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HARD CLAM STOCK ASSESSMENT OF RARITAN AND SANDY HOOK BAYS

Prepared by: Michael P. Celestino
NJ Bureau of Shellfisheries

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ABSTRACT

The New Jersey Bureau of Shellfisheries conducted a hard clam (*Mercenaria mercenaria,* Linnæus, 1758) stock assessment of Raritan and Sandy Hook bays, an area which provides over 50% of the State's commercial hard clam landings via the relay and depuration programs. The Bureau sampled 108 stations in Raritan Bay and 98 stations in Sandy Hook Bay from 14 July to 22 September 2000 using a hydraulic dredge to determine each bay's standing stock and relative distribution of hard clams. The hard clam resource in Raritan and Sandy Hook bays is estimated at 601.7 million and 342.7 million clams, respectively. These estimates represent increases of 379.9 million clams in Raritan Bay and 171.1 million clams in Sandy Hook Bay compared to the Bureau's previous survey in 1983. The increase in hard clam abundance per station in both bays between the two survey years was significant (Raritan Bay: $T^* = 5.598$, $P < 0.0002$; Sandy Hook Bay: $T^* = 4.380$, $P < 0.0002$). Over 77% of the total hard clam stock estimate in Raritan and Sandy Hook bays occurs in designated relay and depuration harvest areas (735.2 million clams).

This study represents the first comprehensive stock assessment of Raritan and Sandy Hook bays since 1983 and points to the importance of the availability of current and quantitative stock estimates. Our conclusions are necessarily limited by the availability of data between the two surveys. This work represents an important step in the management of the bay's hard clam resource and should be followed by subsequent monitoring efforts.

INTRODUCTION

With a commercial hard clam harvest representing over 50% of New Jersey's total reported harvest since 1994 (as reported by the National Marine Fisheries Service), Raritan and Sandy Hook bays are the center of New Jersey's commercial hard clamming industry. The bays' hard clam fishery is an important contributor to the State's economy as evidenced by a 2001 dockside value of approximately $5.1 million (the last year for which statistics are available).

With the tremendous amount of activity taking place in the bays, and the equally impressive economic importance of the fishery, it is incumbent upon resource managers to have accurate and up to date stock estimates. These estimates provide sustainability for the hard clam fishery and aid in long-term management and economic development. The last comprehensive stock assessment performed in Raritan and Sandy Hook bays took place in 1983. While participation and harvest in the fishery have increased since then, discontinuance of federal funding as well as personnel constraints have prevented updating stock estimates through field surveys.

With support from the Rutgers University Cooperative Extension and commercial shellfishermen, funding was secured to conduct a comprehensive hard clam inventory of Raritan and Sandy Hook bays. The aims of the study were: (1) using a hydraulic dredge, survey the hard clam stocks of the Raritan and Sandy Hook bay areas of northern Monmouth County; quantitative and qualitative comparisons are made between the present survey and an identical survey conducted in 1983, without inference as to what happened in the years prior to or in between these surveys; (2) determine age and growth of clams in various parts of the bay; (3) correlate average harvester catch per unit effort (CPUE) with data taken from dredge samples in various parts of the bay in various situations of season, wind and tide.

MATERIALS AND METHODS

Study Site

All field work was conducted in Raritan and Sandy Hook bays, Monmouth County, New Jersey (Figure 1). This area (the Hudson-Raritan Estuary) 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) (Wilk *et al.* 1998). The Hudson, Raritan and Shrewsbury River systems feed into the estuary from the north, west and south, respectively (Wilk *et al.* 1998). Our study was limited to New Jersey state waters in the estuary. This area consists of approximately 30,212 acres.

Sampling

Quantitative sampling was conducted from 14 July 2000 to 22 September 2000 in Raritan and Sandy Hook bays. All stations (108 in Raritan Bay + 98 in Sandy Hook Bay) were sampled using the Research Vessel *Notata*: a 32-foot long, Chesapeake deadrise style vessel equipped with a hydraulic dredge. The dredge is equipped with a 12-inch wide blade that cuts approximately 4-inches into the substrate. The dredge uses water jets to loosen the bottom sediments ahead of the digging blade and to expel sediments through the body of the dredge (see Ropes and Martin 1960). Water is supplied to the jets through a 3-inch hose attached to a water pump on the deck of the vessel. At 35-40 pounds of pressure per square inch the pump delivers approximately 300 gallons of water per minute. The dredge is designed to collect and retain all

hard clams 30 millimeters (mm) in length or greater. Therefore, clams less than 30 mm are not included in any analyses.

The dredge is deployed and retrieved via a 3/8-inch stainless steel wire cable attached to the main haul back winch on the vessel. The actual towing for sample collection was done with a ¾-inch polypropylene graduated line.

Sampling protocols were similar to those used in the Bureau's 1983 shellfish survey of the same area (see McCloy and Joseph 1984). Specifically, a systematic sampling design was employed. The original sampling design was not created to look specifically at statistical changes from year to year per se, but in large part, to depict the distribution and abundance of commercially valuable mulluscan shellfish within New Jersey's coastal estuaries (McCloy and Joseph 1984). Stations sampled for the 2000 inventory were identical to those sampled in 1983 except for stations where it was not practicable due to recent obstructions, changes in bathymetry or submerged telecommunication/electric cable areas, in which case stations were relocated as close to the original stations as feasible. Station locations in Raritan Bay were established at ½-mile intervals; stations in the shallow, near-shore regions of Sandy Hook Bay were established at ¼-mile intervals. In all cases, stations were located using a Northstar 951X Differential GPS receiver chart plotter.

After station position was established, a buoy was placed overboard to ensure the maintenance of the boat's position throughout sampling operations at each station. Following deployment of the buoy, water samples were collected with a Kemmerer water sampler (at the first and last stations sampled each day) for later analysis of dissolved oxygen, salinity and pH at the New Jersey Division of Fish and Wildlife's Nacote Creek Research Laboratory, Port Republic, New Jersey. Air and water temperatures (surface and bottom) were recorded from a mercury thermometer in the field. Dissolved oxygen was determined by Winkler titration. Salinities were determined by a hand-held refractometer and pH readings were obtained using colorimetric visual analyses against know standards (Taylor ® slide comparator).

Following collection of water samples, water depth was recorded from a Lowrance 3200 ® Computer Sonar unit and the towline length determined accordingly. A towline length-to-depth ratio of 4:1 was utilized, although, in several instances it was not possible to maintain this ratio because of water depth and water supply hose limitations (100 feet). In those instances, a ratio of 3:1 was maintained. The towline length-to-depth ratio was never less than 3:1.

Prior to each tow, the substrate was probed with a clam rake handle in order to assist with the determination of dredge nozzle selection (see Tables 1a and 1b). In hard substrates, the forward nozzles were opened and back nozzles closed. In soft substrates, the forward nozzles were closed and back nozzles opened. These nozzle positions have previously been determined to yield optimal dredge efficiency (McCloy and Joseph 1983). Upon dredge nozzle adjustment, one 100-foot tow was made. It was assumed that one tow was representative of a larger area (*i.e.*, an entire sampling cell). Unfortunately there are no data to either support or refute this assumption – limitations on time and funding precluded an investigation. However, to minimize this source of estimation error, sampling frequency was increased to the maximum extent practicable.

The 100-foot distance was measured by paying out a graduated line while towing the dredge. In bottoms with a high percentage of clay or submerged obstructions, where it was not possible to tow the entire 100 feet, tows were shortened and the length of the tow recorded (see Tables 1a and 1b). In instances where it was suspected that the dredge was not fishing properly due to low water pump pressure, dredge knife obstruction or erratic tow speeds for example, the tow was repeated until these concerns were resolved. In all cases, at the end of the measured tow,

the vessel was held as stationary as possible until the dredge was raised off the bottom to prevent sampling more than the desired area.

The dredge catch was deposited on a culling table for sorting and counting. All live hard clams and paired hard clam valves ("boxes") collected in each tow were counted and measured along their anterior-posterior axis to the nearest millimeter using vernier calipers. Hard clams were graded into the following size categories: "sublegals" (30-37 mm), "littlenecks" (38-55 mm), "cherrystones" (56-76 mm) and "chowders" (> 76 mm). Hard clam abundance indices (catch per tow) for each station are expressed in terms of number per square feet. Observations were also made on the presence and number of other species collected in the dredge (*e.g.*, clam predators). Distribution charts of commercially important species (*e.g., Mercenaria mercenaria*) were developed.

Mercenaria Distribution and Abundance Estimation

For the purpose of delineating relative abundance and distribution patterns of the hard clam resource, four classifications of none (0.00 *Mercenaria* foot^{-2}), occurrence (0.01-0.19 *Mercenaria* foot^{-2}), moderate abundance (0.20-0.49 *Mercenaria* foot^{-2}), and high abundance ($\geq$ 0.50 *Mercenaria* foot^{-2}) were established at each station after the data had been adjusted for the efficiency of the dredge (see below). The abundance categories selected equated with those used in the Bureau's 1983 survey.

For the purpose of calculating stock estimates of the hard clam resource, the following abundance classification intervals were established: [0.00], [0.01-0.05], [0.06-0.11], [0.12-0.49], [0.50-0.99], [1.00-1.99] and [$\geq$ 2.00] *Mercenaria* foot^{-2}. The abundance categories matched the intervals used in the Bureau's 1983 survey. Adjacent stations within the same abundance category listed were grouped together and a mean abundance for that area determined by utilizing the *Mercenaria* abundance means of the individual stations. The mean abundance was then applied to the size of the area to yield the standing stock estimate for that particular area. ArcView Geographic Information System (GIS) (2000) was utilized to estimate the size of the individual areas in feet^2. By summing the small areas, a resource estimate of the bay was developed. A 95% confidence interval was placed around the estimate (see below).

The Bureau of Shellfisheries conducted a study to assess the efficiency of the Bureau's dredge (Celestino 2003). The Bureau examined the dredge's efficiency in each of five substrates (Table 2, below) using a mixed-model, hierarchical, two-way ANOVA. While other substrates were encountered, those selected represented the most frequently encountered. Three

TABLE 2. Estimates of dredge efficiency among the five substrates examined.

Substrate	Efficiency (%)
Sand	67.8
Mud & Shell	84.8
Sand & Gravel	91.6
Mud & Sand	95.6
Mud	100.0

replicates were collected from each substrate; the number of replicates was chosen a priori such that the denominator of the F ratio had at least six degrees of freedom (see Hicks and Turner 1999).

The model used for analysis was:

$Y_{ijk} = \mu + S_i + L_{j(i)} + \varepsilon_{k(ij)}$, where μ = a common effect for the entire experiment, S_i = effect of substrate, $L_{j(i)}$ = effect of station within substrate, and $\varepsilon_{k(ij)}$ = the error estimate. The model did not allow for an analysis of variance among the stations within each substrate [$L_{j(i)}$]; this is not a concern as the factor of interest was substrate (S_i). The results of the analysis indicated a "marginally" significant difference among the five substrates ($F_{4,10} = 3.51$, $P = 0.05$).

It is important to note that the experimental design looked at a necessarily limited number of variables (*e.g.*, substrate). Factors other than those examined could potentially influence the dredge's efficiency. Given the myriad factors that could affect dredge efficiency, the relatively small sample size, hard clam population dynamics, and the marginally significant result, it was decided to pool all efficiency estimates into a grand arithmetic mean with a 95% confidence interval.

While this rationale has its drawbacks, it permits justifiable adjustment of raw data without quantitative analysis of substrate types, which would be time and cost prohibitive. [Separate efficiency estimates based on substrate composition would require a quantitative decision based on subjective criteria; that is, application of a specific efficiency estimate to qualitatively different substrates – qualitatively different without sediment grain size analysis (sediment grain size analysis was beyond the scope of original project proposal/objectives)]. The dredge had an overall mean efficiency of 88.0% (±7.7%); all hard clam raw abundances were therefore increased by a factor of 1.137. For more detail on the methods, analysis and interpretation of the dredge efficiency study please refer to Celestino (2003).

Population Size/Age Structure

Length-percent-frequency distribution graphs were constructed for all stations where sufficient numbers of clams ($n \geq 100$) were collected to illustrate population structures. Lengths were combined into three-millimeter groupings (starting at, but not including, 29 mm) as was done in 1983's survey; again, the dredge is designed to retain clams 30 mm in length or greater. The midpoints of each size grouping were plotted on the x-axis of the distribution graphs.

Composite (the sum of all clams measured) length-percent-frequency distribution graphs were constructed for Raritan and Sandy Hook bays and each relay and depuration harvest area (where the harvest area $n \geq 100$) by summing all hard clams measured in the respective bays or harvest area. Stations where commercial densities of soft clams, *Mya arenaria* Linnæus, 1758, and blue mussels, *Mytilus edulis* (Linnæus, 1758), were encountered presented an opportunity to determine year class structure of these populations. As such, a subsample of these shellfish was also measured to the nearest millimeter and length-percent-frequency distributions constructed ($n \geq 100$).

Mercenaria Mortality

An index of natural hard clam mortality was determined at each station. This index was based upon the percentage of empty paired valves ("boxes") in the entire sample of paired valves and live clams: Mortality = {[(no. of boxes at station *i*) ÷ (no. of boxes at station *i* + no. of live *Mercenaria* at station *i*)] × 100%}. This mortality index is independent of age, size, and gender of *Mercenaria*.

