundulus</i> sp.	NC	NC	7

NC = not collected

4.1.2.2 *Epibenthic invertebrates*. A total of 2,359,348 epibenthic invertebrates were collected (Table 4-3). The dominant species were copepods, with 1,760,309 collected (74.6% of the total). They were followed in abundance by crab larvae (Zoea), with 246,475 collected (10.4% of the total); amphipods (Gammaridae), with 120,846 collected (5.1% of the total); *Neomysis americana* and other mysid shrimp, with 91,729 collected (3.9% of the total); Caridae larvae and adults, with 60,793 collected (2.6% of the total); and *Leucon americanus*, with 40,465 collected (1.7% of the total).

Most epibenthic invertebrates were collected during the month of April, with all collections dominated by copepods (Appendix D). Copepods were also very common in May, June, July, February, and March. Crab larvae were very common in June and July. Mysid shrimp were most common in June, July, November, and December, and Caridae larvae were common in July and September. *Crangon septemspinus* were common in November and December. In December, *Leucon americanus* was common in the collections.

**TABLE 4-3**  
**EPIBENTHIC SAMPLING RESULTS BY STATION AND STATIONS COMBINED**  
**NUMBERS PER 1000 CUBIC METER**

APRIL 1996 - MARCH 1996

Station	Project Sites		No. Individuals Collected				Bay Total	%	No. Individuals Collected			Total All Sites	%
	NBSW	NBNW	Reference Sites			Channel Sites			Channel				
			NBSE	NBNE			BBN	GBW	Total				
<b>EPIBENTHOS</b>													
<b>ARTHROPODA</b>													
<i>Amphipoda</i>	23			36	59	0.004		35	35	0.005	94	0.004	
<i>Gammaridae</i>	1,269	17,143	393	1,275	20,080	1.234	56,823	31,773	88,597	12.100	108,676	4.606	
<i>Gammarus sp.</i>	1,992	3,806	1,692	1,728	9,217	0.566	1,175	1,766	2,942	0.402	12,159	0.515	
<i>Gammarus mucronatus</i>				11	11	0.001					11	0.000	
<i>Stenothoidae</i>	27	612	48	149	838	0.051	157		157	0.021	993	0.042	
<i>Parameopelia cypris</i>	11	474	32	11	527	0.032	151	83	234	0.032	761	0.032	
<i>Caprellidae</i>		21		66	87	0.005	11		11	0.001	97	0.004	
<i>Corophidae</i>							34	99	133	0.018	133	0.008	
<i>Corophium sp.</i>	24	1,090		117	1,230	0.076	281	39	321	0.044	1,551	0.066	
<i>Melitidae</i>							43		43	0.006	43	0.002	
<i>Melita nitida</i>		1,059	110	194	1,363	0.084	179	65	243	0.033	1,606	0.068	
<i>Ampeliscidae</i>													
<i>Ampelisca sp.</i>	55	75	180	188	496	0.030	107	20	127	0.017	622	0.026	
<i>Ampelisca abdita</i>	224		74	12	309	0.019					309	0.013	
<i>Aoridae</i>	24				24	0.001	64	95	159	0.022	183	0.008	
<i>Isopoda</i>	12				12	0.001					12	0.001	
<i>Cyathura polita</i>	93	102	19		214	0.013					214	0.009	
<i>Edotea triloba</i>	132	14,863	2,022	1,945	18,961	1.165	282	44	306	0.042	19,267	0.817	
<i>Edotea montosa</i>			21		21	0.001	37	11	48	0.007	69	0.003	
<i>Sphaeroma sp.</i>			11		11	0.001					11	0.000	
<i>Cymothoidae</i>				13	13	0.001					13	0.001	
<b>Cumacea</b>													
<i>Leucon americanus</i>	27,142	4,959	1,987	1,918	36,006	2.213	849	3,611	4,459	0.609	40,465	1.715	
<i>Oxyurostylis smithii</i>		19			19	0.001	140	27	167	0.023	186	0.008	
<i>Copepoda</i>	67,820	539,242	380,042	194,873	1,181,977	72.641	334,845	243,487	578,332	78.987	1,760,309	74.610	
<i>Mysidacea</i>	258	3,967	1,157	1,368	6,750	0.415	1,082	18,226	19,310	2.637	26,060	1.105	
<i>Neomysis americana</i>	5,487	24,964	3,466	11,138	45,055	2.769	12,036	8,578	20,614	2.815	65,670	2.783	
<i>Ostracoda</i>		16	21		37	0.002					37	0.002	
<i>Acar</i>			10	14	23	0.001					23	0.001	
<i>Caridea (Larvae)</i>	7,447	11,658	3,445	3,927	26,477	1.627	3,322	10,758	14,079	1.923	40,556	1.719	
<i>Cranion septempinosus</i>	1,559	12,070	2,574	3,278	19,482	1.197	46	480	526	0.072	20,007	0.848	
<i>Palaemonetes sp.</i>	28	82	25	25	135	0.008	37	57	94	0.013	229	0.010	
<i>Brachyura (Zoea)</i>	653	553	234,348	10,239	245,793	15.106	453	229	682	0.093	246,475	10.447	
<i>Callinectes sapidus</i>	22	145	11		178	0.011		14	14	0.002	193	0.008	
<i>Rhithropanopeus harrisi</i>		49			49	0.003					49	0.002	
<b>MOLLUSCA</b>													
<i>Bivalvia (Larvae)</i>			38	41	79	0.005					79	0.003	
<i>Mytilus edulis</i>							62		62	0.008	62	0.003	
<b>CHAETOGNATHA</b>													
<i>Sagittia sp.</i>	11	144	1,008	107	1,270	0.078	138	87	225	0.031	1,495	0.063	
<b>CHIDARIA (Coelenterata)</b>													
<i>Hydrozoa (Medusa)</i>	549	4,157	4,175	911	9,792	0.602	77	147	224	0.031	10,015	0.424	
<b>CHORDATA</b>													
<i>Molgula manhattensis</i>		198	287	41	525	0.032	13	36	49	0.007	574	0.024	
<b>Total collected</b>	<b>114,894</b>	<b>641,468</b>	<b>637,179</b>	<b>233,619</b>	<b>1,627,160</b>		<b>412,422</b>	<b>319,767</b>	<b>732,189</b>		<b>2,359,349</b>		

Most epibenthic invertebrates were common in both shoal and river areas, including copepods, mysids, and Caridae. Amphipods were more common at the river stations (Table 4-3). Crab larvae were more common at the shoal stations.

Epibenthic invertebrates provide a food source for bottom- and water-column-feeding fishes. Their distribution in Newark Bay is dependent on physical factors (especially tidal currents, freshwater input, temperature, and salinity) as well as time of year. Most were collected in April, followed by high collections in May, June, July, and March.

#### 4.1.3 Ponar Grab

A total of 16,991 benthic invertebrates were collected at shoal and channel stations (Table 4-4). The collections were dominated by *Streblospio benedicti* (51.8%), followed in abundance by *Sabellaria vulgaris* (13.1%), *Scoloplos* sp (9.3%), *Mulinia lateralis* (5.1%), and Paraonidae (4.9%).

Benthic invertebrates were most abundant at channel stations. The two channel stations accounted for 75% of the benthic invertebrates collected. *Streblospio benedicti*, *Sabellaria vulgaris*, Phyllococidae, Oligochaeta, and most Polychaeta were more common at channel stations. *Glycera* sp., *Pectinaria gouldii*, *Nereis succinea*, Paraonidae, *Polydora ligni*, *Scoloplos* sp., *Mulinia lateralis*, *Mya arenaria*, and *Tellina* sp. were common at both shoal and channel stations. March, April, and May were months with highest densities of benthic invertebrates (Appendix E).

#### Other Studies

Few comprehensive studies on the benthic fauna of Newark Bay have been conducted. Ichthyological Associates, Inc. (Anselmini 1974), collected 21 samples in 1972. A total of 52 samples were collected in 1975 (USACE 1980). McCormick and Koepp (1978) collected benthic samples in 1976. In 1984 Cerrato and Bokuniewicz (1985) collected samples from shoal areas near Port Newark Terminal. In June, August, and December 1993 and March 1994, samples were collected seasonally in Newark Bay (NOAA 1995).

Results of earlier studies showed low numbers of species and individuals. A total of 21 samples collected in 1972 contained 13 species and 1031 individuals (Anselmini 1974). In 1973 52 samples contained a total of 11 species and 790 individuals from channel and shoal areas (USACE 1980). Cerrato (1985) reported 68 taxa and NOAA (1995) reported 75 taxa. Sixty-eight taxa were found during this survey.

TABLE 4-4  
BENTHIC INVERTEBRATE TAXA COLLECTED FROM NEWARK BAY,  
ARTHUR KILL, KILL VAN KULL, AREAS 1995-1996

SPECIES COLLECTED	No. Individuals Collected					Bay Total	%	No. Individuals Collected			%	Total All Sites	%
	NSBW (A)	Project Sites NSBW (B)	NSBW	Reference Sites NSBE	NSBE			Channel Sites BBE	Channel Sites BSW	Channel Total			
<b>PHYLLORHYNCHOCOELE</b>													
<i>Nereis</i>	16	7	5	8	21	58	1.50	4	0	4	0.03	80	0.36
<b>ANNELIDA</b>													
<i>Oligochaeta</i>	8	1			3	10	0.23	83	84	167	1.32	177	1.04
<i>Polychaeta</i>	12	13	28	9	16	77	1.78	118	245	363	2.87	440	2.59
<i>Phyllodoce</i>									1	1	0.01	1	0.01
<i>Phyllodoce mucosa</i>									5	5	0.04	5	0.03
<i>Glyceridae</i>									42	18	0.47	133	0.78
<i>Glycera</i> sp.	24	11	9	20	9	73	1.80					5	0.03
<i>Glycera dibranchiata</i>	1	2	1		1	5	0.12					26	0.15
<i>Goniodidae</i>	3	1	1			5	0.12	21		21	0.17		
<i>Pectinariidae</i>													
<i>Pectinaria gouldii</i>	2	2	5	9	8	26	0.60	14	11	26	0.20	51	0.30
<i>Nereidae</i>													
<i>Nereis succinea</i>	8	14	15	3	13	53	1.23	56	23	79	0.62	131	0.77
<i>Ceratonereis</i>	12					12	0.28	17	17	17	0.13	29	0.17
<i>Firminidae</i>	45	38	158	38	31	308	7.13	418	102	521	4.11	829	4.88
<i>Spionidae</i>													
<i>Scotolepis viridis</i>		1	1		1	3	0.07	27	15	42	0.33	46	0.28
<i>Streblospio benedicti</i>	105	268	442	181	73	1,049	24.27	3,703	4,065	7,768	61.24	8,807	61.83
<i>Polydora ligni</i>	17	5	8	38	3	68	1.80	37	55	95	0.73	162	0.86
<i>Spiophanes bombyx</i>								1		1	0.01	1	0.01
<i>Orbinidae</i>													
<i>Scaloplos</i> sp.	287	464	198	167	147	1,261	28.18	128	186	315	2.48	1,576	9.28
<i>Sabellariidae</i>													
<i>Sabellaria vulgaris</i>								2,221	5	2,226	17.57	2,226	13.10
<i>Oruphidae</i>													
<i>Diopatra cuprea</i>								10	13	23	0.18	23	0.14
<i>Eunicidae</i>									19	19	0.16	19	0.11
<i>Eunice norvegica</i>													
<i>Nephtys</i>													
<i>Nephtys</i> sp.								1		1	0.01	1	0.01
<i>Caprellidae</i>													
<i>Caprella capitata</i>	1					1	0.02	8	8	16	0.05	7	0.04
<i>Ampharetidae</i>				2		2	0.05	12	12	12	0.09	14	0.09
<i>Hypenioides grayi</i>								1	1	1	0.01	1	0.01
<i>Sabellidae</i>													
<i>Sabella</i> sp.					1	1	0.02	7	7	14	0.06	8	0.06
<i>Sabella microphthalma</i>								3	3	6	0.02	3	0.02
<i>Cirratulidae</i>				2		2	0.06					2	0.01
<i>Hesionidae</i>													
<i>Podarke</i> sp.								2		2	0.02	2	0.01
<i>Polynoidae</i>													
<i>Lapidonotus squamatus</i>								2		2	0.02	2	0.01
<b>MOLLUSCA</b>													
<i>Bivalvia</i>													
<i>Macoma mercenaria</i>								1		1	0.01	1	0.01
<i>Mya arenaria</i>	55	86	83	4	8	198	4.53	128	107	233	1.84	429	2.52
<i>Mulinia lateralis</i>	7	8	50	85	531	681	15.76	137	43	180	1.42	961	5.07
<i>Tellina</i> sp.	8	21	4	10	10	51	1.18	14	3	17	0.13	68	0.40
<i>Lionia hysalina</i>		1				1	0.02					1	0.01
<i>Mytilus edulis</i>								2	2	4	0.02	2	0.01
<i>Mecoma</i> sp.								2	2	4	0.02	2	0.01
<i>Gastropoda</i>													
<i>Crepidula fornicata</i>								4		4	0.03	4	0.02
<i>Crepidula plana</i>								12	12	12	0.09	12	0.07
<i>Retusa</i> sp.				1		1	0.02					1	0.01
<i>Haminoea solitaria</i>		2	10	1	1	14	0.32		1	1	0.01	16	0.09
<i>Epitonium</i> sp.								1		1	0.01	1	0.01
<b>ARTHROPODA</b>													
<i>Isopoda</i>													
<i>Cyathura polita</i>	45	73	30	50	58	254	5.88	8	3	9	0.07	283	1.55
<i>Edotea triloba</i>			2		2	4	0.09	28	35	64	0.51	68	0.40
<i>Limnoria ligonum</i>								2	1	3	0.02	3	0.02
<i>Cumacea</i>													
<i>Leucon americanus</i>	13		24	10	1	48	1.11	15	40	56	0.43	103	0.61
<i>Oxyuroides smithii</i>									4	4	0.03	4	0.02
<i>Amphipoda</i>					3	4	0.09	49	49	49	0.39	53	0.31
<i>Ampelisca</i> sp.	2		1	2		5	0.12	3		3	0.02	3	0.02
<i>Ampelisca abdita</i>	2	4		16	1	22	0.51	5	11	16	0.13	5	0.03
<i>Corophidae</i>									8	8	0.06	8	0.04
<i>Corophium</i> Sp.								22	1	23	0.18	23	0.14
<i>Gammaridae</i>								40	3	43	0.34	43	0.25
<i>Gammarus</i> sp.	1	1	2	4		8	0.19	1	2	3	0.02	11	0.06
<i>Gammarus mucronatus</i>				2		2	0.05					2	0.01
<i>Aoridae</i>								107		107	0.84	107	0.63
<i>Unciola dilatata</i>					1	1	0.02					1	0.01
<i>Melidae</i>													
<i>Mella</i> sp.								4		4	0.03	4	0.02
<i>Mella rubra</i>								13	2	15	0.12	15	0.09
<i>Thoronidae</i>													
<i>Balanus</i> sp.					2	2	0.05	1	8	9	0.07	11	0.06
<i>Caridea</i>													
<i>Chironomus septempinosus</i>		2			1	3	0.07	2	2	4	0.03	7	0.04
<i>Braconidae</i>													
<i>Callinectes sapidus</i>			2			2	0.06	1		1	0.01	3	0.02
<i>Xanthidae</i>								4	4	4	0.03	4	0.02
<i>Rhithropanopeus harrisi</i>					3	3	0.07	2	2	4	0.02	6	0.03
<i>Neopanope laxana sayi</i>								1	1	1	0.01	1	0.01
<i>Europopanope depressus</i>								1	1	1	0.01	1	0.01
<b>CHORDATA</b>													
<i>Molgula manhattensis</i>			5	1	1	7	0.16	5	11	16	0.13	23	0.14
<b>Total</b>	<b>680</b>	<b>1,005</b>	<b>1,080</b>	<b>628</b>	<b>949</b>	<b>4,322</b>	<b>100.00</b>	<b>7,536</b>	<b>5,133</b>	<b>12,669</b>	<b>100.00</b>	<b>16,991</b>	<b>100.00</b>

In the three most recent studies, only four species were considered common in all three surveys and were ranked as having high dominance. Sixteen species were considered common in one of the three surveys and were ranked as having low dominance (see table below).

**OCCURRENCE AND LISTING OF COMMON BENTHIC ORGANISMS  
COLLECTED IN NEWARK BAY**

Species	Present Study <sup>a</sup>	NOAA (1995) <sup>b</sup>	Cerrato (1985) <sup>c</sup>	Overall Ranking <sup>d</sup>
<i>Sireblospio benedicti</i>	1	1	x	3
<i>Sabellaria vulgaris</i>	2	12	x	3
<i>Scoloplos sp.</i>	3			1
<i>Mulinia lateralis</i>	4	7		2
<i>Paraonidae</i>	5			1
<i>Phyllodoceidae</i>	6			1
<i>Mya arenaria</i>	7	10	x	3
<i>Cyathura polita</i>	8			1
<i>Ohgochaeta</i>	9	6	x	3
<i>Polydora ligni</i>	10		x	2
<i>Tharyx sp.</i>		2		1
<i>Leitoscoloplos robustus</i>		3		1
<i>Leucon americanus</i>		4		1
<i>Mediomastus ambiseta</i>		5		1
<i>Odostomia sp.</i>		8		1
<i>Polydora cornuta</i>		9		1
<i>Unicola serrata</i>		11		1
<i>Nereis succinea</i>			x	1
<i>Scolecopides viridis</i>			x	1
<i>Spio setosa</i>			x	1
<i>Balanus improvisus</i>			x	1
<i>Molgula manhattensis</i>			x	1

<sup>a</sup>1 = most common, 10 = least common.

<sup>b</sup>1 = most common, 12 = least common.

<sup>c</sup>Cerrato (1985) did not indicate the relative dominance of individual species; therefore, the "x's" in this column indicate that species were dominant but do not indicate their degree of dominance.

<sup>d</sup>Ranking:

1 = Low dominance

2 = Moderate dominance

3 = High dominance

Except for the four species that predominated in all three of the most recent studies, most species show shifts in abundance. In general, all benthic sampling programs indicate the dominance of polychaete worms.

Overall, the benthic community of Newark Bay is similar to the soft sediment benthic community found throughout the New York/New Jersey Harbor complex. Seasonal patterns in species composition and abundance follow expected patterns related to growth, maturation, and reproduction. Based on the information available from the current benthic sampling program and the information from the 1985 and 1993-1994 surveys, the Newark Bay benthic community exhibits relatively low species diversity, moderate to low abundance levels, and dominance by polychaete worms capable of tolerating marginal environmental conditions.

#### 4.1.4 Wildlife Observations

Several wildlife species were observed during the study (Table 4-5). Gulls, including herring ring-billed, and great black-backed gulls, were the most commonly observed group. Cormorants were also commonly observed during the surveys resting or foraging in the Bay or flying over the area. Winter observations provided the highest number of species. In addition to gulls and cormorants, several species of waterfowl were observed, including red-breasted mergansers, mallards, gadwall, American wigeon, buffleheads, brant, and Canada geese. Mallards and Canada geese were observed during the breeding season with young and presumably had nested nearby. The buffleheads were observed in small flocks of 10 to 20 birds moving about the Bay and rafting in the protected shoal areas during late fall and winter.

Observations of wildlife made during the year-long study were typical of the wildlife expected to occur on the waters of Newark Bay, the Kill Van Kull, and Arthur Kill. The available habitat in the project area and at the reference stations is suitable for a variety of waterfowl, gulls, and cormorants. The shallow waters (<5 m [ $<16.4$  ft] deep), protected nearshore waters, and adequate food sources (including fish, shellfish, marine worms, and other invertebrates) provide good habitat for waterfowl, gulls, terns, and cormorants.

The protected open-water shoal areas are used by gulls, waterfowl, and cormorants for roosting and foraging. Gulls use the area year-round; waterfowl mostly overwinter in this type of habitat but move around the entire New York/New Jersey Estuary in search of suitable foraging and roosting/resting sites. Other species that may use the project area and adjacent areas include herons and egrets, which could forage along the shoreline in shallow waters, and terns, which could forage over the site for fish (bay anchovy). Least terns were

Table 4-5

## Incidental Wildlife Observations

Common Name	Scientific Name	Seasonal Observations			Area Wide Count
		Spring	Summer	Fall	
<b>Birds</b>					
Great egret	<i>Casmerodius albus</i>	x			
Double-crested cormorant	<i>Phalacrocorax auritus</i>	x	x	x	1
Great cormorant	<i>Phalacrocorax carbo</i>				6
Brant goose	<i>Branta bernicla</i>				75
Canada goose	<i>Branta canadensis</i>		x	x	15
Mallard	<i>Anas platyrhynchos</i>		x	x	8
Black duck	<i>Anas rubripes</i>			x	
Gadwall	<i>Anas strepera</i>				1
Canvasback	<i>Aythya valisineria</i>				150
American wigeon	<i>Anas americana</i>				15
Bufflehead	<i>Bucephala albeola</i>			x	46
Red-breasted merganser	<i>Mergus serrator</i>				6
Peregrine falcon	<i>Falco peregrinus</i>				2
Great black-backed gull	<i>Larus marinus</i>	x	x	x	62
Herring gull	<i>Larus argentatus</i>	x	x	x	239
Ring-billed gull	<i>Larus delawarensis</i>	x	x	x	133
Laughing gull	<i>Larus atricilla</i>		x	x	
UID gull	<i>Larus spp.</i>	x	x	x	300
Rock dove	<i>Columba livia</i>				51
American crow	<i>Corvus brachyrhynchos</i>				2
European starling	<i>Sturnus vulgaris</i>				100

x = with young

reported nesting in Port Newark (10 pairs) during 1977 (Erwin and Korschgen 1979); they have not been reported since (Breden, pers. commun., 1995).

The northern diamondback terrapin is common in the Hackensack Meadowlands (Wood 1995) and may migrate through and forage in Newark Bay but there are no reported sightings from Newark Bay. Herons and egrets nest south of Newark Bay. Individuals move north to feeding areas, flying over Newark Bay (Parsons 1994).

## **4.2 WATER QUALITY/PHYSICAL-CHEMICAL PROGRAM**

### **4.2.1 Temperature**

Newark Bay shoal and channel area temperatures followed typical seasonal patterns for northern temperate waters. Temperatures of around 24°C were recorded from the end of June to the end of August (Table 4-6; Figure 4-5 a to d). Following the summer high, temperatures rapidly dropped during the fall to lows around 1.5°C from the end of December through January, with a slight increase to nearly 4.5°C at the end of February and back down to 3°C at the end of March. The spring temperatures rapidly increased from 3 to 24°C by June.

### **4.2.2 Dissolved Oxygen**

Newark Bay shoal area DO levels followed typical seasonal patterns, with lows of 5-7 mg/l during the warmwater summer period and peaks of 10 to 13.5 mg/l during the cold-water winter period (Table 4-7; Figure 4-5 a to d). Channel stations followed, with lows of 4-6 mg/l during the summer and peaks of 10-13 mg/l during the winter. The lowest values of 4.1 to 4.3 mg/l were found at the channel stations on 12 July 1995; low values for Newark Bay were 4.5 to 4.9 mg/l, also on 12 July 1995. Newark Bay, Arthur Kill, and Kill Van Kull waters are designated Class SE3 by NJDEP; DO values are not to fall below 3.0 mg/l at any time for waters so classified. Newark Bay shoal and channel areas met these standards throughout the year. Seasonal highs recorded on 30 January 1996 at both channel and shoal areas were 12.3 to 12.9 mg/l at the channel stations and 12.9 to 14.4 mg/l at Bay stations.

### **4.2.3 Salinity**

Newark Bay salinity fluctuated seasonally, with a high of 21 ppt recorded in December and a low of 3 ppt recorded in January (Table 4-8; Figure 4-5 a to d). Salinity dropped to 13 ppt in July and increased to 20 and 20.5 ppt during August and September, respectively.

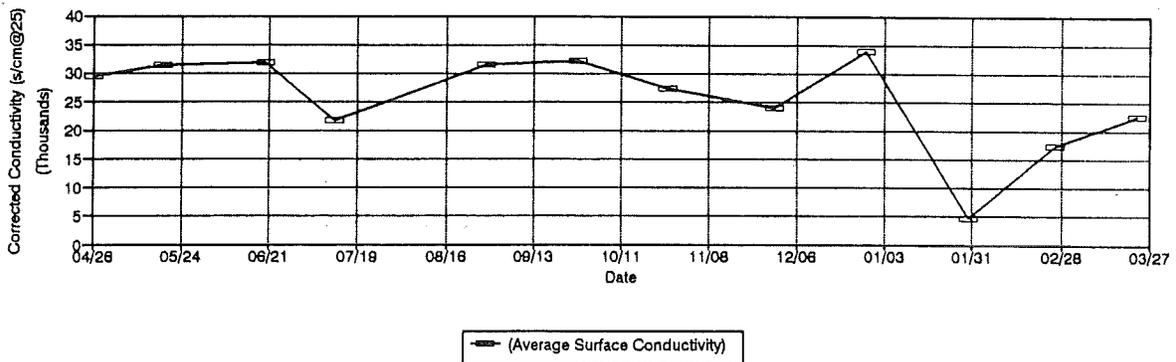
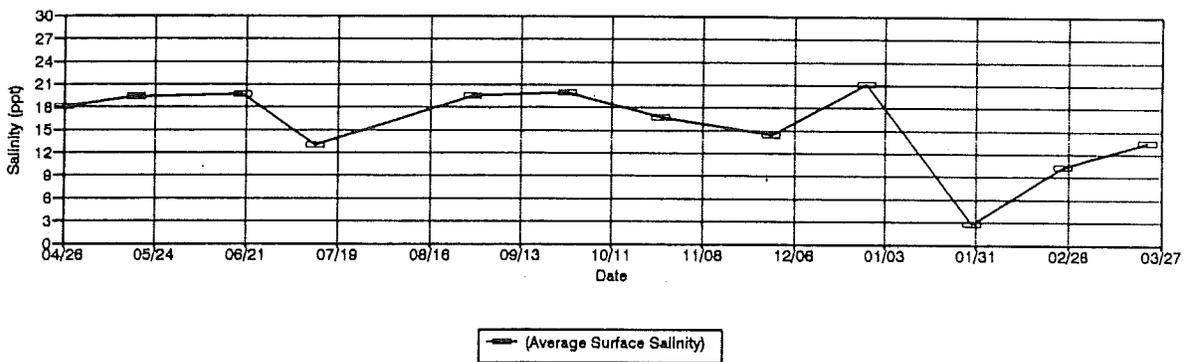
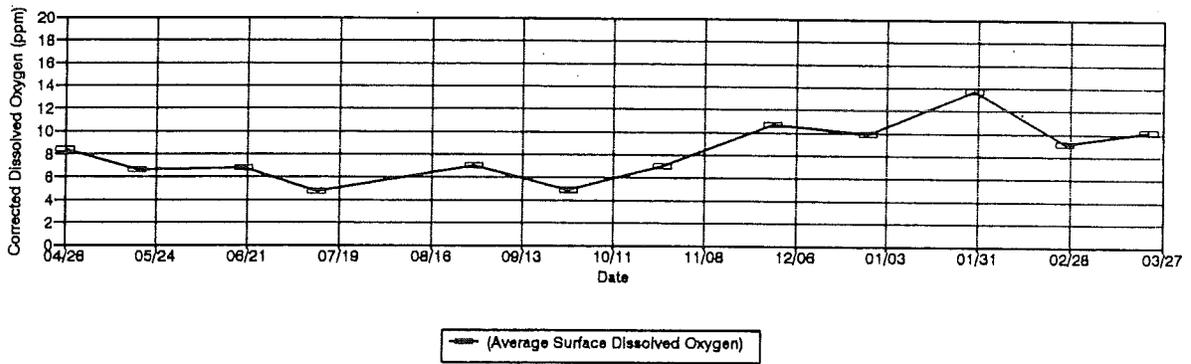
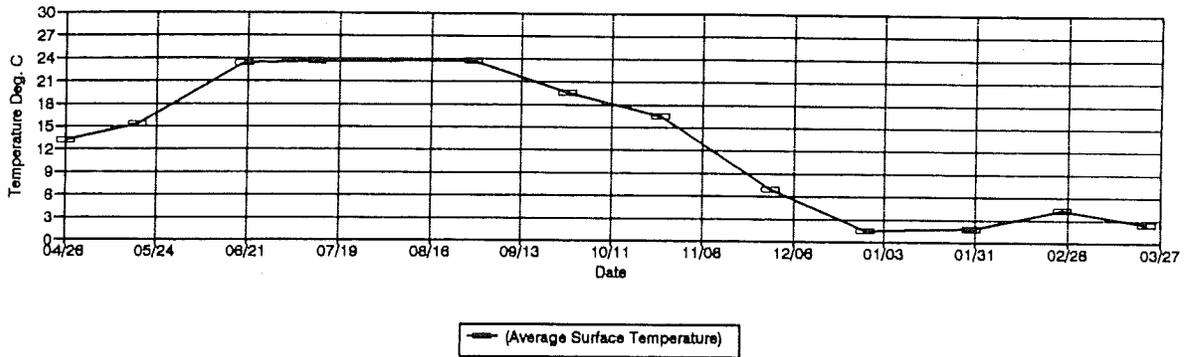
Table 4-6

**Newark Bay Aquatic Sampling Studies 1995-1996**  
*Temperature (Deg. C)*

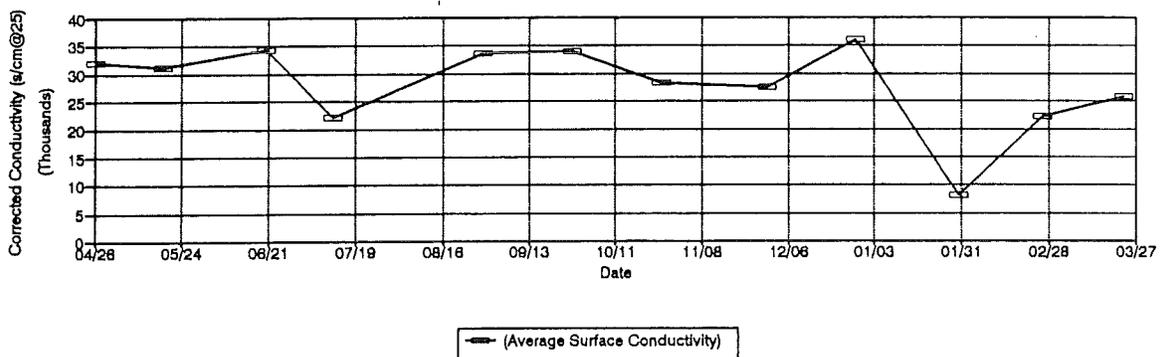
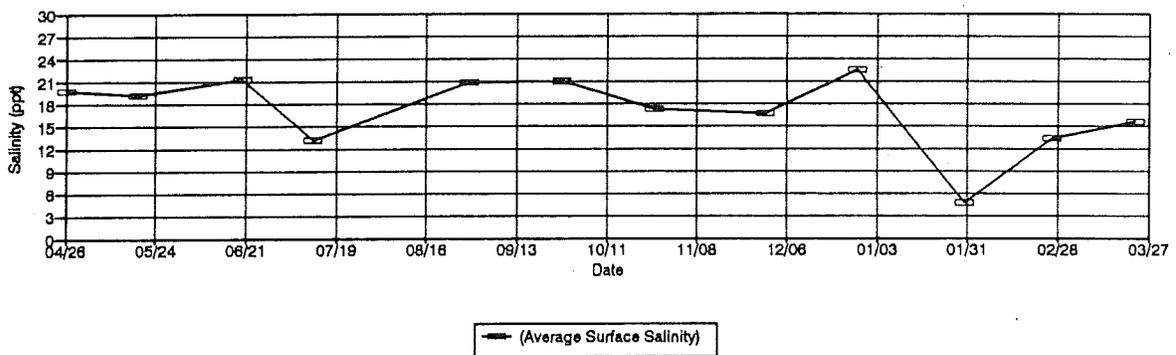
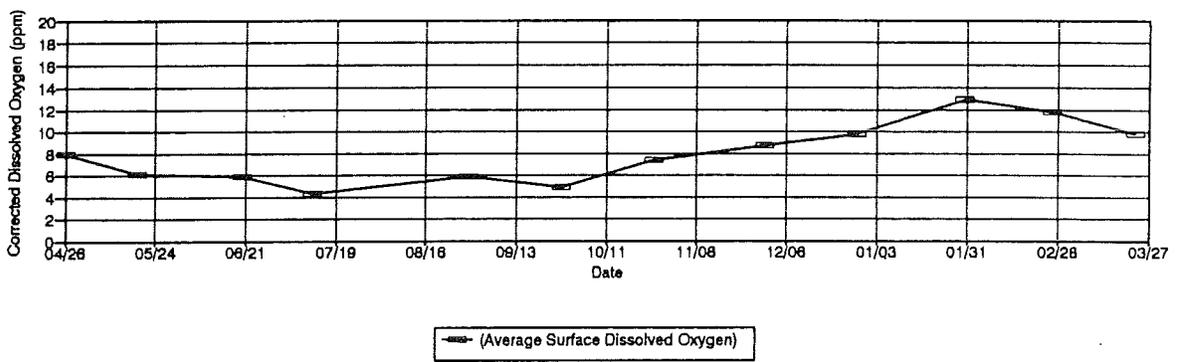
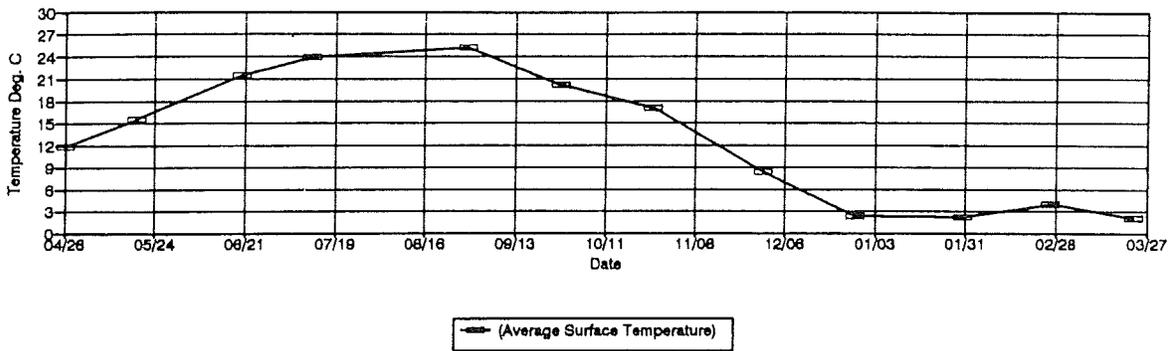
Date	Depth	Project Sites		Reference Sites		Newark Bay	Channel Sites		Channel Sites
		NBSW	NBNW	NBSE	NBNE	Average	BB	GBW	Average
26-Apr-95	Surface	12.3	12.4	13.7	14.2	13.2	11.5	12.2	11.9
26-Apr-95	Bottom	12.2	12.0	12.9	14.2	12.8	11.1	12.1	11.6
18-May-95	Surface	15.5	14.5	15.5	15.8	15.3	15.0	16.1	15.6
18-May-95	Bottom	14.5	14.0	15.0	15.0	14.6	14.5	15.2	14.9
20-Jun-95	Surface	22.0	21.9	24.5	25.0	23.4	21.0	22.0	21.5
20-Jun-95	Bottom	22.0	22.0	23.0	24.0	22.8	20.5	22.0	21.3
12-Jul-95	Surface	23.2	23.2	24.1	23.7	23.6	23.4	24.4	23.9
12-Jul-95	Bottom	23.3	23.1	23.9	23.5	23.5	23.4	24.1	23.8
29-Aug-95	Surface	23.9	23.9	23.7	23.2	23.7	24.6	25.8	25.2
29-Aug-95	Bottom	23.9	24.0	23.8	23.0	23.7	23.6	25.7	24.7
27-Sep-95	Surface	19.4	19.8	19.8	19.2	19.6	19.9	20.4	20.2
27-Sep-95	Bottom	19.5	19.7	19.8	19.2	19.6	19.8	20.3	20.1
26-Oct-95	Surface	16.3	16.9	16.2	16.6	16.5	16.8	17.1	17.0
26-Oct-95	Bottom	16.4	16.6	16.1	16.3	16.4	16.6	17.0	16.8
29-Nov-95	Surface	7.8	7.9	6.3	5.9	7.0	8.3	8.5	8.4
29-Nov-95	Bottom	7.8	8.4	7.5	6.7	7.6	8.7	8.6	8.7
28-Dec-95	Surface	1.7	2.0	0.8	1.6	1.5	2.2	2.5	2.4
28-Dec-95	Bottom	1.7	2.0	0.8	1.5	1.5	2.4	3.0	2.7
30-Jan-96	Surface	1.8	1.7	1.9	1.9	1.8	2.0	2.4	2.2
30-Jan-96	Bottom	1.8	2.1	1.8	1.9	1.9	1.6	2.1	1.9
26-Feb-96	Surface	4.4	3.9	NC	4.6	3.2	3.5	4.4	4.0
26-Feb-96	Bottom	3.3	3.3	NC	4.6	2.8	3.2	3.7	3.5
23-Mar-96	Surface	2.6	1.9	3.3	2.0	2.5	1.9	2.2	2.1
23-Mar-96	Bottom	2.1	1.8	3.2	1.8	2.2	1.9	1.7	1.8

NC - Not Collected

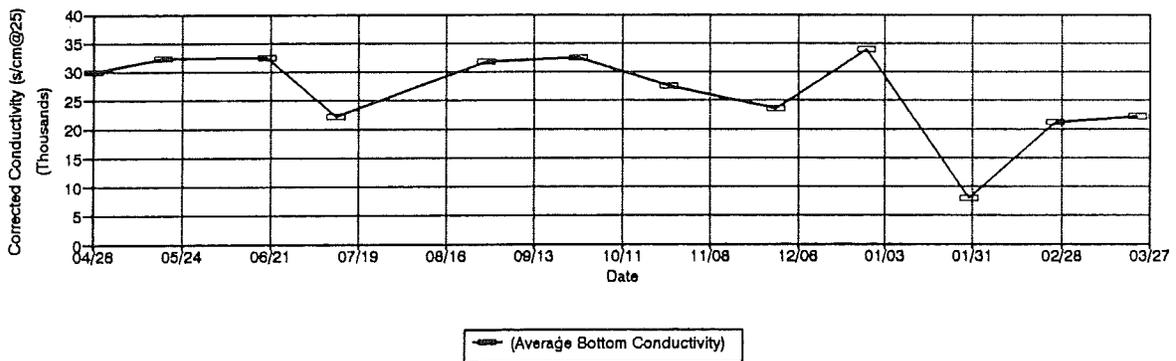
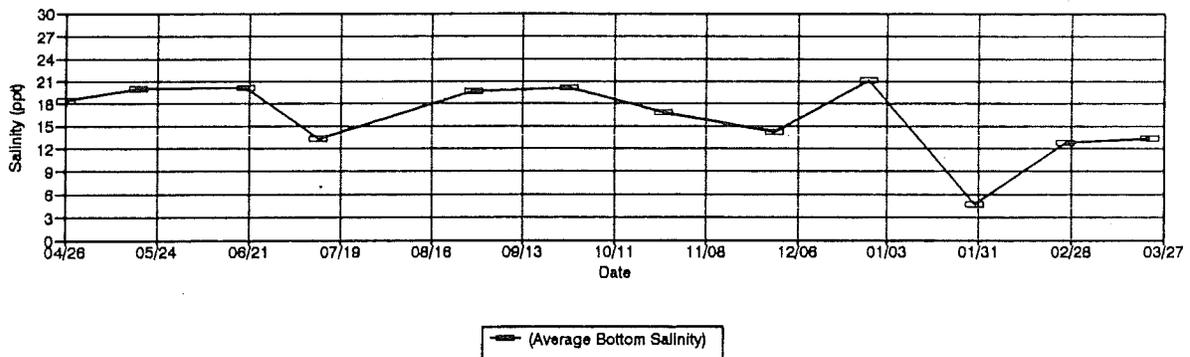
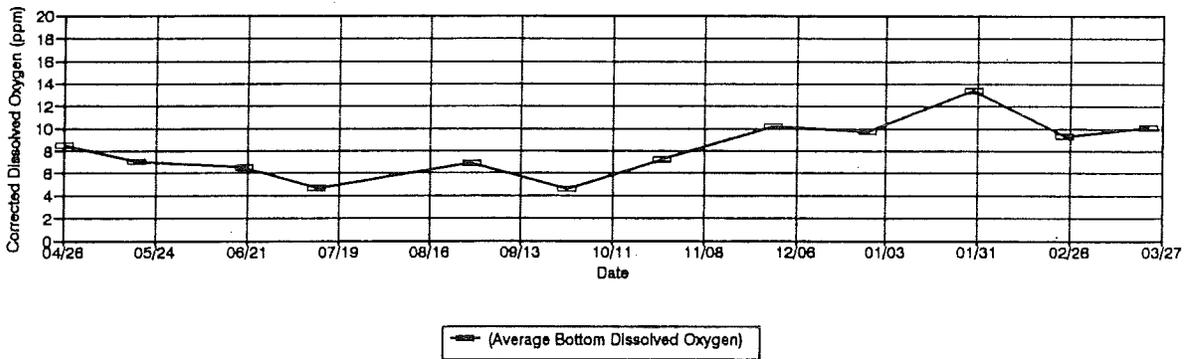
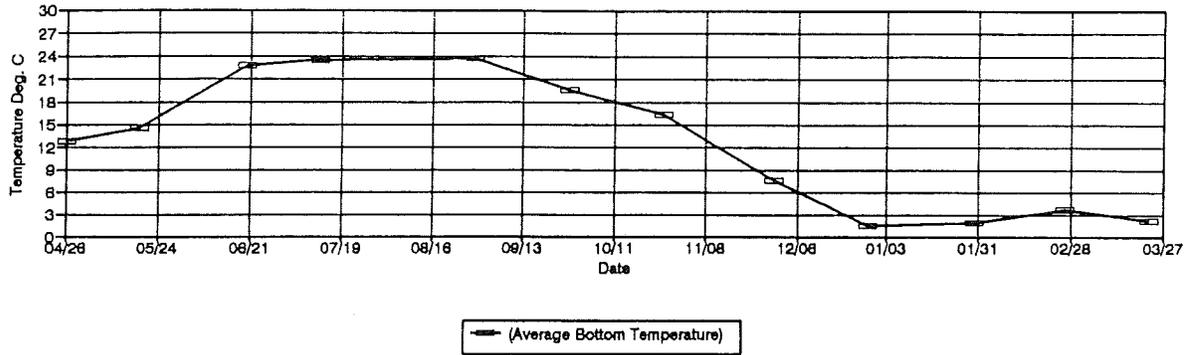
**FIGURE 4-5a**  
**Newark Bay Aquatic Sampling Studies**  
**1995-1996**



**FIGURE 4-5b**  
**Channel Sites Aquatic Sampling Studies**  
**1995-1996**



**FIGURE 4-5c**  
**Newark Bay Aquatic Sampling Studies**  
**1995-1996**



**FIGURE 4-5d**  
**Channel Sites Aquatic Sampling Studies**  
**1995-1996**

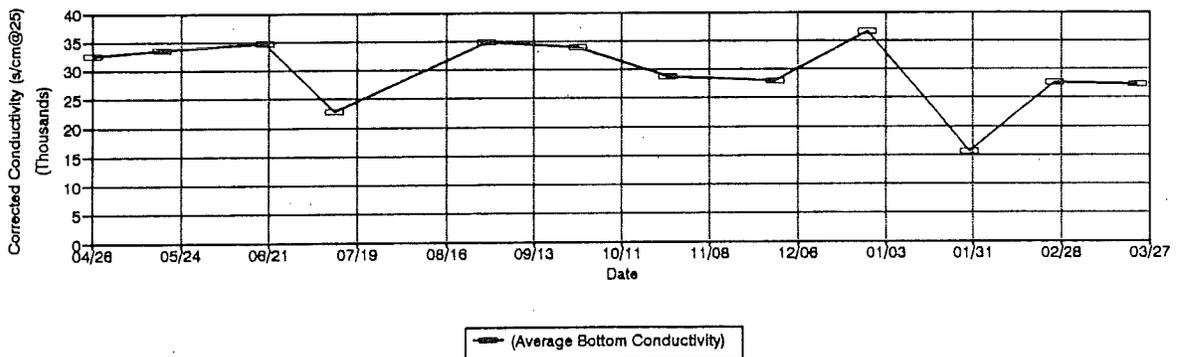
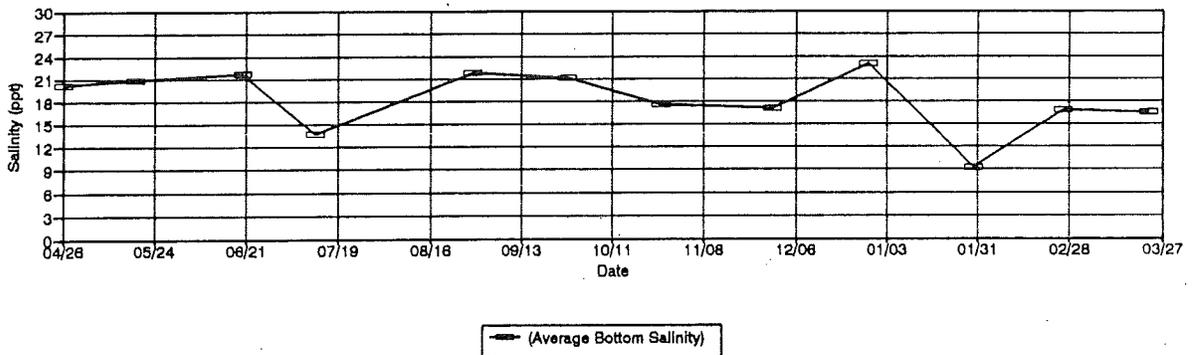
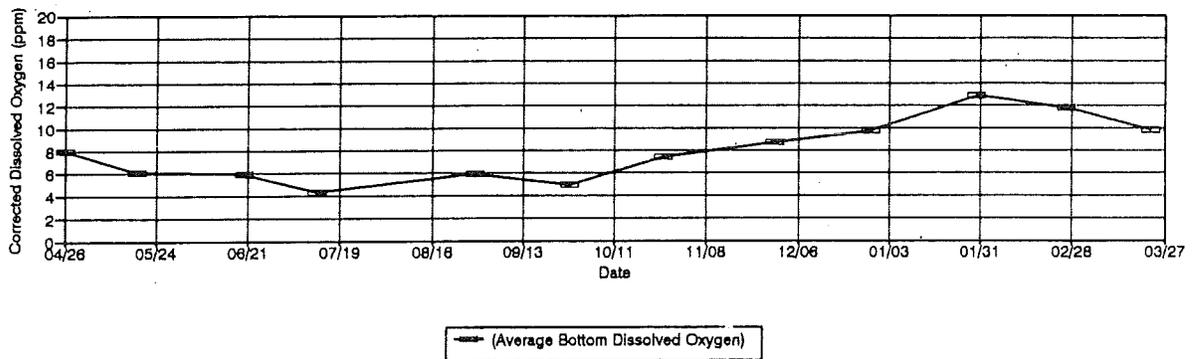
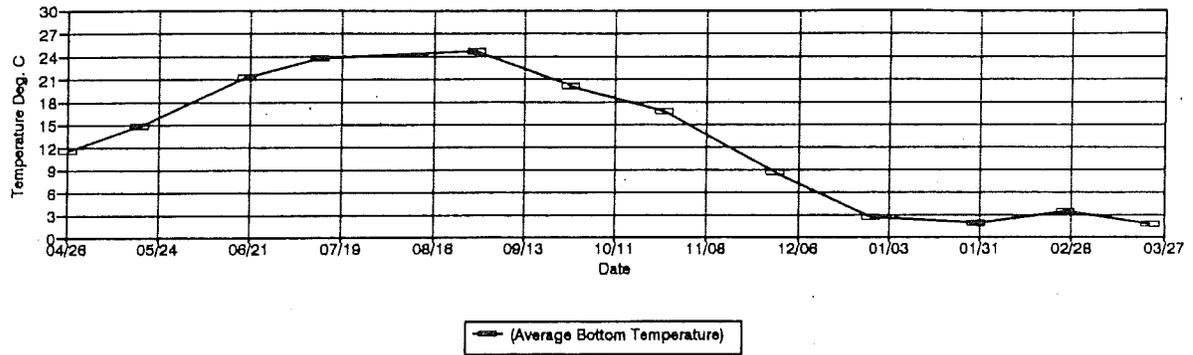


Table 4-7

## Newark Bay Aquatic Sampling Studies 1995-1996

*Dissolved Oxygen (mg/l)*

Date	Depth	Project Sites		Reference Sites		Newark Bay	Channel Sites		Channel Sites
		NBSW	NBNW	NBSE	NBNE	Average	BB	GBW	Average
26-Apr-95	Surface	8.2	8.4	8.7	8.3	8.4	10.0	5.9	8.0
26-Apr-95	Bottom	8.4	8.5	8.7	8.3	8.5	10.0	6.0	8.0
18-May-95	Surface	7.0	6.4	6.6	6.5	6.6	6.5	5.7	6.1
18-May-95	Bottom	7.5	6.7	7.2	6.8	7.0	7.0	6.1	6.5
20-Jun-95	Surface	6.4	5.0	8.1	7.8	6.8	5.9	6.0	5.9
20-Jun-95	Bottom	6.8	4.9	6.8	7.4	6.5	6.9	6.3	6.6
12-Jul-95	Surface	4.7	4.9	4.9	4.7	4.8	4.3	4.3	4.3
12-Jul-95	Bottom	4.5	4.7	4.7	4.8	4.7	4.3	4.1	4.2
29-Aug-95	Surface	6.5	6.1	7.0	8.2	7.0	6.5	5.4	5.9
29-Aug-95	Bottom	6.3	6.1	6.4	8.6	6.9	6.1	5.7	5.9
27-Sep-95	Surface	4.6	4.9	5.1	4.8	4.9	5.1	4.8	4.9
27-Sep-95	Bottom	4.5	4.5	5.0	4.5	4.6	4.9	4.6	4.8
26-Oct-95	Surface	6.7	6.8	6.8	7.8	7.0	7.4	7.4	7.4
26-Oct-95	Bottom	6.4	7.0	6.9	8.6	7.2	7.8	8.5	8.1
29-Nov-95	Surface	10.8	10.2	10.7	11.0	10.7	8.5	8.8	8.7
29-Nov-95	Bottom	10.8	10.0	9.8	10.2	10.2	9.5	10.6	10.0
28-Dec-95	Surface	9.7	9.7	10.5	9.6	9.9	10.1	9.4	9.8
28-Dec-95	Bottom	9.5	9.1	10.4	9.9	9.7	9.9	9.5	9.7
30-Jan-96	Surface	13.6	14.4	12.9	13.7	13.7	12.8	12.9	12.9
30-Jan-96	Bottom	13.6	12.9	13.3	13.7	13.4	12.9	12.3	12.6
26-Feb-96	Surface	12.4	12.1	NC	11.8	9.1	11.2	12.3	11.8
26-Feb-96	Bottom	12.5	12.8	NC	11.8	9.3	11.7	12.2	12.0
23-Mar-96	Surface	9.9	9.7	10.8	10.3	10.2	9.8	9.8	9.8
23-Mar-96	Bottom	9.9	9.8	10.9	9.7	10.1	9.8	9.8	9.8

NC - Not Collected

**Table 4-8**  
**Newark Bay Aquatic Sampling Studies 1995-1996**  
*Salinity (ppt)*

Date	Depth	Project Sites		Reference Sites		Newark Bay	Channel Sites		Channel Sites
		NBSW	NBNW	NBSE	NBNE	Average	BB	GBW	Average
26-Apr-95	Surface	19.1	18.6	18.0	16.9	18.1	20.0	19.6	19.8
26-Apr-95	Bottom	18.7	19.7	18.3	16.9	18.4	20.7	19.7	20.2
18-May-95	Surface	18.9	20.6	19.4	18.6	19.4	20.7	17.7	19.2
18-May-95	Bottom	20.1	20.9	19.7	19.4	20.0	21.8	19.9	20.9
20-Jun-95	Surface	19.6	20.4	20.1	18.7	19.7	21.6	21.1	21.3
20-Jun-95	Bottom	19.6	20.7	20.6	19.5	20.1	22.2	21.1	21.7
12-Jul-95	Surface	13.0	14.3	12.4	12.2	13.0	13.3	13.2	13.2
12-Jul-95	Bottom	13.3	14.4	12.9	12.4	13.3	13.9	13.4	13.7
29-Aug-95	Surface	15.4	20.9	20.3	21.3	19.4	21.3	20.4	20.9
29-Aug-95	Bottom	15.4	20.9	21.0	21.3	19.6	22.4	21.2	21.8
27-Sep-95	Surface	19.3	20.7	19.9	19.8	19.9	21.8	20.4	21.1
27-Sep-95	Bottom	19.7	21.1	19.9	19.8	20.1	21.8	20.4	21.1
26-Oct-95	Surface	17.2	16.5	16.4	16.7	16.7	17.4	17.2	17.3
26-Oct-95	Bottom	17.1	16.7	16.5	16.8	16.8	17.5	17.7	17.6
29-Nov-95	Surface	14.3	15.4	13.9	14.1	14.5	17.0	16.4	16.7
29-Nov-95	Bottom	14.4	15.1	13.4	13.7	14.2	17.3	16.8	17.1
28-Dec-95	Surface	21.3	22.3	20.8	20.1	21.1	23.0	22.1	22.6
28-Dec-95	Bottom	21.2	22.4	20.5	20.3	21.1	23.9	22.1	23.0
30-Jan-96	Surface	3.1	2.6	2.8	2.3	2.7	5.1	4.2	4.7
30-Jan-96	Bottom	3.1	9.9	3.3	2.4	4.6	6.8	11.6	9.2
26-Feb-96	Surface	11.2	12.5	NC	7.1	7.9	13.4	13.3	13.4
26-Feb-96	Bottom	15.5	15.5	NC	7.1	9.6	18.4	15.3	16.8
23-Mar-96	Surface	14.7	15.7	12.2	11.4	13.5	15.1	16.1	15.6
23-Mar-96	Bottom	15.0	15.8	11.2	11.5	13.3	15.7	17.4	16.5

NC - Not Collected

Salinities then decreased through the fall to 14.5 ppt by the end of November. Salinities then increased, with a peak of 21 ppt in December, falling off to 3 ppt by the end of January then increasing through February and March to a high of 13.5 ppt at the end of March. Conductivity is included in Table 4-9 and Figure 4-5 a to d. Conductivity followed the same pattern as salinity; the two are directly related. Channel stations followed a similar pattern, with a high of 22.5 s/cm @ 25°C recorded in December and a low of 4.5 s/cm @ 25°C recorded in January. In general, channel station salinities and conductivities were slightly higher overall than the Bay values. Slight differences are due to influence of fresh water from the Passaic and Hackensack rivers.

