Seasonal Distribution and Abundance of 26 Species of Fish and Megainvertebrates Collected in the Hudson-Raritan Estuary, January 1992 - December 1997

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Stuart J. Wilk, Robert A. Pikanowski, Donald G. McMillan, and Eileen M. MacHaffie

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ABSTRACT

INTRODUCTION

Background

The conflict among the various groups exploiting the Hudson-Raritan Estuary's shared resources involves approximately 40 million people and billions of dollars. Constituencies and agencies need appropriate and current information to make informed management decisions, e.g., site selection for dredge material disposal and widening and deepening of channels (US Army Corp of Engineers 1996, 1997). Therefore, this study was designed to provide: (1) a historical and timely baseline to measure natural as well as anthropogenic changes in fish distribution, abundance, ecology, and life history; (2) a means of identifying and describing habitat requirements and habits of selected species or species assemblages, e.g., temporal and spatial habitat utilization; (3) a statistically sound means of collecting synoptic physical, chemical, and biological information in a space and time framework, e.g., reproductive condition, food habits, incidence of disease, effects/distribution of body burdens of organic and inorganic compounds, benthic biomass, distribution of eggs and larvae, hydrography, etc.; (4) a basis to design and conduct directed field experiments, e.g., before and after dredging, before and after sand mining, etc.; and (5) a means to test laboratory experimental results and/or to identify parameters that can be tested in the laboratory.

Presently, the siting and associated impacts of contaminated dredged material placement, e.g., burrow pits and containment islands, are the focus of an Environmental Impact Statement to be promulgated by a multi-agency Dredge Material Management Plan (Long et al. 1995; US Army Corp of Engineers 1996, 1997). A portion of the siting area includes the Hudson-Raritan Estuary (Palermo et al. 1998). The information available from the aforementioned study conducted by NOAA/NMFS's, James J. Howard Laboratory, represents the only long term temporally comprehensive resource monitoring effort in the area (Wilk et al. 1996); and thus, must be included in this siting process. Therefore, it is the purpose of this document to illustrate the distribution and abundance of the 26 most abundant species of fish and megainvertebrate collected during the first six years of the study.

METHODS AND MATERIALS

Geographic Setting

The Hudson-Raritan Estuary (74°05', 40°30') is formed by the apex of Monmouth County, New Jersey, on the south and Staten Island and Brooklyn, New York, on the north (Figure 1). The Hudson, Raritan, and Shrewsbury-Navasink river systems feed into the estuary from the north, west, and south, respectively.
**Station Selection**

This study is based upon a stratified-random design. Detailed statistical descriptions and case study applications of this method can be found in Azarovitz (1980, 1994); Fogarty (1989); Grosslein (1969, 1974); Survey Working Group, Northeast Fisheries Science Center (1988) and Wilk *et al.* (1996). The design ensures both a statistically valid sample as well as comprehensive coverage of the possible ecological zones of the survey area.

The Hudson-Raritan Estuary was divided (stratified) into nine strata - the three main channels and the six non-channel areas naturally defined by the channels and the study area boundaries (Figure 2). Trawl tows could not be made in depths less than 3 m due to vessel draft. Each stratum was then divided into blocks of sufficient size to accommodate a trawl tow (Figure 3). The plan called for 40 tows to be made per cruise, 10 times per annum. However, some cruises were canceled and, on occasion, fewer than the planned 40 tows were made due to weather, vessel down-time, etc. Tows were allocated among strata in proportion to stratum surface area with the provision that at least two tows were made in each stratum. For each cruise and within each stratum the blocks towed were selected at random.

**Sampling for Finfish and Megainvertebrates**

Collections of fish and megainvertebrates were accomplished at randomly-selected stations from the 19.8-m (65-ft) NOAA R/V *Gloria Michelle*. The otter trawl deployed had an 8.5-m (28-ft) headrope and a 10.4-m (34-ft) footrope. The body of the trawl was constructed of 102-mm (4-inch) stretch mesh 21-thread knotted nylon. The cod end was constructed of 45-mm (1.75-inch) stretch mesh 30-thread knotted nylon and lined with 35-mm (1.375-inch) stretch mesh 18-thread knotted nylon. Three 203-mm (8-inch) diameter plastic trawl floats were equally spaced along the headrope with a sweepline constructed of 8-mm (0.313-inches) chain attached to the footrope at intervals of $\approx 356$ mm (14-inches). Trawl doors weighing $\approx 36.3$-kg (80-lb) were used to spread and hold the net open.