Mortality indices by commercial size class for each station were also calculated in two fashions: 1) Mortality within one specific commercial size class [**mortality** $\mathbf{I}_{\text{sublegals}}$ = {[(no. of sublegal boxes at station *i*) ÷ (no. of sublegal boxes at station *i* + no. of live sublegal *Mercenaria* at station *i*)] × 100%}, …, mortality I_{chowders} = {[(no. of chowder boxes at station *i*) ÷ (no. of chowder boxes at station *i* + no. of live chowder *Mercenaria* at station *i*)] × 100%}] and 2)

Mortality at a given station among all size classes [**mortality $II_{sublegals}$** = {[(no. of sublegal boxes at station *i*) ÷ [total no. of boxes (all size classes) at station *i*]] × 100%}, …, {[(no. of chowder boxes at station *i*) ÷ [total no. of boxes (all size classes) at station *i*]] × 100%}]. These definitions imply that Σ **mortality I** at station *i* may (but does not have to) ≠ 100%, whereas Σ **mortality II** at station *i* = 100%. (See Tables 14 or 15 for further explanation and examples).

Mercenaria Recruitment

For the purpose of this study, recruitment is defined as the percentage of clams entering the fishery at the legal size of 38 mm in length. To estimate annual recruitment, "sublegals" (*Mercenaria* collected between 30 and 37 mm in length) represented a single year class and would thus be expected to be recruited into the fishery within the coming year. The recruitment index per station was calculated as: {[(no. of *Mercenaria* collected between 30 and 37 mm at station *i*) ÷ (total no. of *Mercenaria* collected at station *i*)] × 100%}. The total number of sublegals estimated to be present in the bay is also reported. As in 1983's study, data from areas of occurrence (abundance < 0.20 *Mercenaria* foot^{-2}) were not taken into consideration when calculating recruitment indices due to concerns related to interpretation of small sample sizes. The effect of this exclusion on the fishery (*e.g.*, through stock-recruitment relationships) is not addressed in the present report.

Age Determination and Growth

To assist Dr. Michael Kennish (Institute of Marine and Coastal Sciences at Rutgers University) in determining the age and growth of hard clams in Raritan and Sandy Hook bays, twelve clams from each of 40 sites were collected. Sites were dispersed throughout the bays to ensure comprehensive coverage. Two clams from each of six size classes (20-30 mm, 30-40 mm, 40-50 mm, 50-60 mm, 60-70 mm and 70-80 mm) were randomly selected at each station and placed into labeled freezer storage bags. The collected shellfish were then transported to the Nacote Creek Research Station (Port Republic, New Jersey) and stored in a freezer. Rutgers Cooperative Extension personnel transported the clams from Nacote Creek to the Institute of Marine and Coastal Sciences (New Brunswick, New Jersey) for actual age determination and growth studies.

Average Harvester Catch per Unit Effort Correlation

To correlate average harvester catch per unit effort (CPUE) with data collected from dredge samples in various parts of the bay, the original project proposal indicated that Rutgers Cooperative Extension staff would coordinate side-by-side studies where representatives from the commercial clamming industry would conduct sampling at the dredged stations using manual harvesting gear (*e.g.*, Shinnecock or Bull rakes). The Bureau provided personnel from Rutgers Cooperative Extension and the Baymen's Protective Association with a weekly schedule of anticipated sampling dates, times and locations. The Bureau also provided personnel from Rutgers Cooperative Extension a list of stations with known abundances after sampling was completed. Unfortunately, personnel from Rutgers Cooperative Extension were not able to complete this component of the original project proposal.

Statistical Analysis: Mercenaria abundance

A single dredge efficiency adjustment factor (*i.e.*, 1.137 – see above) was applied to all *Mercenaria* abundance data from both surveys for which paired data existed [*i.e.*, "paired data" = the same station coordinates were sampled in 1983 and 2000; stations added or deleted in 2000 would not have a "companion" station from 1983, and are consequently omitted from these analyses. One of 108 stations did not have a companion in Raritan Bay (∴ N = 107 × 2); four of

98 stations did not have a companion in Sandy Hook Bay ($\therefore N = 94 \times 2$)]. Because the data are paired and therefore not independent, Wilcoxon's distribution-free signed rank test for paired replicates was employed. The null hypothesis is that there is no shift in location (median) due to treatment (Hollander and Wolfe 1999). Because there were tied values among the data, the test is only approximate, and not exactly of significance level α [an exact level α test statistic in the tied setting requires deriving the exact conditional distribution of the test statistic (T^+) which has, in this case, 1.62×10^{32} possible outcomes in Raritan Bay and 1.98×10^{28} possible outcomes in Sandy Hook Bay] (Hollander and Wolfe 1999). A distribution-free point estimator associated with Wilcoxon's signed rank test statistic was calculated to provide some measure of the magnitude of change in *Mercenaria* abundance. Finally, a distribution-free confidence interval around the point estimator based on Wilcoxon's signed rank test was calculated.

An analysis of variance was conducted on *Mercenaria* abundances by relay and depuration harvest areas to detect significant patterns [*nota bene*: all analyses involving relay and depuration "harvest areas" are performed on sub-areas (*e.g.*, 12B, 12A, ..., 1B, 1C) unless explicitly stated otherwise]. Normality of the response variable was examined via SAS (2001) software.

Statistical Analysis: Mercenaria mortality

Analyses of variance were conducted on mortalities (**mortality I**) 1) among the four commercial size classes of hard clams (sublegals, littlenecks, cherrystones, and chowders) in each bay (each bay separately via one-way ANOVA) and 2) among the commercial size classes by relay and depuration harvest areas (two-way ANOVA). Normality of the response variables was examined using SAS (2001) software.

Statistical Analysis: Mercenaria recruitment

The correlation between recruitment and hard clam abundance was examined via a distribution-free test for independence based on ranks (Spearman rank correlation coefficient) (see Hollander and Wolfe 1999). Correlations were examined for recruitment at stations where *Mercenaria* abundance ≥ 0.20 clams foot^{-2} ($N = 142$).

An analysis of variance was also performed to examine recruitment among the relay and depuration harvest areas. Normality of the response variable was examined via SAS (2001) software.

Note on statistical analyses: univariate procedures were employed in lieu of multivariate procedures due to multicollinearity and problems associated with multivariate normality. Consequently, significance levels for multiple analyses need to be corrected for maintenance of experimentwise error rate levels. This was done using Bonferroni corrections (see Rice 1990). Multiple comparison tests (Student-Newman-Keuls) were also employed where appropriate.

RESULTS

Description of Study Site

Substrates qualitatively ranged from mud to coarse sand and gravel (see Tables 1a and 1b). The distribution of substrates from the 1983 shellfish survey is provided in Figure 2. Information on historical water quality parameters and substrate composition can be found in Dean and Haskin (1964; salinity, dissolved oxygen and substrate) and Dean (1975; temperature, salinity, dissolved oxygen and substrate). All locations were characterized by having bottom

salinities between 19‰ and 26‰ ($\bar{x}$ = 23‰; SD = 1.9‰), bottom water temperatures between 20° and 26°C ($\bar{x}$ = 23°C; SD = 1.3°C) and air temperatures between 15° and 31°C ($\bar{x}$ = 24°C; SD = 3.3°C). Physical and chemical data are summarized in Table 3.

***Mercenaria* Abundance and Distribution**

All *Mercenaria* data provided is adjusted for the dredge's efficiency unless otherwise specified.

Station location, hard clam abundance, mean length, percent mortality, commercial size class percentages [including percent sublegals (the measure of recruitment for purposes of this study)], depth, substrate, nozzle position and tow distance at each station in Raritan and Sandy Hook bays are presented in Tables 1a and 1b. The locations of the 108 stations sampled in Raritan Bay and the 98 stations sampled in Sandy Hook Bay are presented in Figures 3 and 4, respectively.

The hard clam resource in Raritan and Sandy Hook bays (taking into account the dredge's efficiency) is estimated at 601.7 million clams [- 48.4 / + 57.7 million clams] and 342.7 million clams [- 27.6 / + 32.9 million clams] (Table 4, below), respectively – a conservative estimate of the resource (*i.e.*, not taking into account the dredge's efficiency) is 529.2 million clams in Raritan Bay and 301.4 million clams in Sandy Hook Bay. Stock estimates with means, variances and standard errors (SEM) by commercial size class for both Raritan and Sandy Hook bays (separately) are presented in Table 5.

Table 6 depicts the number and percentage of stations sampled with no *Mercenaria*, low, moderate and high abundances of *Mercenaria* in Raritan and Sandy Hook bays.

TABLE 4. Comparison of hard clam stock estimates in Raritan and Sandy Hook bays from the 1983 and 2000 hard clam surveys.

601,650,715	= **2000 Raritan Bay** stock estimate (clams)
221,714,632	= **1983 Raritan Bay** stock estimate (clams)
342,746,995	= **2000 Sandy Hook Bay** stock estimate (clams)
171,686,715	= **1983 Sandy Hook Bay** stock estimate (clams)

Figures 5 and 6 depict the distribution and abundance of hard clams in Raritan and Sandy Hook bays in 1983 and 2000, respectively. [*Nota bene*: both the 1983 and 2000 charts show adjusted hard clam abundances (*i.e.*, adjusted for dredge efficiency)]. Hard clam abundances ranged from 0.00 to 3.25 clams foot^{-2} in 2000 ($\bar{x}$ = 0.62 clams foot^{-2}; SEM = 0.07 clams foot^{-2}) and from 0.00 to 1.80 clams foot^{-2} in 1983 ($\bar{x}$ = 0.25 clams foot^{-2}; SEM = 0.03 clams foot^{-2}) in Raritan Bay (Table 7, below). Hard clam abundances ranged from 0.00 to 4.93 clams foot^{-2} in 2000 ($\bar{x}$ = 0.92 clams foot^{-2}; SEM = 0.08 clams foot^{-2}) and from 0.00 to 3.10 clams foot^{-2} in 1983 ($\bar{x}$ = 0.56 clams foot^{-2}; SEM = 0.06 clams foot^{-2}) in Sandy Hook Bay (Table 7, below). Wilcoxon's signed rank test (on all dredge efficiency adjusted data) indicated a significant increase in *Mercenaria* abundances in 2000 versus 1983 in both Raritan *($T^* = 5.598$, $P < 0.0002$)* and Sandy Hook *($T^* = 4.380$, $P < 0.0002$)* bays. [For completeness, an analysis was run on unadjusted 2000 data (*i.e.*, raw abundance) versus dredge efficiency adjusted 1983 data: the results remained significant for both Raritan *($P < 0.0001$)* and Sandy Hook *($P = 0.0002$)* bays]. The mean increase *($\hat{\theta}$)* in Raritan Bay is estimated at 0.28 clams foot^{-2} *[Pr (0.15 clams foot^{-2} < θ*

<0.42 clams foot^{-2}) = 95%] while the mean increase *($\hat{\theta}$)* in Sandy Hook Bay is estimated at 0.33 clams foot^{-2} *[Pr (0.18 clams foot^{-2} $< \theta <$ 0.50 clams foot^{-2}) = 95%]*.

TABLE 7. Comparison of hard clam abundance statistics from Raritan and Sandy Hook bays between the 1983 and 2000 surveys.

Summary Statistic	1983 (clams foot^{-2})	2000 (clams foot^{-2})
	– Raritan Bay –	
Average Abundance	**0.25**	**0.62**
Minimum Abundance	0.00	0.00
Maximum Abundance	1.80	3.25
Standard Error of the Mean	0.03	0.07
	– Sandy Hook Bay –	
Average Abundance	**0.56**	**0.92**
Minimum Abundance	0.00	0.00
Maximum Abundance	3.10	4.93
Standard Error of the Mean	0.06	0.08

Figure 7 shows the location of each relay and depuration harvest area, as well as two hypothetical areas in western Raritan Bay. All results presented EXCLUDE the hypothetical areas in western Raritan Bay unless explicitly stated. The hard clam stock estimate for relay and depuration harvest areas in Raritan and Sandy Hook bays is 735.2 million clams [- 59.2 / + 70.5 million clams]. Stock estimates and abundances with means, variances and SEMs for individual harvest areas are provided in Appendix I; these same data (save variance) are summarized in Figures 8 and 9. Analysis of variance with abundance (clams foot^{-2}) by harvest area as the response variable indicated a significant difference *($F_{20,157} = 3.46$, $P < 0.0001$)* in *Mercenaria* abundance among the harvest sub-areas. Results of Student-Newman-Keuls (SNK) multiple comparison test are illustrated in Figure 10. Normality assumptions were met for most (12/21) harvest areas, but given the small sample sizes and the normality aberrations (9/21), these results are best viewed as descriptive and preliminary.

Hard clam stock estimates by individual harvest areas and by commercial size class are presented in Appendix II and summarized in Figure 11. Commercial size class stock estimates across all relay and depuration harvest areas are summarized in Table 8, below.

TABLE 8. 2000 hard clam stock estimates of relay and depuration harvest areas by commercial size class.

	Commercial Size Class Stock Estimates			
	Sublegals	Littlenecks	Cherrystones	Chowders
Clams	105,591,821	178,183,050	280,024,751	171,383,795
Mean	636,095	1,073,392	1,686,896	1,032,433
Variance	5.51 E+12	6.79 E+12	1.17 E+13	3.14 E+12
SEM	1.82 E+05	2.02 E+05	2.65 E+05	1.38 E+05
Percent of Total	14.4%	24.2%	38.1%	23.3%

All statistics EXCLUDE western and eastern western Raritan Bay (see Figure 7).
Sublegals: 30-37 mm; Littlenecks: 38-55 mm; Cherrystones: 56-76 mm; Chowders: >76 mm.

Table 9 summarizes *Mercenaria* depuration and relay reported harvest and effort for Raritan and Sandy Hook bays from 1987 through 2002. Vagaries in reporting preclude accurate estimation of harvest and effort confined to those areas prior to 1987. Hard clam relay and depuration reported harvest and effort by harvest areas in 2000 is summarized in Appendix III.

Population Structure

To give an overall description of the hard clam population in Raritan and Sandy Hook bays, composite (the sum of all clams measured) length-percent-frequency distribution graphs are presented in Figures 12 and 13 for Raritan and Sandy Hook bays, respectively. A total of 5,750 clams ($\bar{x}$ = 61.7 mm) were measured in Raritan Bay and 8,820 clams ($\bar{x}$ = 64.7 mm) were measured in Sandy Hook Bay.