### **4.3 Literature Search**

#### **4.3.1 Biological Literature**

Over 40 biological studies covering the lower Hudson River Estuary and Newark Bay Estuary have been conducted since the 1970s and reported in the literature (Tables 4-10 and 4-11). Of the reported studies, 90% included information on fish population, 50% included information on benthos, and 17% included information on zooplankton and phytoplankton. Most studies reported some water quality sampling results, including water temperature, DO, and salinity/conductivity. Only 13 of the studies included Newark Bay, while 33 included the Hudson River and lower New York Harbor area. Studies that focused on Newark Bay are summarized in Table 4-11. Over 20 studies included information on water quality, sediment quality, and pollution of Newark Bay. Of these, eight included contamination in biota, mostly benthic organisms such as clams and crabs, and one included fish; these nine are included in Table 4-11.

Newark Bay has been relatively understudied compared to the Hudson River and New York Bight. Few studies were conducted in the Bay prior to the 1970s; 316(b) studies for Public Service Electric & Gas (PSE&G) were conducted in the early 1970s and one USACE study was conducted in the mid-1970s. Several studies were conducted in the mid to late 1980s. Recently, the Bay has received more attention, although much of this work has focused on the dredged channels of the Bay. The Newark Bay studies for the most part avoided the very shallow areas sampled during this study. Studies on contaminants in the Bay, primarily organic pollutants (including dioxin, PCBs and PAHs), have increased in recent years, with several papers published in the 1990s.

Four comprehensive biological surveys - Will and Houston (1988), USACE (1987), NOAA (1995), and Hagerty (1972) - were conducted in Newark Bay prior to this survey. The data

Table 4-9

## Newark Bay Aquatic Sampling Studies 1995-1996

Conductivity (s/cm@25)

Date	Depth	Project Sites		Reference Sites		Newark Bay	Channel Sites		Channel Sites
		NBSW	NBNW	NBSE	NBNE	Average	BB	GBW	Average
26-Apr-95	Surface	31,026	30,289	29,330	27,718	29,591	32,338	31,766	32,052
26-Apr-95	Bottom	30,443	31,928	29,913	27,718	30,000	33,356	31,847	32,601
18-May-95	Surface	30,786	33,273	31,519	30,329	31,477	33,375	28,915	31,145
18-May-95	Bottom	32,522	33,675	31,891	31,520	32,402	35,024	32,233	33,629
20-Jun-95	Surface	31,823	32,951	32,510	30,500	31,946	34,647	33,945	34,296
20-Jun-95	Bottom	31,823	33,415	33,271	31,604	32,528	35,556	33,945	34,751
12-Jul-95	Surface	21,748	23,819	20,859	20,509	21,734	22,178	22,053	22,115
12-Jul-95	Bottom	22,222	23,970	21,655	20,796	22,161	23,209	22,385	22,797
29-Aug-95	Surface	25,537	33,708	32,815	34,175	31,559	34,262	32,996	33,629
29-Aug-95	Bottom	25,537	33,643	33,774	34,311	31,816	35,756	34,045	34,900
27-Sep-95	Surface	31,354	33,308	32,198	32,051	32,228	34,900	32,890	33,895
27-Sep-95	Bottom	31,845	33,935	32,198	32,051	32,507	34,974	32,959	33,966
26-Oct-95	Surface	28,183	27,210	27,046	27,395	27,458	28,457	28,265	28,361
26-Oct-95	Bottom	28,119	27,395	27,108	27,584	27,551	28,586	28,919	28,753
29-Nov-95	Surface	23,828	25,542	23,179	23,458	24,002	27,899	27,013	27,456
29-Nov-95	Bottom	23,977	25,039	22,381	22,907	23,576	28,315	27,666	27,991
28-Dec-95	Surface	34,236	35,670	33,471	32,546	33,981	36,668	35,423	36,046
28-Dec-95	Bottom	34,056	35,848	33,099	32,840	33,961	38,005	35,357	36,681
30-Jan-96	Surface	5,387	4,505	5,011	4,027	4,732	8,917	7,390	8,154
30-Jan-96	Bottom	5,387	16,886	5,836	4,206	8,079	11,753	19,552	15,652
26-Feb-96	Surface	18,960	20,938	NC	12,288	13,047	22,398	22,257	22,327
26-Feb-96	Bottom	25,618	25,618	NC	12,288	15,881	29,985	25,288	27,637
23-Mar-96	Surface	24,469	25,949	20,494	19,262	22,543	25,054	26,571	25,813
23-Mar-96	Bottom	24,884	26,038	18,848	19,394	22,291	25,949	28,470	27,209

NC - Not Collected

TABLE 4-10 (Page 1 of 2)

SUMMARY OF MAJOR BIOLOGICAL STUDIES CONDUCTED ON THE LOWER HUDSON RIVER ESTUARY

STUDY	DATES ENCOMPASSING FIELD WORK	GEOGRAPHIC AREA COVERED	MAJOR ORGANISM GROUPS STUDIED
1. Ristich, S.S., et al.	May - Oct 1972	Hudson River, Upper New York Bay (included 48 sites north of the George Washington Bridge to Poughkeepsie area)	Benthos
2. QLM (LMS) for Consolidated Edison Co. of New York, Inc.	Oct 1971 - Dec 1972	East River at Astoria power plant	Fish impingement on intake screens
3. Dovel, W.L.	Mar - Dec 1972	Hudson River, Upper New York Bay (included 16 sites north of the George Washington Bridge to Poughkeepsie)	Ichthyoplankton
4. Malone, Thomas C.	Sep 1973 - Aug 1974	Hudson River and Upper New York Bay (included one site north of George Washington Bridge, one site directly south of the Verrazano Narrows Bridge and one site in New York Bight)	Phytoplankton
5. Texas Instruments for Liberty State Park, Port Authority of New York & New Jersey	Aug 1975 - Jul 1976	Liberty State Park Area	Fish (larvae-adult), Phytoplankton, Benthos, Zooplankton
6. LMS for Westway	Apr 1979 - Apr 1980	Hudson River (Battery to George Washington Bridge)	Fish (larvae-adult), Benthos, Macrozooplankton, Microzooplankton, Phytoplankton
7. Hazen and Sawyer for New York City Department of Environmental Protection (Newtown Creek Water Pollution Control Plant)	May - Oct 1980	East River	Benthos, Phytoplankton, Zooplankton, Periphyton
8. Normandeau Associates for Consolidated Edison Co. of New York, Inc.	Nov 1982 - Feb 1983	Hudson River (bottom trawling was primary sampling method between Battery and George Washington Bridge)	Fish (Atlantic tomcod was target species)
9. LMS for Westway (Phase I)	Dec 1982 - Apr 1983	Hudson River, East River, Upper New York Bay (included Hudson River north of George Washington Bridge and Newark Bay)	Fish
10. LMS for Westway (Phase II)	May - Sep 1993	Hudson River, Upper New York Bay (included two sites north of George Washington Bridge)	Fish
11. New Jersey Department of Environmental Protection	Nov 1982 - Nov 1983	Hudson River, Upper New York Bay (west side and channel: M.P. 3 to 21)	Fish
12. LMS for ARCOP	Dec 1982 - Mar 1984	Hudson River on NJ shore-line opposite mid-Manhattan	Fish and Benthos
13. LMS for River Walk	Mar - Oct 1982 Nov 1983 - Apr 1984	East River (project area and vicinity)	Fish and Benthos

TABLE 4-10 (Page 2 of 2)

SUMMARY OF MAJOR BIOLOGICAL STUDIES CONDUCTED ON THE LOWER HUDSON RIVER ESTUARY

STUDY	DATES ENCOMPASSING		GEOGRAPHIC AREA COVERED	MAJOR ORGANISM GROUPS STUDIED
	FIELD WORK			
14. LMS for Westway (Phase III a)	Oct 1983 - Apr 1984		Hudson River, Upper New York Bay (included two sites north of George Washington Bridge)	Fish and Benthos
15. New Jersey Marine Sciences Consortium for Westway	Dec 1983 - May 1984		Hudson River, East River, Upper New York Bay (included sites in Newark Bay, Arthur Kill, western Long Island Sound, Jamaica Bay, and north)	Fish
16. U.S. Army Corps of Engineers (USACE), New York District	Spring and Summer 1985		Arthur Kill, Newark Bay, Kill Van Kull Upper Bay	Fish and Benthos
17. LMS for Port Authority of New York & New Jersey	Mar 1985 - May 1986		East River at Hunters Point	Fish, Benthos, Plankton
18. New York State Department Of Transportation	Dec 1985 - Oct 1986		East River, 23rd to 90th Streets on Manhattan side	Fish and Benthos
19. LMS for Zeckendorf Corp.	Nov 1986 - Mar 1987		South Ferry Terminal at Battery	Fish and Benthos
20. New York City Public Development Corporation	Jan 1985 - Dec 1987		Lower east side of Manhattan shoreline and Wallabout Bay on Brooklyn side	Fish and Benthos
21. New York City Public Development Corporation	1986-1987		Lower east side of Manhattan shoreline and seven under-piers in project	Fish
22. New York City Public Development Corporation	1986-1987		Hudson River interpier area at 40th Street	Fish
23. EEA, Inc., for New York City Public Development Corporation	Aug 1987 - Apr 1988		East River south of South Street Seaport	Fish and Benthos
24. EA, Inc., for PSE&G	Feb 1988 - Jan 1989		Arthur Kill-Linden and Seward Generating Stations	Fish, benthos, phytoplankton, microzooplankton, macrozooplankton, and impingement
25. LMS for Port Authority of New York & New Jersey	Apr - May 1990		Atlantic Basin and Lower East River	Fish and Benthos
26. LMS for Port Authority of New York & New Jersey	Apr - May 1990		Atlantic Basin and Lower East River	Fish and Benthos
27. LMS for Port Authority of New York & New Jersey	Apr - May 1990		Atlantic Basin and Lower East River	Fish and Benthos
28. LMS, for Consolidated Edison	Sep 1991 - Sep 1992		Arthur Kill - Arthur Kill Generating Station	Impingement and Entrainment
29. LMS, for Consolidated Edison	Sep 1991 - Sep 1992		East River - Ravenwood Generating Station	Impingement and Entrainment
30. LMS, for Port Authority of NY/NJ	Mar 1991 - Feb 1993		Lower Hudson River - World Trade Center	Impingement and Entrainment
31. LMS, for Consolidated Edison	Jan to Dec 1993		East River - Astoria Generating Station	Impingement and Entrainment
32. NAI, for New York Power Authority (NYPA)	Nov to Apr 1988-1994		Lower Hudson River and New York Harbor	Striped Bass and Atlantic tomcod
33. LMS, for Parsons, Brinckerhoff, Quade and Douglas	Mar 1994 to Feb 1995		Arthur Kill - Goethals Bridge area	Fish and Benthos

TABLE 4-11 (Page 1 of 2)

LIST OF BIOLOGICAL STUDIES CONDUCTED IN NEWARK BAY  
 APPLICABLE TO THE PORT AUTHORITY OF NY/NJ (PANY/NJ) NEWARK BAY PROJECT

No.	STUDY	DATES	LOCATIONS	FISH	ICTHYO-			WATER QUALITY	COMMENTS	REFERENCE
					PLANKTON	PLANKTON	PLANKTON			
1	PSE&G - Ecological Study conducted by Ichthyological Associates (IA)	Sep to Dec 1971, 1972-1973	Newark Bay	✓	✓	✓	✓	Monthly trawls, seines and plankton tows	Anselmini 1974	
2	USACE	1976	Hackensack and Passaic Rivers Newark Bay Arthur Kill Hackensack River			✓			USACE 1980 McCormick Koepp 1978	
3	Partial Recovery of Newark Bay, N.J. Following Pollution Abatement	Jul-Oct 1980	Newark Bay Kill VanKull Passaic River Newark Bay		✓		✓		McCormick et al. 1983	
4	Chronic Stress Due to Contaminants	May and Nov 1980	Newark Bay				✓	Contaminants in soft shell clams	Koepp and McCormick Unpublished Report	
5	New York Bight Benthos	Summary of past data	Upper New York Bay Newark Bay Arthur Kill Kill VanKull				✓	Distribution and abundance of benthic organisms	Carriker et al. 1982	
6	LMS Westway Winter Sampling 11	Dec 1982 - Apr 1983	Newark Bay South Elizabeth Channel	✓			✓	Monthly trawls	LMS 1983	
7	N.J. Marine Science Consortium 10	2 Jan to 24 Feb 1984	Newark Bay Arthur Kill	✓			✓	Trawl stations randomly selected	Malcolm Pirnie 1984	
8	LMS Westway winter Sampling 9	16 Feb, 28 Feb & 14 Mar 1984	Upper NY Harbor Newark Bay South Elizabeth Channel				✓	Mid & Bottom trawls 3 sampling dates	LMS 1984	
9	USACE	1984	Shallows near Port Newark Terminal				✓		Cerrato and Bokuniewicz 1985	
10	USACE	Jul 1984 to Jun 1985	Southern Newark Bay Kill Van Kull	✓				Bottom trawls once per month stations in Newark Bay	USACE 1987 DEIS Woodhead and McAfferty 1986 and Woodhead 1985	

TABLE 4-11 (Page 2 of 2)

LIST OF BIOLOGICAL STUDIES CONDUCTED IN NEWARK BAY  
 APPLICABLE TO THE PORT AUTHORITY OF NY/NJ (PANY/NJ) NEWARK BAY PROJECT

No.	STUDY	DATES	LOCATIONS	FISH	ICTHYO-			BENTHOS	WATER QUALITY	COMMENTS	REFERENCE
					PLANKTON	PLANKTON	PLANKTON				
11	USACE	Jul 1984 to Jun 1985	Southern Newark Bay Kill Van Kull	✓					Bottom trawls, Gill nets and seines once per month, ___ stations in Newark Bay	USACE 1987 USF & WS 1985 DEIS	
12	USACE	May and Aug 1985	Newark Bay				✓		TCDD in sediments	USACE 1987 DEIS, Cerrato 1986, Cerrato 1986 Bopp et al 1991	
13	Contaminants	1985-1986	Newark Bay and Passaic River	✓			✓		TCDD and PCDFs in the clam <i>Mya arenaria</i>	Brown et al 1994	
14	Contaminants	1986-1987	Newark Bay and upper Arthur Kill	✓			✓		Summary and Final Report	Versar, Inc. 1989	
15	PSE&G 3168	1971-1973 and 1986-1987	Newark Bay Hackensack River Passaic River Arthur Kill	✓	✓		✓				
16	USACE	May 1987 to Apr 1988	Newark Bay	✓				✓	Monthly trawls on Shoals and in Channels	Will & Houston 1992	
17	Contaminants	ND	Newark Bay	✓			✓		TCDD and PCDFs in blue combs and striped bass	Rappe et al 1991	
18	Hudson/Raritan Benthos	Summary of past data	Newark Bay, Arthur Kill and Kill VanKull				✓		Distribution of benthic organisms	Cristini 1991	
19	Contaminants	1991-1992	Newark Bay, Hackensack and Passaic Rivers, Kill VanKull and Arthur Kill	✓			✓		PCDD/Fs in Blue crabs	Zonqwed et al 1994	
20	Passaic River Tunnel Flood Control Project - ACOE NMFS	May 1993 to Apr 1994	Newark Bay - Northern Portion	✓	✓		✓		Monthly trawls, Gill Nets and Plankton Nets	NMFS 1995	
21	PANY/NJ LMS	Apr 1995 to Mar 1996	Newark Bay Kill Van Kull Arthur Kill	✓	✓		✓		Monthly Sampling	LMS 1996 this Report	

Key:

S = Shallow-water  
 D = Deep-water

\*Includes sediment quality.

from all but Hagerty (1972) are available in a usable format, e.g., numbers of fish per month by gear type. Specific data and numbers by month at specific locations are not available for USACE (1987) or Will and Houston (1988).

#### 4.3.2 Agency File Search

Results of state and Federal agency file searches are provided in Appendix F. Several species, groups of species, and habitats were mentioned in the responses from NJDEP, USF&WS, and NMFS. The list below includes only TES known to be present in the area and other wildlife and fish common in the project area. TES that may visit the Bay, but have not been reported, include Kemp's ridley turtle (endangered), loggerhead turtle (endangered), and green sea turtle (threatened). The leatherback turtle (endangered), right whale (endangered), humpback (endangered), and finback whale (endangered) occur in the New York Bight; though highly unlikely, occasional transients could enter Newark Bay.

Agency	Species, Group or Habitat	Status
NJDEP	Least tern	Endangered (NJ)
	Coastal heron rookery	Significant habitat
USF&WS	Peregrine falcon	Endangered (NJ and Federal)
NMFS	Winter flounder	Spawning and Nursery Area
	Atlantic tomcod	Spawning and Nursery Area
	Striped bass	Seasonal use
	Weakfish	Seasonal use
	Bluefish	Seasonal use
	Bay anchovy	Seasonal use
	White perch	Seasonal use
	Blue crab	Seasonal use

## CHAPTER 5

### LIFE HISTORY OF SELECTED SPECIES

Seasonality, abundance, habitat use, and life history information (feeding, spawning and resting) are important factors to consider for species using Newark Bay.

- Seasonality provides information to determine the time periods when species may be in the area.
- The abundance/proportion of individuals of a population using the Bay compared to abundance in a wider geographic area or the entire species range provides information on the regional importance of the Bay.
- The habitat needs of the species and the proportion of available habitat located within the Bay are used to predict the species potential reliance on the project area at times when the species are present.
- The use of the Bay for feeding, resting, spawning, and other uses provides information to determine the importance of the habitat to each species.
- Life history information provides the links between habitat, seasonality, abundance, and the ages/life stages of species that are using available habitat.

The six most common fish species collected by LMS in the Bay were bay anchovy, striped bass, winter flounder, Atlantic silversides, bluefish, and summer flounder. The blue crab was the dominant macroinvertebrate collected in the Bay. Five of these have recreational/commercial value; two (Atlantic silversides and bay anchovy) are valuable components of the food chain.

- **Bay anchovy (*Anchoa mitchilli*).** Bay anchovies are small, slender fish, 4 to 10 mm (1.5 to 4 in.) long, that are ubiquitous in shallow coastal waters of North America from southern Maine to the Yucatan Peninsula (LMS 1996). They have a wide salinity tolerance, from fresh water to more than twice the salinity of normal seawater, but they prefer salinities found at seaward ends of estuaries. Where temperatures do not drop below 5°C during the winter, bay anchovies remain in the estuaries throughout the year (Wang and Kernehan 1979). However, north of Delaware Bay they leave the estuaries during the winter and move offshore to overwinter along the coastal shelf.

Bay anchovies school in large numbers, feeding on plankton as they swim. Their mouths are large, which gives them a tremendous gape relative to their small size, enabling them to pass large quantities of water through their gill rakers

(long slender projections on their gills) and filter out their prey. They feed throughout the water column, primarily on invertebrates. Larval anchovies feed on a variety of microzooplankton, including the larval stages of crustaceans and molluscs. Juvenile bay anchovies feed on larger macrozooplankton, including copepods, cladocerans, amphipods, and, to a lesser extent, mysid shrimp. Adult anchovies feed most often on mysid shrimp, although their diet typically includes a wide variety of crustaceans.

Bay anchovies rarely survive longer than two years. They mature rapidly to a size of 25 to 51 mm (1 to 2 in.). In southern waters they may mature within three months of hatching, but in northern waters they usually mature in their second summer, 11 to 14 months after hatching.

Bay anchovies have very high fecundity; individual females may spawn 50 or more times per year, averaging about 1100 eggs per spawn (Houde and Zastrow 1991). As a result of this early maturity and high fecundity, bay anchovies may be the most abundant fish species in the western north Atlantic (McHugh 1967). Bay anchovies spawn in lower estuarine and inshore coastal waters throughout the warmer months of the year. In the New York Bight, spawning occurs from May through August, and possibly into September, with peak egg abundance occurring in late June or early July when water temperatures exceed 21°C (LMS 1996). Spawning areas usually have salinities greater than 10 ppt; egg abundance is typically highest in waters with salinities greater than 20 ppt, and egg viability apparently declines at salinities less than 8 ppt. Spawning occurs throughout all areas of the Hudson-Raritan Bay complex, including Raritan and Newark bays, Arthur Kill, Kill Van Kill, and the Upper and Lower bays, as well as throughout Long Island Sound.

The eggs, from 0.6 to 1.2 mm (0.25 to 0.50 in.) in diameter, are transparent and initially buoyant, but after 12 to 16 hrs of floating they sink. Hatching occurs approximately 24 hrs after spawning. Newly hatched yolk-sac larvae (YSL) are 1.8 to 2.7 mm (0.71 to 1.06 in.) long, transparent, and drift along the bottom with the tidal currents. The YSL stage is very brief, typically lasting less than one day. Due to their small size, short duration, and epibenthic nature, few YSL are collected. The post yolk-sac larvae (PYSL) stage is longer, lasting about a month. In the New York/New Jersey Harbor area, peak abundance of PYSL occurs during early July, and the center of their distribution shifts slightly upriver compared to that of eggs and YSL.

Bay anchovies are about 13 mm (0.5 in.) long at the beginning of the juvenile stage. Juveniles continue to move farther into shallow protected coastal waters and into brackish waters within estuaries. Juvenile anchovies are found in New York/New Jersey area estuaries from mid-August through October (Schmidt 1992). Juveniles grow rapidly and reach an average size of 51 to 76 mm (2 to 3 in.) before cooling water temperatures cause them to leave the estuary and move offshore to overwinter.

- ***Striped bass (Morone saxatilis)***. Striped bass, one of the most important sport and commercial fishes of the United States, occur from the St. Lawrence River south to northern Florida and into the northern Gulf of Mexico (Scott and Crossman 1973).

Striped bass are anadromous, maturing offshore and returning to spawn in fresh water for the first time at 6 to 8 years of age. Adults generally move into the New York/New Jersey area in April, when water temperatures are 11 to 21°C, and remain until mid-June. Spawning takes place in fresh water near the salt front, where there is sufficient current to keep the eggs suspended. Depending on age and size, females produce from 150,000 to several million semibuoyant eggs, which drift back and forth with the tidal currents. The eggs are relatively large (averaging 34 mm [1.34 in.] in diameter after water hardening) but vary with the size of the female.

Principal East Coast spawning rivers and bays are the Hudson River; Delaware Bay and Delaware River; Chesapeake Bay and tributaries; the Roanoke and Chowan Rivers and Albermarle Sound, North Carolina; the Santee River, South Carolina; and the St. Johns River, Florida. Striped bass do not reproduce in large populations north of the Hudson River in the eastern United States, but small spawning populations occur in several river systems in eastern Canada.

Striped bass eggs are found throughout most of the New York/New Jersey Estuary from late April through June. Peak egg abundance usually occurs in May. Striped bass eggs usually hatch into YSL 20 to 37 mm (0.79 to 1.46 in.) long in two to three days, depending on water temperature. Currents move the YSL downstream, and they transform into PYSL at 7 to 8 mm (0.25 to 0.3 in.) in length in three to 14 days. YSL are present from late April to mid-June, and PYSL are present from mid-May to late July.

In the New York/New Jersey area, the PYSL stage typically lasts less than 30 days, with transformation to the juvenile stage when the fish is 150 to 200 mm (5.91 to 7.87 in.) in length. Juveniles remain near shore until late fall, generally moving downriver to feed in nursery areas located in the higher-salinity waters. As water temperature decreases in November and December, the juveniles move either to the lower estuary or into adjacent bays, including Newark Bay and Long Island Sound, to overwinter (McFadden 1979). Juvenile striped bass (two-year-olds and younger) overwinter in portions of New York Harbor, with two peaks of abundance noted: fall and spring to early summer (LMS 1983b, 1984a). Recent studies show a strong preference for deeper waters of channels and interpier areas during the winter months (LMS 1984a, 1984b; NOAA 1995).

The striped bass is carnivorous, feeding on various organisms of suitable size. Of 250 striped bass collected from the Connecticut River from April and October, most common food items were silversides, menhaden, and shrimp (*Paleomonetes* sp.); less common food items were gunnels, herrings, mummichogs, striped killifish, squid, sandworms, and blood worms (Merriman 1936). The contents of 48 stomachs taken from specimens caught in salt and brackish water of Chesapeake Bay consisted of fish, crustaceans, annelid worms, and insects. The larger fish had fed principally on fish, whereas the smaller ones had eaten mainly crustaceans. Juveniles feed on mysid shrimp, amphipods, annelids, and insects (Hildebrand and Schroeder 1972). Juvenile striped bass are preyed upon by Atlantic tomcod, Atlantic cod, silver hake, bluefish, and larger striped bass. Adults, which commonly reach 13,636 g (30 lb), have few predators other than man (Cole 1978; Thomson et al. 1978).

- *Atlantic silversides (Menidia menidia)*. Atlantic silversides occur along the Atlantic coast of North America from New Brunswick and Nova Scotia to Florida (Jones et al. 1978). They are widespread and abundant in coastal waters and in lower tributaries of coastal rivers. Adults occur near sandy and gravelly shores, beaches and tidal creeks, and the mouths of rivers. Adults are also found off shore during late fall and winter. Movements are influenced by tidal currents, with large schools following tides (Jones et al. 1978).

Adults spawn in the intertidal zone or shallow estuaries during late spring-early summer (May to July) in southern New England, New York, and New Jersey (Jones et al. 1978; Bigelow and Schroeder 1957). Juveniles range up to 88 mm (3.5 in.) total length (Jones et al. 1978). Juveniles grow about 14 mm (0.5 in.)

per month and are 27 to 30 mm (1.1 to 1.2 in.) in 48 days. Most adults are 50 to 88 mm (2.0 to 3.5 in.) standard length in one year. Silversides reach lengths of 100 to 114 mm (4-4.5 in.) (Bigelow and Schroeder 1953). The food of this fish, based on the contents of 27 stomachs, consists largely of small crustaceans, worms, insects, minute ova of unknown origin, and algae (Hildebrand and Schroeder 1972).

- **Winter flounder (*Pleuronectes americanus*).** The winter flounder is a right-eyed flatfish (eyes and viscera on the right side) with a small, weakly toothed mouth. The scales are rough to the touch on the eyed side, but they are smooth on the blind (white) side. The color varies from reddish brown to a dark slate gray. It is a bottom dweller, as are the rest of the flatfishes. Adult winter flounder are generally 305 to 381 mm (12 to 15 in.) and 454 to 909 g (1 to 2 lb), sometimes reaching 508 mm (20 in.) and 2272 g (5 lb). The larger fish are sometimes called sea flounders to distinguish them from the smaller bay fish. In waters off Montauk Point, New York, and around Block Island, Rhode Island, there exist populations of large flounders, locally known as snowshoes because of their shape and size. These larger individuals can weigh up to 2727 g (6 lb), and a winter flounder of 3636 g (8 lb) has been caught (McClane 1974).

The winter flounder occurs from Labrador to Georgia but is more commonly found from the Gulf of St. Lawrence to Chesapeake Bay (Smith 1985). This is a shallow-water flounder, found from well up into the high-tide mark to depths of about 122 m (400 ft). Generally, smaller fish are found in shallow water and large fish in deeper water, although large fish will enter water less than 0.3 m (1 ft) deep. They prefer muddy sand but may occur on sand, clay, or fine gravel. Offshore, they may be found on hard bottom as well as soft. They enter mouths of estuaries and occasionally are taken in water that is nearly fresh (Bigelow and Schroeder 1953).

The winter flounder is a resident of New York/New Jersey waters. It moves within the estuary system through its annual cycle, as reflected in trawl survey catches. Winter flounder spawn in mid-winter in the shallows, mainly in the Lower Bay and New York Bight, and catches in the Harbor are low. By March-April the flounder are feeding heavily, and catches of these foraging fish increase. During early summer, the large flounders generally leave the estuary system and move offshore, where they support a commercial trawl fishery off estuary mouths along the coast. In contrast to the adults, many juvenile flounder

remain within New York Harbor in summer. During the fall, the abundance of flounder increases as adult fish move back into the Harbor, and large numbers of YOY are recruited to the population in November-December (HRF 1990).

Spawning typically occurs over sandy bottom from January to May, with a peak from March to April. The spawning depth is often 1.8 to 5.5 m (6 to 18 ft), and the eggs, unlike those of other flatfishes, sink to the bottom and stick together. Incubation takes 15 to 18 days at water temperatures of 2.8 to 3.3°C. The larvae are 3 to 3.5 mm (1.18 to 1.38 in.) at hatching. The rate of development of the larvae is governed by temperature; it generally takes three months for the larvae to become juveniles. Fish in the New York area are 20.3 to 25.4 mm (8 to 10 in.) at two to three years of age. Most spawning fish are greater than 8 in. long and three years of age (Scott and Crossman 1973).

Young winter flounder feed mainly on small crustaceans and worms. Adults feed on a wide variety of aquatic organisms, including amphipods, copepods, isopods, crabs, shrimp, worms, clams, snail eggs, and some seaweed. Bigelow and Schroeder (1953) report the adults are limited to a diet of small prey organisms because of their small mouths.

- **Bluefish (*Pomatomus saltatrix*).** Bluefish have an irregular distribution throughout the warmer oceans (Bigelow and Schroeder 1953). Along the eastern coast of North and South America, they occur regularly from Argentina to Cape Cod, Massachusetts. Snapper blues (juveniles up to 254 mm [10 in.] long) are quite common in the New York/New Jersey Harbor (Smith 1985). The abundance of menhaden (a favorite food) to some extent governs the movements of the bluefish (Hildebrand and Schroeder 1972).

Bluefish migrate up and down the Atlantic coast, following schools of menhaden and other fish, upon which they feed voraciously. In midwinter, Hildebrand and Schroeder (1953) report, they are caught off southern Florida with purse seines and gill nets, together with Spanish mackerel. Large schools pass the Carolinas during March and April, and the first catches are made off New Jersey and Long Island during April and May. In southern Massachusetts the first catch is usually made in late May. North of Cape Cod the fishery is small, and only a few stragglers are taken along the coast of Maine during the summer.

Bluefish, along the east coast of North America, overwinter off Florida but return to New York marine waters in April or May (Smith 1985; Hildebrand and Schroeder 1972). The majority of adults spawn offshore during the early summer (Jones et al. 1978). Concentrations of larvae occur 82 km (51 miles) offshore to within 24 km (15 miles) of the continental shelf. YOY fish (juveniles) move inshore during the growing season, where they are found during late summer and early fall. Growth is rapid, with lengths of up to 76 mm (3 in.) by summer, and 102 to 178 mm (4 to 7 in.) by fall (October). Yearlings are 203 to 305 mm (8 to 12 in.) by spring.

- **Summer flounder (*Paralichthys dentatus*).** The summer flounder is a left-eyed flatfish with a large, strongly toothed jaw. The summer flounder lies on the bottom on its right side, resembling the mirror image of the winter flounder in outline. The color is brownish but variable, some specimens being darker than others. Most individuals are marked with dark spots on the upper side, more prominent near the posterior.

Summer flounder occur along the Atlantic coast from Maine to South Carolina (Bigelow and Schroeder 1953). They are fairly common in the New York area and up the Hudson River to the Tappan Zee Bridge (Smith 1985). They are found through late spring to late fall in shallow coastal areas, hence, their name summer flounder. They migrate to deeper waters during the winter, where they spawn in a variety of habitats (Hildebrand and Schroeder 1972). The larger fish usually remain offshore throughout the year (Bigelow and Schroeder 1953).

The summer flounder is a bottom dweller that feeds on a variety of organisms. Most common are fish but invertebrates, including squid, shrimp, crabs, and smaller invertebrates, are eaten (Hildebrand and Schroeder 1972). They are also reported to feed on molluscs, worms, and even sand dollars.

Growth is rapid; by the first winter after hatching yearlings are 120 to 180 mm (4.7 to 7.1 in.) in total length (Hildebrand and Schroeder 1972). Poole (1961), in a more detailed study, found one-year-old individuals 231 to 271 mm (9.1 to 10.7 in.); two-year-olds 343 to 384 mm (13.5 to 15.1 in.); three-year-olds 401 to 477 mm (15.8 to 18.8 in.); and four-year-olds 446 to 534 mm (17.6 to 21.0 in.). Summer flounder can reach lengths near 100 cm (39-in.) and weigh nearly 7 kg (15 lb).

- **Blue crab (*Callinectes sapidus*).** The blue crab is found in marine and brackish waters from Nova Scotia southward to the northern part of Argentina. In the United States, it is abundant from Massachusetts to southern Texas, where it supports major commercial and recreational fisheries. Detailed studies of blue crab life history have not been conducted in the New York area (Wilson and Able 1992). However, based on studies from other systems, particularly the Delaware and Chesapeake bays, much of its life history can be inferred. Blue crabs mate from May through October in the relatively low-salinity waters of bays, estuaries, and lower reaches of rivers. After mating, females migrate to higher-salinity areas (20 to 32 ppt) of lower estuaries, sounds, and nearshore areas where they overwinter by burrowing into the mud. The following summer, females extrude their fertilized eggs into a cohesive mass or "sponge" attached to the abdominal appendages. A "sponge" may contain as many as 700,000 to 2,000,000 eggs. Females mate only once during their lives. Sperm from this single mating is stored and used two or more times during a one- or two-year period.

After a seven- to 14-day incubation period, the eggs hatch into a swimming larva called a zoea. In the lower Delaware Estuary, zoea abundance peaks in early August and again in early September (Epifanio et al. 1984). These larvae molt seven to eight times before reaching the next stage, the megalops (Epifanio et al. 1984). Blue crab zoea are unable to complete development to the megalops stage at salinities below 25 ppt. Peaks in megalops abundance occur about five weeks after the peak zoea abundance.

The megalops stage typically lasts from six to 20 days, after which the larvae molt into the "first crab" stage and begin to move upriver. The juvenile first crab, while only approximately 2.5 mm (0.01 in.) wide (from tip to tip of the lateral spines of the carapace), has the proportions and appearance of an adult blue crab (Hill et al. 1989).

In the Hudson River, juvenile blue crabs are most abundant in August through October, depending on location. Peak abundance occurred in August at the furthest downriver sites studied by Wilson and Able (1992) - Liberty State Park, Piermont Marsh, and Croton Bay. At upriver sites - Iona Marsh and Moodna Creek - peak abundance did not occur until September. Where present, aquatic vegetation appears to be a favored habitat and may serve to reduce predation on juveniles. Wilson and Able (1992) found that in the Hudson River greatest

concentrations of juvenile blue crabs (51 mm [ $<2$  in.]) occurred in sites heavily vegetated with *Valisneria* and *Potamogeton*.

Growth and maturation occurs through a series of molts and intermolt phases. Molting and growth ceases during the winter but resumes as the water warms in spring. Blue crabs generally reach maturity during the spring or summer of the year following the year of hatching (Hill et al. 1989). Males continue to molt and grow after they reach sexual maturity, while females cease to grow after they mate. The average size at maturity is approximately 178 mm (7 in.) (Churchill 1919). Individual females at maturity may range from 51 to 203 mm (2 to 8 in.), while males may reach 203 mm (8 in.) (Williams 1984). The maximum age for most blue crabs in the mid-Atlantic region is three years.

Blue crabs perform a variety of roles in the ecosystem and can be a major factor in the transfer of energy within estuaries. During its life cycle, the blue crab may serve as prey and as consumer. Zoea consume phytoplankton, dinoflagellates, and copepod nauplii (Tagatz 1968); megalops feed on fish larvae, small shellfish (including blue crab), and aquatic plants (Van Engel 1958; Darnell 1959; Tagatz 1968). As much of the early development occurs in offshore coastal waters, the megalops stage imports energy into the estuary. Postlarval blue crabs are considered general scavengers, bottom carnivores, detritivores, and omnivores. In turn, blue crabs are prey of a variety of animals. Larval blue crabs are consumed by fish, shellfish, jellyfish, combjellies, and a variety of other planktivores, while juvenile and adult blue crabs are preyed on by a wide variety of fish, birds, and mammals. In the Hudson, juveniles were found in the stomach of striped bass, white perch, banded killifish, weakfish, and hogchoker (Wilson and Able 1992).

The following sections on epibenthic and benthic invertebrates describe their value to higher-level consumers in Bay and channel areas.

- Epibenthic invertebrates provide a major source of food for fish (Hargreaves 1995). As primary consumers of phytoplankton and smaller zooplankton they support higher-level consumers such as fish (Stearns 1995). Larval, juvenile, and adult fish feed on epibenthic invertebrates. As larval fish increase mouth gap and swimming ability develops they switch from feeding on the most abundant but smaller copepod species to crab zoea and larger amphipods and mysid shrimp (Hargreaves 1995). Juvenile fish, including striped bass, bluefish, weakfish,

summer flounder, and hake, are dependent on mysids (Allen, Clymer, and Herman 1978). Larger fish species, including striped bass, bluefish, weakfish, tautog, and hake, feed on larger invertebrates, including small decapods (crabs and shrimp) (Steimle 1995). Aquatic birds, including shorebirds, also utilize this epibenthic resource (Steimle 1995).

- Benthic invertebrate populations (a filter-feeder-dominated community) provide an essential source of food for valuable fish, crustaceans, and waterfowl (Steimle 1995). Some of these species include polychaete worms, oligochaetes, molluscs, and crustacean, which are common at Bay and channel stations.

The following sections on diving ducks, puddle ducks, northern diamondback terrapins, and the Harbor Herons Complex describe potential life history information that indicates potential use of existing habitats in the Newark Bay area.

- *Diving ducks.* USF&WS (USDI 27 March 1986 letter to Colonel F.H. Griffis, USACE, regarding comments concerning the supplemental draft environmental impact statement [SDEIS] for Newark Bay/Kill Van Kull Proposed Navigation Project) indicated the importance of the benthic and epibenthic invertebrates as a food source for waterfowl.

About 15 species of diving ducks can be expected to pass through and use portions of the New York/New Jersey Estuary for migration stopovers and for overwintering (Nichols 1995). In the New York/New Jersey area, canvasbacks, greater scaup, and buffleheads were the most common species observed (TI 1976; LMS 1984a, 1984c, 1987). These species and others are found along the East Coast during winter, where they move throughout the estuary in search of food and protected resting areas on a daily basis. Most breed farther north and west in the Northeast, Midwest, Canada, and Alaska (Bellrose 1980).

Large, shallow, open-water areas with abundant food sources (primarily bivalves) near mouths of estuaries are preferred foraging sites for these species (Stott and Olson 1973). Benthic worms, isopods, amphipods, snails, shrimp, crabs, and small fish are also eaten by a variety of diving ducks that overwinter in areas along the east coast (TI 1976; Stott and Olson 1973).

Many diving ducks overwinter in coastal areas; others overwinter in large bodies of water, lakes, impoundments, and rivers where fish and invertebrates are

plentiful. Diving ducks begin the fall migration to overwintering areas in October and November after recruitment of young into the population. Large concentrations move south to overwinter, passing over open-water areas in the Northeast and Mid-Atlantic (Bellrose 1980).

Canvasbacks, greater scaups, and buffleheads may spend the entire winter in the New York/New Jersey Estuary. Stott and Olson (1973) found that substrate, prey species available, and physical conditions were determinants in the distribution of overwintering diving ducks off the New Hampshire coastline. The northward migration from the New York/New Jersey Estuary begins as early as February for some species, but for most occurs in March.

The shallow-water habitats of Newark Bay provide overwintering habitat. These habitats are used by diving ducks because they provide a food source (benthic invertebrates and fish), relatively protected waters, reduced disturbance from channel traffic (watercraft), and water shallow enough to forage along the bottom.

- ***Puddle ducks.*** Puddle ducks breed and overwinter in the New York/New Jersey Estuary. Mallards and black ducks are common nesters in this area, with occasional nesting by gadwall, green-winged teal, and blue-winged teal (Andrle and Carroll 1988). Overwintering species, including gadwalls and black ducks, are common; pintails and mallards are less common overwintering species (TI 1976; LMS 1984a, 1984b, 1987).

Prior to the 1900s few mallards nested in the New York/New Jersey area. Increased numbers began to spread eastward across New York State at the same time captured, reared mallards escaped and began breeding. Mallards took advantage of improved marshes created by NYSDEC (Cook 1957), accelerating their spread eastward and rapid habitation of new marshes. Mallards usually nest on the ground near ponds and wetlands where they feed. The nest is commonly found under bushes, in grassy weedy areas, in cattails, or in common reed (Bent 1923). The nests typically consist of a shallow depression well lined with vegetation and downy feathers (Bent 1923). The mallard now breeds commonly in the New York area (Andrle and Carroll 1988).

The American black duck was once the most common duck breeding in New York (Eaton 1910). Numbers declined during the 1950s and 1960s; much of this

decline was blamed on increasing populations of breeding mallards (Smith and Ryan 1978). The hybridization between mallards and black ducks is partially responsible for the decline (Andrie and Carrol 1988). Habitat loss, toxicants, excessive hunting, and acid rain have also been blamed for the decline (Andrie and Carroll 1988).

The black duck population using coastal salt marsh habitat in the New York area has remained stable, while inland populations have declined (Bull 1974). The black duck breeds in a variety of habitats, from coastal salt marshes and brackish tidal marshes to freshwater marshes, bogs, lakes, ponds, streams, and wetlands of inland hemlock and northern hardwood forests (Stewart 1958). Nests are found on the ground in dense vegetation, along the edges of wetlands, or along water (Andrie and Carroll 1988). The nest generally consists of a depression made by the hen and lined with vegetation and down (Andrie and Carroll 1988).