The trawl was towed for 10 minutes at $\approx 3.7$ km/hr (2 kts) at each sampling location. If possible, trawl tows were made along isobaths to minimize sudden depth changes. Although tow time was kept constant, direction and distance of each tow were affected by current, tide, wind, and in some cases by the need to shift heading to avoid commercial and recreational vessel traffic. LORAN C coordinates and/or GPS positions, latitude, longitude, depth, and time were recorded at the beginning and end of each trawl tow.

After each tow, the trawl was retrieved and emptied on the deck. All fish and megainvertebrates were separated and identified. In addition, the more numerous crab species were segregated by sex and dealt with as separate entities. All specimens of each
species, as well as the sexed crabs, were weighed to the nearest 0.1 kg and individually measured to the nearest whole cm as follows: fish from the snout to the end of the middle caudal ray (i.e., either fork or total length depending on species); bivalves across the widest point of the shell; crabs across the widest point of the carapace; squid from the anterior margin to the posterior end of the dorsal mantle; and lobsters from the tip of the rostrum to the end of the carapace. All specimens of each species were usually measured except when large catches required subsampling. In such cases, an expansion factor (weight of total catch/weight of subsample) was applied to the number and length frequency of the subsample to estimate the number and length frequency of the total catch. All data were recorded at sea on forms designed for subsequent inclusion into a universal data management system which incorporates sorting, listing, graphical, and statistical systems to simplify data recall, analysis, and illustration.

**DATA MAPPING**


Selected species fit into one or more of the following categories: (1) dominant, i.e., in the top 10, in terms of number, weight, or occurrence (e.g., little skate and spotted hake); (2) commercially and/or recreationally important, and in most cases, included in State, State/Federal, or Federal Fishery Management Plans (e.g., striped bass, Atlantic herring, and bluefish; and/or (3) ecologically important in the Hudson-Raritan Estuary (e.g., bay anchovy and alewife).

The analysis/map production for each species consisted of two layers. The first layer was a single map which provides overall distribution and abundance in the Hudson-Raritan Estuary, based on all trawl tows made (Figure 4). The second layer provides more detail by segregating the data by season as follows: *Winter* (Figure 5) = January-March; *Spring*
(Figure 6) = April and June (May is not sampled); Summer (Figure 7) = July-August (September is not sampled); and Fall (Figure 8) = October-December. Figures 9-138 illustrate the total as well as seasonal distribution and abundance for each species. Table 1 lists the Total and Seasonal figure numbers for each species. All maps were produced using SURFER® for Windows software. It should be noted that size, weight, and sex were not used as delineators in this Reference Document; however, they will be considered in subsequent individual species and species group publications.

ACKNOWLEDGMENTS

We thank all those NOAA Corp officers who expertly captained and crewed the R/V Gloria Michelle over the course of the study. In addition, we thank all reviewers for their critical comments that substantially improved this manuscript.
REFERENCES CITED


Table 1.

Phylogenetic listing, including figure numbers, of the most common fish and megainvertebrates collected with an 8.5-m otter trawl in the Hudson-Raritan Estuary between January 1992 and December 1997. Fish are arranged according to Robins et al. (1991), and megainvertebrates according to Gosner (1978), Turgeon et al. (1988), and Williams et al. (1989).