The total number and mean lengths of clams collected in each relay and depuration harvest area are listed in Table 10, to the right. Length-percent-frequency distribution graphs for individual stations (where $n \geq 100$) in Raritan and Sandy Hook bays are plotted in Appendices IV and V, respectively. Composite length-percent-frequency distribution graphs for each relay and depuration harvest area (where $n \geq 100$) are provided in Appendix VI.

TABLE 10. List of hard clam population statistics (number collected and mean size) for the 2000 shellfish survey in relay and depuration harvest areas in Raritan and Sandy Hook bays.

Area	n	$\bar{x}$ (mm)
12B	984	65.0
12A	1,002	56.7
11A	61	62.3
11B	23	80.5
11C	1,508	59.7
11D	146	77.5
11E	51	61.8
10A	295	73.1
10B	1,583	56.7
10C	731	72.7
10D	1,952	56.9
10E	785	71.8
10F	1,080	64.2
2A	174	73.3
2B	504	71.6
2C	328	62.9
1A	822	69.5
1B	106	72.9
1C	1	87.0
W. W. RB	77	62.5
E. W. RB	756	64.3

Recruitment

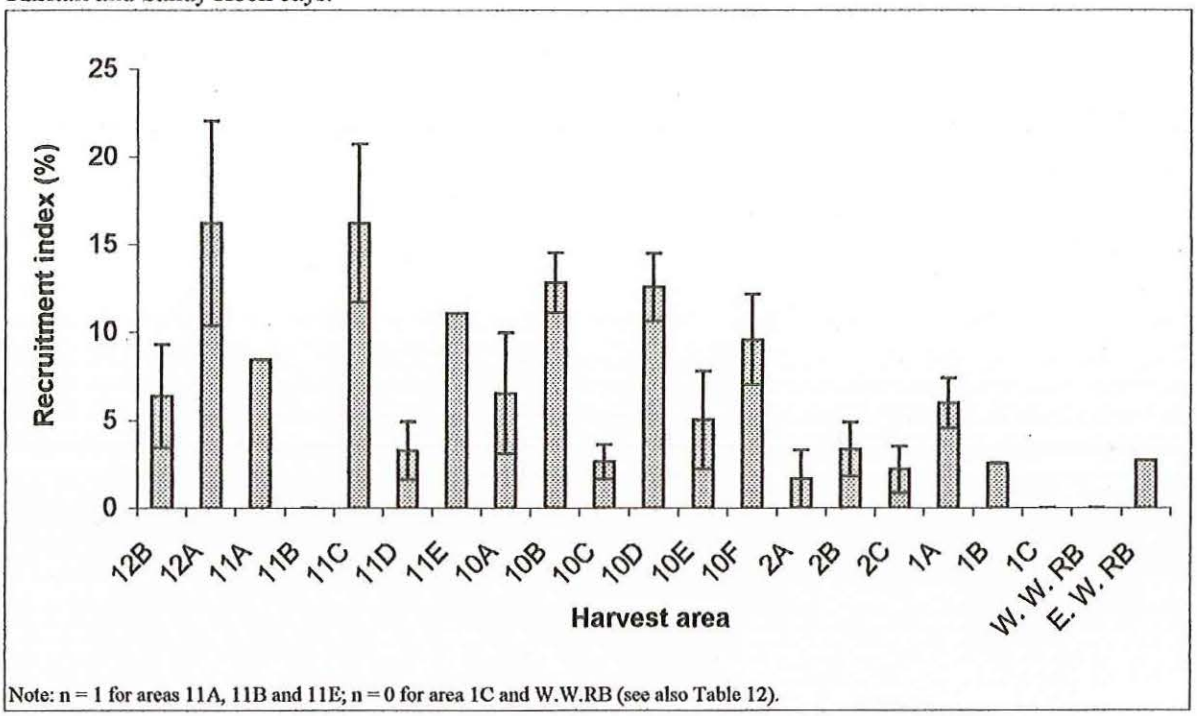
Recruitment indices were variable among stations, ranging from 0.0% to 53.4% with a mean of 10.2% in Raritan Bay and 0.0% to 24.4% with a mean of 7.9% in Sandy Hook Bay (Tables 1a, 1b and 11). Recruitment indices (where *Mercenaria* abundance ≥ 0.20 clams foot^{-2}) in Raritan and Sandy Hook bays are spatially depicted in Figures 14 and 15, respectively.

Average recruitment indices for relay and depuration harvest areas are presented in Table 12 and summarized in Figure 16, below. The ratio and percentage of stations in relay and depuration harvest areas excluded from recruitment indices due to low hard clam abundances (< 0.20 clams foot^{-2}) are listed in Table 13.

Spearman correlation analysis between recruitment (for <u>all</u> stations where *Mercenaria* abundance was ≥ 0.20 clams foot^{-2}) and *Mercenaria* abundance indicated a significant positive correlation between the two variables ($r_s = 0.43$, $P < 0.0001$). [Analysis of only stations inside relay and depuration harvest areas (including western and eastern Western Raritan Bay) where abundance ≥ 0.20 clams foot^{-2} had similar results ($r_s = 0.42$, $P < 0.0001$)]. Analysis of variance examining recruitment indices among the relay and depuration harvest areas (including western and eastern Western Raritan Bay) indicated no significant difference in the response variable ($F_{18,106} = 1.64$, $P = 0.0630$). However, due to sample sizes (for some areas $n = 1$), some

normality violations and the fact that the model for analysis described only about 22% of the total variation, these results are best viewed as descriptive and preliminary.

FIG. 16. Average *Mercenaria* recruitment indices (± 1 SEM) for relay and depuration harvest areas in Raritan and Sandy Hook bays.



Note: n = 1 for areas 11A, 11B and 11E; n = 0 for area 1C and W.W.RB (see also Table 12).

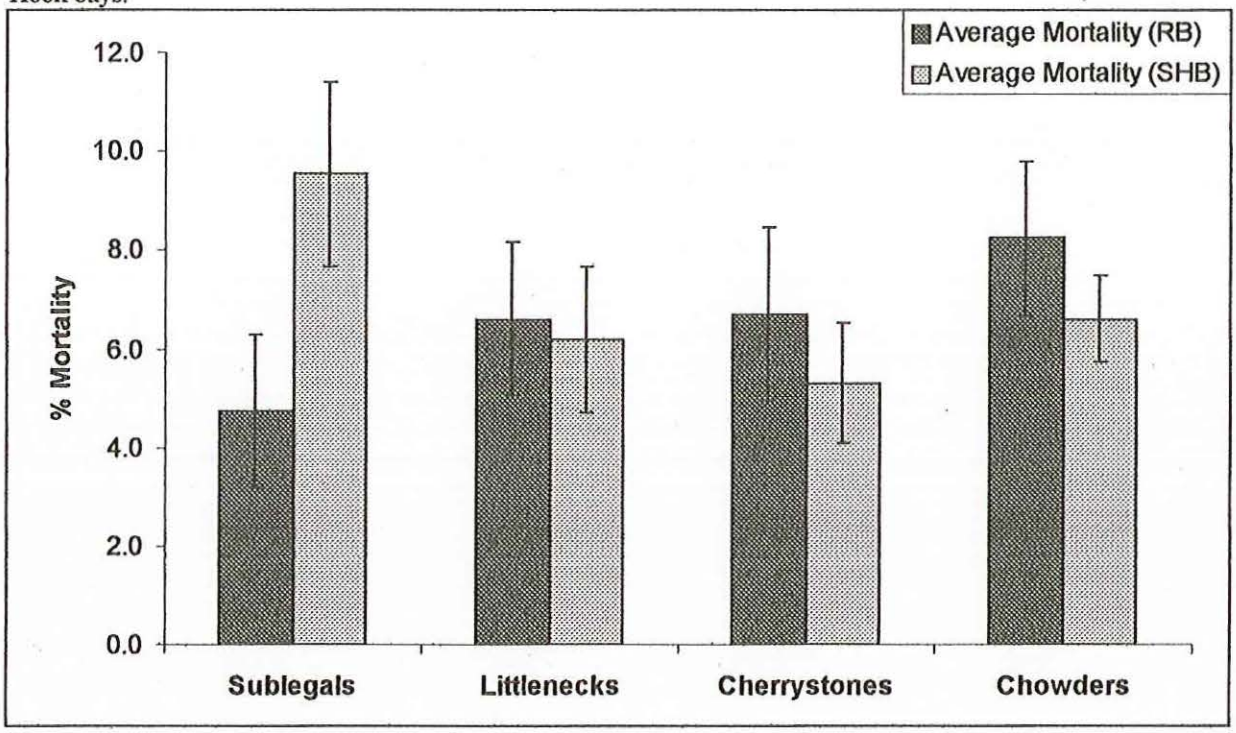
Mortality

The average hard clam mortality for Raritan and Sandy Hook bays was 9.0% (SD = 18.6%) and 8.3% (SD = 12.5%), respectively (Table 11). Mortalities were very variable, ranging from 0% to 100% in both bays (Tables 1a, 1b and 11). Mortality indices for individual commercial size classes at each station, and among commercial size classes at each station (where mortality > 0.0%), for Raritan and Sandy Hook bays are provided in Tables 14 and 15, respectively. Average mortalities by commercial size class for Raritan and Sandy Hook bays are depicted in Figure 17, below.

Inspection of mortality data (Mortality I) indicated that the data were not normally distributed. Arcsine transforming the data (see Sokal and Rohlf 1995) did not improve the normality of the distribution, so analyses were performed on actual un-transformed data. Analysis of variance of indicated no significant difference in average mortality among the commercial size classes in either Raritan ($F_{3,428} = 0.75$, $P = 0.5224$) or Sandy Hook ($F_{3,388} = 1.66$, $P = 0.1754$) bays. Mortality indices 1) partitioned by commercial size class for relay and depuration harvest areas and 2) across all commercial size classes in Raritan and Sandy Hook bays are listed in Table 16. Two-way analysis of variance of *Mercenaria* mortality (harvest area and commercial size class) indicated a significant difference in average mortality among the harvest areas only ($F_{20,628} = 2.22$, $P = 0.0018$; Figure 18) (*nota bene*: SNK analysis used $\alpha = 0.10$, because at $\alpha = 0.05$ no differences appeared despite the ANOVA indicating that there were differences at $\alpha = 0.05$ → this is probably a result of unequal sample/cell sizes in the SNK analysis).

Mortality indices from the 2000 survey are spatially depicted in Figures 19 and 20 for Raritan and Sandy Hook bays, respectively.

FIG. 17. Average hard clam mortality (± 1 SEM) (mortality I) by commercial size class for Raritan and Sandy Hook bays.



Associated Commercial Species' Abundance and Distribution

Blue mussels (*Mytilus edulis*) were collected at eight stations in 2000. These stations were concentrated in two offshore regions: northwest of the tip of Sandy Hook (Flynn's Knoll) and western Raritan Bay (Figure 21). In 1983, mussels were widely distributed in eastern Raritan Bay and central Sandy Hook Bay (Figure 22), occurring at 50 stations.

In 2000, surf clams [*Spisula solidissima* (Dillwyn, 1817)] were collected at 10 stations, all in low abundances (*i.e.*, < 0.20 clams foot^{-2}). Stations where surf clams were collected in 2000 were clustered in two regions: northwest of the tip of Sandy Hook (Flynn's Knoll) and southeastern Sandy Hook Bay (Figure 23). In 1983, surf clams were collected at Flynn's Knoll only, but in "commercially significant" (McCloy and Joseph 1984) densities (Figure 24).

In 2000, soft clams (*Mya arenaria*) were collected at only six stations in Raritan Bay (Figure 23). In contrast, soft clams were collected at 41 stations in 1983 (Figure 24).

Quantitative estimates of *Mytilus* and *Mya* are not provided because the dredge was not designed to efficiently retain the small sizes that were observed. Length-percent-frequency distributions were not created, as insufficient numbers were collected or measured (n < 100 per station) in 2000. However, of the mussels retained in the dredge in 2000, sizes ranged from 5 to 65 mm, while soft clams ranged in size from 9 to 43 mm.

DISCUSSION AND CONCLUSIONS

Abundance, distribution and size

Between 1983 and 2000, the estimated hard clam standing stock in Raritan and Sandy Hook bays have increased by 171% and 100%, respectively (see Table 4). Stock estimates by commercial size class (Table 5) indicate a preponderance of "cherrystone" clams in both Raritan (43.7%) and Sandy Hook (33.8%) bays, while sublegal sized clams represented the smallest percentage of clams in both bays. Inspection of the composite length-percent-frequency distribution graphs for Sandy Hook bay reveals a stable population with no dominant year classes evident (Figure 13); a similar pattern exists in Raritan Bay (Figure 12). This pattern may be a result of consistent annual recruitment and/or large sample sizes. Inspection of length-percent-frequency distribution graphs for individual stations indicates that approximately 5 to at least 11 year classes are represented in Sandy Hook Bay, but only 6 to at least 8 in Raritan Bay (Appendices IV and V).

Bay-wide quantitative comparisons of Raritan and Sandy Hook bays between 1983 and 2000 revealed that there was a significant increase in average per-station *Mercenaria* abundance of 0.28 clams foot^{-2} in Raritan Bay and 0.33 clams foot^{-2} in Sandy Hook Bay. However, quantitative analysis of *Mercenaria* abundance among relay and depuration harvest areas indicated no significant difference in abundance among current existing harvest areas save 1C and 11B (Figure 10). Results of the ANOVA need to be viewed in light of the parametric assumptions required for the test.