The mallard nests and fledges young earlier than the black duck. Andrie and Carroll (1988) show egg dates from late March to early July for mallards. The mallard may raise two broods, while the black duck lays one set of eggs from early April to mid-late June. Unfledged young occur from late April through mid-August for the mallard and to mid-July for the black duck (Andrie and Carroll 1988). Young of both species fly at seven to eight weeks (Andrie and Carroll 1988).

Both mallards and black ducks are expected to use wetland habitat for nesting and feedings located along the northwest side of Newark Bay. At least one mallard was observed raising young in this area during the biological survey. These species prefer marshes, bays, and estuaries for overwintering (Howe et al. 1978). As with diving ducks, their presence in the Newark Bay area is dependent on availability of food and appropriate resting habitats (Howe et al. 1978).

- ***Northern diamondback terrapins.*** The northern diamondback terrapin has been reported in the Hackensack Meadowlands Complex of northern New Jersey (Wood 1995). No terrapins were collected or observed during the monthly biological survey conducted in Newark Bay from April 1995 to March 1996. Bottom trawls are an acceptable method for collecting adult terrapins (Hurd et al. 1979; Yearicks et al. 1981); however, the density and duration of any transient terrapins in the project area moving between the Hackensack Complex

and marshes and tidal creeks to the south along the Arthur Kill were not high enough or long enough to be adequately sampled by monthly trawls.

Northern diamondback terrapins are year-round residents along estuaries and bays bordering marshes. They occur from Cape Cod, Massachusetts, to Cape Hatteras, North Carolina (NYSDEC 1993). Their numbers were reduced during the early part of this century because of market hunting (Garber 1990). During the 1970s and 1980s, their numbers increased as a result of reduced market demand. A recent surge in market demand for terrapins may impact populations adversely (Garber 1990).

Wood (1995) considers terrapins relatively common along the Delaware Bay shoreline. Diamondbacks also appear to be quite hardy species, thriving in polluted waters such as those of the Hackensack Meadowlands of northern New Jersey (Wood 1995). Northern diamondback terrapin populations are considered stable in New York (NYSDEC 1993). At the Federal level, the northern diamondback terrapin is listed as a "C3 candidate species" (Wood 1995), a designation that indicates they are being considered for listing but insufficient information is currently available to proceed to formal listing.

Terrapins are active from April through October and hibernate from November through March. Diamondback terrapins are sexually dimorphic; adult females are about 180-200 mm (7.1 to 7.9 in.) in length, compared to adult males of about 109 to 130 mm (4.3 to 5.1 in.) (Wood 1995). They are highly aquatic and their cryptic behavior gives little indication of their presence. They are a diurnal turtle, preferring salt marshes, brackish water areas, and estuaries (NYSDEC 1993).

Terrapins are primarily carnivores, but will occasionally scavenge. Stomach analysis of individuals showed food items consisting of snails, crabs, marine annelids, molluscs, and other crustaceans (NYSDEC 1993). Some terrapins may take vegetable matter such as tender shoots and nuts of marsh plants (NYSDEC 1993).

Adult females are most visible during the nesting season, late May to early July (Wood 1995; NYSDEC 1993). Females search for nest sites above high tide line (Wood 1995). Nests are excavated in dunes, sandy hummocks, dike roads, and

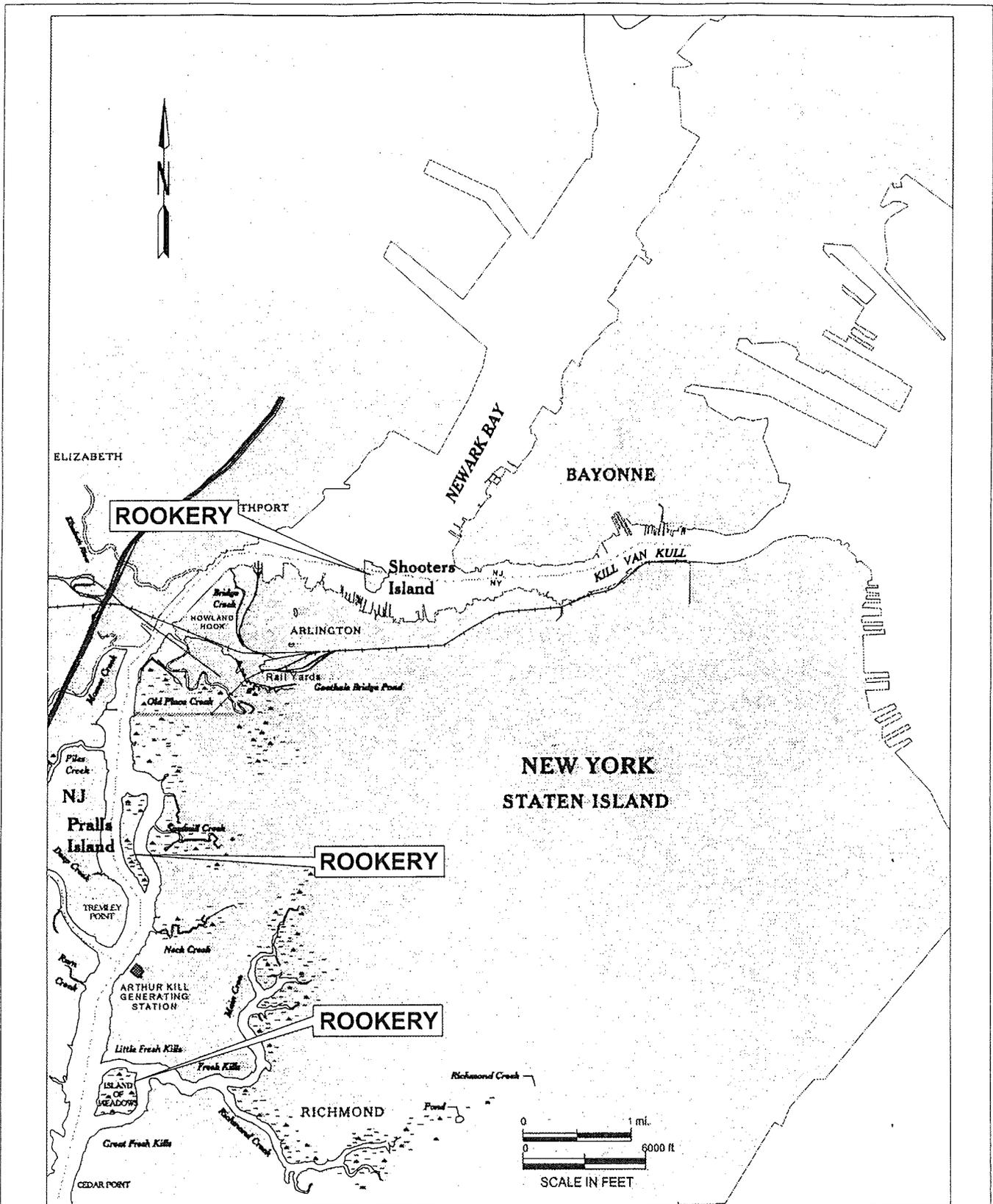
disturbed areas to a depth of 10 to 20 cm (3.9 to 7.9 in.). Nesting sites may be individual or colonial (NYSDEC 1993).

Eggs usually hatch in September after about 90 days of incubation (NYSDEC 1993). Hatchlings range from 27 to 29 mm (1.1 to 1.2 in.) carapace length and resemble adults. Late hatchlings may enter hibernation immediately or shortly after emerging. Apparently, little information is available on the activity of hatchlings and juvenile terrapins.

- **Harbor Herons Complex.** This wading bird rookery complex has been designated by the State of New York and USF&WS as a Significant Coastal Fish and Wildlife Habitat. The Harbor Herons Complex is the largest heron rookery in the northeast United States. Three rookeries, Shooters Island (5 km [3.1 miles] south of the project area), Prall's Island (10 km [6.2 miles] south of the project area), and the Isle of Meadows (14 km [8.7 miles] south of the project area) make up the complex (Figure 5-1). Numbers of herons and egrets nesting in these rookeries have been stable over the last few years (Parsons 1994). Expanding populations will require larger foraging areas and a continued supply of forage, including fish and invertebrates.

The most common nesting species during 1994 were black-crowned night heron (35% of nesting pairs), glossy ibis (22%), cattle egret (12%), great egret (11%), and snowy egret (8%) at all three rookeries (Parsons 1994). The least common species were little blue heron (0.5%), green-backed heron (0.8%), and yellow-crowned night heron (1.8%). The yellow-crowned night heron and little blue heron are listed as New Jersey threatened species.

Shooters Island (the rookery island nearest Newark Bay) is about 5 km (3.1 miles) south of Port Elizabeth and Newark and the proposed NBCDF. It hosts about 25% of the number of breeding pairs (Parsons 1994). An estimated 85 great egret, three snowy egret, 215 black-crowned night heron, and 22 glossy ibis nests were counted on Shooters Island during 1994 (Parsons 1994). The species composition and number of nests at these rookeries change frequently; for example, during 1990, 26 great egret, 62 snowy egret, 93 black-crowned night heron, and 35 glossy ibis nests were counted on Shooters Island (Parsons 1994). These shifts in numbers of active nests at one rookery were observed with corresponding but opposite shifts at other rookeries. The overall numbers



Source: Maccarone and Parsons, 1988.

Map source:  
 USGS 7.5 minute quadrangle maps Arthur Kill, NY-NJ, 1966, photorevised 1981,  
 Elizabeth NJ-NY, 1967, photorevised 1981, and Jersey City, NJ-NY, 1967.

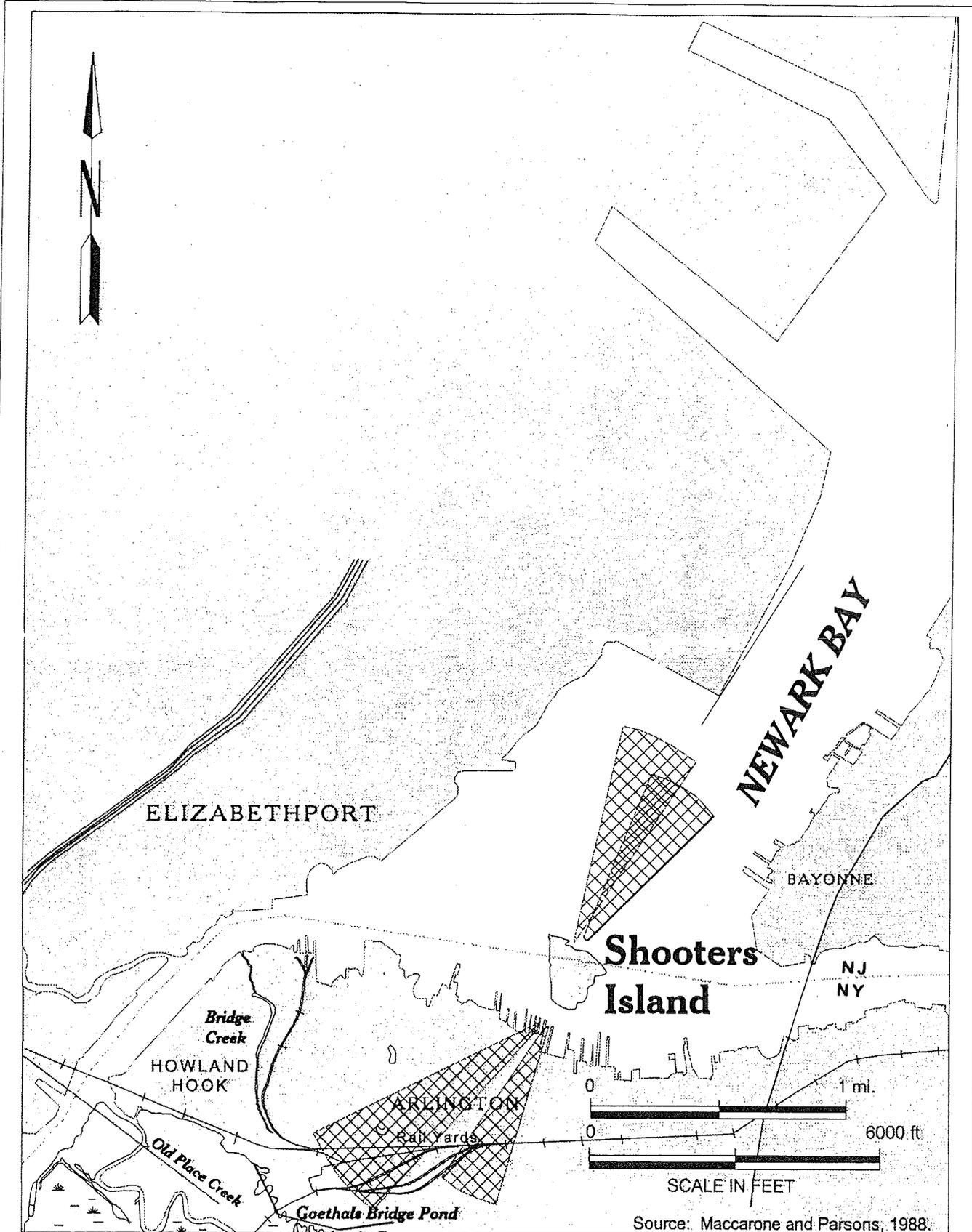
of nests at the three rookeries was 1156 during 1990 and 1125 during 1994, indicating rather stable but dynamic populations.

The foraging habitats of these wading bird species are generally similar, with some differences related to prey selected, prey size, feeding habits, and physical/biological conditions in foraging areas (Berger et al. 1982). In this discussion, the snowy egret, great egret, black-crowned night heron, little blue heron, green-backed heron, and glossy ibis are treated as a group rather than individually. The yellow-crowned night heron and cattle egret are not discussed because their prey selection and habitat are more specialized than the others. Suitable foraging habitat for yellow-crowned night herons and cattle egrets does not occur in the project area or nearby.

Wading birds generally select foraging habitats with physical conditions suitable for efficient foraging and with available prey. Berger et al. (1982) studied three marsh habitats used by wading birds and concluded that wading birds chose nontidal habitats because of a preference for nonfluctuating water levels. Custer and Osborn (1978) found few wading birds using open waters of bays as foraging habitats unless they contained aquatic vegetation. Water depth prevents individuals from foraging in many areas and tidal fluctuations prevent individuals from foraging at certain tidal stages (Berger et al. 1982; Custer and Osborn 1978). The great egret was restricted to using aquatic weed beds to between 1.5 hrs before and after low tide (Custer and Osborn 1978).

Custer and Osborn (1978) found that most great egrets and snowy egrets foraged in areas near the breeding colony (within 4 km [2.5 miles]). However, egrets and herons are known to forage in suitable habitat over 20 km (12.4 miles) from their rookeries (Custer and Osborn 1978; Kushlan 1976; Bateman 1970).

Flight lines from Shooters Island (Figure 5-2) indicate that many great egrets and snowy egrets fly north over Newark Bay to forage. The actual destinations of these flights are unknown but are presumed to be in the Hackensack River and Meadowlands Complex, where there are numerous foraging areas. Flight distance is greater than 10 km (6.2 miles) and upwards of 20 km (12.4 miles) to some of the areas. The New Jersey Greenways report identifies several areas in New Jersey where wading birds are known to forage (Greiling 1993; Kane et al. 1990).



Map source: USGS 7.5 minute quadrangle maps Arthur Kill, NY-NJ, 1966, photorevised 1981, Elizabeth NJ-NY, 1967, photorevised 1981, and Jersey City, NJ-NY, 1967.

Source: Maccarone and Parsons, 1988.

Figure 5-2  
 Flightlines From Shooter's Island Rookery

The Hackensack River, Meadowlands Complex, and areas identified in the Greenways report provide a variety of foraging habitats, including marshes, mudflats, and tidal creeks. Most of these areas are well beyond the optimum 4-km (2.5-mile) flight distance identified by Custer and Osborn (1978). It is likely that if suitable foraging locations exist in the lower Newark Bay they would be used by wading birds.

The existing habitat in lower Newark Bay is within 6 km (3.7 miles) of Shooters Island but does not contain aquatic weed beds, and most of the area is too deep (> 0.3 m [ $> 1$  ft]) at MLW for wading birds to use. Observations made during the 1995-1996 biological surveys were made around high tide to allow boat access over the shoal areas. Because depths were about 1.8 to 2.4 m (6 to 8 ft) and normal tide ranges in Newark Bay are 0.9 m (3 ft), the depths at low water would be about 0.9 to 1.5 m (3 to 5 ft). Only at extreme low tide levels (0.3 m [1 ft] below mean low water) does water depth allow some long-legged waders to use the shallower areas of the project area. No surveys were conducted during these times to determine whether any waders were using the shoal areas of Newark Bay. However, it is doubtful that this area is used by waders except along the shoreline outside the proposed CDF area.

Several species mentioned in the file search have been discussed in previous sections, including winter flounder, bay anchovy, striped bass, bluefish, and blue crabs. The Harbor Herons Complex was also discussed. Species not discussed, including peregrine falcon, least tern, Atlantic tomcod, weakfish, and white perch, are discussed in this section.

- *Peregrine falcon (Endangered in New Jersey and Federally)*. This species was not observed using the project area, but three nest sites were identified within 8 km (5 miles) of the project area. Because peregrines may forage over the waters of Newark Bay, they could be affected by the proposed NBCDF. They are year-round residents of the area, and during the winter they may forage on waterfowl overwintering in the project area or may forage year-round on other species that feed in the project area such as shorebirds, terns, and smaller gulls. Their primary prey in this area are pigeons and other passerines (Mr. Chris Nadareski, pers. commun.).
- *Least tern (Endangered in New Jersey)*. This species was identified nesting in Port Newark near the project area. Ten pairs were confirmed on 7 June 1977 (Erwin and Korschgen 1979). This species is not presently known to nest in the

project area. Least terns are colonial nesters, usually nesting near water bodies where they forage for fish. No least terns were observed during the biological surveys and it is unlikely that nesting habitat still occurs in the area. Growth of herbaceous vegetation on the open nesting areas would soon reduce the suitability of the site for nesting.

- **Marine mammals.** The possibility of cetaceans (whales, dolphins, porpoises) entering Newark Bay is relatively remote. However, some species of pinnipeds (seals), especially harbor seals, are possible any time of the year. Schoelkopf and Stetzar (1995b) report species commonly encountered in the Delaware Estuary include bottlenose dolphin, harbor porpoise, humpback whale, harbor seal, and gray seal. They report that less commonly sighted species include pygmy sperm whale, long-finned pilot whale, fin whale, northern right whale, harp seal, hooded seal, and ringed seal.

It remains uncertain whether these species would enter the Kill Van Kull or Arthur Kill to obtain access to Newark Bay. Both the harbor seal and harbor porpoise are reported as uncommon visitors to Newark Bay (Schoelkopf, pers. commun., 1996).

- **Marine turtles.** Three of the seven species of marine turtles are known to inhabit the New York/New Jersey Estuary on a regular basis: Kemp's ridley, loggerhead, and green (Schoelkopf and Stetzar 1995a; Durham, pers. commun., 1996). Sea turtles migrate into the New York/New Jersey area in late May and remain until November. The loggerhead is the most common visitor, followed by the Kemp's ridley and then the green, which is a more tropical species (Schoelkopf and Stetzar 1995a).

Although no nesting takes place as far north as New Jersey, juvenile sea turtles move inshore to bays, estuaries, and coastal areas, where they remain until reaching maturity after 10 years of age (Schoelkopf and Stetzar 1995a). Turtles forage on estuarine invertebrates and vegetation; crabs, in particular, attract foraging sea turtles to the estuary (Schoelkopf and Stetzar 1995a). Burke et al. (1990) found that over 75% of the diet of loggerhead turtles and Kemp's ridleys consisted of blue crabs, with the other 25% consisting of molluscs, algae, and natural debris.

In Chesapeake Bay, Keinath et al. (1987) found that loggerheads and Kemp's ridleys partition the Bay by water depth. Loggerheads tend to reside in deeper water and forage for their preferred prey, horseshoe crab, while Kemp's ridleys inhabit the shallower areas in search of their preferred prey, blue crab. They found that juvenile green turtles eat both invertebrates and aquatic vegetation and move into shallow water to feed during summer.

The possibility of any of these marine turtles entering Newark Bay is relatively remote. Juvenile sea turtles are late spring to fall visitors to Newark Bay (Schoelkopf, pers. commun., 1996). The loggerhead or Kemp's ridley could possibly be attracted by the large number of blue crabs that occur in Newark Bay; however, they would be considered uncommon visitors, and the green turtle is a rare visitor (Schoelkopf, pers. commun., 1996).

- *Atlantic tomcod*. This species was once listed as a threatened species in New Jersey. Tomcod were removed from the list because they were found to be abundant in Newark Bay (Will and Houston 1988). During this study, tomcod were the sixteenth most common species collected in the shallow Newark Bay trawls. Tomcod are usually found in deeper water, preferring channels to shoals. No tomcod eggs or larvae were collected in the ichthyoplankton tows.
- *Weakfish*. Weakfish prefer the deeper waters of channels to shoal areas of Newark Bay. They were fourteenth in abundance during this study. Weakfish eggs were collected on the shoals; however, no larvae were collected.
- *White perch*. White perch were ninth in abundance in the shoal trawls; no eggs or larvae were collected. White perch were more common in the channel area trawls than on the shoals during 1993-1994 (NOAA 1995).

## CHAPTER 6

### SUMMARY

- Biological surveys were conducted monthly from April 1995 to March 1996 at four Newark Bay shoal stations. In addition, two deepwater channel stations - one in the Arthur Kill and another in the Kill Van Kull - were evaluated. The project stations in the immediate vicinity of the proposed CDF were designated Newark Bay Southwest (NBSW) and Newark Bay Northwest (NBNW); two reference stations located on the west side of the Bay were designated Newark Bay Northeast (NBNE) and Newark Bay Southeast (NBSE). The sampling program focused on the collection and analysis of fish, ichthyoplankton, macro-invertebrates (blue crabs), epibenthos, and benthos. Water quality measurements taken with biological samples included dissolved oxygen (DO), salinity/conductivity, and water temperature.
- The project area stations were found to have higher numbers of fish species (higher species richness) and more individuals than the reference or channel stations. The greater number of individual fish was due primarily to large numbers of bay anchovy, which moved into the project area during August and September; the greater number of species was due to seven uncommon species collected at the project stations. Removing one species, the bay anchovy, from the data reverses the abundance results, so that the channel stations have higher numbers of individuals than the project and reference stations.
- There was a consistent seasonal pattern for fishes among the shoal stations. Fish were generally abundant from April through October but much less abundant from November through March.
- Striped bass were present at all stations; their numbers were higher at reference stations, followed by the project stations and then channel stations. Striped bass, bay anchovy, winter flounder, and summer flounder were commonly collected in project and reference stations from April through October. Earlier studies showed a similar movement off the shoals during the winter months (November through March). Bluefish were present on the shoals from August through October and Atlantic silversides were present in September and October.
- Atlantic tomcod, butterfish, cunner, grubby, scup, spot, and windowpane were collected predominantly at channel stations.

- No threatened or endangered fish were collected. (The shortnose sturgeon is the only [Federally listed] threatened or endangered fish species in New Jersey.) This species has not been collected in any of the studies conducted in Newark Bay and adjacent waters.
- Blue crabs were collected from both project and reference stations; slightly high abundance was recorded from the project stations, while blue crabs were less common at channel stations. Blue crabs were abundant in the trawl samples in all studies reviewed. They occur on the shoals from April through October and are not present during the remainder of the year. They were present in the channel during the winter months, but their relative abundance may not be well represented because they burrow to the bottom sediments.
- Relatively little is known of the use of Newark Bay as a spawning area or nursery area for larval and juvenile fish. Ichthyoplankton collections indicate that several species - bay anchovy, goby, weakfish, tautog, silver hake, winter flounder, and summer flounder - spawn in the Bay. Greater numbers of eggs and larvae of bay anchovy, goby, and winter flounder were found at the shallow water stations, indicating a spawning preference for the shoals, while tautog and grubby prefer deeper water.
- Epibenthic invertebrates, including copepods, crab zoea, amphipods, and mysid shrimp, were abundant in collections from all areas. These invertebrates, predominantly primary consumers of phytoplankton and smaller zooplankton, provide a food source for higher-level consumers such as larval and juvenile bay anchovy, silversides, striped bass, weakfish, bluefish, summer flounder, and hake.
- Benthic invertebrates included polychaete worms, oligochaetes, molluscs, and crustaceans. The channel stations contained five to seven times the number of benthic invertebrates as the other stations, due primarily to a higher density of polychaetes and oligochaetes. The benthic invertebrate community, primarily a filter-feeder-dominated community, provides an essential source of food for fish, crabs, and waterfowl.
- Newark Bay water quality followed typical seasonal patterns, with temperatures ranging from a low of 1.5°C during winter to 24°C during summer; DO ranged from 5 to 7 mg/l during summer to 13.5 mg/l during winter; and salinity fluctuated from a high of 21 ppt in December to a low of 3 ppt during January. Water quality in the channel area followed patterns similar to those observed in previous studies.
- Observations of other vertebrate species indicated some usage of the Newark Bay shoals by cormorants, gulls, and waterfowl (ducks and geese). No wading birds, shorebirds, raptors, or terns were observed using the project area during biological sampling. Channel areas were used mainly as movement corridors for gulls and cormorants and were generally not used as resting or foraging areas.

- A literature search provided references for studies conducted in Newark Bay, adjacent waters, and the New York/New Jersey Estuary. Studies on fish populations dominated the available literature, although other studies included lower taxonomic groups as well as pollution and water quality. Recent sampling data are available that can be used to characterize the fish and shellfish community of Newark Bay. Data available from adjacent water bodies provide information on species that might be expected to occur in Newark Bay. Fish sampling was conducted in Newark Bay in 1984-1985 (USACE 1987b), in 1987-1988 (Will and Houston 1992), and from May 1993 to April 1994 (NMFS 1994).

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**APPENDIX A**

**CATCHES BY STATION AND MONTH - FISH AND BLUE CRAB**







Table A-4

**NEWARK BAY AQUATIC SAMPLING STUDIES 1995 - 1996  
NUMBER OF FISH AND BLUE CRAB COLLECTED BY TRAWL**

Station Appx. Depth at MLW	Project Sites		Reference Sites		Bay Total	Percent Comp.	Channel Sites		Channel Total	Percent Comp.	Total All Trawls	Percent Comp.
	NBSW 3-5'	NBNW 3-5'	NBSE 3-5'	NBNE 3-5'			BBN 42-44'	GBW 38-40'				
<b>Species Collected</b>												
<b>30 ft Bottom Trawl</b>												
<i>Alewife</i>		1			1	0.03					1	0.03
<i>American shad</i>	3	10			13	0.40					13	0.38
<i>Atlantic croaker</i>	2				2	0.06					2	0.06
<i>Atlantic herring</i>	1	3			4	0.12					4	0.12
<i>Atlantic silverside</i>	4	23	9	99	135	4.19					135	4.00
<i>Atlantic tomcod</i>	1			1	2	0.06	4	13	17	10.90	19	0.58
<i>Bay anchovy</i>	1002	1340	135	197	2674	82.99	8	1	9	5.77	2683	79.43
<i>Blueback herring</i>	1	2			3	0.09					3	0.09
<i>Bluefish</i>	10	21	2	12	45	1.40					45	1.33
<i>Butterfish</i>							1		1	0.64	1	0.03
<i>Creville jack</i>	1	1		2	4	0.12					4	0.12
<i>Cunner</i>							2		2	1.28	2	0.06
<i>Gizzard shad</i>			1		1	0.03					1	0.03
<i>Grubby</i>							17	14	31	19.87	31	0.92
<i>Northern puffer</i>		1			1	0.03					1	0.03
<i>Northern kingfish</i>	8	8	1		15	0.47					15	0.44
<i>Northern pipefish</i>	1		2	5	8	0.25					8	0.24
<i>Scup</i>							2		2	1.28	2	0.06
<i>Spot</i>							1	1	2	1.28	2	0.06
<i>Spotted hake</i>		1	2	4	7	0.22	2	17	19	12.18	26	0.77
<i>Striped anchovy</i>		1			1	0.03					1	0.03
<i>Striped bass</i>	38	43	4	97	180	5.59	4	12	16	10.26	196	5.80
<i>Summer flounder</i>	13	2	7	7	29	0.90					29	0.86
<i>Weakfish</i>	1	1	1	4	7	0.22	3	1	4	2.58	11	0.33
<i>White perch</i>		2	1	8	9	0.28	2	8	10	6.41	19	0.58
<i>Windowpane</i>	1				1	0.03		2	2	1.28	3	0.09
<i>Winter flounder</i>	22	15	27	16	80	2.48		41	41	26.28	121	3.58
<i>Number of species</i>	16	17	12	12	22		11	10	13	13	27	
<i>Total number (individuals)</i>	1105	1475	192	450	3222	100.00	48	110	156	100.00	3378	100.00
<i>Percent of total fish</i>	32.71	43.66	5.68	13.32			1.38	3.26				100.00
<i>Blue crab</i>	728	972	722	777	3199		33	102	135		3334	
<i>Percent of total crabs</i>	21.84	29.15	21.68	23.31			0.99	3.06				100.00

**FISH AND BLUE CRABS COLLECTED  
NUMBER PER TEN MINUTE TRAWL EFFORT**

Station Appx. Depth at MLW	Project Sites		Reference Sites		Bay Total	Percent Comp.	Channel Sites		Channel Total	Percent Comp.	Total All Trawls	Percent Comp.
	NBSW 3-5'	NBNW 3-5'	NBSE 3-5'	NBNE 3-5'			BBN 42-44'	GBW 38-40'				
<b>Species Collected</b>												
<b>30 ft Bottom Trawl</b>												
<i>Alewife</i>		1			1	0.03					1	0.03
<i>American shad</i>	3	10			13	0.40					13	0.35
<i>Atlantic croaker</i>	2				2	0.06					2	0.05
<i>Atlantic herring</i>	1	3			4	0.12					4	0.11
<i>Atlantic silverside</i>	4	23	9	99	135	4.18					135	3.66
<i>Atlantic tomcod</i>	1			1	2	0.06	10	43	53	11.5	55	1.50
<i>Bay anchovy</i>	1002	1340	138	197	2677	82.97	20	3	23	5.0	2700	73.14
<i>Blueback herring</i>	1	2			3	0.09					3	0.08
<i>Bluefish</i>	10	21	2	12	45	1.39					45	1.22
<i>Butterfish</i>							3		3	0.5	3	0.07
<i>Creville jack</i>	1	1		2	4	0.12					4	0.11
<i>Cunner</i>							5		5	1.1	5	0.14
<i>Gizzard shad</i>			1		1	0.03					1	0.03
<i>Grubby</i>							43	45	88	18.8	88	2.37
<i>Northern puffer</i>		1			1	0.03					1	0.03
<i>Northern kingfish</i>	8	8	1		15	0.46					15	0.41
<i>Northern pipefish</i>	1		2	5	8	0.25					8	0.22
<i>Scup</i>							5		5	1.1	5	0.14
<i>Spot</i>							3	3	6	1.3	6	0.16
<i>Spotted hake</i>		1	2	4	7	0.22	5	43	48	10.3	55	1.49
<i>Striped anchovy</i>		1			1	0.03					1	0.03
<i>Striped bass</i>	37	43	4	97	181	5.60	10	40	50	10.7	231	6.24
<i>Summer flounder</i>	13	2	7	7	29	0.91					29	0.79
<i>Weakfish</i>	1	1	1	4	7	0.22	8	3	11	2.3	18	0.48
<i>White perch</i>		2	1	8	9	0.28	5	27	32	8.8	41	1.10
<i>Windowpane</i>	1				1	0.03		7	7	1.4	8	0.21
<i>Winter flounder</i>	23	15	27	16	81	2.50		138	138	29.2	217	5.87
<i>Number of species</i>	16	17	12	12	22		11	10	13		27	
<i>Total number (individuals)</i>	1108	1475	195	450	3228	100.00	115	350	465	100.0	3691	100.00
<i>Percent of total fish</i>	30.0	40.0	5.3	12.2			3.1	9.5				100.00
<i>Blue crab</i>	729	972	736	777	3214		83	332	414		3628	
<i>Percent of total crabs</i>	20.1	26.8	20.3	21.4			2.3	9.1				100.00

TABLE A-5

NEWARK BAY AQUATIC SAMPLING STUDIES 1995 - 1996  
 NUMBER OF FISH AND BLUE CRAB COLLECTED BY TRAWL

Station Apprx. Depth at MLW Date	TOTAL ALL STATIONS (4-Newark Bay; 2-Channel Sites)												TOTAL	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>Species Collected</b>															
<b>30 ft Bottom Trawl</b>															
Alewife							1							1	0.03
American shad			1			9	3							13	0.38
Atlantic croaker					1					1				2	0.06
Atlantic herring		4												4	0.12
Atlantic silverside						78	50	7						135	4.00
Atlantic tomcod		3		15						1				19	0.56
Bay anchovy		4	21	147	795	1703	11	2						2683	79.43
Blueback herring			2	1										3	0.09
Bluefish					5	33	7							45	1.33
Butterfish					1									1	0.03
Crevalle jack						4								4	0.12
Cunner						1	1							2	0.06
Gizzard shad										1				1	0.03
Grubby		5	1	5					6	12		2		31	0.92
Northern puffer					1									1	0.03
Northern kingfish						15								15	0.44
Northern pipefish		3	1	4										8	0.24
Scup		2												2	0.06
Spot			1					1						2	0.06
Spotted hake		25							1					26	0.77
Striped anchovy							1							1	0.03
Striped bass	83	89	17	13		2	15			7	4	3	3	196	5.80
Summer flounder		5	7	7	8	2								29	0.86
Weakfish		1		5		2	3							11	0.33
White perch	1	2				6			1	4	2		3	19	0.56
Windowpane				2							1			3	0.09
Winter flounder	9	16	22	19	6	17	9	9	2	4	3	5		121	3.58
Number of species	3.0	12	9	10	7	12	11	5	6	6	2	4		27	
Total number (individuals)	73	139	73	218	817	1872	102	20	21	24	6	13		3378	100.0
Percent of total fish	2.2	4.1	2.2	6.5	24.2	55.4	3.0	0.6	0.6	0.7	0.2	0.4			100.0
Blue crab	40	780	470	977	109	522	433	1	1	0	1	0		3334	
Percent of total crabs	1.2	23.4	14.1	29.3	3.3	15.7	13.0	0.0	0.0	0.0	0.0	0.0			100.0

FISH AND BLUE CRABS COLLECTED  
 NUMBER PER TEN MINUTE TRAWL EFFORT

Station Apprx. Depth at MLW Date	TOTAL ALL STATIONS (4-Newark Bay; 2-Channel Sites)												TOTAL	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>Species Collected</b>															
<b>30 ft Bottom Trawl</b>															
Alewife							1							1	0.03
American shad			1			9	3							13	0.35
Atlantic croaker					1					1				2	0.05
Atlantic herring		4												4	0.11
Atlantic silverside						78	50	7						135	3.68
Atlantic tomcod		5		48						3				55	1.50
Bay anchovy		4	24	147	807	1703	13	2						2700	73.14
Blueback herring			2	1										3	0.08
Bluefish					5	33	7							45	1.22
Butterfish					3									3	0.07
Crevalle jack						4								4	0.11
Cunner						3	3							5	0.14
Gizzard shad										1				1	0.03
Grubby		13	3	17						18	33		5	88	2.37
Northern puffer					1									1	0.03
Northern kingfish						15								15	0.41
Northern pipefish		3	1	4										8	0.22
Scup		5												5	0.14
Spot			3					3						6	0.16
Spotted hake		52							3					55	1.49
Striped anchovy							1							1	0.03
Striped bass	64	69	17	13		4	15			20	13	5	10	231	6.24
Summer flounder		5	7	7	8	2								29	0.79
Weakfish		1		5		4	8							18	0.48
White perch	1	4				8			1	10			10	41	1.10
Windowpane				4						3				8	0.21
Winter flounder	10	18	55	47	15	22	9	11	7	13	3	7		217	5.87
Number of species	3	12	9	10	7	12	11	5	6	6	2	4		27	
Total number (individuals)	74	181	113	293	840	1885	112	24	58	70	8	32		3691	100.00
Percent of total fish	2.0	4.9	3.1	7.9	22.8	51.1	3.0	0.7	1.6	1.9	0.2	0.9			100.0
Blue crab	41	795	555	1110	123	538	468	1	1	0	1	0		3628	
Percent of total crabs	1.1	21.9	15.3	30.6	3.4	14.8	12.8	0.0	0.0	0.0	0.0	0.0			100.0

TABLE A-6

NEWARK BAY AQUATIC SAMPLING STUDIES 1995 - 1996  
NUMBER OF FISH AND BLUE CRAB COLLECTED BY TRAWL

Station Appx. Depth at MLW Date	TOTAL NEWARK BAY (4 stations) 3-6'												Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR		TOTAL
<b>Species Collected</b>														
<b>30 ft Bottom Trawl</b>														
<i>Alewife</i>								1					1	0.03
<i>American shad</i>				1		9	3						13	0.40
<i>Atlantic croaker</i>					1					1			2	0.06
<i>Atlantic herring</i>		4											4	0.12
<i>Atlantic silverside</i>						78	50	7					135	4.19
<i>Atlantic tomcod</i>		2											2	0.06
<i>Bay anchovy</i>		4	21	147	787	1703	10	2					2674	82.99
<i>Blueback herring</i>			2	1									3	0.09
<i>Bluefish</i>					5	33	7						45	1.40
<i>Butterfish</i>														
<i>Creville jack</i>						4							4	0.12
<i>Cunner</i>														
<i>Gizzard shad</i>										1			1	0.03
<i>Grubby</i>														
<i>Northern puffer</i>					1								1	0.03
<i>Northern kingfish</i>						15							15	0.47
<i>Northern pipefish</i>		3	1	4									8	0.25
<i>Scup</i>														
<i>Spot</i>														
<i>Spotted hake</i>		7											7	0.22
<i>Striped anchovy</i>								1					1	0.03
<i>Striped bass</i>	63	69	17	13		1	15				2		180	5.59
<i>Summer flounder</i>		5	7	7	8	2							29	0.90
<i>Weakfish</i>		1		5		1							7	0.22
<i>White perch</i>	1	1				5			1	1			9	0.28
<i>Windowpane</i>				1									1	0.03
<i>Winter flounder</i>	9	15	8	7	2	15	9	8			3	4	80	2.48
<i>Number of species</i>	3	10	7	8	6	11	8	4	2	1	2	1	22	
<i>Total number (individuals)</i>	73	111	57	185	804	1868	98	18	2	1	5	4	3222	100.0
<i>Percent of total fish</i>	2.3	3.4	1.8	5.7	25.0	57.9	3.0	0.6	0.1	0.0	0.2	0.1		100.0
<i>Blue crab</i>	40	770	439	909	103	518	419	1	1	0	1	0	3199	
<i>Percent of total crabs</i>	1.3	24.1	13.7	28.4	3.2	16.1	13.1	0.0	0.0	0.0	0.0	0.0		100.0

FISH AND BLUE CRAB COLLECTED  
NUMBER PER TEN MINUTE TRAWL EFFORT

Station Appx. Depth at MLW Date	TOTAL NEWARK BAY (4 stations) 3-6'												Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR		TOTAL
<b>Species Collected</b>														
<b>30 ft Bottom Trawl</b>														
<i>Alewife</i>								1					1	0.0
<i>American shad</i>				1		9	3						13	0.4
<i>Atlantic croaker</i>					1					1			2	0.1
<i>Atlantic herring</i>		4											4	0.1
<i>Atlantic silverside</i>						78	50	7					135	4.2
<i>Atlantic tomcod</i>		2											2	0.1
<i>Bay anchovy</i>		4	24	147	787	1703	10	2					2677	83.0
<i>Blueback herring</i>			2	1									3	0.1
<i>Bluefish</i>					5	33	7						45	1.4
<i>Butterfish</i>														
<i>Creville jack</i>						4							4	0.1
<i>Cunner</i>														
<i>Gizzard shad</i>										1			1	0.0
<i>Grubby</i>														
<i>Northern puffer</i>					1								1	0.0
<i>Northern kingfish</i>						15							15	0.5
<i>Northern pipefish</i>		3	1	4									8	0.2
<i>Scup</i>														
<i>Spot</i>														
<i>Spotted hake</i>		7											7	0.2
<i>Striped anchovy</i>								1					1	0.0
<i>Striped bass</i>	64	69	17	13		1	15				2		181	5.6
<i>Summer flounder</i>		5	7	7	8	2							29	0.9
<i>Weakfish</i>		1		5		1							7	0.2
<i>White perch</i>	1	1				5			1	1			9	0.3
<i>Windowpane</i>				1									1	0.0
<i>Winter flounder</i>	10	15	8	7	2	15	9	8			3	4	81	2.5
<i>Number of species</i>	3	10	7	8	6	11	8	4	2	1	2	1	22	
<i>Total number (individuals)</i>	74	111	60	185	804	1868	98	18	2	1	5	4	3226	100.0
<i>Percent of total fish</i>	2.3	3.4	1.9	5.7	24.9	57.8	3.0	0.6	0.1	0.0	0.2	0.1		100.0
<i>Blue crab</i>	41	770	453	909	103	518	419	1	1	0	1	0	3214	
<i>Percent of total crabs</i>	1.3	24.0	14.1	28.3	3.2	16.1	13.0	0.0	0.0	0.0	0.0	0.0		100.0

TABLE A-7

NEWARK BAY AQUATIC SAMPLING STUDIES 1995 - 1996  
NUMBER OF FISH AND BLUE CRAB COLLECTED BY TRAWL

Station Appx. Depth at MLW Date	NBSW 3-5'												TOTAL	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>Species Collected</b>															
<b>30 ft Bottom Trawl</b>															
<i>Alewife</i>						2	1						3	0.27	
<i>American shad</i>					1					1			2	0.18	
<i>Atlantic croaker</i>													1	0.09	
<i>Atlantic herring</i>		1											4	0.38	
<i>Atlantic silverside</i>								1	3				1	0.09	
<i>Atlantic tomcod</i>		1											1	0.09	
<i>Bay anchovy</i>			1	7	665	322	7						1002	90.68	
<i>Blueback herring</i>				1									1	0.09	
<i>Bluefish</i>							9	1					10	0.90	
<i>Butterfish</i>															
<i>Crevalle jack</i>							1						1	0.09	
<i>Cunner</i>															
<i>Gizzard shad</i>															
<i>Grubby</i>															
<i>Northern puffer</i>													6	0.54	
<i>Northern kingfish</i>							6						1	0.09	
<i>Northern pipefish</i>				1											
<i>Scup</i>															
<i>Spot</i>															
<i>Spotted hake</i>															
<i>Striped anchovy</i>															
<i>Striped bass</i>	2	20	6	4									36	3.26	
<i>Summer flounder</i>		4	3	2	3	1							13	1.18	
<i>Weakfish</i>						1							1	0.09	
<i>White perch</i>															
<i>Windowpane</i>				1									1	0.09	
<i>Winter flounder</i>	3	1	6	2		4	3	3					22	1.99	
<i>Number of species</i>	2	5	5	6	3	8	8	2	1	0	0	0	16		
<i>Total number (individuals)</i>	5	27	17	17	669	348	17	6	1	0	0	0	1105	100.00	
<i>Percent of total fish</i>	0.5	2.4	1.5	1.5	80.5	31.3	1.5	0.5	0.1	0.0	0.0	0.0		100.00	
<i>Blue crab</i>	2	150	122	173	39	155	85	1	0	0	1	0	728		
<i>Percent of total crabs</i>	0.3	20.6	16.8	23.8	5.4	21.3	11.7	0.1	0.0	0.0	0.1	0.0		100.00	

FISH AND BLUE CRAB COLLECTED  
NUMBER PER TEN MINUTE TRAWL EFFORT

Station Appx. Depth at MLW Date	NBSW 3-5'												TOTAL	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>Species Collected</b>															
<b>30 ft Bottom Trawl</b>															
<i>Alewife</i>						2	1						3	0.27	
<i>American shad</i>					1					1			2	0.18	
<i>Atlantic croaker</i>													1	0.09	
<i>Atlantic herring</i>		1											4	0.38	
<i>Atlantic silverside</i>								1	3				1	0.09	
<i>Atlantic tomcod</i>		1											1	0.09	
<i>Bay anchovy</i>			1	7	665	322	7						1002	90.58	
<i>Blueback herring</i>				1									1	0.09	
<i>Bluefish</i>							9	1					10	0.90	
<i>Butterfish</i>															
<i>Crevalle jack</i>							1						1	0.09	
<i>Cunner</i>															
<i>Gizzard shad</i>															
<i>Grubby</i>															
<i>Northern puffer</i>													6	0.54	
<i>Northern kingfish</i>							6						1	0.09	
<i>Northern pipefish</i>				1											
<i>Scup</i>															
<i>Spot</i>															
<i>Spotted hake</i>															
<i>Striped anchovy</i>															
<i>Striped bass</i>	3	20	6	4									37	3.30	
<i>Summer flounder</i>		4	3	2	3	1							13	1.18	
<i>Weakfish</i>						1							1	0.09	
<i>White perch</i>															
<i>Windowpane</i>				1									1	0.09	
<i>Winter flounder</i>	4	1	6	2		4	3	3					23	2.06	
<i>Number of species</i>	2	5	5	6	3	8	6	2	1	0	0	0	16		
<i>Total number (individuals)</i>	6	27	17	17	669	348	17	6	1	0	0	0	1108	100.00	
<i>Percent of total fish</i>	0.6	2.4	1.5	1.5	80.5	31.3	1.5	0.5	0.1	0.0	0.0	0.0		100.00	
<i>Blue crab</i>	3	150	122	173	39	155	85	1	0	0	1	0	729		
<i>Percent of total crabs</i>	0.3	20.6	16.7	23.7	5.4	21.3	11.7	0.1	0.0	0.0	0.1	0.0		100.00	

TABLE A-8

**NEWARK BAY AQUATIC SAMPLING STUDIES 1995 - 1996  
NUMBER OF FISH AND BLUE CRAB COLLECTED BY TRAWL**

Station Appx. Depth at MLW Date	NBNW 3-5'												TOTAL	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>Species Collected</b>															
<b>30 ft Bottom Trawl</b>															
<i>Alewife</i>							1							1	0.07
<i>American shad</i>			1				7							10	0.68
<i>Atlantic croaker</i>															
<i>Atlantic herring</i>		3												3	0.20
<i>Atlantic silverside</i>							4	19						23	1.58
<i>Atlantic tomcod</i>															
<i>Bay anchovy</i>		3	7	4	25	1300	1							1340	90.85
<i>Blueback herring</i>			2											2	0.14
<i>Bluefish</i>					5	15	1							21	1.42
<i>Butterfish</i>															
<i>Creville jack</i>						1								1	0.07
<i>Cunner</i>															
<i>Gizzard shad</i>															
<i>Grubby</i>															
<i>Northern puffer</i>					1									1	0.07
<i>Northern kingfish</i>						8								8	0.54
<i>Northern pipefish</i>															
<i>Scup</i>															
<i>Spot</i>															
<i>Spotted hake</i>		1												1	0.07
<i>Striped anchovy</i>								1						1	0.07
<i>Striped bass</i>	12	18	2	5			8							43	2.92
<i>Summer flounder</i>			2											2	0.14
<i>Weakfish</i>		1												1	0.07
<i>White perch</i>	1								1					2	0.14
<i>Windowpane</i>															
<i>Winter flounder</i>	3	5	2	1		3			1					15	1.02
<i>Number of species</i>	3	6	6	3	3	7	7	2	0	0	0	0	0	17	
<i>Total number (individuals)</i>	16	31	16	10	31	1338	31	2	0	0	0	0	0	1475	100.00
<i>Percent of total fish</i>	1.1	2.1	1.1	0.7	2.1	90.7	2.1	0.1	0.0	0.0	0.0	0.0	0.0	100.00	
<i>Blue crab</i>	4	184	204	373	30	105	72	0	0	0	0	0	0	972	
<i>Percent of total crabs</i>	0.4	18.9	21.0	38.4	3.1	10.8	7.4	0.0	0.0	0.0	0.0	0.0	0.0	100.00	