<table>
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<th>Nomenclature</th>
<th>Figure Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Name / Scientific Name</td>
<td>Total Winter</td>
</tr>
</tbody>
</table>
| Clearnose Skate *Raja eglanteria* | 9 10 11 12 13 | Winter
| Little Skate *Raja erinacea*   | 14 15 16 17 18| Spring
| Winter Skate *Raja ocellata*   | 19 20 21 22 23| Summer
| Blueback Herring *Alosa aestivalis* | 24 25 26 27 28| Fall
| Alewife *Alosa pseudoharengus* | 29 30 31 32 33|
| Atlantic Herring *Clupea harengus* | 34 35 36 37 38| 
| Bay Anchovy *Anchoa mitchilli*  | 39 40 41 42 43| 
| Silver Hake *Merluccius bilinearis* | 44 45 46 47 48| 
| Red Hake *Urophycis chuss*      | 49 50 51 52 53| 
| Spotted Hake *Urophycis regia*  | 54 55 56 57 58| 
| Northern Searobin *Prionotus carolinus* | 59 60 61 62 63| 
| Striped Searobin *Prionotus evolans* | 64 65 66 67 68| 
| Striped Bass *Morone saxatilis* | 69 70 71 72 73| 
| Black Sea Bass *Centropristis striata* | 74 75 76 77 78|
| Bluefish *Pomatomus saltatrix* | 79 80 81 82 83|
| Scup *Stenotomus chrysops*     | 84 85 86 87 88|
| Weakfish *Cynoscion regalis*   | 89 90 91 92 93|
| Spot *Leiostomus xanthurus*    | 94 95 96 97 98|
| Butterfish *Peprilus triacanthus* | 99 100 101 102 103| 
| Summer Flounder *Paralichthys dentatus* | 104 105 106 107 108| 
| Windowpane *Scophthalmus aquosus* | 109 110 111 112 113|
| Winter Flounder *Pleuronectes americanus* | 114 115 116 117 118| 
| Blue Crab *Callinectes sapidus* | 119 120 121 122 123| 
| Atlantic Rock Crab *Cancer irroratus* | 124 125 126 127 128| 
| Lady Crab *Ovalipes ocellatus*  | 129 130 131 132 133| 
| Longfin Squid *Loligo pealeii*  | 134 135 136 137 138|
Figure 1. Location of the Hudson-Raritan Estuary; area in which a trawl survey was conducted between January 1992 and December 1997.
Figure 2. Hudson-Raritan Estuary divided into nine strata where fish and megainvertebrates were sampled with an 8.5-m otter trawl between January 1992 and December 1997.
Figure 3. Hudson-Raritan Estuary divided into 217 blocks where fish and megainvertebrates were sampled with an 8.5-m otter trawl between January 1992 and December 1997.
Figure 4. Location of all trawl stations sampled in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 5. Location of trawl stations sampled during Winter (January, February, and March) in the Hudson-Raritan Estuary between 1992 and 1997.
Figure 6. Location of trawl stations sampled during Spring (April and June) in the Hudson-Raritan Estuary between 1992 and 1997.
Figure 7. Location of trawl stations sampled during Summer (July and August) in the Hudson-Raritan Estuary between 1992 and 1997.
Figure 8. Location of trawl stations sampled during Fall (October, November, and December) in the Hudson-Raritan Estuary between 1992 and 1997.
Figure 9. Distribution and abundance of all clearnose skate collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 10. Distribution and abundance of all clearnose skate collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 11. Distribution and abundance of clearnose skate collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 15. Distribution and abundance of all little skate collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 17. Distribution and abundance of little skate collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 19. Distribution and abundance of all winter skate collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Winter Skate
Hudson-Raritan Estuary
Spring

Figure 21. Distribution and abundance of winter skate collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Winter Skate
Hudson-Raritan Estuary

Summer

Sandy Hook

Staton Island

NEW YORK

NEW JERSEY

Number/Tow

• None
• 1 - 2
• 3 - 4
• 5 - 9
• 10 - 14
• 15 - 20

Figure 22. Distribution and abundance of winter skate collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 23. Distribution and abundance of winter skate collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 25. Distribution and abundance of all blueback herring collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 26. Distribution and abundance of blueback herring collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 27. Distribution and abundance of blueback herring collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 45. Distribution and abundance of all silver hake collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 47. Distribution and abundance of silver hake collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Silver Hake
Hudson-Raritan Estuary
Fall

Figure 48. Distribution and abundance of silver hake collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 49. Distribution and abundance of all red hake collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 51. Distribution and abundance of red hake collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Red Hake
Hudson-Raritan Estuary
Summer

Figure 52. Distribution and abundance of red hake collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 56. Distribution and abundance of spotted hake collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 57. Distribution and abundance of spotted hake collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 58. Distribution and abundance of spotted hake collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 59. Distribution and abundance of all northern searobin collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 60. Distribution and abundance of all northern searobin collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 61. Distribution and abundance of northern searobin collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 62. Distribution and abundance of northern searobin collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 64. Distribution and abundance of all striped searobin collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 66. Distribution and abundance of striped searobin collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 67. Distribution and abundance of striped searobin collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 68. Distribution and abundance of striped searobin collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 70. Distribution and abundance of all striped bass collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 71. Distribution and abundance of striped bass collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Striped Bass
Hudson-Raritan Estuary