Qualitative (*i.e.,* visual) comparisons of the region between survey years indicate that the relative abundance of hard clams in the inshore region of Raritan Bay appears largely unchanged from 1983's expanse of low abundances (occurrence) in this area (Figures 5 and 6). A general trend of increased relative abundance appears in western Raritan Bay as well as the entire offshore region of Raritan Bay. The most striking feature of the hard clam relative abundance distribution in Sandy Hook Bay is the prevalence of high abundances in the center and southeastern portions of the Bay. Relative abundances in 1983 were, in general, lower and more disjunct these areas (Figure 5).

Over 77% of the hard clam stock in Raritan and Sandy Hook bays occurs in relay and depuration harvest areas and is therefore potentially available for harvest. Moreover, all harvest areas average at least moderate abundances of hard clams, save three (1C, 11B and WW_RB; Figure 10). While the three harvest areas with lowest average abundances were only statistically different from the area of highest abundance, this result must be viewed in light of parametric assumptions required for such analyses.

In 2000, 33.6 million clams were reported harvested (via relay and depuration) from Raritan and Sandy Hook bays during 14,548 man-days of fishing effort for a resultant catch per unit effort (CPUE) of 2,312 clams/man/day (Appendix III). While statewide reported landings (from the National Marine Fisheries Service) and CPUE (from reported relay and depuration harvest in Raritan and Sandy Hook bays) in 2000 were at their lowest levels since 1995, CPUE was only slightly below the historical average of 2,359 clams/man/day and the landings were still above the historical average of ~44.8 million clams. In 2001, the CPUE was above the historical average and in 2002 CPUE was at a record high. Reported landings for this time period (*i.e.,* 2001 and 2002) are difficult to interpret due to depuration plant closings and changes in depuration plant policies.

Given the consistent CPUE figures in the years between 1995 and 2000, it is possible that the decrease in 2000 is a result of a depuration plant policy of not accepting "chowder" sized

clams which represented nearly a quarter of all clams in harvestable waters (Table 8). It should also be noted that the majority of the Raritan and Sandy Hook bay harvest is processed through depuration plants which have a finite capacity; the number of people participating in the depuration program can therefore affect the CPUE.

Recruitment

Despite an analysis of variance indicating no significant difference in recruitment indices among the relay and depuration harvest areas, some general areas exhibited above average recruitment. For example, the area surrounding Raritan Bay East Reach Channel in Raritan Bay exhibited above average recruitment ($\bar{x}$ = 34.5%, SEM = 4.5%) (Figure 14). In Sandy Hook Bay, above average recruitment was observed in the large area between Horseshoe Cove and the Atlantic Highlands Municipal Yacht Basin ($\bar{x}$ = 17.2%, SEM = 1.0%) and an area immediately east of the Earle Naval Weapons Pier ($\bar{x}$ = 13.2%, SEM = 1.7%) (Figure 15). Results of the ANOVA need to be viewed in light of the parametric assumptions required for the test.

The significant positive correlation between recruitment and *Mercenaria* abundance was not entirely unexpected. If under conditions where large numbers of widely dispersed spawners occur, lower fertilization rates are likely (Fegley 2001), then perhaps the opposite is also true, contributing to the increased recruitment success observed.

Mortality

The SNK multiple comparison test (Figure 18) indicated that the differences in mortality among relay and depuration areas could be attributed to the two hypothetical areas (*i.e.*, western and eastern western Raritan Bay). Nevertheless, some general areas exhibited above average mortality. For example, the area of Raritan Bay offshore and between Union Beach and Keansburg displayed above average mortality ($\bar{x}$ = 18.8%, SEM = 5.1%) as did an area east of Chapel Hill Channel ($\bar{x}$ = 40.8%, SEM = 18.8%; Figure 19).

In general, mortality indices appear higher in eastern Sandy Hook Bay than in western or central parts of the bay (Figure 20).

Observed abundances of the common clam predators such as conchs, *Busycotypus canaliculatus*; moon snails, *Euspira heros*; oyster drills, *Eupleura caudata* and *Urosalpinx cinerea*; sea stars, *Asterias forbesi* and *Astropecten* spp.; rock crabs, *Cancer irroratus* and *C. borealis*; blue crabs, *Callinectes sapidus*; and horseshoe crabs *Limulus polyphemus* were relatively low. The lady crab, *Ovalipes ocellatus*, and the lobed moon snail, *Neverita duplicatus*, were relatively abundant.

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Table 1a. Station locations, hard clam abundances, commercial size class percentages and percent mortalities for the 2000 hard clam stock assessment of Sandy Hook Bay.

Station	Date	Latitude	Longitude	Depth (feet)	Substrate	Nozzle Position	Tow Distance	Abundance adj (clams foot^{-2})	Mean Length (mm)	Percent Sublegals	Percent Littlenecks	Percent Cherrystones	Percent Chowders	Percent Mortality
SHB-00-001	22-Aug-00	40 28.000	74 02.360	27	sand	open	100	0.09	90.0	0.00	0.00	0.00	100.00	27.27
SHB-00-002	22-Aug-00	40 28.445	74 01.729	29	sand, mud	both open	100	0.00	0.0	0.00	0.00	0.00	0.00	0.00
SHB-00-003	22-Aug-00	40 28.000	74 01.720	25	mud	closed	100	0.34	87.6	0.00	0.00	10.00	90.00	30.23
SHB-00-004	22-Aug-00	40 28.026	74 01.020	28	mud	closed	100	0.43	68.4	7.89	28.95	18.42	44.74	7.32
SHB-00-005	22-Aug-00	40 27.500	74 01.080	21	mud	closed	100	1.32	69.0	12.93	14.66	20.69	51.72	10.77
SHB-00-006	22-Aug-00	40 27.500	74 01.720	22	mud	closed	100	0.45	74.0	2.50	25.00	17.50	55.00	13.04
SHB-00-007	22-Aug-00	40 27.000	74 02.360	21	mud	closed	100	2.06	60.1	10.00	30.00	41.67	18.33	3.21
SHB-00-008	22-Aug-00	40 27.000	74 01.720	22	mud	closed	100	1.75	61.5	11.11	24.84	41.18	22.88	1.28
SHB-00-009	22-Aug-00	40 27.000	74 01.080	23	mud	closed	100	1.00	68.0	1.14	15.91	53.41	29.55	0.00
SHB-00-010	22-Aug-00	40 26.500	74 01.080	23	mud	closed	100	1.30	60.0	8.77	37.72	34.21	19.30	4.20
SHB-00-011	22-Aug-00	40 26.500	74 01.720	22	mud	closed	100	1.21	65.5	4.72	21.70	44.34	29.25	1.85
SHB-00-012	22-Aug-00	40 26.500	74 02.360	22	mud	closed	100	1.43	61.2	10.32	26.19	45.24	18.25	0.79
SHB-00-013	24-Aug-00	40 26.000	74 03.000	15	mud	closed	100	0.53	58.7	2.13	48.94	31.91	17.02	7.84
SHB-00-014	24-Aug-00	40 26.000	74 02.360	17	mud	closed	100	0.98	53.5	12.79	50.00	27.91	9.30	1.15
SHB-00-015	24-Aug-00	40 26.000	74 01.720	18	mud	closed	100	1.09	50.9	19.79	41.67	32.29	6.25	2.04
SHB-00-016	7-Sep-00	40 26.000	74 01.080	20	mud	closed	100	1.18	56.5	10.58	35.58	44.23	9.62	9.57
SHB-00-017	7-Sep-00	40 26.004	74 00.791	21	mud	closed	100	1.15	58.0	7.92	39.60	37.62	14.85	10.62
SHB-00-018	7-Sep-00	40 26.000	74 00.440	21	mud	closed	100	0.98	49.5	19.77	48.84	30.23	1.16	13.13
SHB-00-019	7-Sep-00	40 25.750	74 00.440	20	mud	closed	100	0.40	55.7	14.29	40.00	31.43	14.29	12.50
SHB-00-020	7-Sep-00	40 25.500	74 00.120	21	mud	closed	100	2.57	64.7	5.31	25.22	43.36	26.11	0.88
SHB-00-021	7-Sep-00	40 25.500	74 00.440	18	sand, mud	both open	100	0.99	53.0	12.64	50.57	32.18	4.60	6.45
SHB-00-022	7-Sep-00	40 25.259	74 00.468	17	sand, mud	open	100	0.22	58.3	5.26	31.58	47.37	15.79	5.00
SHB-00-023	7-Sep-00	40 25.000	74 00.760	16	sand, mud	open	100	0.48	60.6	16.67	19.05	45.24	19.05	10.64
SHB-00-024	7-Sep-00	40 25.500	74 00.760	19	mud	closed	100	1.47	54.0	11.63	48.06	31.78	8.53	7.86
SHB-00-025	7-Sep-00	40 25.500	74 01.080	19	mud	closed	100	1.02	49.1	24.44	48.89	18.89	7.78	10.89
SHB-00-026	7-Sep-00	40 25.250	74 01.080	19	mud	closed	100	1.52	49.9	21.64	48.51	23.13	6.72	4.29
SHB-00-027	7-Sep-00	40 25.215	74 01.367	18	sand, mud	closed	100	0.97	49.2	22.35	57.65	10.59	9.41	1.16
SHB-00-028	8-Sep-00	40 27.684	74 00.470	9	sand, gravel	open	100	0.20	82.5	5.56	0.00	22.22	72.22	5.26
SHB-00-029	8-Sep-00	40 27.500	74 00.440	9	sand	open	100	0.11	85.6	0.00	0.00	22.22	77.78	0.00
SHB-00-030	8-Sep-00	40 27.250	74 00.440	9	sand, shell	open	100	0.07	90.0	0.00	0.00	0.00	100.00	0.00
SHB-00-031	8-Sep-00	40 27.000	74 00.440	9	sand, shell	open	100	0.00	0.0	0.00	0.00	0.00	0.00	0.00
SHB-00-032	8-Sep-00	40 26.750	74 00.440	24	mud	closed	100	2.59	58.2	13.60	28.07	45.18	13.16	4.60
SHB-00-033	8-Sep-00	40 26.500	74 00.440	21	mud	closed	100	1.74	52.2	18.30	40.52	34.64	6.54	6.71
SHB-00-034	8-Sep-00	40 26.250	74 00.440	20	mud	closed	100	1.50	54.6	23.48	34.09	24.24	18.18	9.59

Table 1a. Station locations, hard clam abundances, commercial size class percentages and percent mortalities for the 2000 hard clam stock assessment of Sandy Hook Bay.

Station	Date	Latitude	Longitude	Depth (feet)	Substrate	Nozzle Position	Tow Distance	Abundance adj (clams foot^{-2})	Mean Length (mm)	Percent Sublegals	Percent Littlenecks	Percent Cherrystones	Percent Chowders	Percent Mortality
SHB-00-035	8-Sep-00	40 25.750	74 00.120	20	mud	closed	100	1.05	66.5	4.35	17.39	42.39	35.87	8.91
SHB-00-036	8-Sep-00	40 26.000	74 00.120	16	sand	open	100	0.52	70.1	4.35	6.52	56.52	32.61	2.13
SHB-00-037	8-Sep-00	40 26.250	74 00.120	22	mud	closed	100	0.81	61.1	8.45	28.17	46.48	16.90	2.74
SHB-00-038	8-Sep-00	40 26.500	74 00.120	20	mud	closed	100	0.56	68.4	2.04	20.41	40.82	36.73	3.92
SHB-00-039	11-Sep-00	40 25.750	74 03.32	12	sand	open	100	2.44	81.7	0.00	0.93	26.98	72.09	2.71
SHB-00-040	11-Sep-00	40 25.500	74 03.320	8	sand	open	100	1.09	78.2	1.04	6.25	33.33	59.38	2.04
SHB-00-041	11-Sep-00	40 25.250	74 03.000	6	sand, gravel, sod	open	100	0.55	60.7	6.25	33.33	37.50	22.92	7.69
SHB-00-042	11-Sep-00	40 25.500	74 03.000	9	sand, shell	open	100	0.14	81.6	0.00	0.00	33.33	66.67	14.29
SHB-00-043	11-Sep-00	40 25.750	74 03.000	17	sand	open	100	1.02	69.2	2.22	12.22	51.11	34.44	1.10
SHB-00-044	11-Sep-00	40 25.750	74 02.680	19	mud	closed	100	0.98	64.0	6.98	29.07	33.72	30.23	6.52
SHB-00-045	11-Sep-00	40 25.500	74 02.680	11	sand	open	100	1.03	82.8	1.10	1.10	21.98	75.82	2.15
SHB-00-046	11-Sep-00	40 25.250	74 02.680	7	sand, gravel	open	100	0.13	79.9	9.09	0.00	27.27	63.64	15.38
SHB-00-047	11-Sep-00	40 25.250	74 02.360	7	sand	open	100	0.34	85.1	0.00	6.90	10.34	82.76	13.06
SHB-00-048	11-Sep-00	40 25.248	74 02.129	7	sand	open	100	0.28	74.4	4.00	4.00	44.00	48.00	3.85
SHB-00-049	11-Sep-00	40 25.500	74 02.360	16	mud	closed	100	1.35	65.6	3.36	19.33	49.58	27.73	0.83
SHB-00-050	11-Sep-00	40 25.500	74 02.040	17	mud	closed	100	1.64	55.8	16.67	36.11	32.64	14.58	6.49
SHB-00-051	11-Sep-00	40 25.500	74 01.720	17	mud	closed	100	2.08	47.6	23.50	54.10	18.03	4.37	7.11
SHB-00-052	11-Sep-00	40 25.250	74 01.720	15	mud	closed	100	1.36	51.6	21.67	56.67	13.33	8.33	8.40
SHB-00-053	11-Sep-00	40 25.000	74 01.080	14	mud	closed	100	2.47	55.4	14.75	41.94	29.49	13.82	3.98
SHB-00-054	11-Sep-00	40 25.000	74 01.400	12	mud	closed	100	0.40	51.0	17.14	48.57	31.43	2.86	10.26
SHB-00-055	11-Sep-00	40 24.861	74 01.080	4	sand	open	100	1.60	83.2	0.71	0.71	20.00	78.57	2.76
SHB-00-056	12-Sep-00	40 26.750	74 00.120	7	sand, gravel	open	100	0.19	74.6	5.88	11.76	35.29	47.06	10.53
SHB-00-057	12-Sep-00	40 26.750	73 59.800	11	sand, gravel	open	100	1.56	68.7	6.57	16.06	40.88	36.50	2.14
SHB-00-058	12-Sep-00	40 26.630	73 59.650	9	sand	open	100	4.93	66.0	8.99	22.12	34.33	34.56	3.98
SHB-00-059	12-Sep-00	40 26.500	73 59.800	11	sand	open	100	0.90	68.8	8.86	24.05	20.25	46.84	1.25
SHB-00-060	12-Sep-00	40 26.362	73 59.654	8	sand	open	100	0.94	78.6	3.61	8.43	18.07	69.88	4.60
SHB-00-061	12-Sep-00	40 26.316	73 59.804	11	sand	open	68.9	0.19	81.1	0.00	4.35	17.39	78.26	11.44
SHB-00-062	12-Sep-00	40 26.160	73 59.720	11	sand	open	43.6	0.13	80.3	0.00	0.00	40.00	60.00	0.00
SHB-00-063	12-Sep-00	40 26.000	73 59.800	10	sand, gravel	open	100	0.61	79.4	1.85	7.41	27.78	62.96	3.57
SHB-00-064	12-Sep-00	40 25.750	73 59.800	6	sand, shell	n/a	100	0.19	82.9	0.00	5.88	17.65	76.47	10.53
SHB-00-065	12-Sep-00	40 25.500	73 59.800	5	sand	open	100	0.44	70.7	2.56	15.38	46.15	35.90	7.14
SHB-00-066	12-Sep-00	40 25.283	73 59.831	6	sand	open	100	0.11	72.6	0.00	10.00	50.00	40.00	9.09
SHB-00-067	12-Sep-00	40 25.250	74 00.120	6	sand	open	100	0.24	70.8	2.50	12.50	52.50	32.50	9.09
SHB-00-068	13-Sep-00	40 25.000	74 00.120	12	sand	open	100	0.14	78.9	0.00	0.00	58.33	41.67	0.00