**FISH AND BLUE CRAB COLLECTED  
NUMBER PER TEN MINUTE TRAWL EFFORT**

Station Appx. Depth at MLW Date	NBNW 3-5'												TOTAL	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>Species Collected</b>															
<b>30 ft Bottom Trawl</b>															
<i>Alewife</i>							1							1	0.07
<i>American shad</i>			1				7	2						10	0.68
<i>Atlantic croaker</i>															
<i>Atlantic herring</i>		3												3	0.20
<i>Atlantic silverside</i>							4	19						23	1.58
<i>Atlantic tomcod</i>															
<i>Bay anchovy</i>		3	7	4	25	1300	1							1340	90.85
<i>Blueback herring</i>			2											2	0.14
<i>Bluefish</i>					5	15	1							21	1.42
<i>Butterfish</i>							0							0	0.00
<i>Creville jack</i>						1								1	0.07
<i>Cunner</i>															
<i>Gizzard shad</i>															
<i>Grubby</i>															
<i>Northern puffer</i>					1									1	0.07
<i>Northern kingfish</i>						8								8	0.54
<i>Northern pipefish</i>															
<i>Scup</i>															
<i>Spot</i>															
<i>Spotted hake</i>		1												1	0.07
<i>Striped anchovy</i>								1						1	0.07
<i>Striped bass</i>	12	18	2	5			8							43	2.92
<i>Summer flounder</i>			2											2	0.14
<i>Weakfish</i>		1												1	0.07
<i>White perch</i>	1								1					2	0.14
<i>Windowpane</i>															
<i>Winter flounder</i>	3	5	2	1		3			1					15	1.02
<i>Number of species</i>	3	6	6	3	3	7	8	2	0	0	0	0	0	18	
<i>Total number (individuals)</i>	16	31	16	10	31	1338	31	2	0	0	0	0	0	1475	100.00
<i>Percent of total fish</i>	1.1	2.1	1.1	0.7	2.1	90.7	2.1	0.1	0.0	0.0	0.0	0.0	0.0	100.00	
<i>Blue crab</i>	4	184	204	373	30	105	72	0	0	0	0	0	0	972	
<i>Percent of total crabs</i>	0.4	18.9	21.0	38.4	3.1	10.8	7.4	0.0	0.0	0.0	0.0	0.0	0.0	100.00	

TABLE A-9

NEWARK BAY AQUATIC SAMPLING STUDIES 1995 - 1996  
 NUMBER OF FISH AND BLUE CRAB COLLECTED BY TRAWL

Station Appx. Depth at MLW Date	NBSE 3-5'												TOTAL	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>Species Collected</b>															
<b>30 ft Bottom Trawl</b>															
Alewife							6	3						9	4.69
American shad															
Atlantic croaker															
Atlantic herring															
Atlantic silverside															
Atlantic tomcod															
Bay anchovy		1	10	116	2	3	1	2						135	70.31
Blueback herring															
Bluefish						1	1							2	1.04
Butterfish															
Crevalle jack															
Cunner															
Gizzard shad											1			1	0.52
Grubby															
Northern puffer															
Northern kingfish							1							1	0.52
Northern pipefish		1		1										2	1.04
Scup															
Spot															
Spotted hake		2												2	1.04
Striped anchovy															
Striped bass	2	2												4	2.08
Summer flounder		1	1	4		1								7	3.65
Weakfish				1										1	0.52
White perch						1								1	0.52
Windowpane															
Winter flounder	1	5		4	1	6	4	4				1	1	27	14.06
Number of species	2	6	2	5	2	6	4	3	0	1	1	1	1	12	
Total number (Individuals)	3	12	11	128	3	13	12	9	0	1	1	1	1	192	100.00
Percent of total fish	1.6	6.3	5.7	65.6	1.6	6.8	6.3	4.7	0.0	0.5	0.5	0.5	0.5		100.00
Blue crab	22	127	56	167	0	142	207	0	1	0	0	0	0	722	
Percent of total crabs	3.0	17.6	7.8	23.1	0.0	19.7	28.7	0.0	0.1	0.0	0.0	0.0	0.0		100.00

FISH AND BLUE CRAB COLLECTED  
 NUMBER PER TEN MINUTE TRAWL EFFORT

Station Appx. Depth at MLW Date	NBSE 3-5'												TOTAL	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>Species Collected</b>															
<b>30 ft Bottom Trawl</b>															
Alewife							6	3						9	4.62
American shad															
Atlantic croaker															
Atlantic herring															
Atlantic silverside															
Atlantic tomcod															
Bay anchovy		1	13	116	2	3	1	2						138	70.60
Blueback herring															
Bluefish						1	1							2	1.03
Butterfish															
Crevalle jack															
Cunner															
Gizzard shad											1			1	0.51
Grubby															
Northern puffer															
Northern kingfish							1							1	0.51
Northern pipefish		1		1										2	1.03
Scup															
Spot															
Spotted hake		2												2	1.03
Striped anchovy															
Striped bass	2	2												4	2.05
Summer flounder		1	1	4		1								7	3.72
Weakfish				1										1	0.51
White perch						1								1	0.51
Windowpane															
Winter flounder	1	5		4	1	6	4	4				1	1	27	13.86
Number of species	2	6	2	5	2	6	4	3	0	1	1	1	1	12	
Total number (Individuals)	3	12	14	128	3	13	12	9	0	1	1	1	1	195	100.00
Percent of total fish	1.5	6.2	7.1	64.7	1.5	6.7	6.2	4.6	0.0	0.5	0.5	0.5	0.5		
Blue crab	22	127	70	167	0	142	207	0	1	0	0	0	0	736	
Percent of total crabs	3.0	17.3	9.5	22.7	0.0	19.3	28.1	0.0	0.1	0.0	0.0	0.0	0.0		100.00

TABLE A-10

NEWARK BAY AQUATIC SAMPLING STUDIES 1995 - 1996  
 NUMBER OF FISH AND BLUE CRAB COLLECTED BY TRAWL

Station Appx. Depth at MLW Date	APR	MAY	JUN	JUL	AUG	SEP	NBNE 3-5' OCT	NOV	DEC	JAN	FEB	MAR	TOTAL	Percent Comp.
	1995									1996				
<b>Species Collected</b>														
<b>30 ft Bottom Trawl</b>														
<i>Alewife</i>							74	24	1				99	22.00
<i>American shad</i>													1	0.22
<i>Atlantic croaker</i>													197	43.78
<i>Atlantic herring</i>														
<i>Atlantic silverside</i>						74	24	1						
<i>Atlantic tomcod</i>		1											1	0.22
<i>Bay anchovy</i>			3	20	95	78	1						197	43.78
<i>Blueback herring</i>														
<i>Bluefish</i>						8	4						12	2.67
<i>Butterfish</i>														
<i>Crevalle jack</i>						2							2	0.44
<i>Cunner</i>														
<i>Gizzard shad</i>														
<i>Grubby</i>														
<i>Northern puffer</i>														
<i>Northern kingfish</i>														
<i>Northern pipefish</i>		2		3									5	1.11
<i>Scup</i>														
<i>Spot</i>														
<i>Spotted hake</i>		4											4	0.89
<i>Striped anchovy</i>														
<i>Striped bass</i>	47	29	9	4		1	5				2		97	21.56
<i>Summer flounder</i>			1	1	5								7	1.56
<i>Weakfish</i>				4									4	0.89
<i>White perch</i>		1				4				1			6	1.33
<i>Windowpane</i>														
<i>Winter flounder</i>	2	4			1	2	2				2	3	16	3.56
<i>Number of species</i>	2	6	3	5	3	7	5	1	1	0	2	1	12	
<i>Total number (individuals)</i>	49	41	13	32	101	169	38	1	1	0	4	3	450	100.00
<i>Percent of total fish</i>	10.9	9.1	2.9	7.1	22.4	37.6	8.0	0.2	0.2	0.0	0.9	0.7		100.00
<i>Blue crab</i>	12	309	57	196	34	114	55	0	0	0	0	0	777	
<i>Percent of total crabs</i>	1.5	39.8	7.3	25.2	4.4	14.7	7.1	0.0	0.0	0.0	0.0	0.0		100.00

FISH AND BLUE CRAB COLLECTED  
 NUMBER PER TEN MINUTE TRAWL EFFORT

Station Appx. Depth at MLW Date	APR	MAY	JUN	JUL	AUG	SEP	NBNE 3-5' OCT	NOV	DEC	JAN	FEB	MAR	TOTAL	Percent Comp.
	1995									1996				
<b>Species Collected</b>														
<b>30 ft Bottom Trawl</b>														
<i>Alewife</i>							74	24	1				99	22.00
<i>American shad</i>													1	0.22
<i>Atlantic croaker</i>													197	43.78
<i>Atlantic herring</i>														
<i>Atlantic silverside</i>						74	24	1						
<i>Atlantic tomcod</i>		1											1	0.22
<i>Bay anchovy</i>			3	20	95	78	1						197	43.78
<i>Blueback herring</i>														
<i>Bluefish</i>						8	4						12	2.67
<i>Butterfish</i>														
<i>Crevalle jack</i>						2							2	0.44
<i>Cunner</i>														
<i>Gizzard shad</i>														
<i>Grubby</i>														
<i>Northern puffer</i>														
<i>Northern kingfish</i>														
<i>Northern pipefish</i>		2		3									5	1.11
<i>Scup</i>														
<i>Spot</i>														
<i>Spotted hake</i>		4											4	0.89
<i>Striped anchovy</i>														
<i>Striped bass</i>	47	29	9	4		1	5				2		97	21.56
<i>Summer flounder</i>			1	1	5								7	1.56
<i>Weakfish</i>				4									4	0.89
<i>White perch</i>		1				4				1			6	1.33
<i>Windowpane</i>														
<i>Winter flounder</i>	2	4			1	2	2				2	3	16	3.56
<i>Number of species</i>	2	6	3	5	3	7	5	1	1	0	2	1	12	
<i>Total number (individuals)</i>	49	41	13	32	101	169	38	1	1	0	4	3	450	100.00
<i>Percent of total fish</i>	10.9	9.1	2.9	7.1	22.4	37.6	8.0	0.2	0.2	0.0	0.9	0.7		100.00
<i>Blue crab</i>	12	309	57	196	34	114	55	0	0	0	0	0	777	
<i>Percent of total crabs</i>	1.5	39.8	7.3	25.2	4.4	14.7	7.1	0.0	0.0	0.0	0.0	0.0		100.00

TABLE A-11

NEWARK BAY AQUATIC SAMPLING STUDIES 1995 - 1996  
NUMBER OF FISH AND BLUE CRAB COLLECTED BY TRAWL

Station Appx. Depth at MLW Date	APR	MAY	JUN	JUL	AUG	SEP	BBN 42-44' OCT	NOV	DEC	JAN	FEB	MAR	TOTAL	Percent Comp.
	1995									1996				
<b>Species Collected</b>														
<b>30 ft Bottom Trawl</b>														
<i>Alewife</i>														
<i>American shad</i>														
<i>Atlantic croaker</i>														
<i>Atlantic herring</i>														
<i>Atlantic silverside</i>														
<i>Atlantic tomcod</i>				2					1				4	8.70
<i>Bay anchovy</i>			1		8								8	17.39
<i>Blueback herring</i>														
<i>Bluefish</i>														
<i>Butterfish</i>					1								1	2.17
<i>Crevalle jack</i>														
<i>Cunner</i>						1	1						2	4.35
<i>Gizzard shad</i>														
<i>Grubby</i>		3							3	9		2	17	36.96
<i>Northern puffer</i>														
<i>Northern kingfish</i>														
<i>Northern pipefish</i>														
<i>Scup</i>		2											2	4.35
<i>Spot</i>							1						1	2.17
<i>Spotted hake</i>		1						1					2	4.35
<i>Striped anchovy</i>														
<i>Striped bass</i>									4				4	8.70
<i>Summer flounder</i>														
<i>Weakfish</i>							3						3	6.52
<i>White perch</i>		1							1				2	4.35
<i>Windowpane</i>														
<i>Winter flounder</i>														
<i>Number of species</i>	0	5	0	1	2	1	3	1	4	1	0	1	11	
<i>Total number (individuals)</i>	0	8	0	2	9	1	5	1	9	9	0	2	46	100.00
<i>Percent of total fish</i>	0.0	17.4	0.0	4.3	19.6	2.2	10.9	2.2	19.6	19.6	0.0	4.3		100.00
<i>Blue crab</i>	0	0	2	31	0	0	0	0	0	0	0	0	33	
<i>Percent of total crabs</i>	0.0	0.0	6.1	93.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		100.00

FISH AND BLUE CRAB COLLECTED  
NUMBER PER TEN MINUTE TRAWL EFFORT

Station Appx. Depth at MLW Date	APR	MAY	JUN	JUL	AUG	SEP	BBN 42-44' OCT	NOV	DEC	JAN	FEB	MAR	TOTAL	Percent Comp.
	1995									1996				
<b>Species Collected</b>														
<b>30 ft Bottom Trawl</b>														
<i>Alewife</i>														
<i>American shad</i>														
<i>Atlantic croaker</i>														
<i>Atlantic herring</i>														
<i>Atlantic silverside</i>														
<i>Atlantic tomcod</i>				5					3				10	8.67
<i>Bay anchovy</i>					20								20	17.34
<i>Blueback herring</i>														
<i>Bluefish</i>														
<i>Butterfish</i>					3								3	2.17
<i>Crevalle jack</i>														
<i>Cunner</i>						3	3						5	4.33
<i>Gizzard shad</i>														
<i>Grubby</i>		8							8	23		5	43	36.84
<i>Northern puffer</i>														
<i>Northern kingfish</i>														
<i>Northern pipefish</i>														
<i>Scup</i>		5											5	4.33
<i>Spot</i>							3						3	2.17
<i>Spotted hake</i>		3						3					5	4.64
<i>Striped anchovy</i>														
<i>Striped bass</i>									10				10	8.87
<i>Summer flounder</i>														
<i>Weakfish</i>							8						8	6.50
<i>White perch</i>		3							3				5	4.33
<i>Windowpane</i>														
<i>Winter flounder</i>														
<i>Number of species</i>	0	5	0	1	2	1	3	1	4	1	0	1	11	
<i>Total number (individuals)</i>	0	20	0	5	23	3	13	3	23	23	0	5	115	100.00
<i>Percent of total fish</i>	0.0	17.3	0.0	4.3	19.5	2.2	10.8	2.5	19.5	19.5	0.0	4.3		100.00
<i>Blue crab</i>	0	0	5	78	0	0	0	0	0	0	0	0	83	
<i>Percent of total crabs</i>	0.0	0.0	6.1	93.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		100.00

TABLE A-12

NEWARK BAY AQUATIC SAMPLING STUDIES 1995 - 1996  
NUMBER OF FISH AND BLUE CRAB COLLECTED BY TRAWL

Station Appx. Depth at MLW Date	GBW 38-40'												TOTAL	Percent Comp.			
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR					
<b>Species Collected</b>																	
<b>30 ft Bottom Trawl</b>																	
<i>Alewife</i>																	
<i>American shad</i>																	
<i>Atlantic croaker</i>																	
<i>Atlantic herring</i>																	
<i>Atlantic silverside</i>																	
<i>Atlantic tomcod</i>					13											13	11.82
<i>Bay anchovy</i>										1						1	0.91
<i>Blueback herring</i>																	
<i>Bluefish</i>																	
<i>Butterfish</i>																	
<i>Creville jack</i>																	
<i>Cunner</i>																	
<i>Gizzard shad</i>																	
<i>Grubby</i>			2	1	5						3	3				14	12.73
<i>Northern puffer</i>																	
<i>Northern kingfish</i>																	
<i>Northern pipefish</i>																	
<i>Scup</i>																	
<i>Spot</i>				1												1	0.91
<i>Spotted hake</i>			17													17	15.45
<i>Striped anchovy</i>																	
<i>Striped bass</i>							1				3	4	1	3		12	10.91
<i>Summer flounder</i>																	
<i>Weakfish</i>							1									1	0.91
<i>White perch</i>							1				2	2		3		8	7.27
<i>Windowpane</i>					1							1				2	1.82
<i>Winter flounder</i>			1	14	12	4	2			1	2	4		1		41	37.27
<i>Number of species</i>	0	3	3	4	1	4	1	1	1	4	5	1	3		10		
<i>Total number (individuals)</i>	0	20	18	31	4	5	1	1	10	14	1	7			110		100.00
<i>Percent of total fish</i>	0.0	18.2	14.5	28.2	3.6	4.5	0.9	0.9	9.1	12.7	0.9	6.4					100.00
<i>Blue crab</i>	0	10	29	37	6	6	14	0	0	0	0	0			102		100.00
<i>Percent of total crabs</i>	0.0	9.8	28.4	36.3	5.9	5.9	13.7	0.0	0.0	0.0	0.0	0.0					100.00

FISH AND BLUE CRAB COLLECTED  
NUMBER PER TEN MINUTE TRAWL EFFORT

Station Appx. Depth at MLW Date	GBW 38-40'												TOTAL	Percent Comp.			
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR					
<b>Species Collected</b>																	
<b>30 ft Bottom Trawl</b>																	
<i>Alewife</i>																	
<i>American shad</i>																	
<i>Atlantic croaker</i>																	
<i>Atlantic herring</i>																	
<i>Atlantic silverside</i>																	
<i>Atlantic tomcod</i>					43											43	12.38
<i>Bay anchovy</i>										3						3	0.95
<i>Blueback herring</i>																	
<i>Bluefish</i>																	
<i>Butterfish</i>																	
<i>Creville jack</i>																	
<i>Cunner</i>																	
<i>Gizzard shad</i>																	
<i>Grubby</i>			5	3	17					10	10					45	12.86
<i>Northern puffer</i>																	
<i>Northern kingfish</i>																	
<i>Northern pipefish</i>																	
<i>Scup</i>																	
<i>Spot</i>				3												3	0.95
<i>Spotted hake</i>			43													43	12.14
<i>Striped anchovy</i>																	
<i>Striped bass</i>							3			10	13	3	10			40	11.43
<i>Summer flounder</i>																	
<i>Weakfish</i>							3									3	0.95
<i>White perch</i>							3			7	7		10			27	7.62
<i>Windowpane</i>					3						3					7	1.90
<i>Winter flounder</i>			3	47	40	13	7			3	7	13		3		136	38.81
<i>Number of species</i>	0	3	3	4	1	4	1	1	4	5	1	3			10		
<i>Total number (individuals)</i>	0	50	53	103	13	17	3	3	33	47	3	23			350		100.00
<i>Percent of total fish</i>	0.0	14.3	15.2	29.5	3.8	4.8	1.0	1.0	9.5	13.3	1.0	6.7					100.00
<i>Blue crab</i>	0	25	97	123	20	20	47	0	0	0	0	0			332		100.00
<i>Percent of total crabs</i>	0.0	7.5	29.1	37.2	6.0	6.0	14.1	0.0	0.0	0.0	0.0	0.0					100.00

**APPENDIX B**  
**LENGTH-FREQUENCY DATA - FISH**

Figure B-1

Bay Anchovy Length Frequency By Month  
Four Shoal Stations

Length (mm)	Number of Fish Per Length Interval											
	Apr 1995	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1996	Feb	Mar
1-10		2	1									
11-20												
21-30									1			
31-40						6			1			
41-50					11	38		1				
51-60		1	1	4	36	36		7				
61-70		1	11	54	43	12		2				
71-80			6	23	3	4						
81-90			2	4	3	1						
91-100				1								
101-110												
111-120												
121-130												
131-140												
141-150												
151-160												
161-170												
171-180												
181-190												
191-200												
201-210												
211-220												
221-230												
231-240												
241-250												
251-260												
261-270												
271-280												
281-290												
291-300												
301-310												
311-320												
321-330												
331-340												
341-350												
351-360												
361-370												
371-380												
381-390												
391-400												
401-410												
411-420												
421-430												
431-440												
441-450												
451-460												
461-470												
471-480												
481-490												
491-500												
501-510												
511-520												
521-530												
531-540												
541-550												
551-560												
TOTAL	0	4	21	86	96	97	10	2	0	0	0	0

Figure B-2

Bay Anchovy Length Frequency By Month  
Two Channel Stations

Length (mm)	Number of Fish Per Length Interval											
	Apr 1995	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1996	Feb	Mar
1-10												
11-20												
21-30												
31-40												
41-50								1				
51-60					2							
61-70					5							
71-80					1							
81-90												
91-100												
101-110												
111-120												
121-130												
131-140												
141-150												
151-160												
161-170												
171-180												
181-190												
191-200												
201-210												
211-220												
221-230												
231-240												
241-250												
251-260												
261-270												
271-280												
281-290												
291-300												
301-310												
311-320												
321-330												
331-340												
341-350												
351-360												
361-370												
371-380												
381-390												
391-400												
401-410												
411-420												
421-430												
431-440												
441-450												
451-460												
461-470												
471-480												
481-490												
491-500												
501-510												
511-520												
521-530												
531-540												
541-550												
551-560												
TOTAL	0	0	0	0	8	0	1	0	0	0	0	0

Figure B-3

**Striped Bass Length Frequency By Month  
Four Shoal Stations**

Length (mm)	Number of Fish Per Length Interval											
	Apr 1995	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1996	Feb	Mar
1-10		1										
11-20												
21-30			3									
31-40			1									
41-50												
51-60												
61-70												
71-80		2									2	
81-90		3										
91-100		10										
101-110		1										
111-120		4										
121-130	1	1										
131-140												
141-150		1										
151-160		3				1						
161-170	2	2										
171-180	3	2	1					1				
181-190	7	6										
191-200	5	6		1								
201-210	8	3		1				2				
211-220	13	7	3					1				
221-230	8	3	1									
231-240	6	3	2	2								
241-250	6	4	1	4				2				
251-260		1	2					1				
261-270		3	1									
271-280	1		2		2			1				
281-290				1								
291-300	1			1				2				
301-310								1				
311-320	1	1						1				
321-330		1						1				
331-340								1				
341-350												
351-360	1	1										
361-370												
371-380												
381-390												
391-400												
401-410												
411-420												
421-430												
431-440												
441-450												
451-460												
461-470												
471-480												
481-490												
491-500												
501-510												
511-520												
521-530												
531-540												
541-550												
551-560								1				
TOTAL	63	69	17	12	0	1	15	0	0	0	2	0

Figure B-4

Striped Bass Length Frequency By Month  
Two Channel Stations

Length (mm)	Number of Fish Per Length Interval											
	Apr 1995	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1996	Feb	Mar
1-10												
11-20												
21-30												
31-40												
41-50												
51-60												
61-70												
71-80										1		
81-90									1			
91-100									1	1		
101-110										1	1	1
111-120										1		1
121-130												
131-140												
141-150									2			1
151-160												
161-170												
171-180												
181-190												
191-200									2			
201-210												
211-220												
221-230												
231-240												
241-250												
251-260												
261-270									1			
271-280												
281-290												
291-300												
301-310												
311-320												
321-330												
331-340												
341-350												
351-360												
361-370												
371-380												
381-390												
391-400						1						
401-410												
411-420												
421-430												
431-440												
441-450												
451-460												
461-470												
471-480												
481-490												
491-500												
501-510												
511-520												
521-530												
531-540												
541-550												
551-560												
TOTAL	0	0	0	0	0	1	0	0	7	4	1	3

Figure B-5

**Atlantic Silverside Length Frequency By Month  
Four Shoal Stations**

Length (mm)	Number of Fish Per Length Interval											
	Apr 1995	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1996	Feb	Mar
1-10												
11-20												
21-30												
31-40												
41-50												
51-60												
61-70						2						
71-80						10	5					
81-90						21	22	2				
91-100						1	13	2				
101-110							8	2				
111-120							2	1				
121-130												
131-140												
141-150												
151-160												
161-170												
171-180												
181-190												
191-200												
201-210												
211-220												
221-230												
231-240												
241-250												
251-260												
261-270												
271-280												
281-290												
291-300												
301-310												
311-320												
321-330												
331-340												
341-350												
351-360												
361-370												
371-380												
381-390												
391-400												
401-410												
411-420												
421-430												
431-440												
441-450												
451-460												
461-470												
471-480												
481-490												
491-500												
501-510												
511-520												
521-530												
531-540												
541-550												
551-560												
TOTAL	0	0	0	0	0	34	50	7	0	0	0	0



Figure B-7

Winter Flounder Length Frequency By Month  
Four Shoal Stations

Length (mm)	Number of Fish Per Length Interval											
	Apr 1995	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1996	Feb	Mar
1-10												
11-20												
21-30												
31-40												
41-50				1	1							
51-60				3	3	1						
61-70				1	1	1						
71-80						3						
81-90						5	1	1				
91-100			1			3	3	1				1
101-110						1	3	1				
111-120	1	1	1				2					
121-130	2	1						4				
131-140	2	7						1			1	
141-150		2		1							1	
151-160	1		2								1	1
161-170		1										
171-180		1				1						
181-190	1											
191-200						1						
201-210				1								
211-220												
221-230												
231-240												
241-250												
251-260												1
261-270												1
271-280												
281-290												
291-300												
301-310	1											
311-320												
321-330												
331-340												
341-350												
351-360												
361-370	1											
371-380												
381-390												
391-400												
401-410												
411-420												
421-430												
431-440												
441-450												
451-460												
461-470												
471-480												
481-490												
491-500												
501-510												
511-520												
521-530												
531-540												
541-550												
551-560												
TOTAL	9	14	8	7	2	14	9	8	0	0	3	4

Figure B-8

Winter Flounder Length Frequency By Month  
Two Channel Stations

Length (mm)	Number of Fish Per Length Interval											
	Apr 1995	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1996	Feb	Mar
1-10												
11-20									1			
21-30												
31-40												
41-50												
51-60												
61-70				2	1							
71-80				3								
81-90					1							1
91-100					1					1		
101-110												
111-120			1		1				1			
121-130				1								
131-140				1								
141-150			2	1								
151-160			6	3								
161-170			1							1		
171-180						1						
181-190									1	2		
191-200		1										
201-210												
211-220						1						
221-230			1									
231-240			2									
241-250			1	1								
251-260												
261-270												
271-280												
281-290												
291-300												
301-310												
311-320												
321-330												
331-340												
341-350												
351-360												
361-370												
371-380												
381-390												
391-400												
401-410												
411-420												
421-430												
431-440												
441-450												
451-460												
461-470												
471-480												
481-490												
491-500												
501-510												
511-520												
521-530												
531-540												
541-550												
551-560												
TOTAL	0	1	14	12	4	2	0	1	2	4	0	1

Figure B-9

**Blue Fish Length Frequency By Month  
Four Shoal Stations**

Length (mm)	Number of Fish Per Length Interval											
	Apr 1995	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1996	Feb	Mar
1-10												
11-20												
21-30												
31-40												
41-50												
51-60												
61-70												
71-80												
81-90												
91-100												
101-110						2						
111-120						3						
121-130						6						
131-140						8	1					
141-150						2	1					
151-160						1	2					
161-170						2	1					
171-180						3						
181-190						1						
191-200					3	1	1					
201-210					1	2						
211-220					1	1	1					
221-230						1						
231-240												
241-250												
251-260												
261-270												
271-280												
281-290												
291-300												
301-310												
311-320												
321-330												
331-340												
341-350												
351-360												
361-370												
371-380												
381-390												
391-400												
401-410												
411-420												
421-430												
431-440												
441-450												
451-460												
461-470												
471-480												
481-490												
491-500												
501-510												
511-520												
521-530												
531-540												
541-550												
551-560												
TOTAL	0	0	0	0	5	33	7	0	0	0	0	0



Figure B-11

Summer Flounder Length Frequency By Month  
Four Shoal Stations

Length (mm)	Number of Fish Per Length Interval											
	Apr 1995	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 1996	Feb	Mar
1-10												
11-20												
21-30												
31-40												
41-50												
51-60												
61-70												
71-80												
81-90												
91-100												
101-110												
111-120												
121-130						1						
131-140												
141-150												
151-160												
161-170												
171-180												
181-190												
191-200												
201-210		1										
211-220				2								
221-230		1		1								
231-240		1										
241-250												
251-260												
261-270												
271-280		1	1	1	3							
281-290			3	1								
291-300			2	1								
301-310				1								
311-320												
321-330		1	1			2						
331-340						1	1					
341-350						1	1					
351-360												
361-370												
371-380												
381-390												
391-400												
401-410												
411-420												
421-430												
431-440												
441-450												
451-460												
461-470												
471-480												
481-490												
491-500												
501-510												
511-520												
521-530												
531-540												
541-550												
551-560												
TOTAL	0	5	7	7	8	2	0	0	0	0	0	0

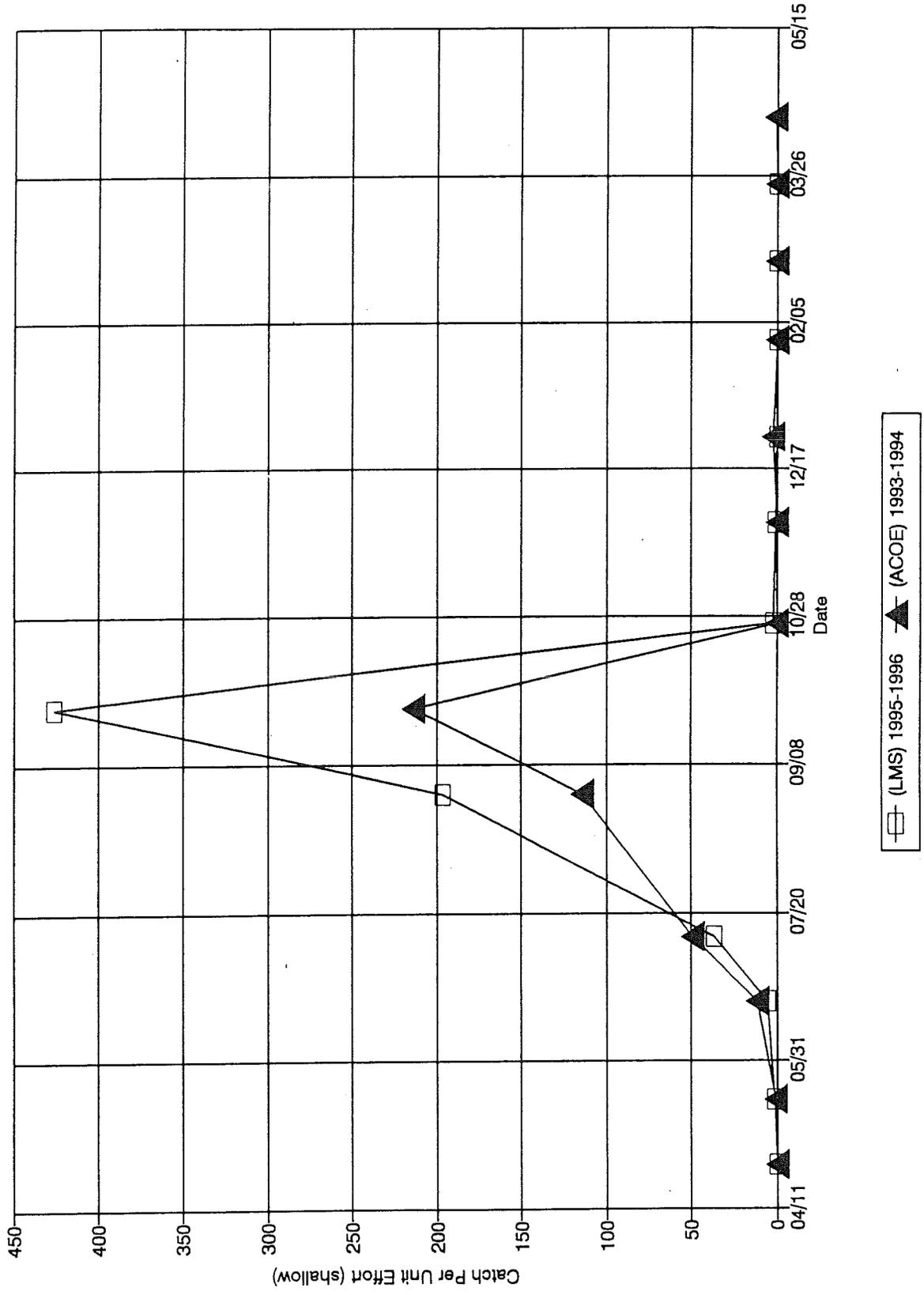


**APPENDIX C**

**SEASONAL OCCURRENCE OF FISH AND BLUE CRABS**

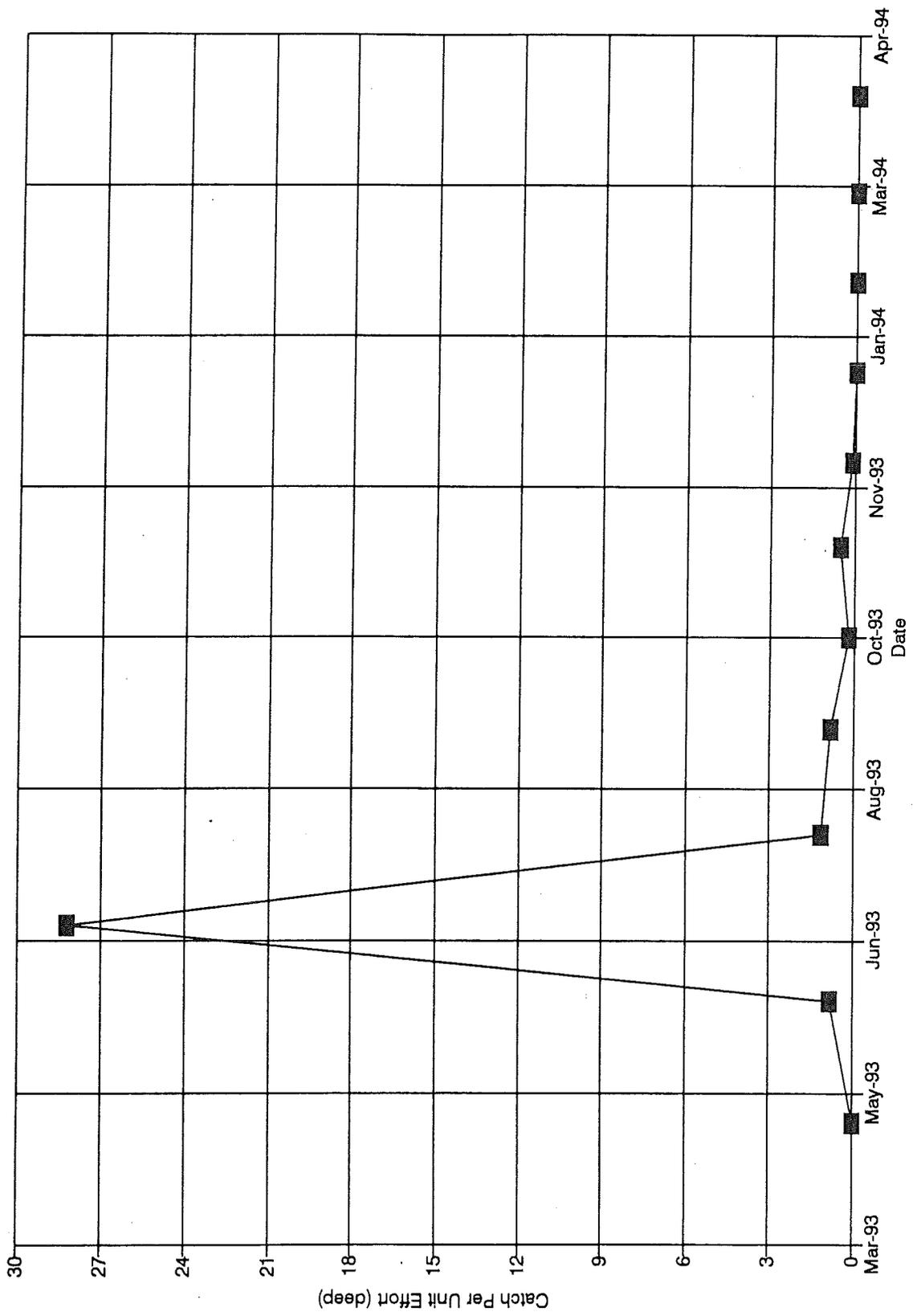
# Newark Bay Aquatic Sampling Studies

Bay Anchovy in Shoal Areas of Newark Bay



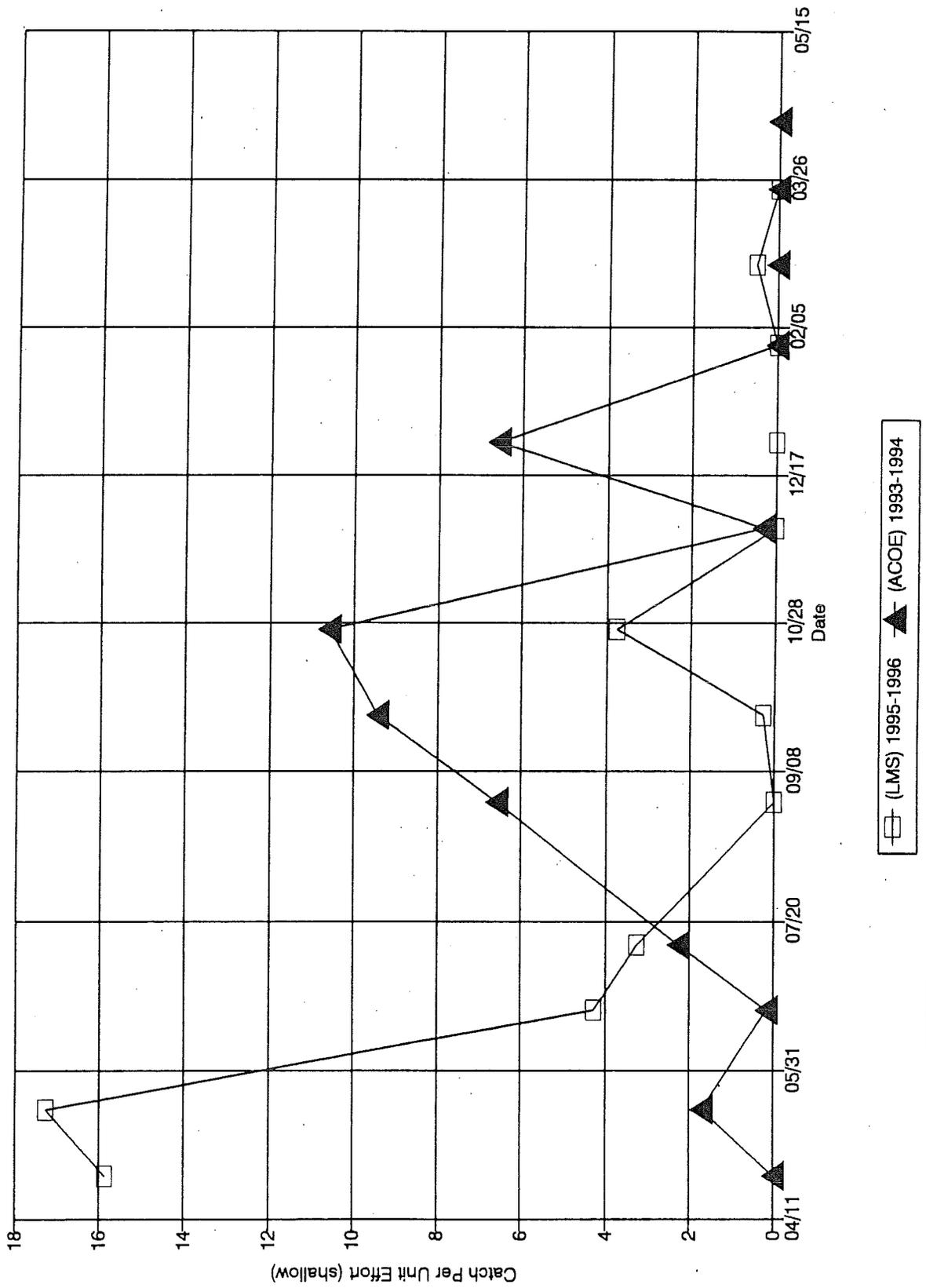
# Newark Bay Aquatic Sampling Studies

ACOE 1993-1994 Bay Anchovy in Channel Areas of Newark Bay



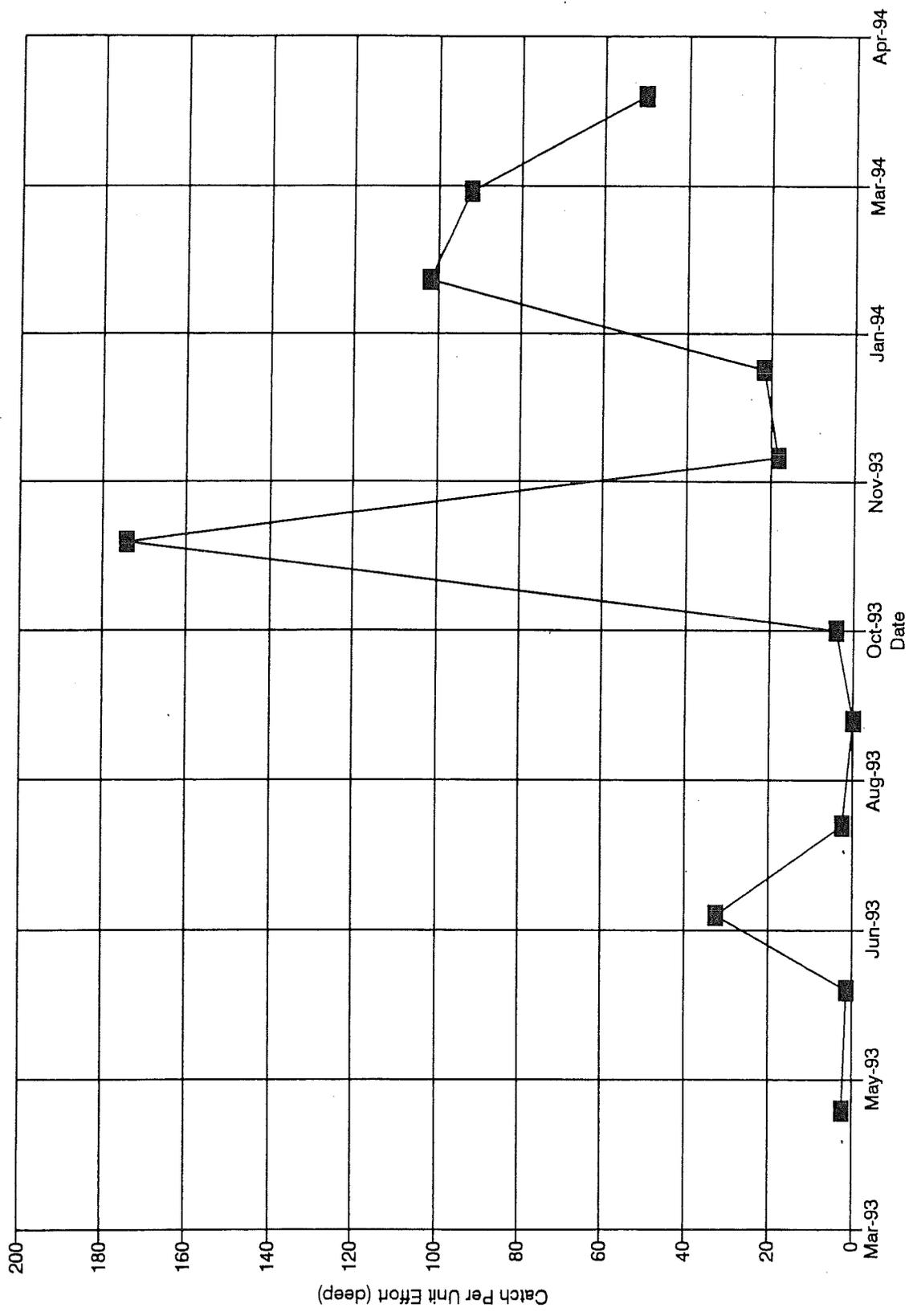
# Newark Bay Aquatic Sampling Studies

## Striped Bass in Shoal Areas of Newark Bay



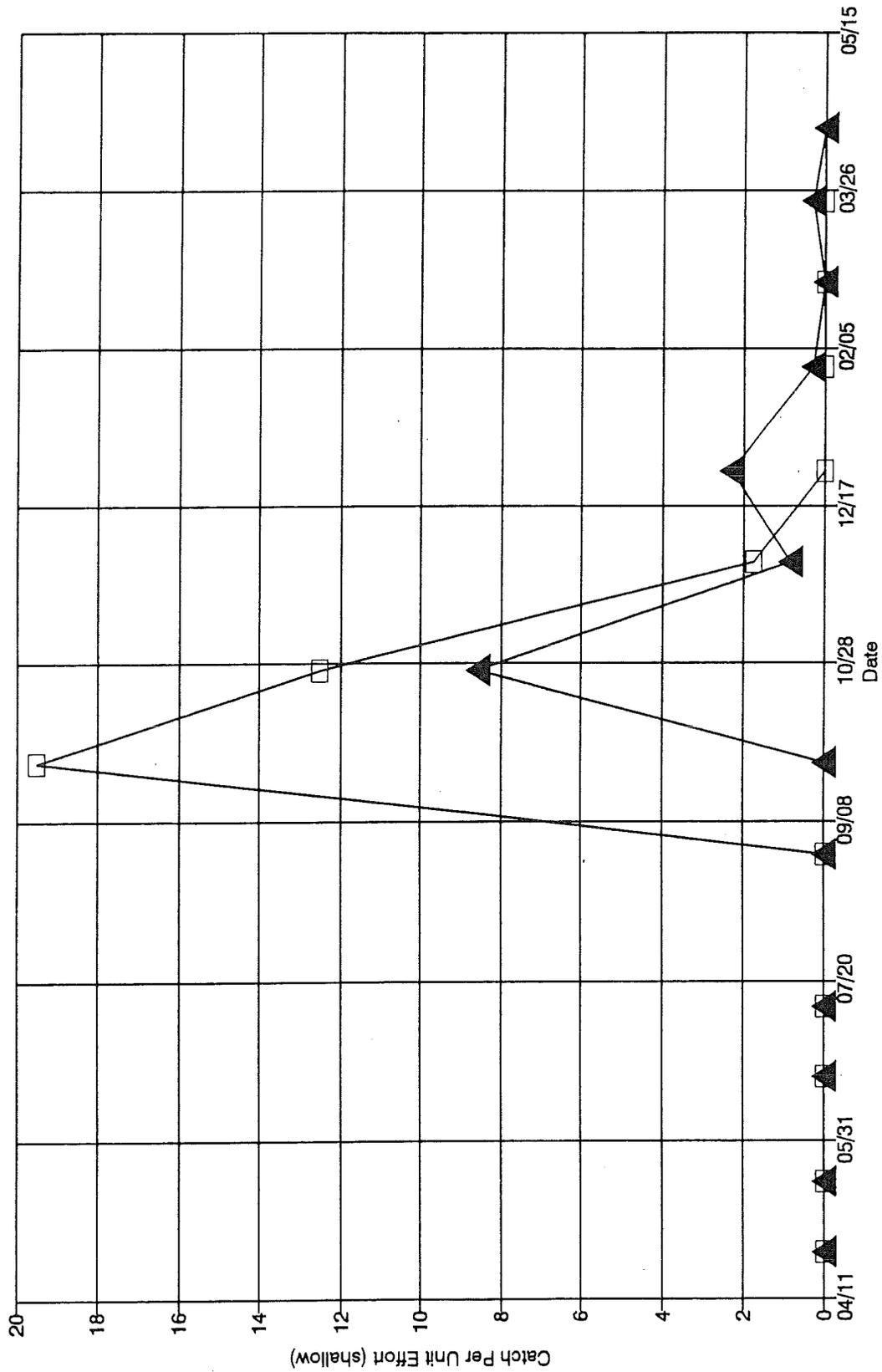
# Newark Bay Aquatic Sampling Studies

## ACOE 1993-1994 Striped Bass in Channel Areas of Newark Bay



# Newark Bay Aquatic Sampling Studies

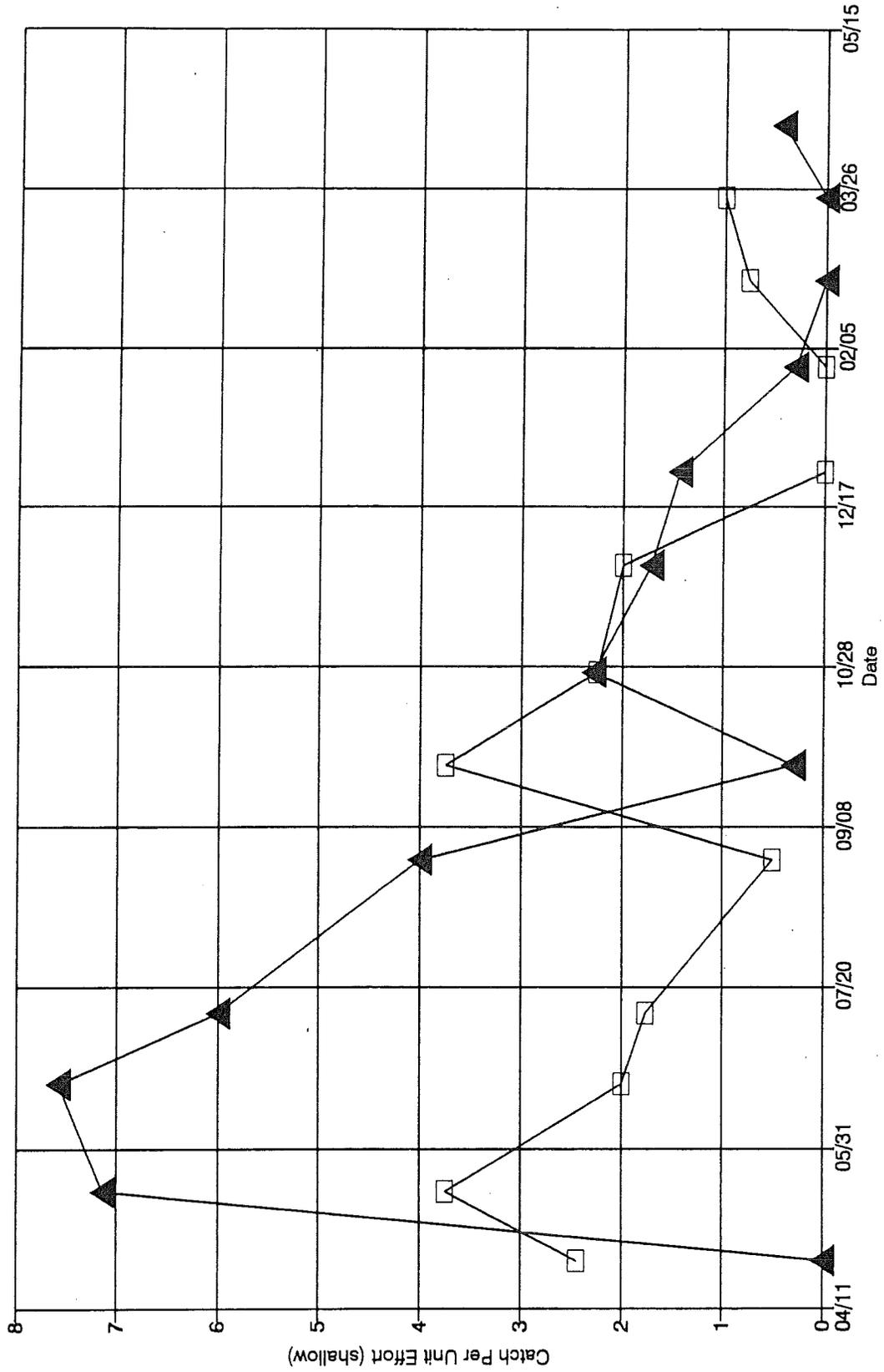
Atlantic Silverside in Shoal Areas of Newark Bay