Summer

Figure 72. Distribution and abundance of striped bass collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 73. Distribution and abundance of striped bass collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 74. Distribution and abundance of all black sea bass collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 75. Distribution and abundance of all black sea bass collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 76. Distribution and abundance of black sea bass collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Black Sea Bass
Hudson-Raritan Estuary
Summer

Figure 77. Distribution and abundance of black sea bass collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 78. Distribution and abundance of black sea bass collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 79. Distribution and abundance of all bluefish collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 80. Distribution and abundance of all bluefish collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 81. Distribution and abundance of bluefish collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 82. Distribution and abundance of bluefish collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 83. Distribution and abundance of bluefish collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 84. Distribution and abundance of all scup collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 85. Distribution and abundance of all scup collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 87. Distribution and abundance of scup collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 88. Distribution and abundance of scup collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
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Figure 90. Distribution and abundance of all weakfish collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 91. Distribution and relative of weakfish collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 92. Distribution and abundance of weakfish collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 93. Distribution and abundance of weakfish collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 94. Distribution and abundance of all spot collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 95. Distribution and abundance of all spot collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 96. Distribution and abundance of spot collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 97. Distribution and abundance of spot collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 98. Distribution and abundance of spot collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Butterfish
Hudson-Raritan Estuary
All Seasons

Figure 99. Distribution and abundance of all butterfish collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 100. Distribution and abundance of all butterfish collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 101. Distribution and abundance of butterfish collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 102. Distribution and abundance of butterfish collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 103. Distribution and abundance of butterfish collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 104. Distribution and abundance of all summer flounder collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 105. Distribution and abundance of all summer flounder collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 106. Distribution and abundance of summer flounder collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 107. Distribution and abundance of summer flounder collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 108. Distribution and abundance of summer flounder collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 109. Distribution and abundance of all windowpane collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 110. Distribution and abundance of all windowpane collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 111. Distribution and abundance of windowpane collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 112. Distribution and abundance of windowpane collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 113. Distribution and abundance of windowpane collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 114. Distribution and abundance of all winter flounder collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Winter Flounder
Hudson-Raritan Estuary

Figure 115. Distribution and abundance of all winter flounder collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Winter Flounder  
Hudson-Raritan Estuary  
Spring

Staten Island  
Sandy Hook  
NEW YORK  
NEW JERSEY

Number/Tow

× None
• 1 - 9
• 10 - 24
• 25 - 49
• 50 - 99
○ 100 - 350

Figure 116. Distribution and abundance of winter flounder collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Winter Flounder
Hudson-Raritan Estuary
Summer

Staten Island

Sandy Hook

NEW YORK

NEW JERSEY

Number/Tow

- None
- 1 - 9
- 10 - 24
- 25 - 49
- 50 - 99
- 100 - 350

Figure 117. Distribution and abundance of winter flounder collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Winter Flounder
Hudson-Raritan Estuary
Fall

Number/Tow

× None
● 1 - 9
● 10 - 24
● 25 - 49
● 50 - 99
● 100 - 350

Figure 118. Distribution and abundance of winter flounder collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 119. Distribution and abundance of all blue crab collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 120. Distribution and abundance of all blue crab collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 121. Distribution and abundance of blue crab collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 122. Distribution and abundance of blue crab collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 123. Distribution and abundance of blue crab collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 124. Distribution and abundance of all Atlantic rock crab collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 125. Distribution and abundance of all Atlantic rock crab collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 126. Distribution and abundance of Atlantic rock crab collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 127. Distribution and abundance of Atlantic rock crab collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 128. Distribution and abundance of Atlantic rock crab collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Lady Crab
Hudson-Raritan Estuary
All Seasons

Figure 129. Distribution and abundance of all lady crab collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 130. Distribution and abundance of all lady crab collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 131. Distribution and abundance of lady crab collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 132. Distribution and abundance of lady crab collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 133. Distribution and abundance of lady crab collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 134. Distribution and abundance of all longfin squid collected in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 135. Distribution and abundance of all longfin squid collected during the Winter (January, February, and March) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 136. Distribution and abundance of longfin squid collected during the Spring (April and June) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 137. Distribution and abundance of longfin squid collected during the Summer (July and August) in the Hudson-Raritan Estuary between January 1992 and December 1997.
Figure 138. Distribution and abundance of longfin squid collected during the Fall (October, November, and December) in the Hudson-Raritan Estuary between January 1992 and December 1997.