Table 1a. Station locations, hard clam abundances, commercial size class percentages and percent mortalities for the 2000 hard clam stock assessment of Sandy Hook Bay.

Station	Date	Latitude	Longitude	Depth (feet)	Substrate	Nozzle Position	Tow Distance	Abundance adj (clams foot^{-2})	Mean Length (mm)	Percent Sublegals	Percent Littlenecks	Percent Cherrystones	Percent Chowders	Percent Mortality
SHB-00-069	12-Sep-00	40 25.000	74 00.440	9	sand	open	100	0.25	73.9	0.00	4.55	59.09	36.36	8.33
SHB-00-070	13-Sep-00	40 24.731	74 00.111	18	sand	open	100	0.05	79.4	0.00	25.00	50.00	25.00	33.33
SHB-00-071	13-Sep-00	40 24.781	74 00.692	8	sand, rock	open	100	0.93	82.6	0.00	2.44	19.51	78.05	2.38
SHB-00-072	13-Sep-00	40 24.750	74 00.440	7	sand	open	100	0.53	80.6	0.00	4.26	25.53	70.21	16.07
SHB-00-073	13-Sep-00	40 25.000	73 59.800	7	sand	open	100	0.01	87.0	0.00	0.00	0.00	100.00	50.00
SHB-00-074	14-Sep-00	40 25.750	73 59.480	6	coarse sand	open	100	0.09	70.1	0.00	37.50	25.00	37.50	0.00
SHB-00-075	14-Sep-00	40 25.500	73 59.480	9	mud	closed	100	0.63	76.8	0.00	9.09	27.27	63.64	11.29
SHB-00-076	14-Sep-00	40 25.501	73 59.193	6	sand	open	100	0.05	81.0	0.00	0.00	25.00	75.00	0.00
SHB-00-076.5	14-Sep-00	40 25.386	73 59.333	7	sand	open	100	0.15	74.3	7.69	23.08	7.69	61.54	13.33
SHB-00-077	14-Sep-00	40 25.243	73 59.193	6	sand	open	100	0.11	72.6	0.00	10.00	40.00	50.00	41.18
SHB-00-078	14-Sep-00	40 25.250	73 59.480	7	sand	open	100	0.69	68.5	3.28	18.03	40.98	37.70	6.15
SHB-00-079	13-Sep-00	40 25.000	73 59.480	25	sand (coarse), gravel	open	100	0.88	71.0	6.49	10.39	44.16	38.96	9.41
SHB-00-080	13-Sep-00	40 24.750	73 59.480	21	sand	open	96.4	1.50	78.4	0.79	2.36	40.16	56.69	4.51
SHB-00-081	13-Sep-00	40 24.750	73 59.800	7	sand	open	100	0.42	75.2	0.00	8.11	43.24	48.65	2.63
SHB-00-082	13-Sep-00	40 24.500	73 59.480	19	sand	open	100	0.52	73.4	3.08	7.69	43.85	45.38	17.19
SHB-00-083	14-Sep-00	40 24.500	73 59.160	17	sand	open	100	1.76	56.3	1.94	47.74	50.32	0.00	7.19
SHB-00-084	13-Sep-00	40 25.250	74 00.760	18	mud	closed	100	1.71	51.1	17.33	45.33	30.67	6.67	6.25
SHB-00-085	13-Sep-00	40 26.000	74 03.320	13	mud	closed	100	2.22	59.2	12.82	30.77	39.49	16.92	1.02
SHB-00-086	13-Sep-00	40 26.000	74 03.640	8	sand	open	100	2.07	80.2	0.00	1.10	31.87	67.03	3.19
SHB-00-087	13-Sep-00	40 26.250	74 03.320	13	mud	closed	100	1.09	61.3	7.29	30.21	45.83	16.67	1.03
SHB-00-088	14-Sep-00	40 25.000	73 59.16	9	sand	open	100	0.93	73.8	0.00	7.32	51.22	41.46	10.87
SHB-00-089	14-Sep-00	40 24.750	73 59.160	8	sand	open	100	0.64	77.4	1.79	12.50	25.00	60.71	6.67
SHB-00-090	14-Sep-00	40 24.766	73 58.884	8	sand, rock	open	100	1.05	63.3	7.61	14.13	35.87	42.39	3.16
SHB-00-091	14-Sep-00	40 24.249	73 59.071	18	sand, gravel	open	100	0.00	0.0	0.00	0.00	0.00	0.00	100.00
SHB-00-092	14-Sep-00	40 24.250	73 58.840	17	sand, gravel	open	100	0.99	75.1	4.60	8.05	32.18	55.17	0.00
SHB-00-093	14-Sep-00	40 24.000	73 58.840	21	sand, gravel	open	100	0.40	71.4	0.00	14.29	45.71	40.00	2.78
SHB-00-094	14-Sep-00	40 26.500	74 03.000	17	mud	closed	100	2.02	54.6	18.54	33.71	35.96	11.80	6.32
SHB-00-095	14-Sep-00	40 27.000	74 02.680	19	mud	closed	100	1.84	62.3	16.05	20.99	36.42	26.54	3.57
SHB-00-096	14-Sep-00	40 27.500	74 02.360	23	sand	open	100	0.43	82.3	2.63	13.16	7.89	76.32	17.39
SHB-00-097	22-Sep-00	40 25.750	74 03.640	9	hard sand, rock	open	100	0.89	77.0	2.56	8.97	37.18	51.28	2.50

Table 1b. Station locations, hard clam abundances, commercial size class percentages and percent mortalities for the 2000 hard clam stock assessment of Raritan Bay.

Station	Date	Latitude	Longitude	Depth (feet)	Substrate	Nozzle Position	Tow Distance	Abundance $_{adj}$ (clams foot^{-2})	Mean Length (mm)	Percent Sublegals	Percent Littlenecks	Percent Cherrystones	Percent Chowders	Percent Mortality
RB-00-001	14-Jul-00	40 29.000	74 16.120	10	mud	closed	83.3	0.13	69.3	0.00	0.00	77.78	22.22	0.00
RB-00-002	14-Jul-00	40 29.000	74 15.470	13	mud	closed	82.9	0.07	65.7	0.00	20.00	60.00	20.00	0.00
RB-00-003	14-Jul-00	40 28.500	74 15.470	12	mud, rock, and shell	closed	83.1	0.18	59.5	0.00	46.15	38.46	15.38	0.00
RB-00-004	14-Jul-00	40 28.250	74 15.470	11	sand, rock, and shell	open	83.2	0.02	67.5	0.00	50.00	0.00	50.00	0.00
RB-00-005	14-Jul-00	40 29.000	74 14.820	19	mud, rock	closed	37.6	0.13	58.6	0.00	0.00	100.00	0.00	0.00
RB-00-006	14-Jul-00	40 28.500	74 14.820	12	mud, rock, and shell	closed	83.1	0.06	69.8	0.00	25.00	50.00	25.00	0.00
RB-00-007	17-Jul-00	40 28.000	74 14.820	10	mud, shell	closed	83.3	0.09	59.6	14.29	14.29	42.86	28.57	0.00
RB-00-008	17-Jul-00	40 28.500	74 14.170	15	mud, shell	closed	82.6	0.08	59.8	0.00	83.33	16.67	0.00	0.00
RB-00-009	17-Jul-00	40 28.000	74 14.170	15	mud, shell	closed	82.6	0.06	57.8	25.00	0.00	75.00	0.00	0.00
RB-00-010	17-Jul-00	40 27.500	74 14.170	8	sand	open	83.5	0.07	67.2	20.00	20.00	0.00	60.00	0.00
RB-00-011	17-Jul-00	40 27.625	74 13.345	16	mud, rock	closed	82.4	0.11	70.4	0.00	12.50	50.00	37.50	0.00
RB-00-012	17-Jul-00	40 28.000	74 13.510	16	mud, shell	closed	82.4	0.27	55.8	10.00	30.00	60.00	0.00	4.76
RB-00-013	17-Jul-00	40 28.600	74 13.510	16	mud, shell	closed	82.4	0.45	61.5	3.03	36.36	54.55	6.06	0.00
RB-00-014	17-Jul-00	40 28.375	74 12.850	15	mud, shell	closed	82.6	0.90	59.7	1.54	27.69	69.23	1.54	2.99
RB-00-015	18-Jul-00	40 27.000	74 11.540	7	sand	open	83.6	0.15	66.5	0.00	27.27	45.45	27.27	0.00
RB-00-016	18-Jul-00	40 26.500	74 12.200	8	mud	closed	83.5	0.16	62.8	0.00	41.67	50.00	8.33	0.00
RB-00-017	18-Jul-00	40 27.000	74 12.200	12	mud, rock	closed	83.1	0.14	60.9	0.00	30.00	50.00	20.00	0.00
RB-00-018	18-Jul-00	40 27.125	74 12.687	7	clay, sand	open	41.6	0.08	69.0	0.00	0.00	66.67	33.33	0.00
RB-00-019	18-Jul-00	40 27.500	74 12.850	15	sand, mud, and rock	open	82.6	0.05	45.0	33.33	33.33	33.33	0.00	0.00
RB-00-020	2-Aug-00	40 27.456	74 12.169	17	mud / mud, sand w/ little shell	closed	82.3	0.22	66.4	0.00	20.00	60.00	20.00	2.94
RB-00-021	18-Jul-00	40 27.500	74 11.540	15	mud	open	82.6	0.08	59.6	16.67	33.33	33.33	16.67	0.00
RB-00-022	18-Jul-00	40 28.000	74 11.540	16	mud, shell	closed	82.4	0.13	68.0	0.00	0.00	77.78	22.22	0.00
RB-00-023	18-Jul-00	40 28.000	74 12.200	15	mud, shell	closed	82.6	0.78	60.8	5.26	24.56	57.89	12.28	1.72
RB-00-024	2-Aug-00	40 28.000	74 12.850	17	mud, a little shell	closed	82.2	0.45	63.6	0.00	24.24	57.58	18.18	0.00
RB-00-025	2-Aug-00	40 28.500	74 12.200	20	mud	closed	81.5	0.53	61.2	2.63	26.32	65.79	5.26	2.56
RB-00-026	3-Aug-00	40 28.500	74 11.540	15	mud	closed	82.6	0.83	65.2	0.00	21.67	55.00	23.33	0.00
RB-00-027	3-Aug-00	40 29.000	74 10.880	18	sand, shell	open	82.0	1.64	67.6	1.71	11.97	63.25	23.08	4.07
RB-00-028	3-Aug-00	40 29.125	74 10.220	21	mud	closed	81.3	0.47	67.1	6.06	18.18	45.45	30.30	5.71
RB-00-029	3-Aug-00	40 28.875	74 09.570	19	mud, sand	both open	81.7	0.44	52.6	40.63	18.75	37.50	3.13	0.00
RB-00-030	3-Aug-00	40 28.500	74 09.570	19	mud, sand	open	81.7	0.83	69.5	1.69	10.17	59.32	28.81	1.64
RB-00-031	3-Aug-00	40 28.500	74 10.220	15	sand	open	82.6	0.44	75.4	0.00	6.45	45.16	48.39	15.79
RB-00-032	3-Aug-00	40 28.500	74 10.880	18	sand	open	82.0	0.31	73.8	4.55	4.55	45.45	45.45	0.00
RB-00-033	3-Aug-00	40 28.000	74 10.880	14	sand	open	82.7	2.07	71.1	1.99	13.25	48.34	36.42	0.00
RB-00-034	3-Aug-00	40 28.000	74 10.220	14	sand	open	82.7	0.50	72.4	0.00	14.29	51.43	34.29	14.29
RB-00-035	3-Aug-00	40 28.000	74 09.570	18	sand, mud	both open	82.0	0.23	62.9	6.25	18.75	43.75	31.25	0.00

Table 1b. Station locations, hard clam abundances, commercial size class percentages and percent mortalities for the 2000 hard clam stock assessment of Raritan Bay.