□ (LMS) 1995-1996    ▲ (ACOE) 1993-1994

# Newark Bay Aquatic Sampling Studies

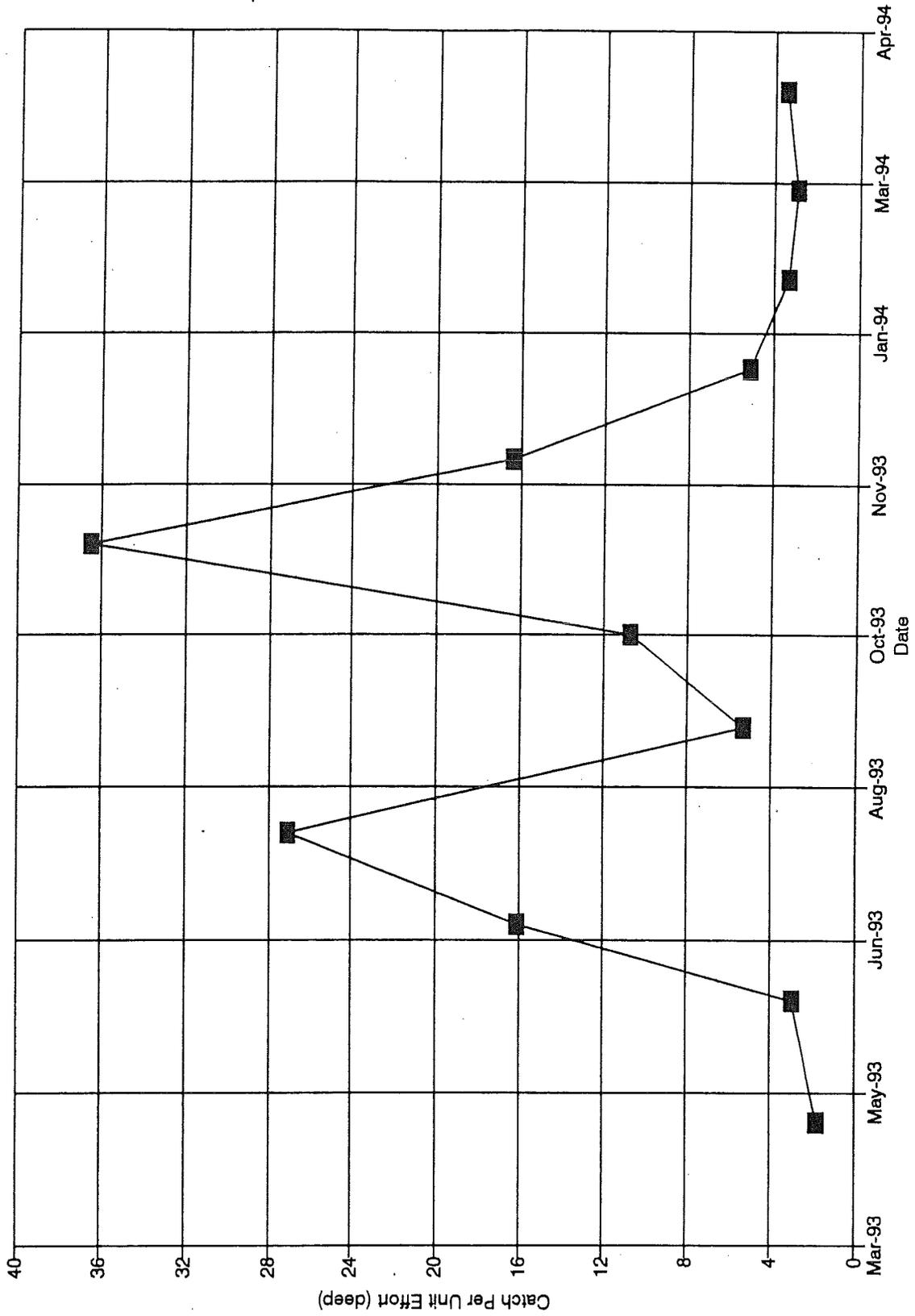
## Winter Flounder in Shoal Areas of Newark Bay



□ (LMS) 1995-1996    ▲ (ACOE) 1993-1994

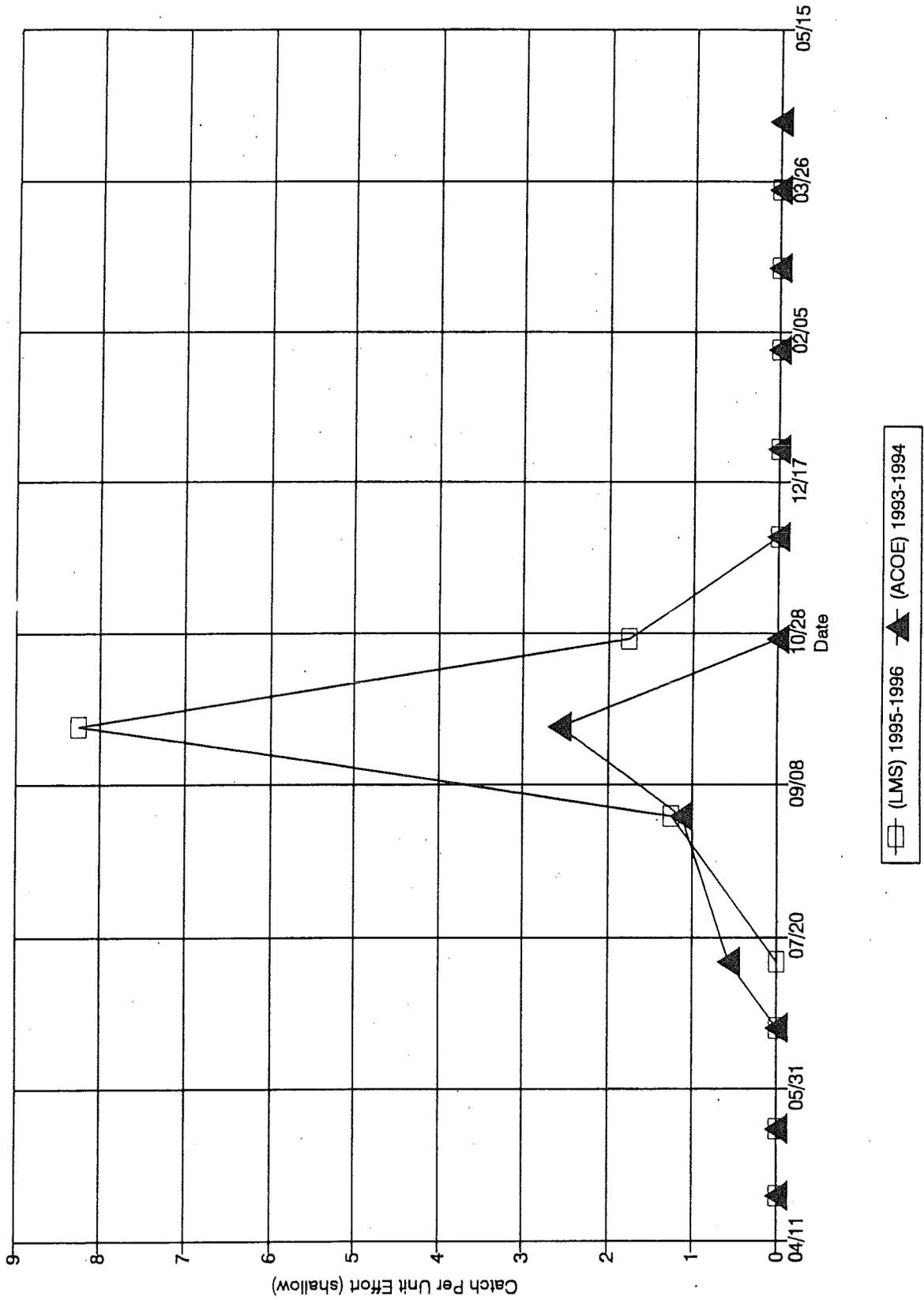
# Newark Bay Aquatic Sampling Studies

ACOE 1993-1994 Winter Flounder in Channel Areas of Newark Bay



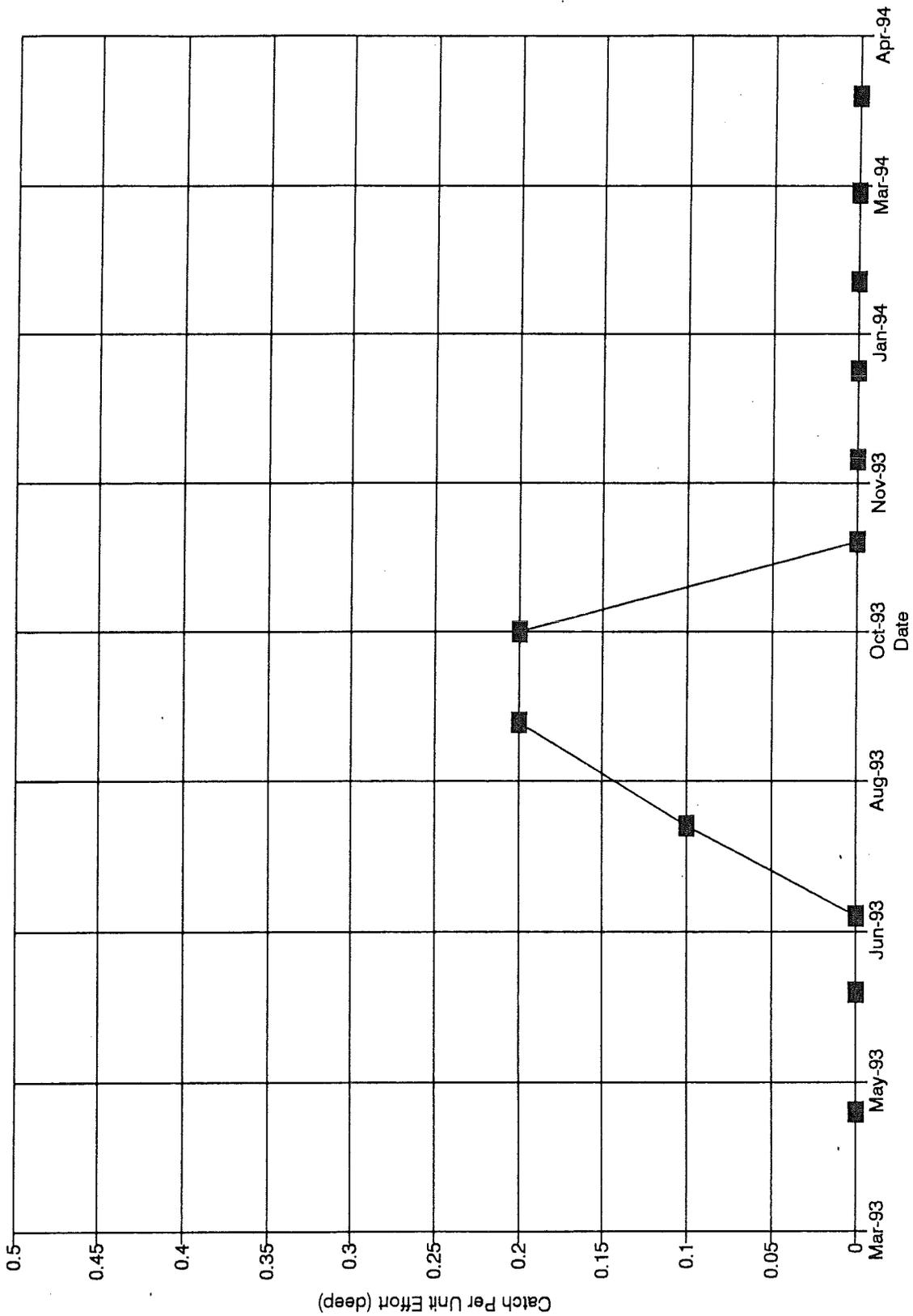
# Newark Bay Aquatic Sampling Studies

Blue Fish in Shoal Areas of Newark Bay



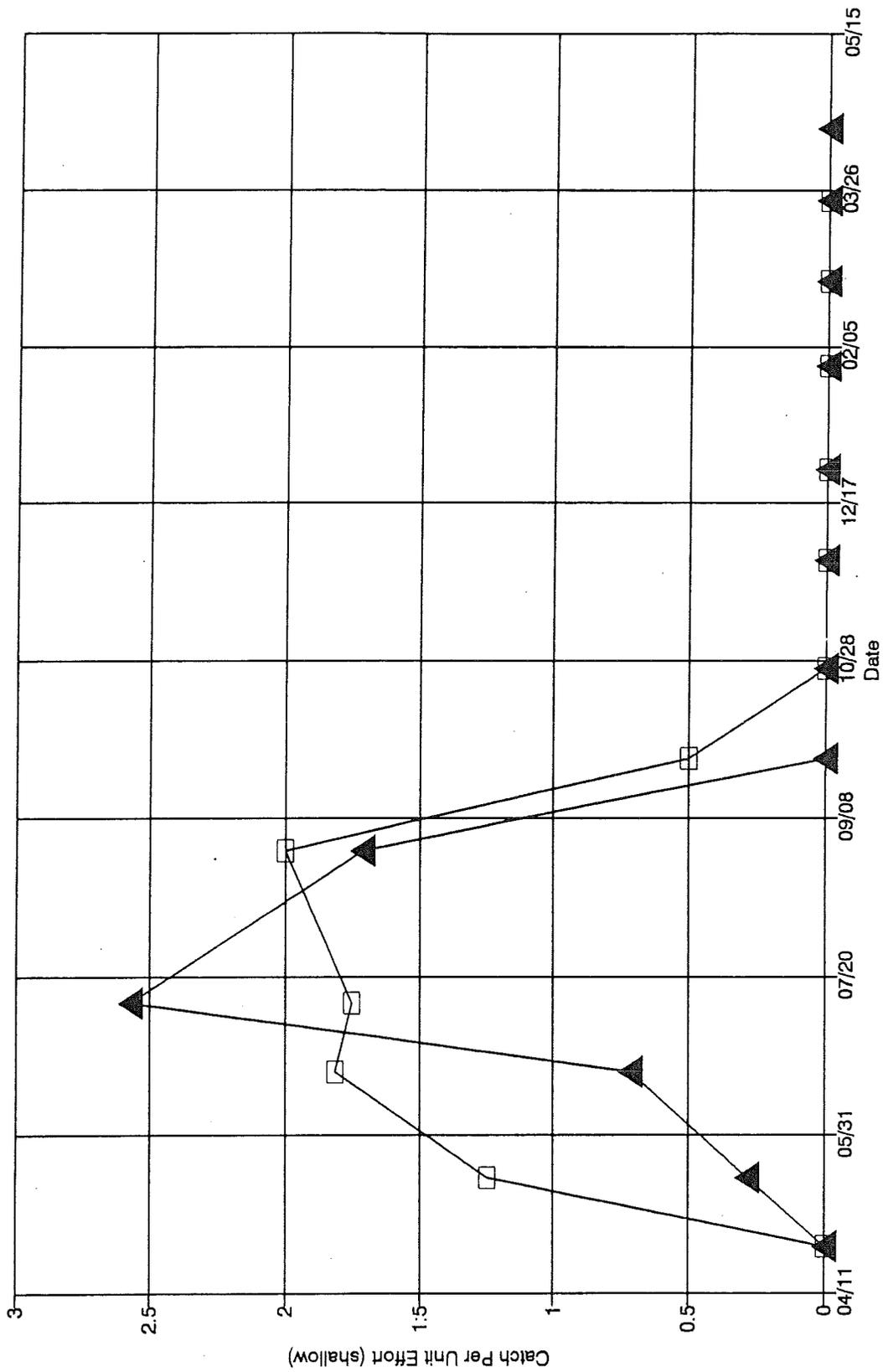
# Newark Bay Aquatic Sampling Studies

ACOE 1993-1994 Blue Fish in Channel Areas of Newark Bay



# Newark Bay Aquatic Sampling Studies

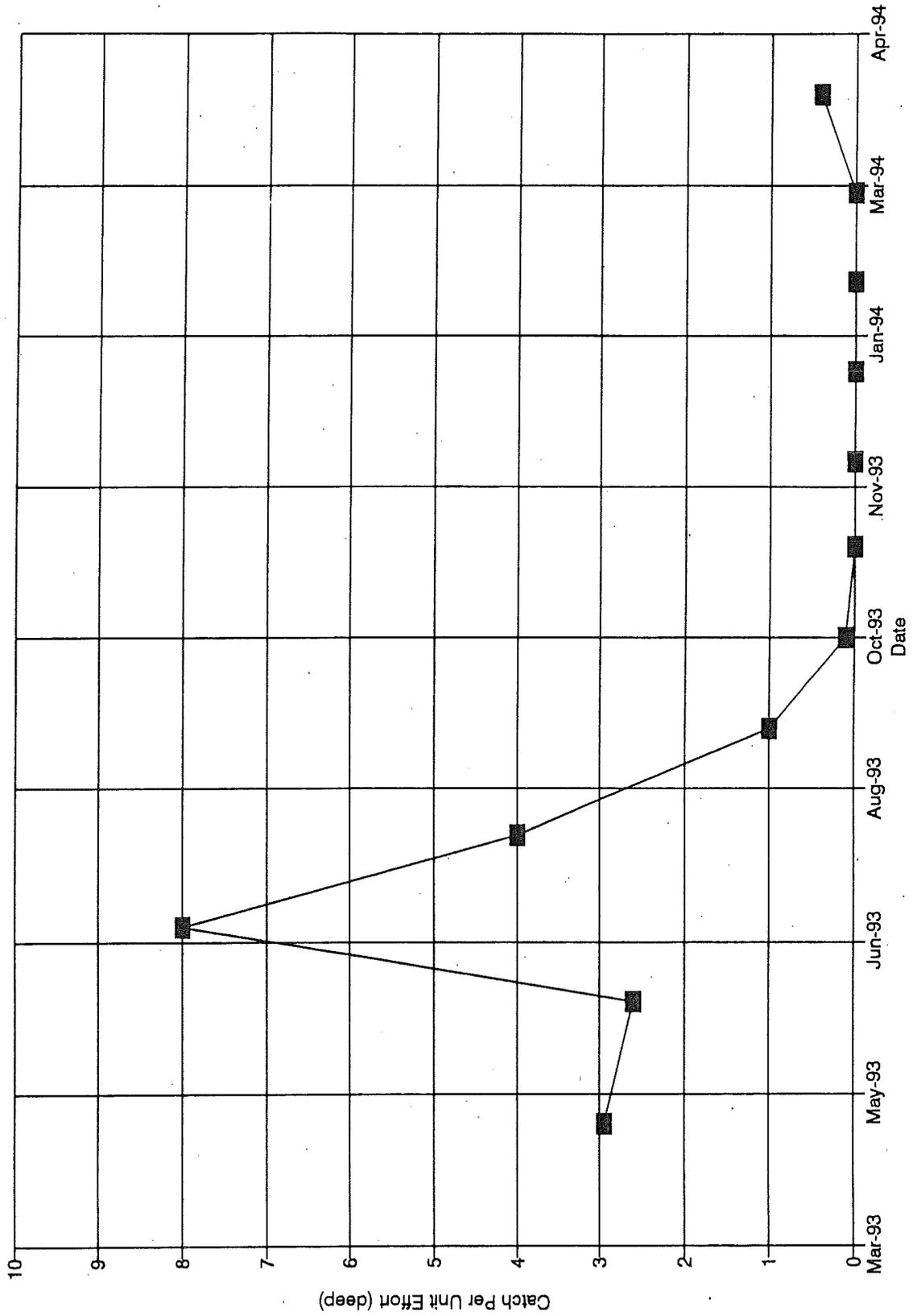
## Summer Flounder in Shoal Areas of Newark Bay



□ (LMS) 1995-1996    ▲ (ACOE) 1993-1994

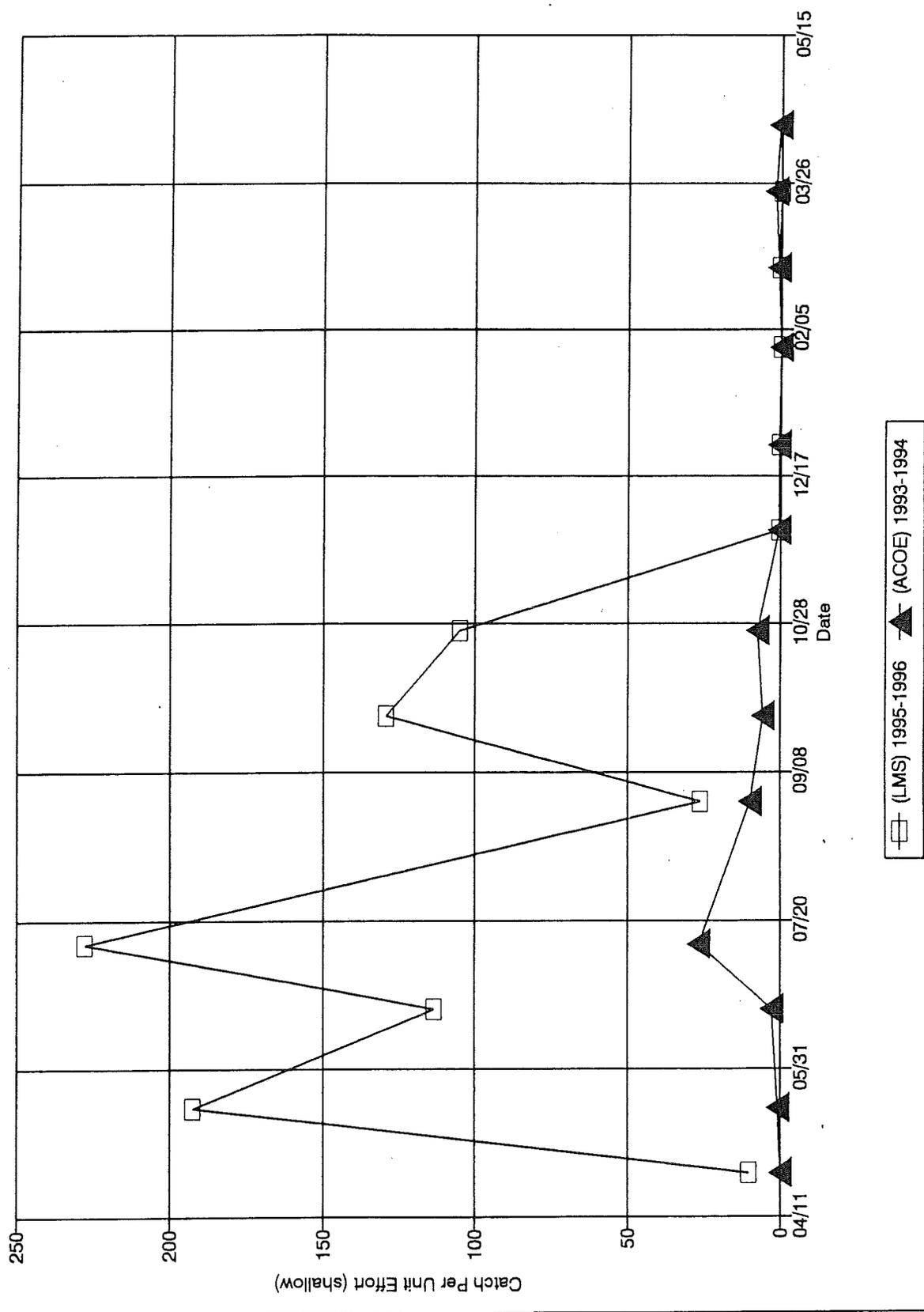
# Newark Bay Aquatic Sampling Studies

ACOE 1993-1994 Summer Flounder in Channel Areas of Newark Bay



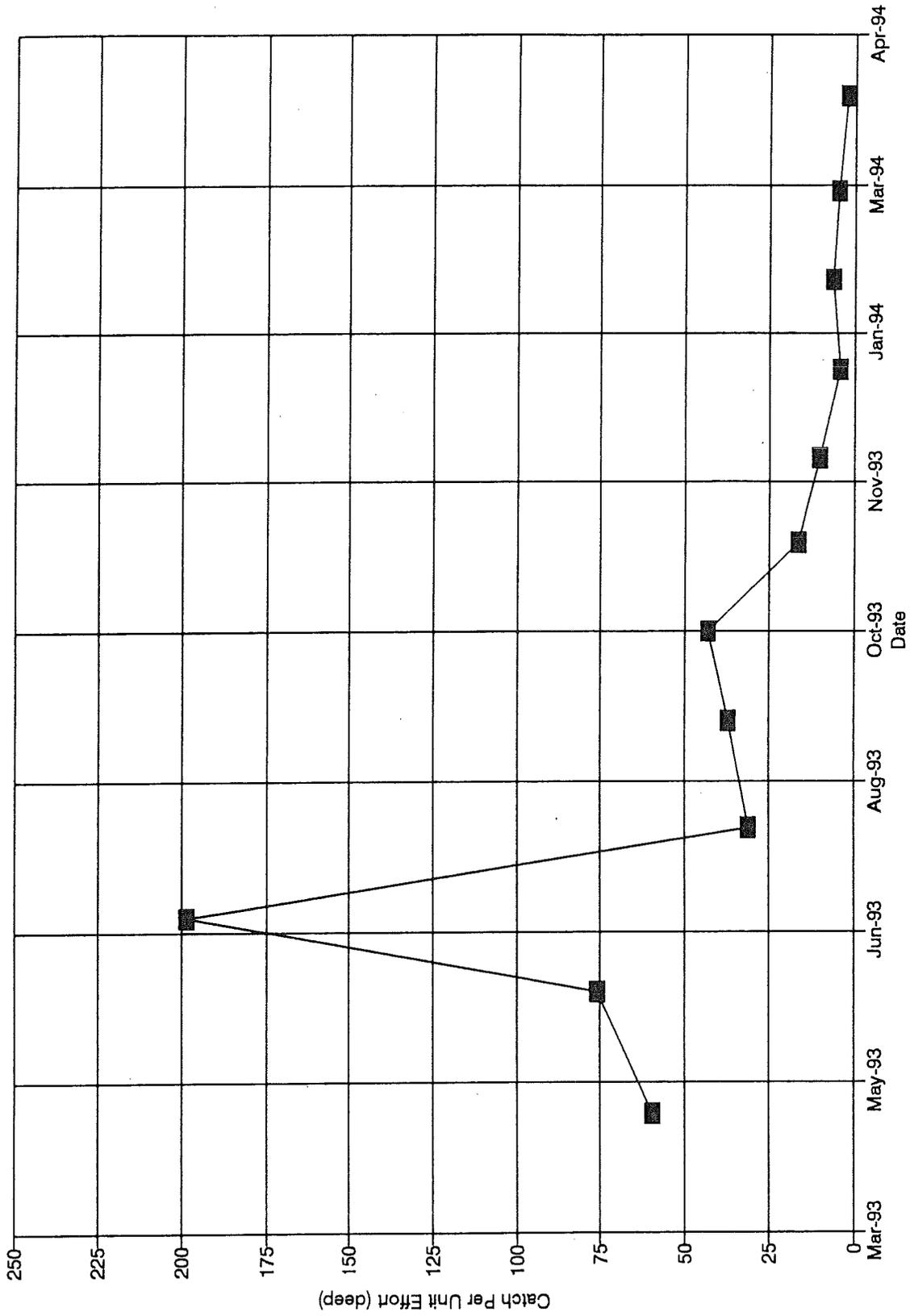
# Newark Bay Aquatic Sampling Studies

## Blue Crab in Shoal Areas of Newark Bay



# Newark Bay Aquatic Sampling Studies

ACOE 1993-1994 Blue Crab in Channel Areas of Newark Bay



**APPENDIX D**

**ICHTHYOPLANKTON AND EPIBENTHIC INVERTEBRATE DATA**

TABLE C-1 (Page 1 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION  
 NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW Date	ALL STATIONS (4 Newark Bay; 2-Channel Sites) 1-2'												Station Total	Percent Comp.	
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>ICHTHYOPLANKTON</b>																
<i>Bay anchovy</i> - egg				52665	28058										80723	
yolk-sac					9										9	
post-yolk sac					963			139	11						1113	
juvenile															0	
Total	0	0	52665	29030	0	139	11	0	0	0	0	0	0	81845	90.235	
<i>Silver hake</i> - egg					876										876	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total	0	0	0	876	0	0	0	0	0	0	0	0	0	876	0.966	
<i>Silverides</i> - egg															0	
yolk-sac			20												20	
post-yolk sac															0	
juvenile															0	
Total	0	20	0	0	0	0	0	0	0	0	0	0	0	20	0.022	
<i>Northern pipefish</i> - egg															0	
yolk-sac						11		29							0	
post-yolk sac						10		22							39	
juvenile				151	21	22	29	0	11	0	0	0	0	194		
Total	0	0	151	21	22	29	0	11	0	0	0	0	0	233	0.257	
<i>Grubby</i> - egg															0	
yolk-sac	25														172	
post-yolk sac	74												147	74		
juvenile														0		
Total	99	0	0	0	0	0	0	0	0	0	0	0	147	246	0.271	
<i>Weakfish</i> - egg	470	831	595												1896	
yolk-sac															0	
post-yolk sac															0	
juvenile									11						11	
Total	470	831	595	0	0	0	0	11	11	0	0	0	0	1907	2.103	
<i>Labridae</i> - egg				254	194										448	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total	0	0	254	194	0	0	0	0	0	0	0	0	0	448	0.494	
<i>Tautog</i> - egg			2755												2755	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total	0	2755	0	0	0	0	0	0	0	0	0	0	0	2755	3.038	
<i>Cunner</i> - egg								10							10	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total	0	0	0	0	0	0	0	10	0	0	0	0	0	10	0.011	
<i>American sand lance</i> - egg															0	
yolk-sac															15	
post-yolk sac															12	
juvenile															0	
Total	0	0	0	0	0	0	0	0	0	0	0	0	27	27	0.030	
<i>Gobiidae</i> - egg															0	
yolk-sac															0	
post-yolk sac				173	1564	24	46								1806	
juvenile															0	
Total	0	0	173	1564	24	46	0	0	0	0	0	0	0	1806	1.991	
<i>Naked goby</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile							14		16						31	
Total	0	0	0	0	0	0	14	0	16	0	0	0	0	31	0.034	
<i>Summer flounder</i> - egg								111	44						155	
yolk-sac								14							14	
post-yolk sac															0	
juvenile															0	
Total	0	0	0	0	0	0	125	44	0	0	0	0	0	169	0.186	
<i>Windowpane</i> - egg															0	
yolk-sac															0	
post-yolk sac			10												10	
juvenile															0	
Total	0	10	0	0	0	0	0	0	0	0	0	0	0	10	0.011	
<i>Winter flounder</i> - egg													73		73	
yolk-sac															0	
post-yolk sac	228	19													247	
juvenile															0	
Total	228	19	0	0	0	0	0	0	0	0	0	0	73	319	0.352	
<b>Total collected</b>		797	3635	53837	31685	46	353	64	38	0	0	0	246	90702	100.00	

TABLE C-1 (Page 2 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION  
 NUMBERS COLLECTED PER 1000 CUBIC METER

Station Appx. Depth at MLW Date	ALL STATIONS (4 Newark Bay; 2-Channel Sites) 1-2'												Station Total	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>SPECIES COLLECTED</b>															
<b>EPIBENTHOS</b>															
<b>ARTHROPODA</b>															
<i>Amphipoda</i>	24							23	22	13	12			93	0.004
<i>Gammaridae</i>		22	38094	70560										108876	4.606
<i>Gammarus sp.</i>	3112	2536				675	586	22	1964	1621	286	233	1124	12159	0.615
<i>Gammarus mucronatus</i>		11												11	0.000
<i>Stenothoidae</i>								151	580	14			248	993	0.042
<i>Paramecopelta cypris</i>	112	123	463	52				11						761	0.032
<i>Caprellidae</i>			21					77						97	0.004
<i>Corophidae</i>			23	109										133	0.006
<i>Corophium sp.</i>	42	31												1550	0.066
<i>Melittidae</i>							120	193	1050	95	10	10		43	0.002
<i>Melita nitida</i>							43	173	842	452	22		74	1606	0.068
<i>Ampelisca sp.</i>								117	33	354	65	22	32	622	0.026
<i>Ampelisca abdita</i>	244		65											309	0.013
<i>Aoridae</i>		104	33	46										183	0.008
<i>Isoopoda</i>			12											12	0.001
<i>Cyathura polita</i>	24		12						33	133			14	215	0.009
<i>Edotea triloba</i>			63	33			13	227	14305	3234	97	251	1043	19266	0.817
<i>Edotea monilosa</i>			89											69	0.003
<i>Sphaeroma sp.</i>			11											11	0.000
<i>Cymothoidae</i>								13						13	0.001
<b>Cumacea</b>															
<i>Leucon americanus</i>	3039	1062	1102	44			28	364	1895	32420	58	238	216	40465	1.715
<i>Oxyurostylis smithii</i>	19	9					134	11		13				186	0.008
<i>Copepoda</i>	1115695	332869	91549	46522			96	5474	4290	5861	1671	39692	116590	1760309	74.610
<i>Myidae</i>	24	437	5319	20281										26060	1.105
<i>Neomysis americana</i>	24	637	2340	8716	173	1290	11371	12374	20888	119	430	7307		65669	2.783
<i>Ostracoda</i>			21					16						37	0.002
<i>Acantho</i>								10	14					23	0.001
<i>Caridea (Larvae)</i>		392	6583	12615	2171	15890	2908							40557	1.719
<i>Crangon septemspinosus</i>	96	220	184	185					10183	6822	335	441	1541	20007	0.848
<i>Palaemonetes sp.</i>							44	22	126	38				229	0.010
<i>Brachyura (Zoeae)</i>		40	11770	234114	61	437	53							246475	10.447
<i>Callinectes sapidus</i>						14	11	131	36					193	0.008
<i>Rhithropanopeus harrisi</i>								49						49	0.002
<b>MOLLUSCA</b>															
<i>Brachidontes (Larvae)</i>										112				112	0.005
<i>Mytilus edulis</i>			62											62	0.003
<b>CHAETOGNATHA</b>															
<i>Sagittia sp.</i>	1366	129												1495	0.063
<b>CNIDARIA (Coelenterata)</b>															
<i>Hydrozoa (Medusa)</i>		140		196	9470	197	11							10015	0.424
<b>CHORDATA</b>															
<i>Molgula manhattensis</i>					26		10	115	423					574	0.024
<b>Total collected</b>	<b>1123820</b>	<b>338761</b>	<b>157795</b>	<b>393473</b>	<b>12576</b>	<b>18904</b>	<b>21269</b>	<b>48017</b>	<b>72542</b>	<b>2676</b>	<b>41316</b>	<b>128189</b>	<b>2359339</b>	<b>100.000</b>	

TABLE C-2 (Page 1 of 2)  
**NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996**  
**EPIBENTHOS COLLECTION**  
**NUMBERS COLLECTED PER 1000 CUBIC METER**

SPECIES COLLECTED	Station Appx. Depth at MLW Date	TOTAL FOUR NEWARK BAY STATIONS												Station Total	Percent Comp.
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR		
<b>ICHTHYOPLANKTON</b>															
<i>Bay anchovy</i> - egg				51682	27050										78732
yok-sac					9										9
post-yok sac					897			139							1037
juvenile															0
Total	0	0	51682	27957	0	139	0	0	0	0	0	0	0	79778	93.204
<i>Silver hake</i> - egg					694										694
yok-sac															0
post-yok sac															0
juvenile															0
Total	0	0	0	694	0	0	0	0	0	0	0	0	0	694	0.811
<i>Silverides</i> - egg															0
yok-sac															0
post-yok sac															0
juvenile															0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Northern pipefish</i> - egg															0
yok-sac															0
post-yok sac								29							29
juvenile				138	10	22									170
Total	0	0	138	10	22	29	0	0	0	0	0	0	0	199	0.233
<i>Grubby</i> - egg															0
yok-sac															24
post-yok sac	19														19
juvenile															0
Total	19	0	0	0	0	0	0	0	0	0	0	0	24	42	0.050
<i>Weakfish</i> - egg		399	494	583											1476
yok-sac															0
post-yok sac															0
juvenile															0
Total	399	494	583	0	0	0	0	0	0	0	0	0	0	1476	1.725
<i>Labridae</i> - egg				254	184										438
yok-sac															0
post-yok sac															0
juvenile															0
Total	0	0	254	184	0	0	0	0	0	0	0	0	0	438	0.511
<i>Tautog</i> - egg			894												894
yok-sac															0
post-yok sac															0
juvenile															0
Total	0	894	0	0	0	0	0	0	0	0	0	0	0	894	1.044
<i>Cunner</i> - egg															0
yok-sac															0
post-yok sac															0
juvenile															0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>American sand lance</i> - egg															0
yok-sac															0
post-yok sac													12		12
juvenile															0
Total	0	0	0	0	0	0	0	0	0	0	0	0	12	12	0.014
<i>Gobiidae</i> - egg															0
yok-sac															0
post-yok sac				173	1476	24	17								1690
juvenile															0
Total	0	0	173	1476	24	17	0	0	0	0	0	0	0	1690	1.974
<i>Naked goby</i> - egg															0
yok-sac															0
post-yok sac															0
juvenile									16	16	0				16
Total	0	0	0	0	0	0	0	0	16	16	0	0	0	16	0.019
<i>Summer flounder</i> - egg							58	11							69
yok-sac							14								14
post-yok sac															0
juvenile															0
Total	0	0	0	0	0	0	72	11	0	0	0	0	0	83	0.097
<i>Windowpane</i> - egg															0
yok-sac															0
post-yok sac															0
juvenile															0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Winter flounder</i> - egg													73		73
yok-sac															0
post-yok sac	200														200
juvenile															0
Total	200	0	0	0	0	0	0	0	0	0	0	0	73	273	0.319
<b>Total collected</b>		618	1387	52830	30321	46	257	11	16	0	0	0	108	85595	100.000

TABLE C-2 (Page 2 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION

NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW Date	TOTAL FOUR NEWARK BAY STATIONS												Station Total	Percent Comp.	
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT 1-2'	NOV	DEC	JAN 1996	FEB	MAR			
<b>EPIBENTHOS</b>																
<b>ARTHROPODA</b>																
<i>Amphipoda</i>	24							23					12		59	0.004
<i>Gammaridae</i>			22	18593	1465										20080	1.234
<i>Gammarus sp.</i>	3112					811	573		1964	1508	179	156	1114		9217	0.566
<i>Gammarus mucronatus</i>			11												11	0.001
<i>Stenothoidae</i>									574	14			248		836	0.051
<i>Parameiopella cypris</i>	112	66	330	9				11							527	0.032
<i>Caprellidae</i>			21					66							87	0.005
<i>Corophidae</i>																
<i>Corophium sp.</i>	42	11						22	1050	95	10				1230	0.076
<i>Meloidae</i>																
<i>Melita nitida</i>							14		836	426	12		74		1363	0.084
<i>Ampeliscidae</i>																
<i>Ampelisca sp.</i>									33	354	55	22	32		496	0.030
<i>Ampelisca abdita</i>	244		65												309	0.019
<i>Acridae</i>					24										24	0.001
<i>Isopoda</i>				12											12	0.001
<i>Cyathura polita</i>	24			12						33	133		14		215	0.013
<i>Edotea trioba</i>				63						14305	3212	97	251	1032	18961	1.165
<i>Edotea montana</i>				21											21	0.001
<i>Sphaeroma sp.</i>				11											11	0.001
<i>Cymothoidae</i>								13							13	0.001
<b>Cumacea</b>																
<i>Leucon americanus</i>	3039	1052	963												36006	2.213
<i>Oxyurostylis smithii</i>	19														19	0.001
<i>Copepoda</i>	793335	180179	87972	41346			68	828	663	1317	1087	8470	66713	1181977	72.641	
<i>Mysidacea</i>	24		4513	2214											6751	0.415
<i>Neomysis americana</i>	24		243	8574			1092	11	10204	17473	11	350	7072	45055	2.769	
<i>Ostracoda</i>			21						16						37	0.002
<i>Acanth</i>									10	14					23	0.001
<i>Caridae (Larvae)</i>			98	5463	7544	1849	10583	940							26477	1.627
<i>Crangon septemspinosus</i>	96	211	136	9						10151	6562	335	441	1541	19481	1.197
<i>Palaemonetes sp.</i>							17	11	82	25					135	0.008
<i>Brachyura (Zoea)</i>		11	11445	233865	35		437								245793	15.106
<i>Callinectes sapidus</i>										131	36				178	0.011
<i>Rhithropanopeus harrisi</i>										49					49	0.003
<b>MOLLUSCA</b>																
<i>Bivalvia (Larvae)</i>											112				112	0.007
<i>Mytilus edulis</i>																
<b>CHAETOGNATHA</b>																
<i>Sagitta sp.</i>	1227	44													1271	0.078
<b>Cnidaria (Coelenterata)</b>																
<i>Hydrozoa (Medusa)</i>		62		196	9380	142	11								9792	0.602
<b>CHORDATA</b>																
<i>Molgula manhattensis</i>	0	0	0	0	0	0	0	0	115	410	0	0	0	525	0.032	
<b>Total collected</b>	<b>801320</b>	<b>181766</b>	<b>129884</b>	<b>295245</b>	<b>11876</b>	<b>12939</b>	<b>1945</b>	<b>41298</b>	<b>61204</b>	<b>1837</b>	<b>9869</b>	<b>77967</b>	<b>1627150</b>	<b>100.000</b>		

TABLE C-3 (Page 1 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION  
 NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW	Date	TWO CHANNEL SITES 1-2'											Station Total	Percent Comp.		
			APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB			MAR	
<b>ICHTHYOPLANKTON</b>																	
<i>Bay anchovy</i> - egg					983	1008										1991	
yolk-sac																0	
post-yolk sac						65				11						76	
juvenile																0	
Total		0	0	983	1073	0	0	11	0	0	0	0	0	0	0	2067	40.471
<i>Silver hake</i> - egg						182										182	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	182	0	0	0	0	0	0	0	0	0	0	182	3.562
<i>Silversides</i> - egg																0	
yolk-sac						20										20	
post-yolk sac																0	
juvenile																0	
Total		0	20	0	0	0	0	0	0	0	0	0	0	0	0	20	0.384
<i>Northern pipefish</i> - egg																0	
yolk-sac																0	
post-yolk sac							11									11	
juvenile					12	11				11						23	
Total		0	0	12	11	0	0	0	11	0	0	0	0	0	0	34	0.664
<i>Grubby</i> - egg																0	
yolk-sac																148	
post-yolk sac		25													123	56	
juvenile		55													0	0	
Total		80	0	0	0	0	0	0	0	0	0	0	0	123	203	3.983	
<i>Weakfish</i> - egg			71	337	12											420	
yolk-sac																0	
post-yolk sac																0	
juvenile										11						11	
Total		71	337	12	0	0	0	0	11	0	0	0	0	0	0	431	8.443
<i>Leoridae</i> - egg						11										11	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	11	0	0	0	0	0	0	0	0	0	0	11	0.210
<i>Tautog</i> - egg				1862												1862	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	1862	0	0	0	0	0	0	0	0	0	0	0	0	1862	36.451
<i>Cunner</i> - egg									10							10	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	10	0	0	0	0	0	0	10	0.192
<i>American sand lance</i> - egg																0	
yolk-sac																15	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	15	15	0.298	
<i>Gobiidae</i> - egg																0	
yolk-sac																0	
post-yolk sac						88		29								117	
juvenile																0	
Total		0	0	0	88	0	29	0	0	0	0	0	0	0	0	117	2.283
<i>Naked goby</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile								14								14	
Total		0	0	0	0	0	0	14	0	0	0	0	0	0	0	14	0.280
<i>Summer flounder</i> - egg								53	32							86	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	53	32	0	0	0	0	0	0	86	1.676
<i>Windowpane</i> - egg																0	
yolk-sac																0	
post-yolk sac						10										10	
juvenile																0	
Total		0	10	0	0	0	0	0	0	0	0	0	0	0	0	10	0.192
<i>Winter flounder</i> - egg																0	
yolk-sac																0	
post-yolk sac			28	19												47	
juvenile																0	
Total		28	19	0	0	0	0	0	0	0	0	0	0	0	0	47	0.912
<b>Total collected</b>			179	2247	1007	1365	0	96	53	22	0	0	0	138	5107	100.00	