Station	Date	Latitude	Longitude	Depth (feet)	Substrate	Nozzle Position	Tow Distance	Abundance $_{adj}$ (clams foot^{-2})	Mean Length (mm)	Percent Sublegals	Percent Littlenecks	Percent Cherrystones	Percent Chowders	Percent Mortality
RB-00-036	3-Aug-00	40 27.500	74 09.570	14	sand	open	82.7	0.20	62.8	6.67	13.33	66.67	13.33	6.25
RB-00-037	3-Aug-00	40 27.625	74 10.220	12	sand	open	83.1	0.06	64.2	0.00	50.00	25.00	25.00	20.00
RB-00-038	3-Aug-00	40 27.250	74 09.895	8	rock shell, and sand	open	83.5	0.00	0.0	0.00	0.00	0.00	0.00	0.00
RB-00-039	4-Aug-00	40 27.500	74 07.620	4	sand	open	83.8	0.07	74.4	0.00	0.00	40.00	60.00	16.67
RB-00-040	4-Aug-00	40 27.500	74 08.270	4	sand	open	83.8	0.05	62.0	0.00	33.33	33.33	33.33	25.00
RB-00-041	4-Aug-00	40 27.500	74 08.920	11	mud	closed	83.2	0.73	62.0	7.55	30.19	50.94	11.32	19.70
RB-00-042	4-Aug-00	40 27.250	74 09.245	8	sand	closed	83.5	0.18	74.3	0.00	0.00	46.15	53.85	53.57
RB-00-043	4-Aug-00	40 28.000	74 08.920	15	sand	open	82.6	2.40	68.1	0.57	16.09	58.62	24.71	0.57
RB-00-044	4-Aug-00	40 28.000	74 08.270	9	sand	open	83.4	0.05	76.0	0.00	0.00	33.33	66.67	0.00
RB-00-045	4-Aug-00	40 28.000	74 07.620	10	sand	open	83.3	0.01	97.5	0.00	0.00	0.00	100.00	75.00
RB-00-046	4-Aug-00	40 28.500	74 07.620	14	sand	open	82.7	0.01	87.0	0.00	0.00	0.00	100.00	66.67
RB-00-047	4-Aug-00	40 28.500	74 08.270	18	sand	open	82.0	0.26	84.2	0.00	0.00	21.05	78.95	5.00
RB-00-048	4-Aug-00	40 28.500	74 08.920	19	mud, sand	open	81.7	0.78	65.5	1.79	21.43	57.14	19.64	1.75
RB-00-049	4-Aug-00	40 29.125	74 08.920	24	sand	open	80.4	3.25	61.8	5.68	24.02	55.90	14.41	4.56
RB-00-050	11-Aug-00	40 26.500	74 05.660	6	sand, clay, gravel	open	83.7	0.02	52.5	0.00	100.00	0.00	0.00	0.00
RB-00-051	9-Aug-00	40 27.000	74 05.66	9	sand	open	83.4	0.00	88.5	0.00	0.00	0.00	0.00	0.00
RB-00-052	9-Aug-00	40 27.000	74 06.310	9	sand	open	83.4	0.01	60.0	0.00	0.00	100.00	0.00	0.00
RB-00-053	16-Aug-00	40 27.000	74 06.970	5	sand, pebble	open	83.9	0.01	87.0	0.00	0.00	0.00	100.00	0.00
RB-00-054	9-Aug-00	40 27.500	74 06.970	12	sand	open	83.1	0.20	70.6	0.00	6.67	66.67	26.67	6.25
RB-00-055	9-Aug-00	40 27.500	74 06.310	13	sand	open	82.9	0.01	87.0	0.00	0.00	0.00	100.00	0.00
RB-00-056	9-Aug-00	40 27.500	74 05.660	13	sand	open	82.9	0.00	0.0	0.00	0.00	0.00	0.00	0.00
RB-00-057	9-Aug-00	40 28.000	74 05.660	19	sand	open	81.7	0.05	71.5	0.00	0.00	66.67	33.33	0.00
RB-00-058	9-Aug-00	40 28.000	74 06.310	19	mud	closed	81.7	1.08	62.5	7.69	21.79	51.28	19.23	1.27
RB-00-059	9-Aug-00	40 27.998	74 06.950	17	mud	closed	82.2	0.43	67.5	0.00	9.68	70.97	19.35	3.13
RB-00-060	9-Aug-00	40 28.500	74 06.970	19	mud	closed	81.7	0.58	62.6	2.38	35.71	38.10	23.81	4.55
RB-00-061.5	22-Sep-00	40 28.500	74 06.310	24	mud	closed	100	2.68	45.2	53.39	19.92	20.76	5.93	8.88
RB-00-062	9-Aug-00	40 28.500	74 05.660	24	mud	closed	80.4	1.76	47.4	45.97	19.35	30.65	4.03	1.57
RB-00-063	10-Aug-00	40 26.500	74 05.000	8	sand	open	83.5	0.22	81.8	0.00	0.00	25.00	75.00	0.00
RB-00-064	10-Aug-00	40 26.500	74 04.330	8	sand	open	83.5	0.01	82.5	0.00	0.00	0.00	100.00	16.67
RB-00-065	10-Aug-00	40 27.125	74 04.165	19	mud	closed	81.7	0.42	70.7	6.67	10.00	43.33	40.00	6.25
RB-00-066	10-Aug-00	40 27.000	74 05.000	9	mud	closed	83.4	0.01	84.0	0.00	0.00	0.00	100.00	0.00
RB-00-067	10-Aug-00	40 27.500	74 05.000	14	sand	open	82.7	0.00	0.0	0.00	0.00	0.00	0.00	100.00
RB-00-068	10-Aug-00	40 27.500	74 04.330	19	mud	closed	81.7	0.55	67.4	1.28	25.64	43.59	29.49	3.66
RB-00-069	11-Aug-00	40 27.500	74 03.670	23	mud	closed	80.7	1.84	58.3	10.69	35.88	39.69	13.74	7.09
RB-00-070	11-Aug-00	40 28.000	74 03.010	26	mud	closed	79.8	0.38	83.5	7.69	11.54	0.00	80.77	18.75

Table 1b. Station locations, hard clam abundances, commercial size class percentages and percent mortalities for the 2000 hard clam stock assessment of Raritan Bay.

Station	Date	Latitude	Longitude	Depth (feet)	Substrate	Nozzle Position	Tow Distance	Abundance $_{adj}$ (clams foot^{-2})	Mean Length (mm)	Percent Sublegals	Percent Littlenecks	Percent Cherrystones	Percent Chowders	Percent Mortality
RB-00-071	11-Aug-00	40 28.000	74 03.670	24	mud	closed	80.4	3.06	56.7	18.98	37.04	19.91	24.07	2.26
RB-00-072	11-Aug-00	40 28.000	74 04.330	23	mud	closed	80.7	1.19	65.9	4.71	9.41	67.06	18.82	4.49
RB-00-073	11-Aug-00	40 28.000	74 05.000	22	sticky sand	open	81.0	1.15	67.3	6.10	13.41	57.32	23.17	0.00
RB-00-074	11-Aug-00	40 28.375	74 05.000	24	mud	closed	80.4	2.15	66.9	1.32	19.08	56.58	23.03	1.94
RB-00-075	11-Aug-00	40 28.625	74 04.330	25	mud	closed	80.1	0.91	63.4	9.38	14.06	60.94	15.63	3.03
RB-00-076	11-Aug-00	40 28.625	74 03.670	24	mud	closed	80.4	1.49	57.1	15.24	40.00	23.81	20.95	1.87
RB-00-077	11-Aug-00	40 28.375	74 03.010	25	mud	closed	80.1	0.10	65.6	0.00	14.29	57.14	28.57	12.50
RB-00-078	16-Aug-00	40 29.000	74 08.270	26	mud	closed	83.3	0.61	62.7	2.22	26.67	46.67	24.44	11.76
RB-00-079	16-Aug-00	40 29.000	74 07.620	28	sand, a little mud	open	83.2	0.61	70.3	2.22	0.00	64.44	33.33	10.00
RB-00-080	16-Aug-00	40 29.500	74 07.620	32	mud	closed	83.0	1.51	65.5	12.96	9.26	49.07	28.70	13.39
RB-00-081	16-Aug-00	40 29.375	74 06.970	33	mud	closed	82.9	1.19	58.1	25.29	16.09	43.68	14.94	5.43
RB-00-082	16-Aug-00	40 29.000	74 06.970	27	mud, sand	closed	83.2	1.38	49.5	42.00	20.00	28.00	10.00	0.98
RB-00-083	16-Aug-00	40 29.000	74 06.310	29	mud, sand	closed	83.1	2.23	51.8	46.63	13.50	21.47	18.40	3.55
RB-00-084	16-Aug-00	40 29.500	74 06.310	30	firm mud	closed	83.1	1.33	62.9	7.22	20.62	54.64	17.53	1.02
RB-00-085	16-Aug-00	40 29.500	74 05.660	27	mud	closed	83.2	1.16	64.6	7.06	18.82	41.18	32.94	9.57
RB-00-086	17-Aug-00	40 29.000	74 01.720	19	sand, shell (mussel)	open	100	0.00	0.0	0.00	0.00	0.00	0.00	0.00
RB-00-087	18-Aug-00	40 26.000	74 04.330	4	clay, sand	open	100	0.17	55.2	6.67	53.33	26.67	13.33	21.05
RB-00-088	18-Aug-00	40 26.500	74 03.670	16	sand, a little mud	open	100	0.41	64.5	11.11	22.22	33.33	33.33	7.69
RB-00-089	18-Aug-00	40 27.000	74 03.670	20	mud	closed	100	0.67	61.6	8.47	37.29	30.51	23.73	3.28
RB-00-090	18-Aug-00	40 27.500	74 03.340	23	mud	closed	100	1.41	65.9	7.26	15.32	50.81	26.61	5.34
RB-00-091	18-Aug-00	40 29.500	74 01.720	22	sand	open	100	0.01	90.0	0.00	0.00	0.00	100.00	75.00
RB-00-092	18-Aug-00	40 30.000	74 01.720	22	sand, shell	open	100	0.00	0.0	0.00	0.00	0.00	0.00	0.00
RB-00-093	18-Aug-00	40 30.000	74 02.360	27	sand	open	100	0.00	0.0	0.00	0.00	0.00	0.00	0.00
RB-00-094	18-Aug-00	40 29.500	74 02.360	27	sand, shell	open	100	0.75	63.2	7.69	24.62	47.69	20.00	37.14
RB-00-095	18-Aug-00	40 29.000	74 02.360	23	mud, shell, firm mud, a little sand	closed	100	2.09	64.9	4.35	23.91	45.65	26.09	10.24
RB-00-096	18-Aug-00	40 29.000	74 03.010	25	mud	closed	100	0.43	71.6	5.26	18.42	26.32	50.00	7.32
RB-00-097	21-Aug-00	40 29.000	74 05.660	26	mud	closed	100	1.99	46.7	47.70	25.29	18.39	8.62	3.31
RB-00-098	21-Aug-00	40 29.000	74 05.000	30	mud	closed	100	0.84	52.1	44.59	10.81	32.43	12.16	3.90
RB-00-099	21-Aug-00	40 29.500	74 05.000	25	mud	closed	100	0.85	65.4	13.33	14.67	42.67	29.33	5.06
RB-00-100	21-Aug-00	40 30.000	74 05.000	24	sand	open	100	0.43	74.4	2.63	5.26	39.47	52.63	9.52
RB-00-101	21-Aug-00	40 30.000	74 04.330	26	sand	open	100	0.26	78.3	0.00	13.04	21.74	65.22	11.54
RB-00-102	21-Aug-00	40 29.500	74 04.330	28	mud, a little sand	closed	100	1.03	65.7	6.74	20.22	47.19	25.84	9.90
RB-00-103	21-Aug-00	40 29.052	74 04.358	30	mud, rock / mud	closed	100	1.03	56.3	17.13	26.52	48.62	7.73	4.51
RB-00-104	21-Aug-00	40 29.000	74 03.670	29	mud	closed	100	1.47	54.7	27.91	24.81	29.46	17.83	3.01
RB-00-105	21-Aug-00	40 29.500	74 03.670	29	mud	closed	100	1.22	64.9	4.67	22.43	42.06	30.84	7.76

Table 1b. Station locations, hard clam abundances, commercial size class percentages and percent mortalities for the 2000 hard clam stock assessment of Raritan Bay.

Station	Date	Latitude	Longitude	Depth (feet)	Substrate	Nozzle Position	Tow Distance	Abundance $_{adj}$ (clams foot^{-2})	Mean Length (mm)	Percent Sublegals	Percent Littlenecks	Percent Cherrystones	Percent Chowders	Percent Mortality
RB-00-106	21-Aug-00	40 30.000	74 03.670	28	sand	open	100	0.18	86.8	0.00	6.25	0.00	93.75	27.27
RB-00-107	21-Aug-00	40 30.000	74 03.010	28	sand	open	100	0.00	0.0	0.00	0.00	0.00	0.00	100.00
RB-00-108	21-Aug-00	40 29.500	74 03.010	30	sand	open	100	0.20	80.8	0.00	5.56	22.22	72.22	10.00

Table 3. Physical and chemical data collected during the 2000 Raritan and Sandy Hook bay hard clam stock assessment.

RARITAN AND SANDY HOOK BAY COMBINED

	Air Temperature (°C)	Surface water Temperature (°C)	Bottom water Temperature (°C)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (°/oo)	Bottom Salinity (°/oo)	Surface pH	Bottom pH
Count (n)	205	205	205	41	41	40	41	29	29
Minimum	15	20	20	5.7	5.2	18	19	7.5	7.5
Maximum	31	28	26	15.3	13.4	25	26	8.4	8.4
Average	23.5	23.4	23.2	9.1	7.0	22.0	22.9	8.1	8.0
Standard Deviation	3.3	1.5	1.3	2.3	1.6	1.8	1.9	0.3	0.2

RARITAN BAY

	Air Temperature (°C)	Surface water Temperature (°C)	Bottom water Temperature (°C)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (°/oo)	Bottom Salinity (°/oo)	Surface pH	Bottom pH
Count (n)	108	110	110	25	24	24	24	14	12
Minimum	15	20	20	5.9	5.5	18	19	7.5	7.5
Maximum	31	28	26	15.3	13.4	24	26	8.3	8.1
Average	24.7	23.9	23.6	8.9	7.2	21.0	21.9	7.9	7.8
Standard Deviation	3.5	1.6	1.4	2.5	1.9	1.3	1.8	0.2	0.2

SANDY HOOK BAY

	Air Temperature (°C)	Surface water Temperature (°C)	Bottom water Temperature (°C)	Surface Dissolved Oxygen (mg/l)	Bottom Dissolved Oxygen (mg/l)	Surface Salinity (°/oo)	Bottom Salinity (°/oo)	Surface pH	Bottom pH
Count (n)	97	95	95	16	17	16	17	15	17
Minimum	17	20	20	5.7	5.2	20	22	8	7.9
Maximum	27	25	24	12.8	9.0	25	26	8.4	8.4
Average	22.2	22.8	22.7	9.3	6.8	23.4	24.4	8.2	8.1
Standard Deviation	2.6	1.2	1.0	2.0	1.2	1.5	1.1	0.1	0.1

Table 5. 2000 Raritan and Sandy Hook bay hard clam stock estimates, means, variances and standard errors by commercial size class.

RARITAN BAY COMMERCIAL SIZE CLASS STOCK ESTIMATES				
	Sublegals	Littlenecks	Cherrystones	Chowders
Clams	81,518,601	124,434,027	262,768,189	132,931,350
Mean*	1,381,671	2,109,051	4,453,698	2,253,074
Variance	1.47E+13	7.07E+12	2.62E+13	5.11E+12
SEM	498,426	346,213	665,841	294,266
Percent of Total	13.5%	20.7%	43.7%	22.1%

* Mean is the average of all values used in grand sum of clams.

SANDY HOOK BAY COMMERCIAL SIZE CLASS STOCK ESTIMATES				
	Sublegals	Littlenecks	Cherrystones	Chowders
Clams	37,777,257	98,882,804	115,938,107	90,152,219
Mean*	726,486	1,901,592	2,229,579	1,733,697
Variance	7.74E+12	4.45E+13	4.51E+13	1.43E+13
SEM	385,819	924,683	931,227	524,639
Percent of Total	11.0%	28.8%	33.8%	26.3%

* Mean is the average of all values used in grand sum of clams.

Sublegals: 30-37 mm; Littlenecks: 38-55 mm; Cherrystones: 56-76 mm; Chowders: >76 mm.

Table 6. Comparison of the number and percent of stations sampled in 1983 and 2000 with no hard clams, low, moderate and high abundances of hard clams.

Bay	Year	**Number** of stations with no clams	**Number** of stations with **low** abundances of hard clams	**Number** of stations with **moderate** abundances of hard clams	**Number** of stations with **high** abundances of hard clams
Raritan Bay	1983	19	46	26	17
Raritan Bay	2000	8	36	21	43
Sandy Hook Bay	1983	2	22	34	42
Sandy Hook Bay	2000	3	17	16	62

Bay	Year	**Percent** of stations with no clams	**Percent** of stations with low abundances of hard clams	**Percent** of stations with moderate abundances of hard clams	**Percent** of stations with high abundances of hard clams
Raritan Bay	1983	17.6	42.6	24.1	15.7
Raritan Bay	2000	7.4	33.3	19.4	39.8
Sandy Hook Bay	1983	2.0	22.0	34.0	42.0
Sandy Hook Bay	2000	3.1	17.3	16.3	63.3

Low abundance: 0.01-.019 clams foot^{-2}; moderate abundance: 0.20-0.49 clams foot^{-2}; high abundance: $\geq$ 0.50 clams foot^{-2}.

Table 9. Reported hard clam relay and depuration harvest and effort from Raritan and Sandy Hook bays from 1987 to 2002.

Year	Man-Days	Harvest (clams) (RB & SHB)	Effort (clams/man/day)	Total State		Percentage of Statewide Landings Attributable to Depuration and Relay from Raritan and Sandy Hook Bays
				Landings* (clams)	Value	
1987	1,366	2,002,095	1,466	46,192,950	$ 5,862,558	4.3
1988**	1,793	2,512,321	1,401	41,526,000	$ 5,260,119	6.0
1989	2,507	5,380,804	2,147	35,181,000	$ 4,451,789	15.3
1990	4,043	9,213,684	2,279	37,120,500	$ 4,353,779	24.8
1991	4,925	10,709,410	2,174	40,217,220	$ 4,052,391	26.6
1992	5,161	10,859,567	2,104	36,055,920	$ 3,530,038	30.1
1993	8,165	18,544,307	2,271	45,356,700	$ 4,902,057	40.9
1994	8,492	18,247,714	2,149	25,740,960	$ 3,107,751	70.9
1995	9,871	22,405,868	2,270	42,771,690	$ 4,948,627	52.4
1996	11,794	30,818,784	2,613	57,797,940	$ 7,315,633	53.3
1997	11,631	31,866,597	2,740	50,871,540	$ 6,701,036	62.6
1998	15,580	39,284,830	2,522	65,800,740	$ 8,712,300	59.7
1999	14,061	37,206,616	2,646	56,409,810	$ 7,363,453	66.0
2000	14,496	33,527,959	2,313	48,666,630	$ 6,757,227	68.9
2001	11,601	29,993,381	2,585	40,713,840	$ 5,636,397	73.7
2002	12,332	36,873,317	2,990	N/A	N/A	N/A

N/A = Not available.

*As reported by the National Marine Fisheries Service.

** 1988 depuration figure includes harvest from 1 January through 30 April. No reports received during the period 1 May through 1 August. Plant closed on 1 August.

Table 11. 2000 recruitment and mortality indices for Raritan and Sandy Hook bays.

RARITAN BAY		
Statistic	Recruitment (%)	Mortality (%)
Count (n)	64	108
Minimum	0.0	0.0
Maximum	53.4	100.0
Average	10.2	9.0
Standard Deviation	13.9	18.6

SANDY HOOK BAY		
Statistic	Recruitment (%)	Mortality (%)
Count (n)	78	98
Minimum	0.0	0.0
Maximum	24.4	100.0
Average	7.9	8.3
Standard Deviation	7.2	12.5

RARITAN AND SANDY HOOK BAY COMBINED		
Statistic	Recruitment (%)	Mortality (%)
Count (n)	142	206
Minimum	0.0	0.0
Maximum	53.4	100.0
Average	9.0	8.7
Standard Deviation	10.8	16.0

Table 12. Average recruitment indices for relay and depuration harvest areas.

	Average (%)	Variance (%)	SEM (%)
12B	6.40	113.21	2.95
12A	16.23	409.95	5.84
11A	8.47	*-- N/A --	-- N/A --
11B	0.00	-- N/A --	-- N/A --
11C	16.26	283.94	4.50
11D	3.26	11.01	1.66
11E	11.11	-- N/A --	-- N/A --
10A	6.54	35.48	3.44
10B	12.85	34.74	1.70
10C	2.63	5.83	0.99
10D	12.61	67.51	1.94
10E	5.03	54.72	2.80
10F	9.61	46.52	2.58
2A	1.64	5.38	1.64
2B	3.34	12.05	1.55
2C	2.18	5.33	1.33
1A	5.98	10.09	1.42
1B	2.53	0.00	0.03
1C	**-	-	-
W. W. RB	-	-	-
E. W. RB	2.72	10.46	1.08
Grand Totals	9.14	123.91	1.00

* N/A = Not applicable due to n = 1.

** - = Not applicable due to n = 0.

Table 13. Ratio and percentage of stations in relay and depuration harvest areas excluded from recruitment indices due to low hard clam abundances (< 0.20 clams foot^{-2}).

Harvest Area	ratio excluded	% excluded
12B	1/14	7%
12A	8/20	40%
11A	1/2	50%
11B	5/6	83%
11C	3/17	18%
11D	0/4	0%
11E	1/2	50%
10A	4/7	57%
10B	0/12	0%
10C	0/6	0%
10D	1/19	5%
10E	1/8	13%
10F	0/7	0%
2A	4/6	67%
2B	0/5	0%
2C	1/4	25%
1A	2/7	29%
1B	2/4	50%
1C	1/1	100%
*Western W. RB	10/10	100%
**Eastern W. RB	8/17	47%

* Western portions of western Raritan Bay excluded from Special Restricted water classification status in 2000.

** Eastern portions of western Raritan Bay excluded from Special Restricted water classification status in 2000.

Table 14. Mortality indices in Raritan Bay (2000 survey) for individual commercial size classes at a station (Mortality I) and among commercial size classes at a station (Mortality II) for stations where mortality > 0.0%.

	Mortality I				Mortality II			
Station	Sublegals	Littlenecks	Cherrystones	Chowders	Sublegals	Littlenecks	Cherrystones	Chowders
RB-00-012	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%	100.0%	0.0%
RB-00-014	0.0%	10.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
RB-00-023	0.0%	0.0%	0.0%	12.5%	0.0%	0.0%	0.0%	100.0%
RB-00-025	0.0%	0.0%	0.0%	12.5%	0.0%	0.0%	0.0%	100.0%
RB-00-027	0.0%	11.8%	0.0%	6.3%	0.0%	50.0%	0.0%	50.0%
RB-00-028	0.0%	14.3%	6.3%	0.0%	0.0%	50.0%	50.0%	0.0%
RB-00-030	0.0%	0.0%	2.8%	0.0%	0.0%	0.0%	100.0%	0.0%
RB-00-031	0.0%	0.0%	6.7%	25.0%	0.0%	0.0%	16.7%	83.3%
RB-00-034	0.0%	25.0%	8.7%	11.1%	0.0%	33.3%	33.3%	33.3%
RB-00-036	0.0%	0.0%	9.1%	0.0%	0.0%	0.0%	100.0%	0.0%
RB-00-037	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	100.0%	0.0%
RB-00-039	0.0%	0.0%	0.0%	25.0%	0.0%	0.0%	0.0%	100.0%
RB-00-040	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	100.0%	0.0%
RB-00-041	0.0%	14.3%	15.8%	28.6%	0.0%	23.1%	46.2%	30.8%
RB-00-042	0.0%	100.0%	60.0%	41.7%	0.0%	6.7%	60.0%	33.3%
RB-00-043	0.0%	3.4%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
RB-00-045	0.0%	0.0%	0.0%	60.0%	0.0%	0.0%	0.0%	100.0%
RB-00-046	0.0%	0.0%	0.0%	66.7%	0.0%	0.0%	0.0%	100.0%
RB-00-047	0.0%	0.0%	0.0%	6.3%	0.0%	0.0%	0.0%	100.0%
RB-00-048	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	100.0%	0.0%
RB-00-049	7.1%	12.7%	0.8%	2.9%	9.1%	72.7%	9.1%	9.1%
RB-00-054	0.0%	50.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
RB-00-058	14.3%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
RB-00-059	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
RB-00-060	0.0%	6.3%	0.0%	9.1%	0.0%	50.0%	0.0%	50.0%
RB-00-061.5	7.4%	7.8%	9.3%	22.2%	43.5%	17.4%	21.7%	17.4%
RB-00-062	1.7%	0.0%	0.0%	16.7%	50.0%	0.0%	0.0%	50.0%
RB-00-064	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	100.0%
RB-00-065	0.0%	0.0%	7.1%	7.7%	0.0%	0.0%	50.0%	50.0%
RB-00-067	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
RB-00-068	50.0%	4.8%	0.0%	4.2%	33.3%	33.3%	0.0%	33.3%
RB-00-069	12.5%	7.8%	5.5%	5.3%	20.0%	40.0%	30.0%	10.0%
RB-00-070	50.0%	0.0%	100.0%	12.5%	33.3%	0.0%	16.7%	50.0%
RB-00-071	0.0%	0.0%	2.3%	7.1%	0.0%	0.0%	20.0%	80.0%
RB-00-072	0.0%	11.1%	3.4%	5.9%	0.0%	25.0%	50.0%	25.0%

- How to read this table: Mortality I describes the mortality within one specific size class - for example: for RB-00-012, sublegals, littlenecks and chowders experienced 0.0% mortality, while 7.7% of cherrystones expired. Mortality II describes the mortality at a station among all size classes. For example, 100% of the mortality seen at RB-00-012 came from cherrystones.

Table 14. Mortality indices in Raritan Bay (2000 survey) for individual commercial size classes at a station (Mortality I) and among commercial size classes at a station (Mortality II) for stations where mortality > 0.0%.