TABLE C-3 (Page 2 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION

NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW Date	TWO CHANNEL SITES 1-2'											Station Total	Percent Comp.	
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB			MAR
<b>EPIBENTHOS</b>															
<b>ARTHROPODA</b>															
<i>Amphipoda</i>															
<i>Gammaridae</i>			19501	69096					22	13				35	0.005
<i>Gammarus sp.</i>		2536				63	13	22		113	107	76	11	2942	0.402
<i>Gammarus mucronatus</i>															
<i>Stenothoidae</i>								151	6					157	0.021
<i>Parameopella cypris</i>		58	133	43										234	0.032
<i>Caprellidae</i>								11						11	0.001
<i>Corophiidae</i>			23	109										133	0.018
<i>Corophium sp.</i>		20					120	171				10		321	0.044
<i>Melitidae</i>								43						43	0.006
<i>Melitta nitida</i>							29	173	6	26	10			243	0.033
<i>Ampeliscidae</i>															
<i>Ampelisca sp.</i>								117			10			127	0.017
<i>Ampelisca abdita</i>															
<i>Aoridae</i>		104	33	22										159	0.022
<i>Isopoda</i>															
<i>Cyathura polita</i>															
<i>Edotea triloba</i>				33			13	227		22			11	306	0.042
<i>Edotea montosa</i>			48											48	0.007
<i>Sphaeroma sp.</i>															
<i>Cymothoidae</i>															
<i>Cumacea</i>															
<i>Leucon americanus</i>			9	139	44		28	353	812	2906	20	59	89	4459	0.609
<i>Oxyurostylis smithii</i>			9				134	11		13				167	0.023
<i>Copepoda</i>	322380	152690	3577	5176			28	4647	3627	4544	585	31221	49877	578332	78.987
<i>Mysidaceae</i>		437	806	18067										19310	2.637
<i>Neomysis americana</i>		637	2096	142		173	198	11360	2170	3415	108	80	235	20614	2.815
<i>Ostracoda</i>															
<i>Acantho</i>															
<i>Caridea (Larvae)</i>		293	1120	5072	322	5306	1966							14079	1.923
<i>Crangon septemspinatus</i>		9	48	176					33	260				526	0.072
<i>Palaemonetes sp.</i>							27	11	44	13				94	0.013
<i>Brachyura (Zoeae)</i>		29	325	249	26		53							682	0.093
<i>Callinectes sapidus</i>							14							14	0.002
<i>Rhithropanopeus harrisi</i>															
<b>MOLLUSCA</b>															
<i>Bivalvia (Larvae)</i>															
<i>Mytilus edulis</i>			62											62	0.008
<b>CHAETOGNATHA</b>															
<i>Sagitta sp.</i>	140	85												225	0.031
<b>CNIDARIA (Coelenterata)</b>															
<i>Hydrozoa (Medusa)</i>		78				90	55							224	0.031
<b>CHORDATA</b>															
<i>Molgula manhattensis</i>					26			10		13				49	0.007
<b>Total collected</b>		322500	156996	27911	98228	700	5965	19324	6719	11338	839	31447	50223	732189	100.000

TABLE C-4 (Page 1 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION

NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW Date	APR 1995	MAY	JUN	JUL	AUG	NBSW 1-2'						Station Total	Percent Comp.	
							SEP	OCT	NOV	DEC	JAN 1996	FEB			MAR
<b>ICHTHYOPLANKTON</b>															
<i>Bay anchovy</i> - egg				7390	9192									16583	
yok-sac														0	
post-yok sac					83		68							151	
juvenile														0	
Total		0	0	7390	9275	0	68	0	0	0	0	0	0	16734	93.218
<i>Silver hake</i> - egg					283									283	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	283	0	0	0	0	0	0	0	0	283	1.578
<i>Silverides</i> - egg														0	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Northern pipefish</i> - egg														0	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Grubby</i> - egg														0	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Weakfish</i> - egg		47	122	211										380	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		47	122	211	0	0	0	0	0	0	0	0	0	380	2.116
<i>Labridae</i> - egg				161	35									197	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	161	35	0	0	0	0	0	0	0	0	197	1.096
<i>Tautog</i> - egg			133											133	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	133	0	0	0	0	0	0	0	0	0	0	133	0.742
<i>Cunner</i> - egg														0	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>American sand lance</i> - egg														0	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Gobidae</i> - egg														0	
yok-sac														0	
post-yok sac					153		17							171	
juvenile														0	
Total		0	0	0	153	0	17	0	0	0	0	0	0	171	0.950
<i>Naked goby</i> - egg														0	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Summer flounder</i> - egg														0	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Windowpane</i> - egg														0	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Winter flounder</i> - egg													54	54	
yok-sac														0	
post-yok sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	54	54	0.301
<b>Total collected</b>		47	255	7762	9747	0	86	0	0	0	0	0	54	17951	100.000

TABLE C-4 (Page 2 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION

NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW Date	NBSW 1-2'												Station Total	Percent Comp.		
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR				
<b>EPIBENTHOS</b>																	
<b>ARTHROPODA</b>																	
<i>Amphipoda</i>															23	0.020	
<i>Gammaridae</i>				868	401										1269	1.105	
<i>Gammarus</i> sp.	1434						107	359				39	54		1992	1.734	
<i>Gammarus mucronatus</i>																	
<i>Stenothoidae</i>															27	0.023	
<i>Parameiopelle cypris</i>			11												11	0.010	
<i>Caprellidae</i>																	
<i>Corophiidae</i>																	
<i>Corophium</i> sp.	24														24	0.020	
<i>Meloidae</i>																	
<i>Melita nitida</i>																	
<i>Ampeliscaidae</i>																	
<i>Ampelisca</i> sp.																	
<i>Ampelisca abdita</i>	212			12						55					55	0.048	
<i>Aoridae</i>							24								24	0.021	
<i>Isopoda</i>				12											12	0.011	
<i>Cyathura polita</i>	24			12											12	0.011	
<i>Edotea triloba</i>															66	0.081	
<i>Edotea monilosa</i>															66	0.081	
<i>Sphaeroma</i> sp.															14	0.011	
<i>Cymochoidea</i>															93	0.081	
<i>Cumacea</i>															132	0.114	
<i>Leucon americanus</i>			944	99							25806	28	157	108	27142	23.623	
<i>Oxyurostylis smithii</i>																	
<i>Copepoda</i>	5640	46620	1414	2667				68	137	468	55	84	2122	8546	67820	59.028	
<i>Mysidacea</i>	24		211	24											258	0.224	
<i>Neomysis americana</i>				153				923		36	3938			314	122	5487	4.775
<i>Ostracoda</i>																	
<i>Acarid</i>																	
<i>Caridae (Larvae)</i>			11	1724	1982	533	3164	34							7447	6.482	
<i>Crangon septemspinosus</i>	47	200	12												1559	1.356	
<i>Palaemonetes</i> sp.								17							28	0.024	
<i>Brachyura (Zoea)</i>					260			393							653	0.568	
<i>Callinectes sapidus</i>															22	0.019	
<i>Rhithropanopeus harrisi</i>															22	0.019	
<b>MOLLUSCA</b>																	
<i>Bivalvia (Larvae)</i>																	
<i>Mytilus edulis</i>											33				33	0.029	
<b>CHAETOGNATHA</b>																	
<i>Sagitta</i> sp.		11													11	0.010	
<b>CNIDARIA (Coelenterata)</b>																	
<i>Hydrozoa (Medusa)</i>					165	383									549	0.477	
<b>CHORDATA</b>																	
<i>Molgula manhattensis</i>																	
<b>Total collected</b>	7403	47797	4365	5676	1022	4925	194	504	31053	112	2934	8910	114894	100.000			

TABLE C-5 (Page 1 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION

NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Appx. Depth at MLW	Station Date	NBNW 1-4'												Station Total	Percent Comp.	
			APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>ICHTHYOPLANKTON</b>																	
<i>Bay anchovy</i> - egg					1813	3186										4998	
yolk-sac						9										9	
post-yolk sac						79		58								137	
juvenile																0	
Total		0	0	1813	3274	0	58	0	0	0	0	0	0	0	0	5144	70.914
<i>Silver hake</i> - egg						370										370	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	370	0	0	0	0	0	0	0	0	0	0	370	5.095
<i>Silversides</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Northern pipefish</i> - egg																0	
yolk-sac																0	
post-yolk sac								14								14	
juvenile				21	0	0	0	0	0	0	0	0	0	0	0	21	
Total		0	0	21	0	0	0	14	0	0	0	0	0	0	0	35	0.482
<i>Grubby</i> - egg																0	
yolk-sac																0	
post-yolk sac		19														24	
juvenile																19	
Total		19	0	0	0	0	0	0	0	0	0	0	0	24	0	42	0.585
<i>Weakfish</i> - egg		112	207	340												659	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		112	207	340	0	0	0	0	0	0	0	0	0	0	0	659	9.079
<i>Labridae</i> - egg				93	97											190	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	93	97	0	0	0	0	0	0	0	0	0	0	190	2.612
<i>Tautog</i> - egg			469													469	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	469	0	0	0	0	0	0	0	0	0	0	0	0	469	6.461
<i>Cunner</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>American sand lance</i> - egg																0	
yolk-sac																0	
post-yolk sac																12	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	12	12	0.164	
<i>Gobidae</i> - egg																0	
yolk-sac																0	
post-yolk sac						167										167	
juvenile																0	
Total		0	0	0	167	0	0	0	0	0	0	0	0	0	0	167	2.305
<i>Naked goby</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile									16	16	0	0	0	0	0	16	
Total		0	0	0	0	0	0	0	16	16	0	0	0	0	0	16	0.226
<i>Summer flounder</i> - egg							58									58	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	58	0	0	0	0	0	0	0	0	58	0.794
<i>Windowpane</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Winter flounder</i> - egg																0	
yolk-sac																0	
post-yolk sac		93														93	
juvenile																0	
Total		93	0	0	0	0	0	0	0	0	0	0	0	0	0	93	1.282
<b>Total collected</b>			223	676	2266	3907	0	130	0	16	0	0	0	36	7254	100.000	

TABLE C-5 (Page 2 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1996-1996  
 EPIBENTHOS COLLECTION

NUMBERS COLLECTED PER 1000 CUBIC METER

Station Appx. Depth at MLW Date	NBNW 1-4'												Station Total	Percent Comp.	
	APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>SPECIES COLLECTED</b>															
<b>EPIBENTHOS</b>															
<b>ARTHROPODA</b>															
<i>Amphipoda</i>															
<i>Gammaridae</i>		22	16593	528										17143	2.672
<i>Gammarus sp.</i>	986				226	130			1935	431	42	21	36	3806	0.593
<i>Gammarus mucronatus</i>															
<i>Stenothoidae</i>									574	14			24	612	0.095
<i>Parameiopella cypris</i>	112	55	299	9										474	0.074
<i>Caprellidae</i>			21											21	0.003
<i>Corophiidae</i>															
<i>Corophium sp.</i>	19	11							1050		10			1090	0.170
<i>Meloidae</i>															
<i>Melita nitida</i>									836	222				1059	0.165
<i>Ampeliscidae</i>															
<i>Ampelisca sp.</i>									33	42				75	0.012
<i>Ampelisca abdita</i>															
<i>Aoridae</i>															
<i>Isopoda</i>															
<i>Cyathura polita</i>									33	70				102	0.016
<i>Edotea triloba</i>									14219	514	10		119	14863	2.317
<i>Edotea monilosa</i>															
<i>Sphaeroma sp.</i>															
<i>Cymothoidae</i>															
<i>Cumacea</i>															
<i>Leucon americanus</i>	2976	87	536						1082	278				4959	0.773
<i>Oxyurostylix smithii</i>	19													19	0.003
<i>Copepoda</i>	300390	128620	86005	3652					502	131	1140	260	3798	539242	84.064
<i>Mysidacea</i>			2225	1742										3967	0.618
<i>Neomysis americana</i>				7498				101	10168	7020			179	24964	3.892
<i>Ostracoda</i>									16					16	0.003
<i>Acarid</i>															
<i>Caridae (Larvae)</i>		65	1803	3608	239	5270	673							11658	1.817
<i>Crangon septemspinosus</i>	37	11	124	9					10135	1640	31		83	12070	1.882
<i>Palaemonetes sp.</i>									82					82	0.013
<i>Brachyura (Zoea)</i>		11	10	475	13	43								553	0.086
<i>Callinectes sapidus</i>									131	14				145	0.023
<i>Rhithropanopeus harrisi</i>									49					49	0.008
<b>MOLLUSCA</b>															
<i>Bivalvia (Larvae)</i>															
<i>Mytilus edulis</i>															
<b>CHAETOGNATHA</b>															
<i>Sagitta sp.</i>	112	33												144	0.022
<b>CNIDARIA (Coelenterata)</b>															
<i>Hydrozoa (Medusa)</i>					4030	115	11							4157	0.648
<b>CHORDATA</b>															
<i>Molgula manhattensis</i>									115	83				198	0.031
<b>Total collected</b>	<b>304649</b>	<b>128914</b>	<b>107614</b>	<b>17521</b>	<b>4509</b>	<b>5659</b>	<b>1186</b>	<b>40590</b>	<b>11468</b>	<b>354</b>	<b>3820</b>	<b>15184</b>	<b>641468</b>	<b>100.000</b>	

TABLE C-6 (Page 1 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION  
 NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW Date	NBSE 1-3'												Station Total	Percent Comp.	
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<i>Bay anchovy</i> - egg				15038	10944										25980	
yolk-sac															0	
post-yolk sac					684										684	
juvenile															0	
Total		0	0	15038	11628	0	0	0	0	0	0	0	0	0	26664	94.584
<i>Silver hake</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Silversides</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Northern pipefish</i> - egg															0	
yolk-sac															0	
post-yolk sac								14							14	
juvenile				42	0	0	0	0	0	0	0	0	0	0	42	
Total		0	0	42	0	0	14	0	0	0	0	0	0	0	56	0.200
<i>Grubby</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Weakfish</i> - egg		158	121												279	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		158	121	0	0	0	0	0	0	0	0	0	0	0	279	0.989
<i>Labridae</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Tautog</i> - egg			152												152	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	152	0	0	0	0	0	0	0	0	0	0	0	152	0.537
<i>Cunner</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>American sand lance</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Gobiidae</i> - egg															0	
yolk-sac															0	
post-yolk sac				11	980	24									1015	
juvenile															0	
Total		0	0	11	980	24	0	0	0	0	0	0	0	0	1015	3.600
<i>Naked goby</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Summer flounder</i> - egg									11						11	
yolk-sac								14							14	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	14	11	0	0	0	0	0	0	26	0.091
<i>Windowpane</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Winter flounder</i> - egg															0	
yolk-sac															0	
post-yolk sac															0	
juvenile															0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<b>Total collected</b>		158	273	15089	12608	24	29	11	0	0	0	0	0	0	28191	100.000



TABLE C-7 (Page 1 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION  
 NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW	Date	NBNE 1-2'												Station Total	Percent Comp.	
			APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>ICHTHYOPLANKTON</b>																	
<i>Bay anchovy</i> - egg					27443	3729										31171	
yolk-sac																0	
post-yolk sac							52		13							65	
juvenile																0	
Total		0	0	27443	3780	0	13	0	0	0	0	0	0	0	0	31236	97.010
<i>Silver hake</i> - egg						41										41	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	41	0	0	0	0	0	0	0	0	0	0	41	0.128
<i>Silversides</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Northern pipefish</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile					76	10	22									108	
Total		0	0	76	10	22	0	0	0	0	0	0	0	0	0	108	0.335
<i>Grubby</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Weakfish</i> - egg		83	43	32												159	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		83	43	32	0	0	0	0	0	0	0	0	0	0	0	159	0.493
<i>Labridae</i> - egg						52										52	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	52	0	0	0	0	0	0	0	0	0	0	52	0.160
<i>Tautog</i> - egg			140													140	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	140	0	0	0	0	0	0	0	0	0	0	0	0	140	0.436
<i>Cunner</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>American sand lance</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Gobiidae</i> - egg																0	
yolk-sac																0	
post-yolk sac					162	175										337	
juvenile																0	
Total		0	0	162	175	0	0	0	0	0	0	0	0	0	0	337	1.047
<i>Naked goby</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Summer flounder</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Windowpane</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Winter flounder</i> - egg														19		19	
yolk-sac																0	
post-yolk sac		107														107	
juvenile																0	
Total		107	0	0	0	0	0	0	0	0	0	0	0	19	126	0.390	
<b>Total collected</b>		190	184	27713	4058	22	13	0	0	0	0	0	0	19	32199	100.000	

TABLE C-7 (Page 2 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION

NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW Date	NBNE 1-2'											Station Total	Percent Comp.	
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB			MAR
<b>EPIBENTHOS</b>															
<b>ARTHROPODA</b>															
<i>Amphipode</i>	24												12	36	0.015
<i>Gammaridae</i>				1058	216									1275	0.546
<i>Gammarus sp.</i>						88	27			581	84	36	911	1726	0.739
<i>Gammarus mucronatus</i>			11											11	0.005
<i>Stenothoidae</i>													149	149	0.064
<i>Parameiopella cypria</i>								11						11	0.005
<i>Caprellidae</i>								66						66	0.028
<i>Corophiidae</i>									22					117	0.050
<i>Corophium sp.</i>										95					
<i>Meloidae</i>															
<i>Melita nitida</i>										108	12		74	194	0.083
<i>Ampellicidae</i>															
<i>Ampelisca sp.</i>										162	12	12		186	0.080
<i>Ampelisca abdita</i>	12													12	0.005
<i>Aoridae</i>															
<i>Isopode</i>															
<i>Cyathura polita</i>															
<i>Edotea trioba</i>											1391	12	96	446	1945
<i>Edotea monilosa</i>											0				0.833
<i>Sphaeroma sp.</i>															
<i>Cymothoidae</i>								13						13	0.006
<i>Cumacea</i>															
<i>Leucon americanus</i>			22	86					11		1769		12	19	1918
<i>Oxyurostyxis smithi</i>															
<i>Copepoda</i>	157080	2646	248	258					110	15	27	240	936	33313	194873
<i>Myiidae</i>			1080	288											1368
<i>Naomysis americana</i>	24		65					53	11		4644		36	6305	11138
<i>Ostracode</i>															
<i>Aceri</i>														14	0.006
<i>Caridae (Larvae)</i>			22	1318	711	1029	705	143			14			3927	1.681
<i>Crangon septemspinatus</i>	12								15	1836	240	96	1079	3278	1.403
<i>Palaemonetes sp.</i>								11		14				25	0.010
<i>Brachyura (Zoea)</i>				10217		22								10239	4.383
<i>Callinectes sapidus</i>															
<i>Rhithropanopeus harrisi</i>															
<b>MOLLUSCA</b>															
<i>Bivalvia (Larvae)</i>											41			41	0.017
<i>Mytilus edulis</i>															
<b>CHAETOGNATHA</b>															
<i>Sagittia sp.</i>	107													107	0.046
<b>CNIDARIA (Coelenterata)</b>															
<i>Hydrozoa (Medusa)</i>			22	31	832	27								911	0.390
<b>CHORDATA</b>															
<i>Molgula manhattensis</i>											41			41	0.017
<b>Total collected</b>	<b>157259</b>	<b>2722</b>	<b>14072</b>	<b>1504</b>	<b>1971</b>	<b>825</b>	<b>385</b>	<b>31</b>	<b>10719</b>	<b>612</b>	<b>1224</b>	<b>42296</b>	<b>233619</b>	<b>100.000</b>	

TABLE C-8 (Page 1 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION  
 NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Apprx. Depth at MLW	Date	BBN 42-44'												Station Total	Percent Comp.	
			APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>ICHTHYOPLANKTON</b>																	
<i>Bay anchovy</i> - egg					972	931										1903	
yolk-sac																0	
post-yolk sac						21				11						32	
juvenile																0	
Total		0	0	972	952	0	0	11	0	0	0	0	0	0	0	1935	57.785
<i>Silver hake</i> - egg						182										182	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	182	0	0	0	0	0	0	0	0	0	0	182	5.433
<i>Silversides</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Northern pipefish</i> - egg																0	
yolk-sac																0	
post-yolk sac																11	
juvenile					12	11										12	
Total		0	0	12	11	0	0	0	0	0	0	0	0	0	0	23	0.687
<i>Grubby</i> - egg																0	
yolk-sac		18														110	
post-yolk sac		55														55	
juvenile																0	
Total		74	0	0	0	0	0	0	0	0	0	0	0	0	91	165	4.922
<i>Weakfish</i> - egg		37	239	12												288	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		37	239	12	0	0	0	0	0	0	0	0	0	0	0	288	8.610
<i>Labridae</i> - egg						11										11	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	11	0	0	0	0	0	0	0	0	0	0	11	0.320
<i>Tautog</i> - egg			607													607	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	607	0	0	0	0	0	0	0	0	0	0	0	0	607	18.135
<i>Cunner</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>American sand lance</i> - egg																0	
yolk-sac																15	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	15	15	0.454	
<i>Gobiidae</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Naked goby</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Summer flounder</i> - egg								53	32							86	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	53	32	0	0	0	0	0	0	86	2.557
<i>Windowpane</i> - egg																0	
yolk-sac																0	
post-yolk sac																0	
juvenile																0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Winter flounder</i> - egg																0	
yolk-sac																0	
post-yolk sac		28	9													37	
juvenile																0	
Total		28	9	0	0	0	0	0	0	0	0	0	0	0	0	37	1.099
<b>Total collected</b>		138	856	996	1156	0	53	43	0	0	0	0	0	106	3348	100.000	

TABLE C-8 (Page 2 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION

NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW Date	APR 1995	MAY	JUN	JUL	AUG	BBN 42-44'		NOV	DEC	JAN 1996	FEB	MAR	Station Total	Percent Comp.
							SEP	OCT							
<b>EPIBENTHOS</b>															
<b>ARTHROPODA</b>															
<i>Amphipoda</i>															
<i>Gammaridae</i>				7946	48878									56823	13.778
<i>Gammarus sp.</i>			929			50	13	22		22	87	52		1175	0.285
<i>Gammarus mucronatus</i>															
<i>Stenothoidae</i>								151	6					157	0.038
<i>Parameleopella cypris</i>			18	111	21									151	0.036
<i>Caprellidae</i>								11						11	0.003
<i>Corophidae</i>				12	21									34	0.008
<i>Corophium sp.</i>							120	151			10			281	0.068
<i>Melittidae</i>								43						43	0.010
<i>Melita nitida</i>								173	6					179	0.043
<i>Ampeliscaidae</i>															
<i>Ampelisca sp.</i>								97			10			107	0.026
<i>Ampelisca abdita</i>															
<i>Aoridae</i>			64											64	0.016
<i>Isopoda</i>															
<i>Cyathura polita</i>															
<i>Edotea trikoba</i>							13	227		22				262	0.064
<i>Edotea montosa</i>				37										37	0.009
<i>Sphaerome sp.</i>															
<i>Cymothoidea</i>															
<i>Cumacea</i>															
<i>Leucon americanus</i>			9	62	11		13	108	6	605	10	10	15	849	0.206
<i>Oxyurostylis smithii</i>			9				120	11						140	0.034
<i>Copepoda</i>	182620	108100	1624	4890			13	1393	1687	1034	456	10213	22815	334845	81.190
<i>Mysidacea</i>		55	406	621										1082	0.262
<i>Neomysis americana</i>			554	43			27	10498	23	737	49	31	76	12036	2.918
<i>Ostracoda</i>															
<i>Aceri</i>															
<i>Caridea (Larvae)</i>			9	1009	760	163	1317	65						3322	0.805
<i>Crangon septemspinus</i>			9	37										46	0.011
<i>Palaemonetes sp.</i>							27	11						37	0.009
<i>Brachyura (Zoea)</i>				258	139	13		43						453	0.110
<i>Callinectes sapidus</i>															
<i>Rhithropanopeus harrisi</i>															
<b>MOLLUSCA</b>															
<i>Bivalvia (Larvae)</i>															
<i>Mytilus edulis</i>				62										62	0.015
<b>CHAETOGNATHA</b>															
<i>Sagitta sp.</i>		92	46											138	0.033
<b>Cnidaria (Coelenterata)</b>															
<i>Hydrozoa (Medusa)</i>						50	27							77	0.019
<b>CHORDATA</b>															
<i>Molgula manhattensis</i>						13								13	0.003
<b>Total collected</b>		182712	109250	12116	55383	288	1689	13003	1727	2420	611	10317	22906	412422	100.000

TABLE C-9 (Page 1 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION  
 NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Apprx. Depth at MLW Date	APR 1995	MAY	JUN	JUL	AUG	GBW 38-40'		NOV	DEC	JAN 1996	FEB	MAR	Station Total	Percent Comp.
							SEP	OCT							
<b>ICHTHYOPLANKTON</b>															
<i>Bay anchovy</i> - egg				11	77									88	
yolk-sac														0	
post-yolk sac					44									44	
juvenile														0	
Total		0	0	11	121	0	0	0	0	0	0	0	0	132	7.511
<i>Silver hake</i> - egg														0	
yolk-sac														0	
post-yolk sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Silversides</i> - egg														0	
yolk-sac			20											20	
post-yolk sac														0	
juvenile														0	
Total		0	20	0	0	0	0	0	0	0	0	0	0	20	1.114
<i>Northern pipefish</i> - egg														0	
yolk-sac														0	
post-yolk sac														0	
juvenile									11					11	
Total		0	0	0	0	0	0	0	11	0	0	0	0	11	0.620
<i>Grubby</i> - egg														0	
yolk-sac		7												39	
post-yolk sac														0	
juvenile														0	
Total		7	0	0	0	0	0	0	0	0	0	0	32	39	2.195
<i>Weakfish</i> - egg		34	98											132	
yolk-sac														0	
post-yolk sac														0	
juvenile									11					11	
Total		34	98	0	0	0	0	0	11	0	0	0	0	143	8.125
<i>Laoridae</i> - egg														0	
yolk-sac														0	
post-yolk sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Tautog</i> - egg			1254											1254	
yolk-sac														0	
post-yolk sac														0	
juvenile														0	
Total		0	1254	0	0	0	0	0	0	0	0	0	0	1254	71.321
<i>Cunner</i> - egg									10					10	
yolk-sac														0	
post-yolk sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	10	0	0	0	0	10	0.557
<i>American sand lance</i> - egg														0	
yolk-sac														0	
post-yolk sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Gobidae</i> - egg														0	
yolk-sac														0	
post-yolk sac					88		29							117	
juvenile														0	
Total		0	0	0	88	0	29	0	0	0	0	0	0	117	6.630
<i>Naked goby</i> - egg														0	
yolk-sac														0	
post-yolk sac														0	
juvenile							14							14	
Total		0	0	0	0	0	14	0	0	0	0	0	0	14	0.813
<i>Summer flounder</i> - egg														0	
yolk-sac														0	
post-yolk sac														0	
juvenile														0	
Total		0	0	0	0	0	0	0	0	0	0	0	0	0	0.000
<i>Windowpane</i> - egg														0	
yolk-sac														0	
post-yolk sac			10											10	
juvenile														0	
Total		0	10	0	0	0	0	0	0	0	0	0	0	10	0.557
<i>Winter flounder</i> - egg														0	
yolk-sac														0	
post-yolk sac			10											10	
juvenile														0	
Total		0	10	0	0	0	0	0	0	0	0	0	0	10	0.557
<b>Total collected</b>		41	1392	11	209	0	43	10	22	0	0	0	32	1759	100.00

TABLE C-9 (Page 2 of 2)  
 NEWARK BAY AQUATIC SAMPLING STUDIES 1995-1996  
 EPIBENTHOS COLLECTION

NUMBERS COLLECTED PER 1000 CUBIC METER

SPECIES COLLECTED	Station Appx. Depth at MLW Date	APR 1995	MAY	JUN	JUL	AUG	GBW 39-40'		NOV	DEC	JAN 1996	FEB	MAR	Station Total	Percent Comp.	
							SEP	OCT								
<b>EPIBENTHOS</b>																
<b>ARTHROPODA</b>																
<i>Amphipoda</i>																
<i>Gammaridae</i>				11555	20218				22	13				35	0.011	
<i>Gammarus sp.</i>			1607			13					20	24	11	31773	9.936	
<i>Gammarus mucronatus</i>														1766	0.552	
<i>Stenothoidae</i>																
<i>Parameiopella cypris</i>			39	22	22									83	0.026	
<i>Caprellidae</i>																
<i>Corophiidae</i>				11	88									99	0.031	
<i>Corophium sp.</i>			20						20					39	0.012	
<i>Melitidae</i>																
<i>Melita nitida</i>							29			26	10			65	0.020	
<i>Ampeliscaidae</i>																
<i>Ampelisca sp.</i>									20					20	0.006	
<i>Ampelisca abdita</i>																
<i>Aoridae</i>			39	33	22									95	0.030	
<i>Isopoda</i>																
<i>Cyathura polita</i>																
<i>Edotea trioba</i>					33								11	44	0.014	
<i>Edotea monilosa</i>				11										11	0.003	
<i>Sphaeroma sp.</i>																
<i>Cymothoidae</i>																
<i>Cumacea</i>																
<i>Leucon americanus</i>				78	33			14	245	807	2301	10	49	74	3611	1.129
<i>Oxyurostylis smithii</i>								14			13			27	0.009	
<i>Copepoda</i>	139740	44590	1954	286				14	3254	1940	3510	129	21008	27062	243487	76.145
<i>Mysididae</i>		382	400	17446										18228	5.700	
<i>Neomysis americana</i>		637	1543	99		173	172	862	2147	2678	59	49	159	8578	2.683	
<i>Ostracoda</i>																
<i>Acanth</i>																
<i>Caridae (Larvae)</i>			284	111	4312	160	3990	1901						10758	3.364	
<i>Crangon septemspinatus</i>				11	176									480	0.150	
<i>Palaemonetes sp.</i>									33	260				57	0.018	
<i>Brachyura (Zoea)</i>			29	67	110	13		10	44	13				229	0.072	
<i>Callinectes sapidus</i>							14							14	0.004	
<i>Rhithropanopeus harrisi</i>																
<b>MOLLUSCA</b>																
<i>Bivalvia (Larvae)</i>																
<i>Mytilus edulis</i>																
<b>CHAETOGNATHA</b>																
<i>Sagittia sp.</i>	48	39												87	0.027	
<b>CNIDARIA (Coelenterata)</b>																
<i>Hydrozoa (Medusa)</i>			78			40	29							147	0.046	
<b>CHORDATA</b>																
<i>Molgula manhattensis</i>						13		10		13				36	0.011	
<i>Total collected</i>	139788	47746	15795	42845	412	4276	6321	4992	8918	228	21130	27316	319767	100.000		

**APPENDIX E**  
**BENTHIC INVERTEBRATE DATA**

Table D-1  
 BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
 ARTHUR KILL, KILL VAN KULL, AREAS 1995  
 NUMBER PER 0.05 SQUARE METER

Species Collected	Station Apprx. Depth at MLW Date	TOTAL ALL STATIONS (5 Newark Bay, 2-Channel Site)											TOTAL	PERCENT COMP.	
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB			MAR
<b>RHYNCHOCOELA</b>															
<i>Nemertes</i>		4	33	6	1		3	1	3		2	1	6	60	0.35
<b>ANNELIDA</b>															
<i>Oligochaeta</i>		18	31		32			2	14	6		25	49	177	1.04
<i>Polychaeta</i>		161	164	2	3		9	3	8	13	5	13	59	440	2.59
<i>Phyllodoce</i>		1												1	0.01
<i>Phyllodoce mucosa</i>														1	0.01
<i>Glyceridae</i>													5	5	0.03
<i>Glycera</i> sp.			16	18	8		13	25	21	19	13			133	0.78
<i>Glycera dibranchiata</i>		2				3								5	0.03
<i>Goniodidae</i>		12	2			2	9	1						26	0.15
<i>Pectinariidae</i>															
<i>Pectinaria gouldii</i>		1				1	16	6	2	9	1	5	10	51	0.30
<i>Nereidae</i>															
<i>Nereis succinea</i>		15	31	13	1		15	4		9	4	4	35	131	0.77
<i>Ophelidae</i>			17		12									29	0.17
<i>Paronidae</i>		88	141	81	91	4	55	37	17	37	12	133	153	829	4.88
<i>Spionidae</i>			1											1	0.01
<i>Scolecopelids viridis</i>		5	35	3			1							45	0.26
<i>Streblospio benedicti</i>		2298	3614	88	102		46	77	186	476	168	648	1104	8807	51.83
<i>Polydora ligni</i>		20	36	9	4		34	5	2	19	12	8	13	162	0.95
<i>Spiophanes bombyx</i>		1												1	0.01
<i>Orbinidae</i>															
<i>Scaloplos</i> sp.		244	336	174	206	31	97	50	46	88	119	93	92	1576	9.28
<i>Sabellariidae</i>															
<i>Sabellaria vulgaris</i>							417	18			44	26	1721	2226	13.10
<i>Onuphidae</i>															
<i>Diopatra cuprea</i>										10	9	1	3	23	0.14
<i>Eunicidae</i>															
<i>Eunice norvegica</i>					2	10	6		1					19	0.11
<i>Nephtyidae</i>															
<i>Nephtys</i> sp.									1					1	0.01
<i>Caprellidae</i>															
<i>Caprella capitata</i>							7							7	0.04
<i>Ampharetidae</i>							2						12	14	0.08
<i>Hypania grayi</i>										1				1	0.01
<i>Sabellidae</i>															
<i>Sabella</i> sp.							7			1				8	0.05
<i>Sabella microphthalma</i>													3	3	0.02
<i>Cirratulidae</i>										2				2	0.01
<i>Hesionidae</i>															
<i>Podarke</i> sp.							2							2	0.01
<i>Polynoidae</i>															
<i>Lepidonotus squamatus</i>									1			1		2	0.01
<b>MOLLUSCA</b>															
<b>Bivalvia</b>															
<i>Mercenaria mercenaria</i>			1											1	0.01
<i>Mya arenaria</i>		91	180	55	6	6	2	1		3	3	13	69	429	2.52
<i>Mulinia lateralis</i>		10	14	1	1	39	137	96	51	122	152	151	87	861	5.07
<i>Tellina</i> sp.		7	17	18	11			1	11				3	68	0.40
<i>Lyonsia hyalina</i>		1												1	0.01
<i>Mytilus edulis</i>		1	1											2	0.01
<i>Macoma</i> sp.													2	2	0.01
<b>Gastropoda</b>															
<i>Crepidula fornicata</i>							2	1				1		4	0.02
<i>Crepidula plana</i>							9	1			1	1		12	0.07
<i>Retusa</i> sp.			1											1	0.01
<i>Haminoea solitaria</i>			1	1			4	1	3	5				15	0.09
<i>Eplonium</i> sp.												1		1	0.01
<b>ARTHROPODA</b>															
<b>Isopoda</b>															
<i>Cyathura polita</i>		51	83	25	25	11	8	18	7	9	8	11	7	263	1.55
<i>Edotea triloba</i>		22	16				2	4	3	12	1	4	4	68	0.40
<i>Limnoria ignorum</i>							1					1	1	3	0.02
<b>Cumacea</b>															
<i>Leucon americanus</i>		48	18	1				1	6	2		20	7	103	0.61
<i>Oxyurostylis smithii</i>		2	2											4	0.02
<b>Amphipoda</b>															
<i>Ampelisca</i>		6	47											53	0.31
<i>Ampelisca</i> sp.									3	2			3	3	0.02
<i>Ampelisca abdita</i>		13	7	1					1	2			6	9	0.05
<i>Corophiidae</i>					6									6	0.04
<i>Corophium</i> Sp.			1							17	1	4		23	0.14
<i>Gammaridae</i>			3										40	43	0.25
<i>Gammarus</i> sp.			1	5		1				1	3			11	0.06
<i>Gammarus mucronatus</i>		2												2	0.01
<i>Aoridae</i>		0	107											107	0.63
<i>Unciola dissimilis</i>		1												1	0.01
<b>Melittidae</b>															
<i>Melitta</i> sp.								4						4	0.02
<i>Melitta nitida</i>							10	2		3				15	0.09
<b>Thoracica</b>															
<i>Balanus</i> sp.										2		9		11	0.06
<b>Caridea</b>															
<i>Crangon septemspinus</i>			2						2		1	2		7	0.04
<b>Brachyura</b>															
<i>Portunidae</i>															
<i>Callinectes sapidus</i>										1			2	3	0.02
<i>Xanthidae</i>														4	0.02
<i>Rhithropanopeus harrisi</i>			2							1			1	5	0.03
<i>Neopanope texana sayi</i>							1						1	1	0.01
<i>Euopanopeus depressus</i>												1		1	0.01
<b>CHORDATA</b>															
<i>Molgula manhattensis</i>		15				1	3				1		2	23	0.14
<b>Total</b>		3140	4961	481	509	101	922	366	387	871	563	1191	3499	16991	100.00

Table D-2  
 BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
 ARTHUR KILL, KILL VAN KULL, AREAS 1995

NUMBER PER 0.05 SQUARE METER

Station Appx. Depth at MLW Date	NBSW (N) 1-2' TOTAL	NBSW (S) 1-2' TOTAL	NBNW 1-4' TOTAL	NBSE 1-3' TOTAL	NBNE 1-2' TOTAL	ALL NEWARK BAY STATIONS TOTAL	PERCENT COMP.
<b>Species Collected</b>							
<b>RHYNCHOCOELA</b>							
<i>Nereis</i>	15	7	5	8	21	56	1.30
<b>ANNELIDA</b>							
<i>Oligochaeta</i>	6	1			3	10	0.23
<i>Polychaeta</i>							
<i>Phyllocoelae</i>	12	13	28	9	15	77	1.78
<i>Phyllocoela mucosa</i>							
<i>Glyceridae</i>							
<i>Glycera</i> sp.	24	11	9	20	9	73	1.69
<i>Glycera dibranchiata</i>	1	2	1		1	5	0.12
<i>Goniadidae</i>	3	1	1			5	0.12
<i>Pectinariidae</i>							
<i>Pectinaria gouldii</i>	2	2	5	9	8	26	0.60
<i>Nereidae</i>							
<i>Nereis succinea</i>	8	14	15	3	13	53	1.23
<i>Ophelidae</i>	12					12	0.28
<i>Paraonidae</i>	45	38	156	38	31	308	7.13
<i>Spionidae</i>							
<i>Scolecoplex viridis</i>		1	1		1	3	0.07
<i>Streblospio benedicti</i>	105	268	442	161	73	1049	24.27
<i>Polydora ligni</i>	17	5	8	36	3	69	1.60
<i>Spiofanus bombyx</i>							
<i>Orbinidae</i>							
<i>Scoloplos</i> sp.	297	464	196	157	147	1261	29.18
<i>Sabellariidae</i>							
<i>Sabellaria vulgaris</i>							
<i>Onuphiidae</i>							
<i>Diopatra cuprea</i>							
<i>Eunicidae</i>							
<i>Eunice norvegica</i>							
<i>Nephtyidae</i>							
<i>Nephtys</i> sp.							
<i>Caprellidae</i>							
<i>Caprella capitata</i>	1					1	0.02
<i>Ampharetidae</i>				2		2	0.05
<i>Hypania grayi</i>							
<i>Sabellidae</i>							
<i>Sabella</i> sp.					1	1	0.02
<i>Sabella microphalma</i>							
<i>Cirralulidae</i>					2	2	0.05
<i>Hesionidae</i>							
<i>Podarke</i> sp.							
<i>Polynoidae</i>							
<i>Lepidonotus squematus</i>							
<b>MOLLUSCA</b>							
<b>Bivalvia</b>							
<i>Mercenaria mercenaria</i>							
<i>Mya arenaria</i>	55	66	63	4	8	196	4.53
<i>Mulinia lateralis</i>	7	8	50	85	531	681	15.76
<i>Tellina</i> sp.	6	21	4	10	10	51	1.18
<i>Lionia hyalina</i>		1				1	0.02
<i>Mytilus edulis</i>							
<i>Macoma</i> sp.							
<b>Gastropoda</b>							
<i>Crepidula fornicata</i>							
<i>Crepidula plana</i>							
<i>Retusa</i> sp.				1		1	0.02
<i>Haminoea solitaria</i>		2	10	1	1	14	0.32
<i>Epteronium</i> sp.							
<b>ARTHROPODA</b>							
<b>Isopoda</b>							
<i>Cyathura polita</i>	45	73	30	50	56	254	5.88
<i>Edotea trioba</i>			2		2	4	0.09
<i>Limnoria lignorum</i>							
<i>Cumacea</i>							
<i>Leucon americanus</i>	13		24	10	1	48	1.11
<i>Oxyurostylis smithii</i>							
<i>Amphipoda</i>	1				3	4	0.09
<i>Ampeliscaidae</i>							
<i>Ampelisca</i> sp.	2		1	2		5	0.12
<i>Ampelisca abdita</i>	2	4		15	1	22	0.51
<i>Corophiidae</i>							
<i>Corophium</i> Sp.							
<i>Gammaridae</i>							
<i>Gammarus</i> sp.	1	1	2	4		8	0.19
<i>Gammarus mucronatus</i>				2		2	0.05
<i>Aoridae</i>							
<i>Unciola dissimilis</i>					1	1	0.02
<i>Melittidae</i>							
<i>Melita</i> sp.							
<i>Melita nitida</i>							
<i>Thoracica</i>							
<i>Balanus</i> sp.					2	2	0.05
<i>Caridae</i>							
<i>Crangon septemspinosus</i>		2			1	3	0.07
<i>Brachyura</i>							
<i>Portunidae</i>							
<i>Callinectes sapidus</i>			2			2	0.05
<i>Xanthidae</i>							
<i>Rhithropanopeus harrisi</i>					3	3	0.07
<i>Neopanope texana sayi</i>							
<i>Europanope depressus</i>							
<b>CHORDATA</b>							
<i>Molgule manhattensis</i>			5	1	1	7	0.16
<b>Total</b>	<b>680</b>	<b>1005</b>	<b>1060</b>	<b>628</b>	<b>949</b>	<b>4322</b>	<b>100.00</b>

TABLE D-3  
BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
ARTHUR KILL, KILL VAN KULL, AREAS 1995

NUMBER PER 0.05 SQUARE METER

Species Collected	Station Appx. Depth at MLW Date	TOTAL												PERCENT COMP.		
		APR 1995	MAY	JUN	JUL	AUG	Two Channel Stations		NOV	DEC	JAN 1996	FEB	MAR		TOTAL	
<b>RHYNCHOCELA</b>																
<i>Nemeritis</i>													4	4	0.03	
<b>ANNELIDA</b>																
<i>Oligochaeta</i>	17	31		27			2	14	4		24	48	167	1.32		
<i>Polychaeta</i>																
<i>Phyllococidae</i>	121	144		2			8	3	5	10	3	9	58	363	2.87	
<i>Phyllococ mucosa</i>	1													1	0.01	
<i>Glyceridae</i>													5	5	0.04	
<i>Glycera sp.</i>		14	12	6			2	10	8	5	3		60	0.47		
<i>Glycera dibranchiata</i>																
<i>Goniodidae</i>	10					2	9							21	0.17	
<i>Pectinariidae</i>																
<i>Pectinaria goukii</i>	1					1	5	5	1	7	1	3	1	25	0.20	
<i>Nereididae</i>																
<i>Nereis succinea</i>	2	11		1			13	2		7	4	4	34	78	0.62	
<i>Ophelidae</i>		17												17	0.13	
<i>Paracidae</i>	66	109	43	80			33	19	8	5	4	11	143	521	4.11	
<i>Spionidae</i>		1												1	0.01	
<i>Scolecopodia viridis</i>	5	34	1				1					1		42	0.33	
<i>Streblospio benedicti</i>	1978	3511	85	101			38	53	145	448	102	324	973	7758	61.24	
<i>Polydora ligni</i>	19	35	9	4				1		11	3	4	7	93	0.73	
<i>Spiophanes bombyx</i>	1													1	0.01	
<i>Orbinidae</i>																
<i>Scoloplos sp.</i>	60	28	50	26	12		6	4	30	17	4	28	50	315	2.49	
<i>Sabellariidae</i>																
<i>Sabellaria vulgaris</i>							417	18			44	26	1721	2226	17.57	
<i>Onuphidae</i>																
<i>Diopatra cuprea</i>										10	9	1	3	23	0.18	
<i>Eunicidae</i>																
<i>Eunice norvegica</i>					2		10	6		1				19	0.15	
<i>Nephtyidae</i>																
<i>Nephtys sp.</i>									1					1	0.01	
<i>Caprellidae</i>																
<i>Caprella capitata</i>							6							6	0.05	
<i>Ampharetidae</i>													12	12	0.09	
<i>Hypaniola grayi</i>										1				1	0.01	
<i>Sabellidae</i>																
<i>Sabella sp.</i>							7							7	0.06	
<i>Sabella microphthalma</i>													3	3	0.02	
<i>Cirratulidae</i>																
<i>Hesionidae</i>																
<i>Podarke sp.</i>							2							2	0.02	
<i>Polynoidae</i>																
<i>Lepidonotus squematus</i>									1				1	2	0.02	
<b>MOLLUSCA</b>																
<i>Bivalvia</i>																
<i>Mercenaria mercenaria</i>			1											1	0.01	
<i>Mya arenaria</i>	41	92	14	2	6		2	1		1	2	3	69	233	1.84	
<i>Mulinia lateralis</i>	10	13	1		31		10	25	22	12	37	11	8	180	1.42	
<i>Tellina sp.</i>	1	4	3						9					17	0.13	
<i>Lyonsia hyalina</i>														2	0.02	
<i>Mytilus edulis</i>	1	1												2	0.02	
<i>Macoma sp.</i>													2	2	0.02	
<i>Gastropoda</i>																
<i>Crepidula fornicata</i>							2	1				1		4	0.03	
<i>Crepidula plana</i>							9	1			1	1		12	0.09	
<i>Relusa sp.</i>																
<i>Haminoea solitaria</i>									1					1	0.01	
<i>Epitonium sp.</i>												1		1	0.01	
<b>ARTHROPODA</b>																
<i>Isopoda</i>																
<i>Cyathura polita</i>	5	1									1		2	9	0.07	
<i>Edotea liriope</i>	21	14									1	4	4	64	0.51	
<i>Limnoria lignorum</i>							1		4	3	11	1	1	3	0.02	
<i>Cumacea</i>																
<i>Leucon americanus</i>	40								1	6		6	2	55	0.43	
<i>Oxyurostylis smithii</i>	2	2												4	0.03	
<i>Amphipoda</i>	2	47												49	0.39	
<i>Ampeliscidae</i>														3	0.02	
<i>Ampelisca sp.</i>																
<i>Ampelisca abdita</i>	7	7	1						1					16	0.13	
<i>Corophiidae</i>						6								6	0.05	
<i>Corophium Sp.</i>		1								17	1	4		23	0.18	
<i>Gammaridae</i>		3											40	43	0.34	
<i>Gammarus sp.</i>			3											3	0.02	
<i>Gammarus mucronatus</i>																
<i>Aoridae</i>		107												107	0.84	
<i>Unciola dissimilis</i>																
<i>Melitidae</i>																
<i>Melita sp.</i>														4	0.03	
<i>Melita nitida</i>							10	2		3				15	0.12	
<i>Thoresica</i>																
<i>Balanus sp.</i>												9		9	0.07	
<i>Caridae</i>																
<i>Crangon septemspinus</i>		2							2					4	0.03	
<i>Brachyura</i>																
<i>Portunidae</i>																
<i>Callinectes sapidus</i>													1	1	0.01	
<i>Xanthidae</i>													4	4	0.03	
<i>Rhithropanopeus harrisi</i>													1	2	0.02	
<i>Neopanope texana sayi</i>													1	1	0.01	
<i>Europoneus depressus</i>												1		1	0.01	
<b>CHORDATA</b>																
<i>Molgula manhattensis</i>	10							3					1	2	16	0.13
<b>Total</b>	<b>2421</b>	<b>4230</b>	<b>222</b>	<b>255</b>	<b>54</b>	<b>597</b>	<b>163</b>	<b>256</b>	<b>570</b>	<b>220</b>	<b>479</b>	<b>3202</b>	<b>12669</b>	<b>100.00</b>		

TABLE D-4  
BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
ARTHUR KILL, KILL VAN KULL, AREAS 1995

NUMBER PER 0.05 SQUARE METER

Species Collected	Station Appx. Depth at MLW Date	NBSW (S) 1-2'												TOTAL	PERCENT COMP.	
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>RHYNCHOCOELA</b>																
<i>Nemeritis</i>			6											1	7	0.70
<b>ANNELIDA</b>																
<i>Oligochaeta</i>														1	1	0.10
<i>Polychaeta</i>																
<i>Phyllodoce</i>		5	7												13	1.29
<i>Phyllodoce mucosa</i>											1					
<i>Glyceridae</i>																
<i>Glycera</i> sp.				3							3	4			11	1.09
<i>Glycera dibranchiata</i>						2	1								2	0.20
<i>Goniodidae</i>									1						1	0.10
<i>Pectinariidae</i>																
<i>Pectinaria gouldii</i>							2								2	0.20
<i>Nereididae</i>																
<i>Nereis succinea</i>		1	9	3							1				14	1.39
<i>Ophelidae</i>																
<i>Paraonis</i>		5	7	5	1	4	4	2			2	1	7		38	3.78
<i>Spionidae</i>																
<i>Scotocolepida viridis</i>				1											1	0.10
<i>Streblospio benedicti</i>		155	44								4	32	30	3	268	26.67
<i>Polydora ligni</i>								3			1	1			5	0.50
<i>Spiophanes bombyx</i>																
<i>Orbinidae</i>																
<i>Scotoplos</i> sp.		69	146	51	39	3	7	12			7	56	50	24	464	46.17
<i>Sabellariidae</i>																
<i>Sabellaria vulgaris</i>																
<i>Onuphidae</i>																
<i>Diopatra cuprea</i>																
<i>Eunicidae</i>																
<i>Eunica norvegica</i>																
<i>Nephtyidae</i>																
<i>Nephtys</i> sp.																
<i>Caprellidae</i>																
<i>Capitella capitata</i>																
<i>Ampharidae</i>																
<i>Hypenidotea grayi</i>																
<i>Sabellidae</i>																
<i>Sabella</i> sp.																
<i>Subellia microphthalmia</i>																
<i>Cirratulidae</i>																
<i>Hesionidae</i>																
<i>Podarke</i> sp.																
<i>Polynoidae</i>																
<i>Lepidonotus squamatus</i>																
<b>MOLLUSCA</b>																
<i>Bivalvia</i>																
<i>Mercenaria mercenaria</i>																
<i>Mya arenaria</i>		11	33	22											66	6.57
<i>Mulinia lateralis</i>			1			5				1			1		8	0.80
<i>Teknia</i> sp.		4	7	7	2				1						21	2.09
<i>Lycostia hyalina</i>		1													1	0.10
<i>Mytilus edulis</i>																
<i>Macoma</i> sp.																
<i>Gastropoda</i>																
<i>Crepidula fornicata</i>																
<i>Crepidula plana</i>																
<i>Retusa</i> sp.																
<i>Haminoea solitaria</i>								2							2	0.20
<i>Epitonium</i> sp.																
<b>ARTHROPODA</b>																
<i>Isopoda</i>																
<i>Cyathura polita</i>		22	27	12	2		1	3			4			2	73	7.26
<i>Edotea trioba</i>																
<i>Limnoria lignorum</i>																
<i>Cumacea</i>																
<i>Leucon americanus</i>																
<i>Oxyurostyxis smithii</i>																
<i>Amphipoda</i>																
<i>Ampeliscidae</i>																
<i>Ampelisca</i> sp.																
<i>Ampelisca abdita</i>		4													4	0.40
<i>Corophiidae</i>																
<i>Corophium</i> Sp.																
<i>Gammaridae</i>																
<i>Gammarus</i> sp.			1												1	0.10
<i>Gammarus mucronatus</i>																
<i>Aoridae</i>																
<i>Unciola dissimilis</i>																
<i>Melitidae</i>																
<i>Melita</i> sp.																
<i>Melita nitida</i>																
<i>Thoracica</i>																
<i>Balanus</i> sp.																
<i>Caridea</i>																
<i>Crangon septemspinus</i>													2		2	0.20
<i>Brachyura</i>																
<i>Portunidae</i>																
<i>Callinectes sapidus</i>																
<i>Xanthidae</i>																
<i>Rhithropanopeus harrisi</i>																
<i>Neopanope texana sayi</i>																
<i>Europaepeus depressus</i>																
<b>CHORDATA</b>																
<i>Molgula manhattensis</i>																
<b>Total</b>		277	288	104	44	14	20	19	0	19	99	91	30	1005	100.00	

TABLE D-5  
 BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
 ARTHUR KILL, KILL VAN KULL, AREAS 1995

NUMBER PER 0.05 SQUARE METER

Species Collected	Station Appx. Depth at MLW Date	NBSW (N) 1-2'												TOTAL	PERCENT COMP.
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR		
<b>RHYNCHOCELA</b>															
<i>Nemertea</i>		2	9						1		2		1	15	2.21
<b>ANNELIDA</b>															
<i>Oligochaeta</i>		1			5									6	0.88
<i>Polychaeta</i>		8			1		1		1		1			12	1.76
<i>Phylodoce mucosa</i>															
<i>Glyceridae</i>															
<i>Glycera sp.</i>				1			3	4	7	6	3			24	3.53
<i>Glycera dibranchiata</i>		1												1	0.15
<i>Goniodidae</i>		2	1											3	0.44
<i>Pectinariidae</i>															
<i>Pectinaria gouldii</i>													1	2	0.29
<i>Nereidae</i>															
<i>Nereis succinea</i>		3	4					1						8	1.18
<i>Ophelidae</i>						12								12	1.76
<i>Parsonidae</i>		3	5	2	8			14		3	8	2		45	6.62
<i>Spionidae</i>															
<i>Scolecopelids viridis</i>															
<i>Streblospio benedicti</i>		76	2					4		15	6	1	1	105	15.44
<i>Polydora ligni</i>								15			1	1		17	2.50
<i>Spiothanes bombyx</i>															
<i>Orbinidae</i>															
<i>Scoloplos sp.</i>		24	39	22	84	9	41	4	4	24	43	1	2	297	43.68
<b>SABELLARIACEA</b>															
<i>Sabellaria vulgaris</i>															
<i>Onuphidae</i>															
<i>Diopatra cuprea</i>															
<i>Eunicidae</i>															
<i>Eunice norvegica</i>															
<i>Nephtyidae</i>															
<i>Nephtys sp.</i>															
<i>Caprellidae</i>															
<i>Caprella capitata</i>								1						1	0.15
<b>AMPHARETIDAE</b>															
<i>Hypania grayi</i>															
<b>SABELLIDAE</b>															
<i>Sabella sp.</i>															
<i>Sabella microphthalma</i>															
<b>CIRRIIDAE</b>															
<i>Hesionidae</i>															
<i>Podarke sp.</i>															
<b>POLYNOIDAE</b>															
<i>Lepidonotus squemalus</i>															
<b>MOLLUSCA</b>															
<b>Bivalvia</b>															
<i>Mercenaria mercenaria</i>															
<i>Mya arenaria</i>		14	28	7	4							2		55	8.09
<i>Mulinia lateralis</i>					1			1				5		7	1.03
<i>Tellina sp.</i>		1	2		2				1					6	0.88
<i>Lyonsia hyalina</i>															
<i>Mytilus edulis</i>															
<i>Macoma sp.</i>															
<b>Gastropoda</b>															
<i>Crepidula fornicata</i>															
<i>Crepidula plana</i>															
<i>Retusa sp.</i>															
<i>Haminoea solitaria</i>															
<i>Ephorulum sp.</i>															
<b>ARTHROPODA</b>															
<b>Isopoda</b>															
<i>Cyathura polita</i>		3	13	1	19	1	1	2	1		2	1	1	45	6.62
<i>Edotea triloba</i>															
<i>Limnoria lignorum</i>															
<b>Cumacea</b>															
<i>Leucon americanus</i>		2	8							1		1	1	13	1.91
<i>Oxyurostylops smithii</i>															
<b>Amphipoda</b>															
<i>Ampeliscidae</i>		1												1	0.15
<i>Ampelisca sp.</i>									2					2	0.29
<i>Ampelisca abdita</i>		2												2	0.29
<b>Corophiidae</b>															
<i>Corophium Sp.</i>															
<b>Gammaridae</b>															
<i>Gammarus sp.</i>											1			1	0.15
<i>Gammarus mucronatus</i>															
<b>Aoridae</b>															
<i>Unciola dissimilis</i>															
<b>Mellicidae</b>															
<i>Melita sp.</i>															
<i>Melita nitida</i>															
<b>Thoracica</b>															
<i>Balanus sp.</i>															
<b>Caridea</b>															
<i>Crangon septemspinus</i>															
<b>Brachyura</b>															
<i>Portunidae</i>															
<i>Callinectes sapidus</i>															
<b>Xanthidae</b>															
<i>Rhithropanopeus harrisi</i>															
<i>Neopanope texana sayi</i>															
<i>Europaepeus depressus</i>															
<b>CHORDATA</b>															
<i>Molgula manhattensis</i>															
<b>Total</b>		143	111	33	136	10	83	10	35	39	61	13	6	680	100.00

TABLE D-6  
 BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
 ARTHUR KILL, KILL VAN KULL, AREAS 1995  
 NUMBER PER 0.05 SQUARE METER

Species Collected	Station Appx. Depth at MLW Date	NBNW 1-4'												TOTAL	PERCENT COMP.	
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR			
<b>RHYNCHOCOELA</b>																
<i>Nemeritis</i>			5												5	0.47
<b>ANNELIDA</b>																
<i>Polychaeta</i>																
<i>Phyllocoelidae</i>		19	8									1			28	2.64
<i>Phyllocoela mucosa</i>																
<i>Glyceridae</i>																
<i>Glycera sp.</i>				1			1	4	2		1				9	0.85
<i>Glycera dibranchiata</i>		1													1	0.09
<i>Goniodidae</i>				1											1	0.09
<i>Pectinariidae</i>																
<i>Pectinaria gouldii</i>							3		1				1		5	0.47
<i>Nereidae</i>																
<i>Nereis succinea</i>		8	7												15	1.42
<i>Ophelidae</i>																
<i>Paronidae</i>		7	1	6	1		1	3	4	13		112	8	156	14.72	
<i>Spionidae</i>																
<i>Scolecopelid viridis</i>			1												1	0.09
<i>Streblospio benedicti</i>		26	53	3			1	6	7	12		251	83	442	41.70	
<i>Polydora ligni</i>			1				2			1			4	8	0.75	
<i>Spiothanes bombyx</i>																
<i>Orbinidae</i>																
<i>Scoloplos sp.</i>		67	59	13	15	3	18	4	3	6	1	5	2	196	18.49	
<i>Sabellariidae</i>																
<i>Sabellaria vulgaris</i>																
<i>Onuphidae</i>																
<i>Diopatra cuprea</i>																
<i>Eunicidae</i>																
<i>Eunice norvegica</i>																
<i>Nephtyidae</i>																
<i>Nephtys sp.</i>																
<i>Caprellidae</i>																
<i>Caprella capitata</i>																
<i>Ampharetidae</i>																
<i>Hypania grayi</i>																
<i>Sabellidae</i>																
<i>Sabella sp.</i>																
<i>Sabella microphalma</i>																
<i>Cirratulidae</i>																
<i>Hesionidae</i>																
<i>Podarke sp.</i>																
<i>Polynoidae</i>																
<i>Lepidonotus squamatus</i>																
<b>MOLLUSCA</b>																
<i>Bivalvia</i>																
<i>Mercenaria mercenaria</i>																
<i>Mya arenaria</i>		19	25	12							1	6		63	5.94	
<i>Mulinia lateralis</i>							35	4	2	8		1		50	4.72	
<i>Tellina sp.</i>			2	2										4	0.38	
<i>Lycote hyalina</i>																
<i>Mytilus edulis</i>																
<i>Mecoma sp.</i>																
<i>Gastropoda</i>																
<i>Crepidula fornicata</i>																
<i>Crepidula plana</i>																
<i>Retusa sp.</i>																
<i>Haminoea solitaria</i>							2	1	2	5				10	0.94	
<i>Epitonium sp.</i>																
<b>ARTHROPODA</b>																
<i>Isopoda</i>																
<i>Cyathura polita</i>		6	14	1	1	1	2	1	2	2				30	2.83	
<i>Edotea triloba</i>		1	1											2	0.19	
<i>Limnoria lignorum</i>																
<i>Cumacea</i>																
<i>Leucon americanus</i>		2	7											24	2.26	
<i>Oxyuroslyka smithii</i>																
<i>Amphipoda</i>																
<i>Ampeliscaidae</i>																
<i>Ampelisca sp.</i>									1					1	0.09	
<i>Ampelisca abdita</i>																
<i>Corophiidae</i>																
<i>Corophium sp.</i>																
<i>Gammaridae</i>																
<i>Gammarus sp.</i>				2										2	0.19	
<i>Gammarus mucronatus</i>																
<i>Aoridae</i>																
<i>Unciola dissimilis</i>																
<i>Melittidae</i>																
<i>Melita sp.</i>																
<i>Melita nitida</i>																
<i>Thoracica</i>																
<i>Balanus sp.</i>																
<i>Caridea</i>																
<i>Crangon septemspinus</i>																
<i>Brachyura</i>																
<i>Portunidae</i>																
<i>Callinectes sapidus</i>										1			1	2	0.19	
<i>Xanthidae</i>																
<i>Rhithropanopeus harrisi</i>																
<i>Neopanope texana sayi</i>																
<i>Europenopeus depressus</i>																
<b>CHORDATA</b>																
<i>Molgula manhattensis</i>		5												5	0.47	
<b>Total</b>		161	185	40	17	4	65	23	24	49	3	387	102	1060	100.00	

TABLE D-7  
BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
ARTHUR KILL, KILL VAN KULL, AREAS 1995

NUMBER PER 0.05 SQUARE METER

Species Collected	Station Appx. Depth at MLW Date	NBSE 1-3'												TOTAL	PERCENT COMP.		
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR				
<b>RHYNCHOCELA</b>																	
<i>Nemeritis</i>			5	2					1							8	1.27
<b>ANNELIDA</b>																	
<i>Oligochaeta</i>																	
<i>Polychaeta</i>																	
<i>Phylodocidae</i>		7	2													9	1.43
<i>Phylodoca mucosa</i>																	
<i>Glyceridae</i>																	
<i>Glycera sp.</i>						2		5	6	2	3	2				20	3.18
<i>Glycera dibranchiata</i>																	
<i>Goniodidae</i>																	
<i>Pectinariidae</i>																	
<i>Pectinaria goukii</i>								3						6		9	1.43
<i>Nereididae</i>																	
<i>Nereis succinea</i>									2		1					3	0.48
<i>Ophelidae</i>																	
<i>Paraonidae</i>		4	5	3	1		1	12	1	3	5	1	2			38	6.05
<i>Spionidae</i>																	
<i>Scolecoplepida viridis</i>																	
<i>Streblospio benedicti</i>		61	2		1			3	16	12	4	25	26	11		161	25.64
<i>Polydora ligni</i>		1						14	4		6	7	3	1		36	5.73
<i>Spiofanus bombyx</i>																	
<i>Orbinidae</i>																	
<i>Scoloplos sp.</i>		15	18	6	30	4	14	24	3	22	8	5	8			157	25.00
<i>Sabellariidae</i>																	
<i>Sabellaria vulgaris</i>																	
<i>Onuphiidae</i>																	
<i>Diopatra cuprea</i>																	
<i>Eunicidae</i>																	
<i>Eunice norvegica</i>																	
<i>Nephtyidae</i>																	
<i>Nephtys sp.</i>																	
<i>Caprellidae</i>																	
<i>Caprella capitata</i>																	
<i>Ampharetidae</i>								2								2	0.32
<i>Hypania grayi</i>																	
<i>Sabellidae</i>																	
<i>Sabella sp.</i>																	
<i>Sabella microphthalma</i>																	
<i>Cirratulidae</i>																	
<i>Heslopiidae</i>																	
<i>Podarke sp.</i>																	
<i>Polynoidae</i>																	
<i>Lepidonotus squamatus</i>																	
<b>MOLLUSCA</b>																	
<i>Bivalvia</i>																	
<i>Mercenaria mercenaria</i>																4	0.64
<i>Mya arenaria</i>		3	1														
<i>Mulinia lateralis</i>							2	8	8	2	7	16	5	37		85	13.54
<i>Tellina sp.</i>		1		3	4									2		10	1.59
<i>Lyonsia hyalina</i>																	
<i>Mytilus edulis</i>																	
<i>Mecoma sp.</i>																	
<i>Gastropoda</i>																	
<i>Crepidula fornicata</i>																	
<i>Crepidula plana</i>																	
<i>Retusa sp.</i>			1													1	0.16
<i>Haminoea solitaria</i>					1											1	0.16
<i>Epitonium sp.</i>																	
<b>ARTHROPODA</b>																	
<i>Isopoda</i>																	
<i>Cyathura polita</i>		3	4	3		5	3	12	2	5	1	10	2			50	7.96
<i>Edotea triloba</i>																	
<i>Limnoria ignorum</i>																	
<i>Cumacea</i>																	
<i>Leucon americanus</i>		4	2	1								2	1			10	1.59
<i>Oxyurostylis smithi</i>																	
<i>Amphipoda</i>																	
<i>Ampeliscaidae</i>																	
<i>Ampelisca sp.</i>											2					2	0.32
<i>Ampelisca abdita</i>												5	9	1		15	2.39
<i>Corophidae</i>																	
<i>Corophium Sp.</i>																	
<i>Gammaridae</i>																	
<i>Gammarus sp.</i>						1							3			4	0.64
<i>Gammarus mucronatus</i>		2														2	0.32
<i>Aoridae</i>																	
<i>Unciola dissimilis</i>																	
<i>Meloidae</i>																	
<i>Melita sp.</i>																	
<i>Melita nitida</i>																	
<i>Thoracica</i>																	
<i>Balanus sp.</i>																	
<i>Caridae</i>																	
<i>Crangon septemspinus</i>																	
<i>Brachyura</i>																	
<i>Portunidae</i>																	
<i>Callinectes sapidus</i>																	
<i>Xanthidae</i>																	
<i>Rhithropanopeus harrisi</i>																	
<i>Neopanope texana sayi</i>																	
<i>Europanopeus depressus</i>																	
<b>CHORDATA</b>																	
<i>Molgula manhattensis</i>						1										1	0.16
<b>Total</b>		101	40	19	38	13	53	85	22	53	69	64	71		628	100.00	

TABLE D-8  
BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
ARTHUR KILL, KILL VAN KULL, AREAS 1995

NUMBER PER 0.05 SQUARE METER

Species Collected	Station	NBNE												TOTAL	PERCENT COMP.
	Appx. Depth at MLW Date	APR 1995	MAY	JUN	JUL	AUG	SEP	1-2' OCT	NOV	DEC	JAN 1996	FEB	MAR		
<b>RHYNCHOCOELA</b>															
<i>Nemeritis</i>		2	8	4	1		3		2			1		21	2.21
<b>ANNELIDA</b>															
<i>Oligochaeta</i>											2		1	3	0.32
<i>Polychaeta</i>															
<i>Phyllococidae</i>		1	3	2					2	3		3	1	15	1.58
<i>Phyllococa mucosa</i>															
<i>Glyceridae</i>															
<i>Glycera sp.</i>			2	1			1	1	2	2				9	0.95
<i>Glycera dibranchiata</i>						1								1	0.11
<i>Gonleclidae</i>															
<i>Pectinariidae</i>															
<i>Pectinaria goukii</i>							2	1		2		1	2	8	0.84
<i>Nereididae</i>															
<i>Nereis succinea</i>		1		10			1						1	13	1.37
<i>Ophelidae</i>															
<i>Paranoidae</i>		3	14	2			2	1	1	8		2		31	3.27
<i>Spionidae</i>															
<i>Scolecopodia viridis</i>				1										1	0.11
<i>Streblospio benedicti</i>		2	2						2	7	8	3	16	33	7.69
<i>Polydora ligni</i>									2					3	0.32
<i>Spiophanes bombyx</i>															
<i>Orbinidae</i>															
<i>Scotoplanes sp.</i>		9	46	32	12		11	2	6	12	7	4	6	147	15.49
<i>Sabellariidae</i>															
<i>Sabellaria vulgaris</i>															
<i>Onuphiidae</i>															
<i>Diopatra cuprea</i>															
<i>Eunicidae</i>															
<i>Eunice norvegica</i>															
<i>Nephtyidae</i>															
<i>Nephtys sp.</i>															
<i>Caprellidae</i>															
<i>Capitella capitata</i>															
<i>Ampharetidae</i>															
<i>Hypankella grayi</i>															
<i>Sabellidae</i>															
<i>Sabella sp.</i>											1			1	0.11
<i>Sabella microphthalma</i>															
<i>Cirratulidae</i>											2			2	0.21
<i>Hesionidae</i>															
<i>Podarke sp.</i>															
<i>Polynoidae</i>															
<i>Lepidonotus squamatus</i>															
<b>MOLLUSCA</b>															
<i>Bivalvia</i>															
<i>Mercenaria mercenaria</i>															
<i>Mya arenaria</i>		3	1							2		2		8	0.84
<i>Mulinia lateralis</i>						1	83	59	25	94	99	128	42	531	55.95
<i>Tellina sp.</i>			2	3	3				1				1	10	1.05
<i>Lyonsia hysalina</i>															
<i>Mytilus edulis</i>															
<i>Macoma sp.</i>															
<i>Gastropoda</i>															
<i>Crepidula fornicata</i>															
<i>Crepidula plana</i>															
<i>Retusa sp.</i>															
<i>Haminoea solitaria</i>			1											1	0.11
<i>Epiplatium sp.</i>															
<b>ARTHROPODA</b>															
<i>Isopoda</i>															
<i>Cyathura polita</i>		12	24	8	3	4	1		2	2				56	5.90
<i>Edotea trioba</i>			1							1				2	0.21
<i>Limnoria ignorum</i>															
<i>Cumacea</i>															
<i>Leucon americanus</i>			1											1	0.11
<i>Oxyurostylis smithii</i>															
<i>Amphipoda</i>															
<i>Ampeliscidae</i>															
<i>Ampelisca sp.</i>															
<i>Ampelisca abdita</i>											1			1	0.11
<i>Corophiidae</i>															
<i>Corophium Sp.</i>															
<i>Gammaridae</i>															
<i>Gammarus sp.</i>															
<i>Gammarus mucronatus</i>															
<i>Aoridae</i>															
<i>Unciola disimilis</i>		1												1	0.11
<i>Melittidae</i>															
<i>Melita sp.</i>															
<i>Melita nitida</i>															
<i>Thoresica</i>															
<i>Balanus sp.</i>										2				2	0.21
<i>Caridea</i>															
<i>Crangon septemspinus</i>											1			1	0.11
<i>Brachyura</i>															
<i>Portunidae</i>															
<i>Callinectes sapidus</i>															
<i>Xanthidae</i>															
<i>Rhithropanopeus harrisi</i>			2							1				3	0.32
<i>Neopanope texana sayi</i>															
<i>Europopanopeus depressus</i>															
<b>CHORDATA</b>															
<i>Molgula manhattanensis</i>											1			1	0.11
<b>Total</b>		37	107	63	19	6	104	66	50	141	111	157	88	949	100.00

TABLE D-9  
 BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
 ARTHUR KILL, KILL VAN KULL, AREAS 1995  
 NUMBER PER 0.05 SQUARE METER

Species Collected	Station	BBN											TOTAL	PERCENT COMP.			
	Appx. Depth at MLW Date	APR 1995	MAY	JUN	JUL	AUG	SEP	42-44' OCT	NOV	DEC	JAN 1996	FEB			MAR		
<b>RHYNCHOCOELA</b>														4	4	0.05	
<i>Nereis</i>																	
<b>ANNELIDA</b>																	
<i>Oligochaeta</i>		12	27						1		4		3	36	83	1.10	
<i>Polychaeta</i>																	
<i>Phylodoceidae</i>		16	18		2			8	3		10		1	4	56	118	1.57
<i>Phylodoce mucosa</i>																	
<i>Glyceridae</i>															5	5	0.07
<i>Glycera sp.</i>			10	8	2				9	7	3		3			42	0.56
<i>Glycera dibranchiata</i>																	
<i>Goniodidae</i>		10				2		9								21	0.28
<i>Pectinariidae</i>							1	3	4	1	1		3	1		14	0.19
<i>Pectinaria gouldii</i>																	
<i>Nereidae</i>																	
<i>Nereis succinea</i>		1	2					9	1		7		1	34	55	0.73	
<i>Ophelidae</i>																	
<i>Paronidae</i>		64	104	39				33	18	5	2	4	9	141	419	5.56	
<i>Spionidae</i>															1	1	0.01
<i>Scotolepida viridis</i>		5	21					1								27	0.36
<i>Streblospio benedicti</i>		729	1524	79	1			36	21	3	445	7	58	800	3703	49.14	
<i>Polydora ligni</i>		7	4	9					1		11			5	37	0.49	
<i>Spiofanse bombyx</i>		1													1	0.01	
<i>Orbinidae</i>																	
<i>Scopelos sp.</i>		15	9	33	26	3			3	7	17		2	14	129	1.71	
<i>Sabellariidae</i>																	
<i>Sabellaria vulgaris</i>								417	18				44	26	1717	2221	29.47
<i>Onuphidae</i>																	
<i>Diopatra cuprea</i>											10					10	0.13
<i>Eunicidae</i>																	
<i>Eunice norvegica</i>																	
<i>Nephtyidae</i>																	
<i>Nephtys sp.</i>										1						1	0.01
<i>Caprellidae</i>																	
<i>Caprella capitata</i>															6	6	0.08
<i>Ampharetidae</i>																	
<i>Hypericola grayi</i>											1					1	0.01
<i>Sabellidae</i>																	
<i>Sabella sp.</i>									7							7	0.09
<i>Sabella microphalma</i>														3		3	0.04
<i>Cirratulidae</i>																	
<i>Hesionidae</i>																	
<i>Podarke sp.</i>								2								2	0.03
<i>Polynoidae</i>																	
<i>Lepidonotus squematus</i>														1		2	0.03
<b>MOLLUSCA</b>																	
<i>Bivalvia</i>																	
<i>Mercenaria mercenaria</i>				1												1	0.01
<i>Mya arenaria</i>		21	8	14		6	2	1			1	2	2	69	126	1.67	
<i>Mulinia lateralis</i>		7		1		31	2	24		14	9	34	8	7	137	1.82	
<i>Tellina sp.</i>			3	3						8					14	0.19	
<i>Lyonsia hyalina</i>																	
<i>Mytilus edulis</i>		1	1													2	0.03
<i>Mecoma sp.</i>															2	2	0.03
<i>Gastropoda</i>																	
<i>Crepidula fornicata</i>								2	1							4	0.05
<i>Crepidula plana</i>								9	1			1				12	0.16
<i>Retusa sp.</i>																	
<i>Haminoea solitaria</i>																	
<i>Epitonium sp.</i>													1			1	0.01
<b>ARTHROPODA</b>																	
<i>Isopoda</i>																	
<i>Cyathura polita</i>		4												2	6	0.08	
<i>Edotea trioba</i>		6	7										2	1	29	0.38	
<i>Limnoria ignorum</i>								1						1	2	0.03	
<i>Cumacea</i>																	
<i>Leucon americanus</i>		15														15	0.20
<i>Oxyurostylis smithii</i>																	
<i>Amphipoda</i>		2	47													49	0.65
<i>Ampeliscaidae</i>																	
<i>Ampelisca sp.</i>																	
<i>Ampelisca abdita</i>		3	2													5	0.07
<i>Corophiidae</i>																	
<i>Corophium Sp.</i>			1								17		4			22	0.29
<i>Gammaridae</i>																	
<i>Gammarus sp.</i>					1											1	0.01
<i>Gammarus mucronatus</i>																	
<i>Aoridae</i>			107													107	1.42
<i>Unciola dissimilis</i>																	
<i>Melittidae</i>																	
<i>Melitta sp.</i>									4							4	0.05
<i>Melitta nitida</i>								10			3					13	0.17
<i>Thoracica</i>													1			1	0.01
<i>Balanus sp.</i>																	
<i>Caridea</i>																	
<i>Crengon septemspinosus</i>										2						2	0.03
<i>Brachyura</i>																	
<i>Portunidae</i>																	
<i>Callinectes sapidus</i>														1	1	0.01	
<i>Xanthidae</i>														4	4	0.05	
<i>Rhithropanopeus harrisi</i>								1						1	2	0.03	
<i>Neopanope texana sayi</i>														1	1	0.01	
<i>Europanopeus depressus</i>													1	1	1	0.01	
<b>CHORDATA</b>																	
<i>Molgula manhattensis</i>								3						1	1	5	0.07
<b>Total</b>		919	1897	187	31	43	563	111	48	552	96	128	2961	7536	100.00		

TABLE D-10  
 BENTHIC INVERTEBRATE TAXA COLLECTED FROM THE NEWARK BAY,  
 ARTHUR KILL, KILL VAN KULL, AREAS 1995  
 NUMBER PER 0.05 SQUARE METER

Species Collected	Station Appx. Depth at MLW Date	GBW 38-40'												TOTAL	PERCENT COMP.
		APR 1995	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN 1996	FEB	MAR		
<b>RHYNCHOCOELA</b>															
<i>Nemeritis</i>															
<b>ANNELIDA</b>															
<i>Oligochaeta</i>		5	4		27			1	14			21	12	84	1.64
<i>Polychaeta</i>															
<i>Phylodoceidae</i>		105	126						5		2	5	2	245	4.77
<i>Phylodoce mucosa</i>		1												1	0.02
<i>Glyceridae</i>															
<i>Glycera sp.</i>			4	4	4		2	1	1	2				18	0.35
<i>Glycera dibranchiata</i>															
<i>Gonoleididae</i>															
<i>Pectinariidae</i>															
<i>Pectinaria gouletii</i>		1					2	1		6	1			11	0.21
<i>Nereididae</i>															
<i>Nereis succinea</i>		1	9		1		4	1			4	3		23	0.45
<i>Ophelidae</i>			17											17	0.33
<i>Parsonidae</i>		2	5	4	80			1	3	3		2	2	102	1.99
<i>Spironidae</i>															
<i>Scolecoplepis viridis</i>			13	1								1		15	0.29
<i>Sireblosipio benedicti</i>		1249	1987	6	100		2	32	142	3	95	266	173	4055	79.00
<i>Polydora ligni</i>		12	31		4						3	4	2	56	1.09
<i>Spiophanes bombyx</i>															
<i>Orbinidae</i>															
<i>Scoloplos sp.</i>		45	19	17		9	6	1	23		4	26	36	186	3.62
<i>Sabellariidae</i>															
<i>Sabellaria vulgaris</i>												1	4	5	0.10
<i>Onuphidae</i>															
<i>Diopatra cuprea</i>											9	1	3	13	0.25
<i>Eunicidae</i>															
<i>Eunice norvegica</i>						2	10	6		1				19	0.37
<i>Nephtyidae</i>															
<i>Nephtys sp.</i>															
<i>Caprellidae</i>															
<i>Caprella capitata</i>															
<i>Ampharetidae</i>															
<i>Hypaniola grayi</i>															
<i>Sabellidae</i>															
<i>Sabella sp.</i>															
<i>Sabella microphthalma</i>															
<i>Cirratulidae</i>															
<i>Hesionidae</i>															
<i>Podarke sp.</i>															
<i>Polynoidae</i>															
<i>Lepidonotus squamatus</i>															
<b>MOLLUSCA</b>															
<i>Bivalvia</i>															
<i>Mercenaria mercenaria</i>															
<i>Mya arenaria</i>		20	84		2							1		107	2.08
<i>Mulinia lateralis</i>		3	13				8	1	8	3	3	3	1	43	0.84
<i>Tellina sp.</i>		1	1						1					3	0.06
<i>Lyonsia hyalina</i>															
<i>Mytilus edulis</i>															
<i>Mecoma sp.</i>															
<i>Gastropoda</i>															
<i>Crepidula fornicata</i>															
<i>Crepidula plana</i>															
<i>Retusa sp.</i>															
<i>Heminoea solitaria</i>									1					1	0.02
<i>Epitonium sp.</i>															
<b>ARTHROPODA</b>															
<i>Isopoda</i>															
<i>Cyathura polita</i>		1	1											3	0.06
<i>Edotea triloba</i>		15	7						4	3	1	2	3	35	0.68
<i>Limnoria ignorum</i>												1		1	0.02
<i>Cumacea</i>															
<i>Leucon americanus</i>		25							1	6		6	2	40	0.78
<i>Oxyurostylis smithii</i>		2	2											4	0.08
<i>Amphipoda</i>															
<i>Ampeliscidae</i>															
<i>Ampelisca sp.</i>															
<i>Ampelisca abdita</i>		4	5	1					1					11	0.21
<i>Corophiidae</i>														6	0.12
<i>Corophium Sp.</i>											1			1	0.02
<i>Gammaridae</i>														3	0.06
<i>Gammarus sp.</i>			3											3	0.06
<i>Gammarus mucronatus</i>				2										2	0.04
<i>Aoridae</i>															
<i>Unciola dissimilis</i>															
<i>Melitidae</i>															
<i>Melita sp.</i>															
<i>Melita nitida</i>								2						2	0.04
<i>Thoracica</i>															
<i>Balanus sp.</i>												8		8	0.16
<i>Caridea</i>															
<i>Crangon septemspinus</i>			2											2	0.04
<i>Brachyura</i>															
<i>Portunidae</i>															
<i>Callinectes sapidus</i>															
<i>Xanthidae</i>															
<i>Rhithropanopeus harrisi</i>															
<i>Neopanope texana sayi</i>															
<i>Europopanopeus depressus</i>															
<b>CHORDATA</b>															
<i>Molgula manhattensis</i>		10											1	11	0.21
<b>Total</b>		1502	2333	35	224	11	34	52	208	18	124	351	241	5133	100.00

**APPENDIX F**  
**AGENCY FILE SEARCH**

**Lawler,  
Matusky  
& Skelly  
Engineers** Environmental Science & Engineering Consultants

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Principal  
SUSAN G. METZGER, Ph. D.

ONE BLUE HILL PLAZA  
P. O. BOX 1608  
PEARL RIVER, NEW YORK 10965  
(914) 735-8300  
FACSIMILE (914) 735-7488

14 July 1995  
File No. 459-053

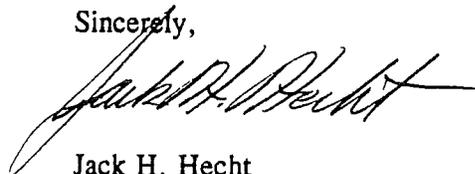
Mr. Clifford Day  
U.S. Fish & Wildlife Service  
New Jersey Field Office  
927 North Main Street  
Building D-1  
Pleasantville, NJ 08232

Dear Mr. Day:

Lawler, Matusky & Skelly Engineers (LMS) is conducting an ecological assessment in Newark Bay. The areas of study are outlined on the attached topographic map, U.S. Geological Survey (USGS), Jersey City and Elizabeth, New Jersey - New York quadrangle. Please provide us with a file search on the presence of endangered, threatened or special concern species in the Newark Bay areas shown in the attached USGS topographic map. We also request information on other fish and wildlife (including breeding birds) species which occur in the study areas. Because each area will be evaluated separately for comparison, we are requesting determinations for each area shown.

If you have any questions regarding this request, please call me at (914) 735-8300. Thank you for your assistance.

Sincerely,



Jack H. Hecht  
Project Biologist

JHH:rb



# United States Department of the Interior

## FISH AND WILDLIFE SERVICE

Ecological Services  
927 North Main Street (Bldg. D1)  
Pleasantville, New Jersey 08232

IN REPLY REFER TO:

ES-95/117

Tel: 609-646-9310  
FAX: 609-646-0352

September 6, 1995

Mr. Jack H. Hecht  
Project Biologist  
Lawler, Matusky & Skelly Engineers  
One Blue Hill Plaza  
P.O. Box 1509  
Pearl River, New York 10965

Re: Newark Bay Ecological Assessment  
Essex, Hudson, and Union Counties, New Jersey

Dear Mr. Hecht:

As requested in your July 14, 1995 letter, the U.S. Fish and Wildlife Service (Service) has reviewed the above-referenced assessment area for the presence of federally-listed endangered and threatened species. The assessment area is within five miles of three peregrine falcon (*Falco peregrinus*) nest locations. The nest locations are on the Goethals and Bayonne Bridges, and adjacent to the General Pulaski Skyway in Kearny.

The peregrine falcon, a federally-listed endangered species, has recently expanded its range and is now found nesting and feeding near urban areas. Peregrines from these nest sites may be expected to forage for prey within the assessment area and generally feed on songbirds, gulls, terns, shorebirds, and wading birds.

Section 7(a)(2) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) requires every federal agency to insure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. Therefore, if the proposed project requires any federal permits or if federal funds will be used, Section 7 consultation with the Service will be necessary on this project if potential impacts to the peregrine falcon are identified during your project investigation.

These comments provide technical assistance only and do not constitute consultation for any project pursuant to Section 7 of the Endangered Species Act of 1973 or comment by the Service as afforded by the Fish and Wildlife Coordination Act (48 Stat. 401, 16 U.S.C. 661 *et seq.*), if any federal permits or licenses are required for the proposed project nor do they preclude comment on any forthcoming environmental documents pursuant to the National Environmental Policy Act (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

Except for the peregrine falcon and an occasional transient bald eagle (*Haliaeetus leucocephalus*), no other federally-listed or proposed threatened or endangered flora or fauna under Service jurisdiction are known to occur in the vicinity of the assessment area. If additional information on federally-listed threatened or endangered species becomes available, this determination may be reconsidered.

Principal responsibility for endangered and threatened marine species is vested with the National Marine Fisheries Service (NMFS). Therefore, the NMFS should be contacted to ensure a thorough investigation for the presence of federally-listed endangered and threatened species:

National Marine Fisheries Service  
Habitat and Protected Resources Division  
Sandy Hook Laboratory  
Highlands, New Jersey 07732  
(908) 872-3023

Enclosed are current summaries of the federally-listed and candidate species in New Jersey. The addresses of State agencies to contact for site-specific candidate and State-listed species information in New Jersey are also enclosed for your consideration in project planning.

Please contact Thomas McDowell of my staff if you have any questions or require further assistance regarding federally-listed threatened or endangered species.

Sincerely,



John C. Staples  
Assistant Supervisor

Enclosures

## FEDERALLY LISTED ENDANGERED AND THREATENED SPECIES IN NEW JERSEY

An **ENDANGERED SPECIES** is any species that is in danger of extinction throughout all or a significant portion of its range.

A **THREATENED SPECIES** is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

### FISHES

Sturgeon, shortnose*	<u>Acipenser brevirostrum</u>	E
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### REPTILES

Turtle, Atl. Ridley*	<u>Lepidochelys kempii</u>	E
Turtle, green*	<u>Chelonia mydas</u>	T
Turtle, hawksbill*	<u>retmochelys imbricata</u>	E
Turtle, leatherback*	<u>Dermochelys coriacea</u>	E
Turtle, loggerhead*	<u>Caretta caretta</u>	T

### BIRDS

Eagle, bald	<u>Haliaeetus leucocephalus</u>	T
Falcon, Am. peregrine	<u>Falco peregrinus anatum</u>	E
Plover, piping	<u>Charadrius melodus</u>	T
Tern, roseate	<u>Sterna dougallii dougallii</u>	E

### MAMMALS

Bat, Indiana	<u>Myotis sodalis</u>	E
Cougar, eastern	<u>Felis concolor couguar</u>	E+
Whale, blue*	<u>Balaenoptera musculus</u>	E
Whale, finback*	<u>Balaenoptera physalus</u>	E
Whale, humpback*	<u>Megaptera novaeangliae</u>	E
Whale, right*	<u>Balaena glacialis</u>	E
Whale, sei*	<u>Balaenoptera borealis</u>	E
Whale, sperm*	<u>Physeter catodon</u>	E
Wolf, gray	<u>Canis lupus</u>	E+

## INVERTEBRATES

Dwarf wedge mussel	<u>Alasmidonta heterodon</u>	E+
Beetle, northeastern beach tiger	<u>Cicindela dorsalis dorsalis</u>	T
Butterfly, Mitchell satyr	<u>Neonympha m. mitchellii</u>	E+
American burying beetle	<u>Nicrophorus americanus</u>	E+

## PLANTS

Pogonia, small whorled	<u>Isotria medeoloides</u>	E
Swamp pink	<u>Helonias bullata</u>	T
Orchid, eastern prairie fringed	<u>Platanthera leucophaea</u>	T+
Knieskern's beaked-rush	<u>Rhynchospora knieskernii</u>	T
American chaffseed	<u>Schwalbea americana</u>	E
Joint-vetch, sensitive	<u>Aeschynomene virginica</u>	T
Pigweed, sea-beach	<u>Amaranthus pumilus</u>	T+

### STATUS:

- E: endangered species
- T: threatened species
- +: presumed extirpated
- PE: proposed endangered
- PT: proposed threatened

- \* Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service.

*Note: for a complete listing of Endangered and Threatened Wildlife and Plants refer to 50 CFR 17.11 and 17.12, August 20, 1994*

## FEDERAL CANDIDATE SPECIES IN NEW JERSEY

**CANDIDATE SPECIES** are species that appear to warrant consideration for addition to the federal List of Endangered and Threatened Wildlife and Plants. Although these species receive no substantive or procedural protection under the Endangered Species Act, the U.S. Fish and Wildlife Service encourages federal agencies and other planners to give consideration to these species in the environmental planning process.

### SPECIES

Bog turtle

Clemmys muhlenbergii

Bog asphodel

Narthecium americanum

Note: Taxa formerly known as "Category 2" candidate species are now known as "species at risk." Species at risk are those species for which the Service does not have conclusive data to support listing the species under the Endangered Species Act at this time. Taxa formerly known as "Category 3B" or "Category 3C" candidate species are no longer considered candidate species or species at risk. Category 3B species were determined, on the basis of current taxonomic understanding, not to represent distinct taxa meeting the Act's definition of "species." Category 3C species are those species that have proven to be more abundant than previously believed and/or those that are not subject to any identifiable threat. If further research or changes in habitat indicate a significant decline in any of these taxa, they may be reevaluated for possible inclusion as candidate species or species at risk.

For complete listings of taxa under review as candidate species or species at risk, refer to Federal Register Vol. 59, No. 219, Nov. 15, 1994 (Animal) and Vol. 58, No. 188, September 30, 1993 (Plants).

## FEDERAL CANDIDATE SPECIES

Candidate species are species under consideration by the U.S. Fish and Wildlife Service (Service) for possible inclusion on the List of Endangered and Threatened Wildlife and Plants. Although these species receive no substantive or procedural protection under the Endangered Species Act, the Service encourages federal agencies and other planners to consider candidate species in project planning.

The New Jersey Natural Heritage Program maintains the most up-to-date information on candidate species and State-listed species in New Jersey, and may be contacted at the following address:

Thomas Breden  
Natural Heritage Program  
Division of Parks and Forestry  
CN 404  
Trenton, New Jersey 08625  
(609/984-0097)

Additionally, information on New Jersey's State-listed wildlife species may be obtained from the following office:

Lawrence Niles, Chief  
Endangered and Nongame Species Program  
Division of Fish, Game and Wildlife  
CN 400  
Trenton, New Jersey 08625  
(609/292-1235)

If information from either of these sources reveals the presence of any federal candidate species in the project area, the Service should be contacted to ensure that these species are not adversely affected by project activities.

**Lawler,  
Matusky  
& Skelly  
Engineers**

Environmental Science & Engineering Consultants

JOHN P. LAWLER, P. E.  
FELIX E. MATUSKY, P. E.  
MICHAEL J. SKELLY, P. E.  
KARIM A. ABOOD, P. E.  
PATRICK J. LAWLER, P. E.  
FRANCIS M. MCGOWAN, P. E.  
THOMAS L. ENGLERT, P. E.  
PETER M. MCGRODDY, P. E.  
THOMAS E. PEASE, P. E.  
THOMAS B. VANDERBEEK, P. E.

Principal  
SUSAN G. METZGER, Ph. D.

ONE BLUE HILL PLAZA  
P. O. BOX 1509  
PEARL RIVER, NEW YORK 10965  
(914) 735-8300  
FACSIMILE (914) 736-7468

16 October 1995  
File No. 459-053

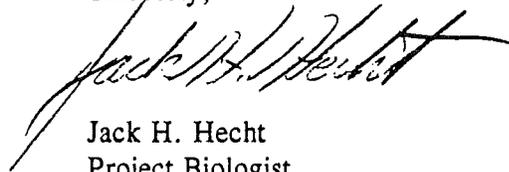
Mr. Stan Gorski  
National Marine Fisheries Service  
Habitat and Protected Resources Division  
Sandy Hook Laboratory  
Highlands, NJ 07732

Dear Mr. Gorski:

Lawler, Matusky & Skelly Engineers (LMS) is conducting an ecological assessment in Newark Bay. The areas of study are outlined on the attached topographic map, U.S. Geological Survey (USGS), Jersey City and Elizabeth, New Jersey - New York quadrangle. Please provide us with a file search on the presence of endangered, threatened or special concern species in the Newark Bay areas shown in the attached USGS topographic map. We also request information on other fish and wildlife species which occur in the study areas. Because each area will be evaluated separately for comparison, we are requesting determinations for each area shown.

If you have any questions regarding this request, please call me at (914) 735-8300. Thank you for your assistance.

Sincerely,



Jack H. Hecht  
Project Biologist

JHH:rb



UNITED STATES DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
NATIONAL MARINE FISHERIES SERVICE  
Habitat and Protected  
Resources Division  
James J. Howard Marine  
Sciences Laboratory  
Highlands, New Jersey 07732

December 14, 1995

Jack H. Hecht  
Lawler, Matusky & Skelly Engineers  
One Blue Hill Plaza  
P.O. Box 1509  
Pearl River, New York 10965

RE: Information Request for Newark Bay

Dear Mr. Hecht:

This letter is in reply to your request for information on the presence of endangered, threatened or special concern species in Newark Bay.

In general, the species found in Newark Bay are typical of those species found throughout the Hudson-Raritan estuary. A wide variety of aquatic species spend all or part of their life cycle in the Newark Bay area. Resident species in the bay include winter flounder (Pleuronectes americanus) and Atlantic tomcod (Microgadus tomcod), which is on the NJ State threatened species list. Studies conducted as part of the Newark Bay/Kill Van Kull Navigation Project indicate that Newark Bay may be an important spawning area for Atlantic tomcod. Both juvenile tomcod and winter flounder use the bay as a nursery area. Newark Bay also provides transit to upstream freshwater spawning grounds. The Hackensack River and the Passiac River provide spawning grounds for several species of anadromous fish including alewife (Alosa pseudoharengus) and blueback herring (Alosa aestivalis). The juveniles of these species also use Newark Bay as a nursery area. Other species encountered seasonally in the bay include bay anchovy (Anchoa mitchilli), weakfish (Cynoscion regalis), Atlantic menhaden (Brevoortia tyrannus), striped bass (Morone saxatilis) and bluefish (Pomatomus saltatrix). Striped bass, white perch (Morone americana) and blue crabs (Callinectes sapidus) overwinter in portions of the bay.

Several species of sea turtles including the threatened loggerhead (Caretta caretta), and the endangered Kemp's ridley (Lepidochelys kempii), and green (Chelonia mydas) sea turtles may occur in the New York Bight Apex. These turtles feed primarily on mollusks, crustaceans, sponges and a variety of marine grasses and seaweeds. In addition, the endangered leatherback (Dermochelys coriacea) sea turtle may be found foraging for



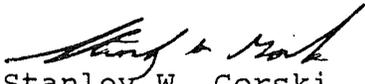
jellyfish in the coastal waters of the New York Bight Apex. These sea turtles can be found in the Hudson-Raritan Bay complex during the months of June through November. Occasional transients may make their way into Newark Bay.

The endangered shortnose sturgeon (Acipenser brevirostrum) is present in the Hudson River and may make excursions into the saline environment of the lower estuary. Occasional transients may make their way into Newark Bay.

The endangered right whale (Eubalaena glacialis), humpback whale (Megaptera novaeangliae) and finback whale (Balaenoptera physalus) may be present in the New York Bight during their early spring or fall migrations. The harbor porpoise (Phocoena phocoena) may also be present. Occasional transients may make their way into Newark Bay.

If you have any questions regarding this information, please contact Anita Riportella at (908) 872-3116.

Sincerely,

  
Stanley W. Gorski  
Assistant Coordinator  
Habitat Program

ar\inforreq\portnewk

**Lawler,  
Matusky  
& Skelly  
Engineers**

Environmental Science & Engineering Consultants

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23 May 1995  
File No. 459-053

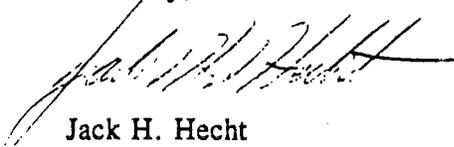
Mr. Thomas Bredan  
Natural Heritage Program  
Division of Parks and Forestry  
New Jersey Department of Environmental Protection and Energy  
CN 404  
Station Plaza 5  
501 East State Street, Floor 3  
Trenton, NJ 08625-0400

Dear Mr. Bredan:

Lawler, Matusky & Skelly Engineers (LMS) is conducting an ecological assessment in Newark Bay. The areas of study are outlined on the attached topographic map, U.S. Geological Survey (USGS), Jersey City and Elizabeth, New Jersey - New York quadrangle. Please provide us with a file search on the presence of endangered, threatened or special concern species in the Newark Bay areas shown in the attached USGS topographic map. We also request information on other fish and wildlife (including breeding birds) species which occur in the study areas. Because each area will be evaluated separately for comparison, we are requesting determinations for each area shown. A Natural Heritage data request form is attached for your files.

If you have any questions regarding this request, please call me at (914) 735-8300. Thank you for your assistance.

Sincerely,



Jack H. Hecht  
Project Biologist

JHH:rb

DEPE - Division of Parks & Forestry, Office of Natural Lands Management  
 NATURAL HERITAGE DATA REQUEST FORM

This form is used to request a search of the Natural Heritage Database for records of rare or endangered species and natural communities on or near a project site. The Natural Heritage Program provides the information in order to assist the requestor in preserving habitat for rare and endangered species and natural communities.

To initiate a search, please provide: A) A letter explaining the project; B) A copy of a USGS quad map(s) delineating the bounds of the project site; C) A completed data request form.

Send completed request to: DEPE - Division of Parks & Forestry, Office of Natural Lands Management, Natural Heritage Program, CN404, Trenton, NJ 08625-0404.

NAME Jack H. Hocht Project Biologist  
 AGENCY Lander Matusky and Skelly Engineers  
 ADDRESS C/O Blue Hill Plaza P.O. Box 1509  
Peapack River, N.J. 10965-8509  
 PHONE (914) 735-8300  
 PROJECT OR SITE NAME Newark Bay

COUNTY (CHECK THOSE THAT APPLY):

ATLANTIC	BERGEN <input checked="" type="checkbox"/>	BURLINGTON	CAMDEN	CAPE MAY	CUMBERLAND	ESSEX <input checked="" type="checkbox"/>
GLoucester	HUDSON <input checked="" type="checkbox"/>	HUNTERDON	MERCER	MIDDLESEX	MONMOUTH	MORRIS
OCEAN	PASSAIC	SALEM	SOMERSET	SUSSEX	UNION	WARREN

USGS QUAD(S): Elizabeth, N.J.-N.Y. And Jersey City, N.J.-N.Y.

Any material supplied by the Office of Natural Lands Management will not be published without crediting the Natural Heritage Database as the source of the material. It is understood that there will be a charge of \$20.00 per hour for the services requested. An invoice will be sent with the request response and payment should be made by check or money order payable to "Treasurer - State of New Jersey."

Date Needed June 10, 1995

Signature Jack H. Hocht

FOR OFFICE USE ONLY				DATE RECEIVED
Item Code:	REG	ST	RTC	NC
	REGEO	STEO	RTCEO	NCEO
Hrs:	_____			
Project Code:	_____			Inv. #: _____



## State of New Jersey

Christine Todd Whitman  
Governor

Department of Environmental Protection  
Division of Parks and Forestry  
Office of Natural Lands Management  
Natural Heritage Program  
CN 404  
Trenton, NJ 08625-0404  
Tel. #609-984-1339  
Fax. #609-984-1427

Robert C. Shinn, Jr.  
Commissioner

June 6, 1995

Jack H. Hecht  
Lawler, Matusky, & Skelly Engineers  
One Blue Hill Plaza  
P.O. Box 1509  
Pearl River, NY 10965-8509

Re: Newark Bay (Sites 1 and 2)

Dear Mr. Hecht:

Thank you for your data request regarding rare species information for the above referenced project sites in Newark, Bayonne City and Jersey City, Essex and Hudson Counties.

The Natural Heritage Data Base has a record for a least tern occurrence which may be in the immediate vicinity of project Site 1. The attached list provides more information about these occurrences. Also attached is a list of rare species and natural communities which have been documented from Essex and Hudson Counties. If suitable habitat is present at the project site, these species have potential to be present. If you have questions concerning the wildlife records or wildlife species mentioned in this response, we recommend you contact the Division of Fish, Game and Wildlife, Endangered and Nongame Species Program.

PLEASE SEE THE ATTACHED 'CAUTIONS AND RESTRICTIONS ON NHP DATA'.

Thank you for consulting the Natural Heritage Program. The attached invoice details the payment due for processing this data request. Feel free to contact us again regarding any future data requests.

Sincerely,

Thomas F. Breden  
Supervisor

cc: Lawrence Niles  
Thomas Hampton  
NHP File No. 95-4007461

# NATURAL LANDS MANAGEMENT

## CAUTIONS AND RESTRICTIONS ON NATURAL HERITAGE DATA

The quantity and quality of data collected by the Natural Heritage Program is dependent on the research and observations of many individuals and organizations. Not all of this information is the result of comprehensive or site-specific field surveys. Some natural areas in New Jersey have never been thoroughly surveyed. As a result, new locations for plant and animal species are continuously added to the data base. Since data acquisition is a dynamic, ongoing process, the Natural Heritage Program cannot provide a definitive statement on the presence, absence, or condition of biological elements in any part of New Jersey. Information supplied by the Natural Heritage Program summarizes existing data known to the program at the time of the request regarding the biological elements or locations in question. They should never be regarded as final statements on the elements or areas being considered, nor should they be substituted for on-site surveys required for environmental assessments. The attached data is provided as one source of information to assist others in the preservation of natural diversity.

This office cannot provide a letter of interpretation or a statement addressing the classification of wetlands as defined by the Freshwater Wetlands Act. Requests for such determination should be sent to the DEP Land Use Regulation Program, CN 401, Trenton, NJ 08625-0401.

**This cautions and restrictions notice must be included whenever information provided by the Natural Heritage Database is published.**

ON OR IN THE IMMEDIATE VICINITY OF PROJECT SITE  
RARE SPECIES AND NATURAL COMMUNITIES PRESENTLY RECORDED IN  
THE NEW JERSEY NATURAL HERITAGE DATABASE

COMMON NAME	FEDERAL STATUS	STATE STATUS	REGIONAL GRANK	SRANK	DATE OBSERVED	IDENT.	LOCATION
LEAST TERN	E		G4	S2	1977-??-??	Y	PORT NEWARK, NEWARK.

Vertebrates  
NA ANTILLARUM  
cords Processed

HUDSON COUNTY  
RARE SPECIES AND NATURAL COMMUNITIES PRESENTLY RECORDED IN  
THE NEW JERSEY NATURAL HERITAGE DATABASE

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS	REGIONAL STATUS	GRANK	SRANK
vertebrates						
CHLEMYS INSCULPTA	WOOD TURTLE		T		G4	S3
FULICA AMERICANA	AMERICAN COOT				G5	S1
POOILYMBUS PODICEPS	PIED-BILLED GREBE		E/S		G5	S1
STERNA ANTILLARUM	LEAST TERN		E		G4	S2
other types						
COASTAL HERON ROOKERY	COASTAL HERON ROOKERY				GU	S3
vascular plants						
AGASTACHE SCROPHULARIIFOLIA	PURPLE GIANT HYSSOP				G4	S2
CAREX PSEUDOCYPERUS	CYPERUS-LIKE SEDGE		E		G5	S1
HIERACIUM KALMII	CANADA HAWKWEED		E		G5	SH
HOTTONTIA INFLATA	FEATHERFOIL		E		G3G4	S1
HYPERICUM MAJUS	LARGER CANADIAN ST.		E		G5	S1
	JOHN'S-WORT					
LEMNA PERPUSILLA	MINUTE DUCKWEED				G5	S1
ONOSMODIUM VIRGINIANUM	VIRGINIA FALSE-GROMWELL		E		G4	S1
PRENANTHES RACEMOSA	SMOOTH RATTLESNAKE ROOT		E		G5	SH
SALIX LUCIDA	SHINING WILLOW				G5	S2
TRIGLOCHIN MARITIMUM	SEA-SIDE ARROW-GRASS		E		G5	S1

ESSEX COUNTY  
 RARE SPECIES AND NATURAL COMMUNITIES PRESENTLY RECORDED IN  
 THE NEW JERSEY NATURAL HERITAGE DATABASE

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS	REGIONAL STATUS	GRANK	SRANK
<b>Vertebrates</b>						
ACCIPITER COOPERII	COOPER'S HAWK		E		G4	S2
AMBYSTOMA LATERALE	BLUE-SPOTTED SALAMANDER		E		G5	S1
AMMODRAMUS SAVANNARUM	GRASSHOPPER SPARROW		T/T		G4	S2
BARTRAMIA LONGICAUDA	UPLAND SANDPIPER		E		G5	S1
BUTEO LINEATUS	RED-SHOULDERED HAWK		E/T		G5	S2
CISTOTHORUS PLATENSIS	SEDGE WREN		E		G5	S1
CLEMmys INSCULPTA	WOOD TURTLE		T		G4	S3
DOLICHONYX ORYZIVORUS	BOBOLINK		T/T		G5	S2
PASSERCULUS SANDWICHENSIS	SAVANNAH SPARROW		T/T		G5	S2
STERNA ANTILLARUM	LEAST TERN		E		G4	S2
STRIX VARIA	BARRED OWL		T/T		G5	S3
<b>Invertebrates</b>						
LAMPUSILIS RADIATA	EASTERN LAMPUSSEL				G5	S3S4
MICROPHORUS AMERICANUS	AMERICAN BURYING BEETLE	LE	E		G1	SH
<b>/ascular plants</b>						
ALISMA TRIVIALE	LARGE WATER-PLANTAIN		E		G5T5	S1
ANEHONE CANADENSIS	CANADA ANEMONE				G5	SX
CALLITRICHIE VERNA	SPRING WATER STARWORT				G5	S2
CALYSTEGIA SPITHAMAEA	ERECT BINDWEED		E		G4G5	S1
LEMNA PERPUSILLA	MINUTE DUCKWEED				G5	S1
MUHLENBERGIA CAPILLARIS	LONG-ARMED SMOKE GRASS		E		G5	S1
PENSTEMON LAEVIGATUS	SMOOTH BEARD TONGUE		E		G5	S1
PHLOX PILOSA	DOWNY PHLOX		E		G5	SH
PYCNANTHEMUM TORREI	TORREY'S MOUNTAIN MINT		E		G2	S1
SALIX LUCIDA	SHINING WILLOW				G5	S2

ESSEX COUNTY  
RARE SPECIES AND NATURAL COMMUNITIES PRESENTLY RECORDED IN  
THE NEW JERSEY NATURAL HERITAGE DATABASE

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS	REGIONAL STATUS	GRANK	SRANK
STYLOSANTHES BIFLORA	PENCIL FLOWER				65	S3

Records Processed

UNION COUNTY  
RARE SPECIES AND NATURAL COMMUNITIES PRESENTLY RECORDED IN  
THE NEW JERSEY NATURAL HERITAGE DATABASE

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS	REGIONAL STATUS	GRANK	SRANK
CLEMYS INSULPTA	WOOD TURTLE		T		G4	S3
CLEMYS MUEHLBERGII	BOG TURTLE	C2	E		G3	S2
EURYCEA LONGICAUDA LONGICAUDA	LONGTAIL SALAMANDER		T		G5T5	S2
PASSERCOLUS SANDWICHENSIS	SAVANNAH SPARROW		T/T		G5	S2
STERNA ANTILLARUM	LEAST TERN		E		G4	S2
TRAPROCK GLADE/ROCK OUTCROP COMMUNITY	TRAPROCK GLADE/ROCK OUTCROP COMMUNITY				G2	S17
ALASRIDONTA UNDULATA	TRIANGLE FLOATER				G4	S3
PAPAPEMA AERATA	LONG DASH	C2			GH	SH
POLITES MYSTIC	CHECKERED WHITE				G5	S3?
PONTIA PROTODICE	CHECKERED WHITE				G4	SX
COASTAL HERON ROOKERY	COASTAL HERON ROOKERY				GU	S3
CAREX BEBBI	BEBB'S SEDGE				G5	S2
CAREX POLYMORPHA	VARIABLE SEDGE	C2	E		G2G3	S1
CYNOGLOSSUM VIRGINIANUM VAR VIRGINIANUM	WILD COMFREY				G5T5	S2
LEMNA VALDIVIANA	PALE DUCKWEED		E		G5	S1
LIATRIS SCARIOSA VAR NOVAE-ANGLIAE	NORTHERN BLAZING STAR	C2	E		G5?T3	SH
MONARDA CLINOPODIA	BASIL BEE-BALM		E		G5	SH
MUEHLBERGIA CAPILLARIS	LONG-ARMED SMOKE GRASS		E		G5	S1

\*\*\* Vertebrates

\*\*\* Ecosystems

\*\*\* Invertebrates

\*\*\* Other types

\*\*\* Vascular plants

14 JUN 1996

UNION COUNTY  
RARE SPECIES AND NATURAL COMMUNITIES PRESENTLY RECORDED IN  
THE NEW JERSEY NATURAL HERITAGE DATABASE

NAME	COMMON NAME	FEDERAL STATUS	STATE STATUS	REGIONAL STATUS	GRANK	SRANK
PHLOX PILOSA	DOAMY PHLOX		E		G5	SH
RANUNCULUS PUSILLUS	LOW SPEARWORT				G5	S2
VIOLA CANADENSIS	CANADA VIOLET		E		G5	S1

21 Records Processed

## EXPLANATIONS OF CODES USED IN NATURAL HERITAGE REPORTS

### FEDERAL STATUS CODES

The following U.S. Fish and Wildlife Service categories and their definitions of endangered and threatened plants and animals have been modified from the U.S. Fish and Wildlife Service (F.R. Vol. 50 No. 188; Vol. 55, No. 35; F.R. 50 CFR 17.11 and 17.12). Federal Status codes reported for species follow the most recent listing.

- LE** Taxa formally listed as endangered.
- LT** Taxa formally listed as threatened.
- PE** Taxa already proposed to be formally listed as endangered.
- PT** Taxa already proposed to be formally listed as threatened.
- C1** Taxa for which the Service currently has on file substantial information on biological vulnerability and threat(s) to support the appropriateness of proposing to list them as endangered or threatened species.
- C1\*** Taxa which may be possibly extinct (although persuasive documentation of extinction has not been made--compare to 3A status).
- C2** Taxa for which information now in possession of the Service indicates that proposing to list them as endangered or threatened species is possibly appropriate, but for which substantial data on biological vulnerability and threat(s) are not currently known or on file to support the immediate preparation of rules.
- C3** Taxa that are no longer being considered for listing as threatened or endangered species. Such taxa are further coded to indicate three subcategories, depending on the reason(s) for removal from consideration.
- 3A** Taxa for which the Service has persuasive evidence of extinction.
- 3B** Names that, on the basis of current taxonomic understanding, do not represent taxa meeting the Act's definition of "species".
- 3C** Taxa that have proven to be more abundant or widespread than was previously believed

and/or those that are not subject to any identifiable threat.

**S/A** Similarity of appearance species.

## STATE STATUS CODES

Two animal lists provide state status codes after the Endangered and Nongame Species Conservation Act of 1973 (NSSA 23:2A-13 et. seq.): the list of endangered species (N.J.A.C. 7:25-4.13) and the list defining status of indigenous, nongame wildlife species of New Jersey (N.J.A.C. 7:25-4.17(a)). The status of animal species is determined by the Nongame and Endangered Species Program (ENSP). The state status codes and definitions provided reflect the most recent lists that were revised in the New Jersey Register, Monday, June 3, 1991.

- D** Declining species-a species which has exhibited a continued decline in population numbers over the years.
- E** Endangered species-an endangered species is one whose prospects for survival within the state are in immediate danger due to one or many factors - a loss of habitat, over exploitation, predation, competition, disease. An endangered species requires immediate assistance or extinction will probably follow.
- EX** Extirpated species-a species that formerly occurred in New Jersey, but is not now known to exist within the state.
- I** Introduced species-a species not native to New Jersey that could not have established itself here without the assistance of man.
- INC** Increasing species-a species whose population has exhibited a significant increase, beyond the normal range of its life cycle, over a long term period.
- T** Threatened species-a species that may become endangered if conditions surrounding the species begin to or continue to deteriorate.
- P** Peripheral species-a species whose occurrence in New Jersey is at the extreme edge of its present natural range.

- S** Stable species—a species whose population is not undergoing any long-term increase/decrease within its natural cycle.
- U** Undetermined species—a species about which there is not enough information available to determine the status.

Status for animals separated by a slash(/) indicate a dual status. First status refers to the state breeding population, and the second status refers to the migratory or winter population.

Plant taxa listed as endangered are from New Jersey's official Endangered Plant Species List N.J.S.A. 131B-15.151 et seq.

- E** Native New Jersey plant species whose survival in the State or nation is in jeopardy.

#### REGIONAL STATUS CODES FOR PLANTS

- LP** Indicates taxa listed by the Pinelands Commission as endangered or threatened within their legal jurisdiction. Not all species currently tracked by the Pinelands Commission are tracked by the Natural Heritage Program. A complete list of endangered and threatened Pineland species is included in the New Jersey Pinelands Comprehensive Management Plan.

#### EXPLANATION OF GLOBAL AND STATE ELEMENT RANKS

The Nature Conservancy has developed a ranking system for use in identifying elements (rare species and natural communities) of natural diversity most endangered with extinction. Each element is ranked according to its global, national, and state (or subnational in other countries) rarity. These ranks are used to prioritize conservation work so that the most endangered elements receive attention first. Definitions for element ranks are after The Nature Conservancy (1982: Chapter 4, 4.1-1 through 4.4.1.3-3).

## GLOBAL ELEMENT RANKS

- G1** Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
- G2** Imperiled globally because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
- G3** Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state; a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range; with the number of occurrences in the range of 21 to 100.
- G4** Apparently secure globally; although it may be quite rare in parts of its range, especially at the periphery.
- G5** Demonstrably secure globally; although it may be quite rare in parts of its range, especially at the periphery.
- GH** Of historical occurrence throughout its range i.e., formerly part of the established biota, with the expectation that it may be rediscovered.
- GU** Possibly in peril range-wide but status uncertain; more information needed.
- GX** Believed to be extinct throughout range (e.g., passenger pigeon) with virtually no likelihood that it will be rediscovered.
- G?** Species has not yet been ranked.

## STATE ELEMENT RANKS

- S1** Critically imperiled in New Jersey because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres). Elements so ranked are often restricted to very specialized conditions or habitats and/or restricted to an extremely small geographical

area of the state. Also included are elements which were formerly more abundant, but because of habitat destruction or some other critical factor of its biology, they have been demonstrably reduced in abundance. In essence, these are elements for which, even with intensive searching, sizable additional occurrences are unlikely to be discovered.

- S2** Imperiled in New Jersey because of rarity (6 to 20 occurrences). Historically many of these elements may have been more frequent but are now known from very few extant occurrences, primarily because of habitat destruction. Diligent searching may yield additional occurrences.
- S3** Rare in state with 21 to 100 occurrences (plant species in this category have only 21 to 50 occurrences). Includes elements which are widely distributed in the state but with small populations/acreage or elements with restricted distribution, but locally abundant. Not yet imperiled in state but may soon be if current trends continue. Searching often yields additional occurrences.
- S4** Apparently secure in state, with many occurrences.
- S5** Demonstrably secure in state and essentially ineradicable under present conditions.
- SA** Accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range; a few of these species may even have bred on the one or two occasions they were recorded; examples include european strays or western birds on the East Coast and visa-versa.
- SE** Elements that are clearly exotic in New Jersey including those taxa not native to North America (introduced taxa) or taxa deliberately or accidentally introduced into the State from other parts of North America (adventive taxa). Taxa ranked SE are not a conservation priority (viable introduced occurrences of G1 or G2 elements may be exceptions).
- SH** Elements of historical occurrence in New Jersey. Despite some searching of historical occurrences and/or potential habitat, no extant occurrences are known. Since not all of the historical occurrences have been field surveyed, and unsearched potential habitat remains, historically ranked taxa are considered possibly extant, and remain a conservation priority for continued field work.

- SN** Regularly occurring, usually migratory and typically nonbreeding species for which no significant or effective habitat conservation measures can be taken in the state; this category includes migratory birds, bats, sea turtles, and cetaceans which do not breed in the state but pass through twice a year or may remain in the winter (or, in a few cases, the summer); included also are certain lepidoptera which regularly migrate to a state where they reproduce, but then completely die out every year with no return migration. Species in this category are so widely and unreliably distributed during migration or in winter that no small set of sites could be set aside with the hope of significantly furthering their conservation. Other nonbreeding, high globally-ranked species (such as the bald eagle, whooping crane or some seal species) which regularly spend some portion of the year at definite localities (and therefore have a valid conservation need in the state) are not ranked SN but rather S1, S2, etc.
- SR** Elements reported from New Jersey, but without persuasive documentation which would provide a basis for either accepting or rejecting the report. In some instances documentation may exist, but as of yet, its source or location has not been determined.
- SRF** Elements erroneously reported from New Jersey, but this error persists in the literature.
- SU** Elements believed to be in peril but the degree of rarity uncertain. Also included are rare taxa of uncertain taxonomical standing. More information is needed to resolve rank.
- SX** Elements that have been determined or are presumed to be extirpated from New Jersey. All historical occurrences have been searched and a reasonable search of potential habitat has been completed. Extirpated taxa are not a current conservation priority.
- SXC** Elements presumed extirpated from New Jersey, but native populations collected from the wild exist in cultivation.
- T** Element ranks containing a "T" indicate that the infraspecific taxon is being ranked differently than the full species. For example *Stachys palustris* var. *homotricha* is ranked "G5T? SH" meaning the full species is globally secure but the global rarity of the var. *homotricha* has not been determined; in New Jersey the variety is ranked historic.
- Q** Elements containing a "Q" in the global portion of its rank indicates that the taxon is of questionable, or uncertain taxonomical standing, e.g., some authors regard it as a full species, while others treat it at the subspecific level.

**.1** Elements documented from a single location.

Note: To express uncertainty, the most likely rank is assigned and a question mark added (e.g., G2?).  
A range is indicated by combining two ranks (e.g., G1G2, S1S3).

#### IDENTIFICATION CODES

These codes refer to whether the identification of the species or community has been checked by a reliable individual and is indicative of significant habitat.

**Y** Identification has been verified and is indicative of significant habitat.

**BLANK** Identification has not been verified but there is no reason to believe it is not indicative of significant habitat.

**?** Either it has not been determined if the record is indicative of significant habitat or the identification of the species or community may be confusing or disputed.

**APPENDIX G**

**WILDLIFE SPECIES LIKELY TO USE THE NEWARK BAY AREA**

Table G-1 (Page 1 of 10)

**Wildlife Species Likely to Use the Newark Bay Area  
as Identified During Studies in the NY/NJ Harbor Area**

Common Name	Scientific Name	Upland, Marine and Adjacent Shoreline Sites		USCG (1995)	Harbor Herons Report (1990) Individuals	Breeding Birds		Liberty State Park TI (1976)	Marine and Adjacent Shoreline Sites		Marine and Open Water Sites Patty/NJ Newark Bay LMS (1996)
		Andrie and Carrol (1988)	Aquila and Alderson (1984)			Overwintering Birds	Hudson River Waterfront LMS Unpublished LMS (1984 a) LMS (1984 b) LMS (1984 c)				
<b>Mammals</b>											
Virginia opossum	<i>Didelphis virginiana</i>			x	x						
Eastern mole	<i>Scalopus aquaticus</i>				x						
Unidentified bat	Unidentified bat			x							
Red bat	<i>Lesiurus borealis</i>				x						
Hoary bat	<i>Lesiurus cinereus</i>				x						
Little brown bat	<i>Myotis lucifugus</i>				x						
Eastern cottontail	<i>Sylvilagus floridanus</i>			x							
Grey squirrel	<i>Sciurus carolinensis</i>			x							
White-footed mouse	<i>Peromyscus leucopus</i>			x							
Meadow vole	<i>Microtus pennsylvanicus</i>			x							
Muskrat	<i>Ondatra zibethica</i>			x							
Norway rat	<i>Rattus norvegicus</i>			x							
House mouse	<i>Mus musculus</i>			x							
Raccoon	<i>Procyon lotor</i>			x							
White-tailed deer	<i>Odocoileus virginianus</i>			x							
<b>Number of species:</b>				11	12	Not Applicable	Not Applicable		Not Applicable		

Table G-1 (Page 2 of 10)

Wildlife Species Likely to Use the Newark Bay Area  
as Identified During Studies in the NY/NJ Harbor Area

Common Name	Scientific Name	Upland, Marine and Adjacent Shoreline Sites				Liberty State Park TI (1976)	Marine and Adjacent Shoreline Sites Hudson River Waterfront LMS Unpublished		Marine and Open Water Sites Pany/NJ Newark Bay LMS (1996)
		USCG (1995)	Harbor Herons Report (1990) Individuals	Andrie and Carrol (1988) Breeding Birds	Aquila and Alderson (1984) Overwintering Birds		LMS (1984 a)	LMS (1984 b)	
Birds									
Common loon	<i>Gavia immer</i>								
Red-throated loon	<i>Gavia stellata</i>				x				
Pied-billed grebe	<i>Podilymbus podiceps</i>				x				
Horned grebe	<i>Podiceps auritus</i>		x		x				x
Great cormorant	<i>Phalacrocorax carbo</i>				x				
Double-crested cormorant	<i>Phalacrocorax auritus</i>		x		x				
Great blue heron	<i>Ardea herodias</i>		x		x				
Green-backed heron	<i>Butorides virescens</i>		x		x				
Little blue heron	<i>Egretta caerulea</i>		x		x				
Cattle egret	<i>Bubucius ibis</i>		x		x				
Great egret	<i>Casmerodius albus</i>		x		x				
Snowy egret	<i>Egretta thula</i>		x		x				
Black-crowned night heron	<i>Nycticorax nycticorax</i>		x		x				
Yellow-crowned night heron	<i>Nycticorax virescens</i>		x		x				
Least bittern	<i>Icthyophaga exilis</i>		x		x				
American bittern	<i>Botaurus lentiginosus</i>		x		x				
Glossy ibis	<i>Plegadis falcinellus</i>		x		x				
Louisiana heron	<i>Hydranassa tricolor</i>		x		x				
White-faced ibis	<i>Plegadis chihii</i>		x		x				
Brant goose	<i>Branta bernicla</i>		x		x				
Snow goose	<i>Chen caerulescens</i>		x		x				
Canada goose	<i>Branta canadensis</i>		x		x				
Mallard	<i>Anas platyrhynchos</i>		x		x				
Black duck	<i>Anas rubripes</i>		x		x				
Gadwall	<i>Anas strepera</i>		x		x				
Northern pintail	<i>Anas acuta</i>		x		x				

Table G-1 (Page 3 of 10)

Wildlife Species Likely to Use the Newark Bay Area  
as Identified During Studies in the NY/NJ Harbor Area

Common Name	Scientific Name	Upland, Marine and Adjacent Shoreline Sites				Liberty State Park TI (1976)	Marine and Adjacent Shoreline Sites Hudson River Waterfront LMS Unpublished		Marine and Open Water Sites Pany/NJ Newark Bay LMS (1996)
		USCG (1989)	Harbor Herons Report (1990) Individuals	Andrie and Carrol (1988) Breeding Birds	Aquila and Alderson (1994) Overwintering Birds		LMS (1984 a)	LMS (1984 b)	
Birds									
Ruddy duck	<i>Oxyura jamaicensis</i>		x		x		x		
Canvasback	<i>Aythya valisineria</i>		x		x		x		
Lesser scaup	<i>Aythya affinis</i>		x		x		x		
Greater scaup	<i>Aythya marila</i>		x		x		x		
Common goldeneye	<i>Bucephala clangula</i>		x		x		x		
Green-winged teal	<i>Anas crecca</i>	x	x	x	x				
Blue-winged teal	<i>Anas discors</i>	x	x	x	x				
American wigeon	<i>Anas americana</i>	x	x	x	x				
Northern shoveler	<i>Anas clypeata</i>		x		x		x		
Wood duck	<i>Aix sponsa</i>		x	x					
Redhead	<i>Aythya americana</i>						x		
Ring-necked duck	<i>Aythya collaris</i>						x		
Bufflehead	<i>Bucephala albeola</i>		x		x		x		
White-winged scoter	<i>Melanitta deglandi</i>						x		
Oldsquaw	<i>Clangula hyemalis</i>				x		x		
Hooded merganser	<i>Lophodytes mergus</i>	x	x		x		x		
Common merganser	<i>Mergus merganser</i>		x		x				
Red-breasted merganser	<i>Mergus serrator</i>		x		x				
Whistling swan	<i>Cygnus olor columbianus</i>		x						
Turkey vulture	<i>Cathartes aura</i>	x							
Cooper's hawk	<i>Accipiter cooperii</i>				x				
Sharp-shinned hawk	<i>Accipiter striatus</i>	x	x		x				
Red-tailed hawk	<i>Buteo jamaicensis</i>	x	x		x				
Red-shouldered hawk	<i>Buteo lineatus</i>				x				
Northern harrier	<i>Circus cyaneus</i>	x	x		x				
Rough-legged hawk	<i>Buteo lagopus</i>		x		x				



Table G-1 (Page 5 of 10)

Wildlife Species Likely to Use the Newark Bay Area as Identified During Studies in the NY/NJ Harbor Area

Common Name	Scientific Name	Upland, Marine and Adjacent Shoreline Sites		Liberty State Park TI (1976)	Marine and Adjacent Shoreline Sites			Marine and Open Water Sites Patterson/Newark Bay LMS (1996)
		USCG (1995)	Harbor Herons Report (1990) Individuals		Andrite and Carrol (1968) Breeding Birds	Aquila and Alderson (1994) Overwintering Birds	LMS (1984 a) LMS (1984 b)	
Dunlin	<i>Calidris alpina</i>							
Short-billed dowitcher	<i>Limnodromus griseus</i>			x				
Silt sandpiper	<i>Micropalama himantopus</i>							
Semipalmated sandpiper	<i>Calidris pusilla</i>	x	x					
Black-bellied plover	<i>Pluvialis squatarola</i>		x					
Red knot	<i>Calidris canutus</i>							
Sandpiper	<i>Calidris alba</i>							
Dowitcher sp.	<i>Limnodromus sp.</i>							
Wilson's phalarope	<i>Sieganopus tricolor</i>							
Great black-backed gull	<i>Larus marinus</i>	x	x					
Herring gull	<i>Larus argentatus</i>	x	x					
Ring-billed gull	<i>Larus delawarensis</i>	x	x					
Laughing gull	<i>Larus atricilla</i>	x	x					
Bonaparte's gull	<i>Larus philadelphia</i>	x	x					
Common tern	<i>Sterna hirundo</i>	x	x					
Roseate tern	<i>Sterna dougallii</i>	x	x					
Least tern	<i>Sterna albifrons</i>	x	x					
Arctic tern	<i>Sterna paradisaea</i>	x	x					
Black skimmer	<i>Rynchops niger</i>	x	x					
Rock dove	<i>Columba livia</i>	x	x					
Mourning dove	<i>Zenaidura macroura</i>	x	x					
Yellow-billed cuckoo	<i>Coccyzus americanus</i>	x	x					
Common barn-owl	<i>Tyto alba</i>	x	x					
Screech-owl	<i>Otus asio</i>							
Great horned owl	<i>Bubo virginianus</i>							
Snowy owl	<i>Nyctea scandiaca</i>							

Table G-1 (Page 6 of 10)

Wildlife Species Likely to Use the Newark Bay Area  
as Identified During Studies in the NY/NJ Harbor Area

Common Name	Scientific Name	Upland, Marine and Adjacent Shoreline Sites				Liberty State Park TI (1976)	Marine and Adjacent Shoreline Sites Hudson River Waterfront LMS (1984 a) LMS (1984 b) LMS (1984 c)		Marine and Open Water Sites Pany/NJ Newark Bay LMS (1986)
		USCG (1985)	Harbor Herons Report (1980) Individuals	Andrie and Carrol (1986) Breeding Birds	Aquila and Alderson (1984) Overwintering Birds		LMS (1984 a)	LMS (1984 b)	
<b>Birds</b>									
Short-eared owl	<i>Asio flammeus</i>		x						
Ruby-throated hummingbird	<i>Archilochus colubris</i>		x						
Chimney swift	<i>Chaetura pelagica</i>	x							
Belted kingfisher	<i>Ceryle alcyon</i>	x							
Northern flicker	<i>Colaptes auratus luteus</i>	x							
Red-bellied woodpecker	<i>Melanerpes carolinus</i>								
Yellow-bellied sapsucker	<i>Sphyrapicus varius vitius</i>								
Hairy woodpecker	<i>Dendrocoptes picoides</i>	x							
Downy woodpecker	<i>Dendrocoptes picoides</i>	x							
Eastern kingbird	<i>Tyrannus tyrannus</i>	x							
Flycatcher sp.	<i>Empidonax sp.</i>	x							
Great crested flycatcher	<i>Myiarchus crinitus</i>	x							
Eastern phoebe	<i>Sayornis phoebe</i>	x							
Eastern wood-pewee	<i>Contopus virens</i>	x							
Willow flycatcher	<i>Empidonax traillii</i>	x							
Horned lark	<i>Eremophila alpestris</i>								
Tree swallow	<i>Iridoprocne bicolor</i>	x							
Bank swallow	<i>Riparia riparia</i>	x							
Rough-winged swallow	<i>Stelgidopteryx ruficollis</i>	x							
Barn swallow	<i>Hirundo rustica</i>	x							
Blue jay	<i>Cyanocitta cristata</i>	x							
American crow	<i>Corvus brachyrhynchos</i>	x							
Fish crow	<i>Corvus ossifragus</i>	x							
Black-capped chickadee	<i>Parus atricapillus</i>	x							
Tufted titmouse	<i>Parus bicolor</i>	x							
White-breasted nuthatch	<i>Sitta carolinensis</i>	x							

Table G-1 (Page 7 of 10)

Wildlife Species Likely to Use the Newark Bay Area  
as Identified During Studies in the NY/NJ Harbor Area

Common Name	Scientific Name	Upland, Marine and Adjacent Shoreline Sites		Liberty State Park TI (1978)	Marine and Adjacent Shoreline Sites		Marine and Open Water Sites Pany/NJ Newark Bay LMS (1996)
		USCG (1985)	Harbor Herons Report (1990) Individuals		Andrie and Carroll (1986) Breeding Birds	Aquila and Alderson (1994) Overwintering Birds	
Birds							
Red-breasted nuthatch	<i>Sitta canadensis</i>				x		
Brown creeper	<i>Certhia familiaris</i>						
House wren	<i>Troglodytes aedon</i>	x	x				
Winter wren	<i>Troglodytes troglodytes</i>						
Carolina wren	<i>Thryothorus ludovicianus</i>	x			x		
Marsh wren	<i>Cistothorus palustris</i>	x	x				
Northern mockingbird	<i>Mimus polyglottos</i>	x	x		x		
Gray catbird	<i>Dumetella carolinensis</i>	x	x		x		
Brown thrasher	<i>Toxostoma rufum</i>	x	x				
American robin	<i>Turdus migratorius</i>	x	x		x		
Wood thrush	<i>Hylocichla ustulata</i>	x	x				
Swainson's thrush	<i>Catharus ustulatus</i>	x	x				
Veery	<i>Catherus fuscescens</i>						
Eastern bluebird	<i>Sialia sialis</i>	x	x				
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>						
Golden-crowned kinglet	<i>Regulus satrapa</i>	x	x		x		
Ruby-crowned kinglet	<i>Regulus calendula</i>	x					
Loggerhead shrike	<i>Lanius ludovicianus</i>						
Cedar waxwing	<i>Bombycilla cedrorum</i>	x					
European starling	<i>Sturnus vulgaris</i>	x			x		
Yellow-throated vireo	<i>Vireo flavifrons</i>	x	x				
Solitary vireo	<i>Vireo solitarius</i>	x					
Red-eyed vireo	<i>Vireo olivaceus</i>	x	x				
Philadelphia vireo	<i>Vireo philadelphicus</i>						
Black-&-white warbler	<i>Mniotilta varia</i>	x	x				
Nashville warbler	<i>Vermivora ruficapilla</i>	x					



Table G-1 (Page 9 of 10)

Wildlife Species Likely to Use the Newark Bay Area as Identified During Studies in the NY/NJ Harbor Area

Common Name	Scientific Name	Upland, Marine and Adjacent Shoreline Sites				Liberty State Park TI (1976)	Marine and Adjacent Shoreline Sites		Marine and Open Water Sites Party/NJ Newark Bay LMS (1986)	
		USCG (1995)	Harbor Herons Report (1980) Individuals	Andrie and Carrol (1988) Breeding Birds	Aquila and Alderson (1994) Overwintering Birds		Hudson River Waterfront LMS Unpublished LMS (1984 a)   LMS (1984 b)   LMS (1984 c)			
Northern cardinal	<i>Cardinalis cardinalis</i>	x	x	x						
Rose-breasted grosbeak	<i>Pheucticus ludovicianus</i>	x								
Indigo bunting	<i>Passerina cyanea</i>	x								
Purple finch	<i>Carpodacus purpureus</i>					x				
House finch	<i>Carpodacus mexicanus</i>									
Common redpoll	<i>Carduelis flammea</i>									
American goldfinch	<i>Spinus carduelis tristis</i>	x	x							
Rufous-sided towhee	<i>Pipilo erythrophthalmus</i>	x	x							
Savannah sparrow	<i>Passerculus sandwichensis</i>	x								
Dark-eyed junco	<i>Junco hyemalis</i>									
American Tree sparrow	<i>Spizella arborea</i>	x								
Chipping sparrow	<i>Spizella passerina</i>									
Field sparrow	<i>Spizella pusilla</i>	x								
White-crowned sparrow	<i>Zonotrichia leucophrys</i>	x								
White-throated sparrow	<i>Zonotrichia albicollis</i>	x								
Seaside sparrow	<i>Ammodramus caudatus</i>									
Sharp-tailed sparrow	<i>Ammodramus maritimus</i>									
Fox sparrow	<i>Passerella iliaca</i>									
Lincoln's sparrow	<i>Melospiza lincolni</i>	x								
Swamp sparrow	<i>Melospiza georgiana</i>	x	x							
Song sparrow	<i>Melospiza melodia</i>	x	x							
Snow bunting	<i>Plectrophenax nivalis</i>									
House sparrow		x								
<b>Number of species:</b>		117	124	72	83	98	45	18	36	20

Table G-1 (Page 10 of 10)

Wildlife Species Likely to Use the Newark Bay Area  
as Identified During Studies in the NY/NJ Harbor Area

Common Name	Scientific Name	Upland, Marine and Adjacent Shoreline Sites					Marine and Adjacent Shoreline Sites Hudson River Waterfront LMS Unpublished LMS (1984 a) LMS (1984 b) LMS (1984 c)	Marine and Open Water Sites Pany/NJ Newark Bay LMS (1986)
		USCG (1985)	Harbor Herons Report (1980) Individuals	Andrie and Carroll (1988) Breeding Birds	Aquila and Alderson (1984) Overwintering Birds	Liberty State Park TI (1976)		
<b>Reptiles</b>								
Northern brown snake	<i>Storeria dekayi</i>	x						
Eastern black racer	<i>Coluber constrictor</i>		x					
Common garter snake	<i>Thamnophis sirtalis</i>		x					
Snapping turtle	<i>Chelydra serpentina</i>	x						
Painted turtle	<i>Chrysemys picta</i>		x					
Diamondback terrapin	<i>Malaclemys terrapin</i>	x						
Eastern fence lizard	<i>Sceloporus undulatus</i>		x					
<b>Number of species:</b>		3	8	Not Applicable	Not Applicable			
<b>Amphibians</b>								
Red-backed salamander	<i>Plethodon cinereus</i>		x					
Green frog	<i>Rana clamitans</i>		x					
Bullfrog	<i>Rana catesbeiana</i>		x					
Eastern grey tree frog	<i>Hyla versicolor</i>		x					
Southern leopard frog	<i>Rana sphenoccephala</i>		x					
Spring peeper	<i>Hyla crucifer</i>	x						
American toad	<i>Bufo americanus</i>		x					
Fowler's toad	<i>Bufo woodhousei fowleri</i>	x						
Woodland salamander	<i>Plethodon sp.</i>		x					
Four-toed salamander	<i>Hemidactylium scutatum</i>		x					
<b>Number of species:</b>		2	10	Not Applicable	Not Applicable			

**Table G-2**  
**Confirmed, Probable, and Possible Wildlife Species**  
**Using The Newark Bay Shoal Areas**

Common Name	Scientific Name	Status	Season	Habitat
<b>Mammals</b>				
Eastern pipistrelle	<i>Pipistrellus subflavus</i>	Possible	Spring to fall	Aerial - over land and water
Big brown bat	<i>Eptesicus fuscus</i>	Possible	Spring to fall	Aerial - over land and water
Red bat	<i>Lasiurus borealis</i>	Possible	Spring to fall	Aerial - over land and water
Hoary bat	<i>Lasiurus cinereus</i>	Possible	Spring to fall	Aerial - over land and water
Evening bat	<i>Nycticeius humeralis</i>	possible	Spring to fall	Aerial - over land and water
Silver-haired bat	<i>Lasionycteris noctivagans</i>	Possible	Spring to fall	Aerial - over land and water
Small-footed bat	<i>Myotis leibii</i>	Possible	Spring to fall	Aerial - over land and water
Little brown bat	<i>Myotis lucifugus</i>	Possible	Spring to fall	Aerial - over land and water
Northern long eared bat	<i>Myotis septentrionalis</i>	Possible	Spring to fall	Aerial - over land and water
Muskrat	<i>Ondatra zibethica</i>	Possible	Spring to fall	Aerial - over land and water
Harbor seal	<i>Phoca vitulina</i>	Possible	All year	Marsh - wetland, riverine, small bays and creeks Marine bays, channels and costal waters
<b>Birds</b>				
Common loon	<i>Gavia immer</i>	Possible	Late fall - early spring	Open water
Red-throated loon	<i>Gavia stellata</i>	Possible	Late fall - early spring	Open water
Pied-billed grebe	<i>Podilymbus podiceps</i>	Possible	Late fall - early spring	Open water
Great cormorant	<i>Phalacrocorax carbo</i>	Probable	Winter	Open water
Double-crested cormorant	<i>Phalacrocorax auritus</i>	Confirmed	All year	Open water
Great blue heron	<i>Ardea herodias</i>	Probable	All year	Marshes - shallow water
Green-backed heron	<i>Butorides virescens</i>	Possible	All year	Marshes - shallow water
Great egret	<i>Casmerodius albus</i>	Probable	Summer	Marshes - shallow water
Snowy egret	<i>Egretta thula</i>	Possible	Summer	Marshes - shallow water
Black-crowned night heron	<i>Nycticorax nycticorax</i>	Possible	Summer	Marshes - shallow water
Yellow-crowned night heron	<i>Nycticorax violacea</i>	Possible	Summer	Marshes - shallow water
Glossy ibis	<i>Plegadis falcinellus</i>	Possible	Summer	Marshes - shallow water
Brant goose	<i>Branta bernicla</i>	Probable	Winter	Marshes - shallow water
Snow goose	<i>Chen caerulescens</i>	Possible	Winter	Marshes - shallow water
Canada goose	<i>Branta canadensis</i>	Confirmed	All year	Marshes and adjacent open water
Mallard	<i>Anas platyrhynchos</i>	Confirmed	All year	Marshes and adjacent open water
Black duck	<i>Anas rubripes</i>	Confirmed	All year	Marshes and adjacent open water
Gadwall	<i>Anas strepera</i>	Confirmed	All year	Marshes and adjacent open water
Northern pintail	<i>Anas acuta</i>	Possible	Fall and early winter	Open water
Ruddy duck	<i>Oxyura jamaicensis</i>	Probable	Fall and early winter	Open water
Canvasback	<i>Aythya valisineria</i>	Confirmed	Late fall - early winter	Open water
Lesser scaup	<i>Aythya affinis</i>	Probable	Late fall - early winter	Open water
Greater scaup	<i>Aythya marila</i>	Probable	Late fall - early winter	Open water
Common goldeneye	<i>Bucephala clangula</i>	Probable	Late fall - early winter	Open water
Green-winged teal	<i>Anas crecca</i>	Probable	Late fall - early spring	Marshes - open water
Blue-winged teal	<i>Anas discors</i>	Probable	All year	Marshes - open water
American wigeon	<i>Anas americana</i>	Confirmed	Late fall - early spring	Marshes - open water
Northern shoveler	<i>Anas clypeata</i>	Possible	Late fall - early spring	Marshes - open water
Redhead	<i>Aythya americana</i>	Possible	Late fall - early spring	Open water
Ring-necked duck	<i>Aythya collaris</i>	Possible	Late fall - early spring	Marshes - open water
Bufflehead	<i>Bucephala albeola</i>	Confirmed	Late fall - early spring	Open water
White-winged teal	<i>Melanitta deglandi</i>	Possible	Late fall - early spring	Open water
Oldsquaw	<i>Clangula hyemalis</i>	Possible	Late fall - early spring	Open water
Hooded merganser	<i>Lophodytes mergus</i>	Probable	Late fall - early spring	Open water
Common merganser	<i>Mergus merganser</i>	Probable	Late fall - early spring	Open water
Red-breasted merganser	<i>Mergus serrator</i>	Confirmed	Late fall - early spring	Open water
Red-tailed hawk	<i>Buteo jamaicensis</i>	Possible	All year	Upland
Northern harrier	<i>Circus cyaneus</i>	Possible	All year	Marshes
Osprey	<i>Pandion haliaetus</i>	Possible	Summer	Over open water
Peregrine falcon	<i>Falco peregrinus</i>	Probable	All year	Over water and land
Merlin	<i>Falco columbarius</i>	Possible	Winter	Over water and land
American kestrel	<i>Falco sparverius</i>	Possible	All year	Over land
American coot	<i>Fulicia americana</i>	Possible	Summer	Marshes, tidal creeks and open water
Great black-backed gull	<i>Larus marinus</i>	Confirmed	All year	Open water
Herring gull	<i>Larus argentatus</i>	Confirmed	All year	Open water
Ring-billed gull	<i>Larus delawarensis</i>	Confirmed	All year	Open water
Laughing gull	<i>Larus atricilla</i>	Confirmed	Summer	Open water
Common tern	<i>Sterna hirundo</i>	Probable	Summer	Open water
Roseate tern	<i>Sterna dougallii</i>	Possible	Summer	Open water
Least tern	<i>Sterna albifrons</i>	Probable	Summer	Open water
Black skimmer	<i>Rynchops niger</i>	Possible	Summer	Open water, tidal creeks and rivers
Tree swallow	<i>Iridoprocne bicolor</i>	Probable	Summer	Over land and water
Barn swallow	<i>Hirundo rustica</i>	Probable	Summer	Over land and water
American crow	<i>Corvus brachyrhynchos</i>	Confirmed	All year	Along shores and mudflats
<b>Reptiles</b>				
Loggerhead	<i>Caretta caretta</i>	Possible	Summer	Costal waters
Kemp's ridley	<i>Lepidochelys kempii</i>	Possible	Summer	Costal waters
Green sea turtle	<i>Chelonia mydas</i>	Possible	Summer	Costal waters