	Mortality I				Mortality II			
Station	Sublegals	Littlenecks	Cherrystones	Chowders	Sublegals	Littlenecks	Cherrystones	Chowders
RB-00-074	33.3%	0.0%	1.1%	2.8%	33.3%	0.0%	33.3%	33.3%
RB-00-075	0.0%	0.0%	2.5%	9.1%	0.0%	0.0%	50.0%	50.0%
RB-00-076	0.0%	2.3%	0.0%	4.3%	0.0%	50.0%	0.0%	50.0%
RB-00-077	0.0%	50.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
RB-00-078	0.0%	0.0%	8.7%	26.7%	0.0%	0.0%	33.3%	66.7%
RB-00-079	0.0%	20.0%	5.3%	9.1%	0.0%	20.0%	40.0%	40.0%
RB-00-080	6.7%	16.7%	8.6%	22.5%	5.9%	11.8%	29.4%	52.9%
RB-00-081	8.3%	6.7%	2.6%	7.1%	40.0%	20.0%	20.0%	20.0%
RB-00-082	0.0%	4.8%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
RB-00-083	2.6%	4.3%	2.8%	6.3%	33.3%	16.7%	16.7%	33.3%
RB-00-084	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%	100.0%	0.0%
RB-00-085	5.0%	5.9%	1.8%	9.4%	11.1%	22.2%	11.1%	55.6%
RB-00-087	50.0%	20.0%	20.0%	0.0%	25.0%	50.0%	25.0%	0.0%
RB-00-088	0.0%	0.0%	7.7%	14.3%	0.0%	0.0%	33.3%	66.7%
RB-00-089	0.0%	0.0%	10.0%	0.0%	0.0%	0.0%	100.0%	0.0%
RB-00-090	10.0%	5.0%	4.5%	5.7%	14.3%	14.3%	42.9%	28.6%
RB-00-091	100.0%	100.0%	100.0%	0.0%	33.3%	33.3%	33.3%	0.0%
RB-00-094	14.3%	45.7%	35.1%	11.1%	2.6%	41.0%	51.3%	5.1%
RB-00-095	0.0%	12.0%	6.7%	15.8%	0.0%	28.6%	28.6%	42.9%
RB-00-096	33.3%	12.5%	0.0%	5.0%	33.3%	33.3%	0.0%	33.3%
RB-00-097	3.5%	0.0%	5.9%	6.3%	50.0%	0.0%	33.3%	16.7%
RB-00-098	2.9%	11.1%	0.0%	10.0%	33.3%	33.3%	0.0%	33.3%
RB-00-099	0.0%	8.3%	5.9%	4.3%	0.0%	25.0%	50.0%	25.0%
RB-00-100	0.0%	33.3%	6.3%	9.1%	0.0%	25.0%	25.0%	50.0%
RB-00-101	0.0%	0.0%	16.7%	11.8%	0.0%	0.0%	33.3%	66.7%
RB-00-102	0.0%	5.3%	4.5%	23.3%	0.0%	10.0%	20.0%	70.0%
RB-00-103	0.0%	4.0%	5.4%	12.5%	0.0%	22.2%	55.6%	22.2%
RB-00-104	0.0%	3.0%	7.3%	0.0%	0.0%	25.0%	75.0%	0.0%
RB-00-105	0.0%	14.3%	4.3%	8.3%	0.0%	44.4%	22.2%	33.3%
RB-00-106	0.0%	0.0%	100.0%	25.0%	0.0%	0.0%	16.7%	83.3%
RB-00-107	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
RB-00-108	0.0%	50.0%	0.0%	7.1%	0.0%	50.0%	0.0%	50.0%
Average	4.7%	6.6%	6.7%	8.2%	6.5%	13.7%	18.4%	23.5%
Variance	2.6%	2.6%	3.3%	2.7%	2.9%	5.6%	7.3%	8.6%
SEM	1.5%	1.6%	1.7%	1.6%	1.6%	2.3%	2.6%	2.8%

- How to read this table: Mortality I describes the mortality within one specific size class - for example: for RB-00-012, sublegals, littlenecks and chowders experienced 0.0% mortality, while 7.7% of cherrystones expired. Mortality II describes the mortality at a station among all size classes. For example, 100% of the mortality seen at RB-00-012 came from cherrystones.

Table 15. Mortality indices in Sandy Hook Bay (2000 survey) for individual commercial size classes at a station (Mortality I) and among size classes at a station (Mortality II) for stations where mortality > 0.0%.

	Mortality I				Mortality II			
Station	Sublegals	Littlenecks	Cherrystones	Chowders	Sublegals	Littlenecks	Cherrystones	Chowders
SHB-00-001	0.0%	0.0%	0.0%	21.4%	0.0%	0.0%	0.0%	100.0%
SHB-00-003	0.0%	0.0%	0.0%	32.5%	0.0%	0.0%	0.0%	100.0%
SHB-00-004	0.0%	8.3%	12.5%	5.6%	0.0%	33.3%	33.3%	33.3%
SHB-00-005	0.0%	10.5%	11.1%	13.0%	0.0%	14.3%	21.4%	64.3%
SHB-00-006	50.0%	0.0%	0.0%	18.5%	16.7%	0.0%	0.0%	83.3%
SHB-00-007	5.3%	5.3%	2.6%	0.0%	16.7%	50.0%	33.3%	0.0%
SHB-00-008	10.5%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
SHB-00-010	28.6%	0.0%	0.0%	4.3%	80.0%	0.0%	0.0%	20.0%
SHB-00-011	0.0%	4.2%	0.0%	3.1%	0.0%	50.0%	0.0%	50.0%
SHB-00-012	7.1%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
SHB-00-013	66.7%	0.0%	0.0%	20.0%	50.0%	0.0%	0.0%	50.0%
SHB-00-014	8.3%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
SHB-00-015	5.0%	2.4%	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%
SHB-00-016	22.2%	6.7%	0.0%	5.9%	54.5%	36.4%	0.0%	9.1%
SHB-00-017	42.9%	7.0%	5.0%	6.3%	50.0%	25.0%	16.7%	8.3%
SHB-00-018	32.0%	8.7%	3.7%	0.0%	61.5%	30.8%	7.7%	0.0%
SHB-00-019	37.5%	12.5%	0.0%	0.0%	60.0%	40.0%	0.0%	0.0%
SHB-00-020	7.7%	1.7%	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%
SHB-00-021	15.4%	6.4%	3.4%	0.0%	33.3%	50.0%	16.7%	0.0%
SHB-00-022	0.0%	0.0%	0.0%	20.0%	0.0%	0.0%	0.0%	100.0%
SHB-00-023	0.0%	11.1%	17.4%	0.0%	0.0%	20.0%	80.0%	0.0%
SHB-00-024	28.6%	3.1%	2.4%	15.4%	54.5%	18.2%	9.1%	18.2%
SHB-00-025	18.5%	6.4%	10.5%	12.5%	45.5%	27.3%	18.2%	9.1%
SHB-00-026	0.0%	3.0%	3.1%	25.0%	0.0%	33.3%	16.7%	50.0%
SHB-00-027	3.2%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
SHB-00-028	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
SHB-00-032	11.4%	8.6%	1.0%	0.0%	36.4%	54.5%	9.1%	0.0%
SHB-00-033	24.3%	1.6%	1.9%	0.0%	81.8%	9.1%	9.1%	0.0%
SHB-00-034	20.5%	4.3%	8.6%	4.0%	57.1%	14.3%	21.4%	7.1%
SHB-00-035	0.0%	6.9%	8.2%	4.4%	0.0%	22.2%	55.6%	22.2%
SHB-00-036	0.0%	25.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
SHB-00-037	14.3%	0.0%	2.9%	0.0%	50.0%	0.0%	50.0%	0.0%
SHB-00-038	0.0%	0.0%	9.1%	0.0%	0.0%	0.0%	100.0%	0.0%
SHB-00-039	0.0%	33.3%	1.7%	2.5%	0.0%	16.7%	16.7%	66.7%
SHB-00-040	0.0%	0.0%	3.0%	1.7%	0.0%	0.0%	50.0%	50.0%

- How to read this table: Mortality I describes the mortality within one specific size class - for example: for SHB-00-001, sublegals, littlenecks and cherrystones experienced 0.0% mortality, while 21.4% of chowders expired. Mortality II describes the mortality at a given station among all size classes. For example, 100% of the mortality seen at SHB-00-001 came from chowders.

Table 15. Mortality indices in Sandy Hook Bay (2000 survey) for individual commercial size classes at a station (Mortality I) and among size classes at a station (Mortality II) for stations where mortality > 0.0%.

	Mortality I				Mortality II			
Station	Sublegals	Littlenecks	Cherrystones	Chowders	Sublegals	Littlenecks	Cherrystones	Chowders
SHB-00-041	25.0%	11.1%	0.0%	8.3%	25.0%	50.0%	0.0%	25.0%
SHB-00-042	0.0%	0.0%	0.0%	13.3%	0.0%	0.0%	0.0%	100.0%
SHB-00-043	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	100.0%	0.0%
SHB-00-044	14.3%	3.8%	6.5%	7.1%	16.7%	16.7%	33.3%	33.3%
SHB-00-045	0.0%	0.0%	4.8%	1.4%	0.0%	0.0%	50.0%	50.0%
SHB-00-046	0.0%	0.0%	25.0%	12.5%	0.0%	0.0%	50.0%	50.0%
SHB-00-047	0.0%	0.0%	0.0%	17.2%	0.0%	0.0%	0.0%	100.0%
SHB-00-048	0.0%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%	100.0%
SHB-00-049	0.0%	0.0%	1.7%	0.0%	0.0%	0.0%	100.0%	0.0%
SHB-00-050	0.0%	5.5%	7.8%	12.5%	0.0%	30.0%	40.0%	30.0%
SHB-00-051	8.5%	5.7%	10.8%	0.0%	28.6%	42.9%	28.6%	0.0%
SHB-00-052	6.7%	0.8%	13.7%	0.0%	27.3%	9.1%	63.6%	0.0%
SHB-00-053	5.9%	1.1%	3.0%	11.8%	22.2%	11.1%	22.2%	44.4%
SHB-00-054	25.0%	5.6%	8.3%	0.0%	50.0%	25.0%	25.0%	0.0%
SHB-00-055	0.0%	0.0%	3.4%	2.7%	0.0%	0.0%	25.0%	75.0%
SHB-00-056	0.0%	33.3%	0.0%	11.1%	0.0%	50.0%	0.0%	50.0%
SHB-00-057	10.0%	0.0%	1.8%	2.0%	33.3%	0.0%	33.3%	33.3%
SHB-00-058	4.9%	3.0%	3.2%	5.1%	11.1%	16.7%	27.8%	44.4%
SHB-00-059	0.0%	0.0%	0.0%	2.6%	0.0%	0.0%	0.0%	100.0%
SHB-00-060	0.0%	22.2%	0.0%	3.3%	0.0%	50.0%	0.0%	50.0%
SHB-00-061	100.0%	50.0%	0.0%	5.3%	33.3%	33.3%	0.0%	33.3%
SHB-00-063	0.0%	0.0%	6.3%	2.9%	0.0%	0.0%	50.0%	50.0%
SHB-00-064	0.0%	0.0%	0.0%	13.3%	0.0%	0.0%	0.0%	100.0%
SHB-00-065	0.0%	14.3%	5.3%	6.7%	0.0%	33.3%	33.3%	33.3%
SHB-00-066	0.0%	0.0%	0.0%	20.0%	0.0%	0.0%	0.0%	100.0%
SHB-00-067	0.0%	0.0%	16.0%	23.5%	0.0%	0.0%	50.0%	50.0%
SHB-00-069	0.0%	0.0%	13.3%	0.0%	0.0%	0.0%	100.0%	0.0%
SHB-00-070	0.0%	50.0%	14.3%	0.0%	0.0%	50.0%	50.0%	0.0%
SHB-00-071	0.0%	0.0%	0.0%	1.8%	0.0%	0.0%	0.0%	100.0%
SHB-00-072	0.0%	0.0%	0.0%	21.4%	0.0%	0.0%	0.0%	100.0%
SHB-00-073	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	100.0%
SHB-00-075	0.0%	14.3%	10.7%	6.1%	0.0%	14.3%	42.9%	42.9%
SHB-00-076.5	0.0%	0.0%	50.0%	11.1%	0.0%	0.0%	50.0%	50.0%
SHB-00-077	100.0%	66.7%	33.3%	28.6%	14.3%	28.6%	28.6%	28.6%
SHB-00-078	33.33%	8.3%	7.4%	0.0%	25.0%	25.0%	50.0%	0.0%
SHB-00-079	0.0%	0.0%	2.9%	18.9%	0.0%	0.0%	12.5%	87.5%

- How to read this table: Mortality I describes the mortality within one specific size class - for example: for SHB-00-001, sublegals, littlenecks and cherrystones experienced 0.0% mortality, while 21.4% of chowders expired. Mortality II describes the mortality at a given station among all size classes. For example, 100% of the mortality seen at SHB-00-001 came from chowders.

Table 15. Mortality indices in Sandy Hook Bay (2000 survey) for individual commercial size classes at a station (Mortality I) and among size classes at a station (Mortality II) for stations where mortality > 0.0%.

	Mortality I				Mortality II			
Station	Sublegals	Littlenecks	Cherrystones	Chowders	Sublegals	Littlenecks	Cherrystones	Chowders
SHB-00-080	0.0%	0.0%	7.3%	2.7%	0.0%	0.0%	66.7%	33.3%
SHB-00-081	0.0%	0.0%	5.9%	0.0%	0.0%	0.0%	100.0%	0.0%
SHB-00-082	0.0%	15.4%	12.1%	8.6%	0.0%	12.5%	50.0%	37.5%
SHB-00-083	30.0%	4.3%	3.7%	16.7%	25.0%	33.3%	33.3%	8.3%
SHB-00-084	7.1%	2.9%	11.5%	0.0%	20.0%	20.0%	60.0%	0.0%
SHB-00-085	0.0%	0.0%	2.5%	0.0%	0.0%	0.0%	100.0%	0.0%
SHB-00-086	0.0%	0.0%	1.7%	3.9%	0.0%	0.0%	16.7%	83.3%
SHB-00-087	0.0%	0.0%	0.0%	5.9%	0.0%	0.0%	0.0%	100.0%
SHB-00-088	0.0%	0.0%	10.6%	12.8%	0.0%	0.0%	50.0%	50.0%
SHB-00-089	0.0%	0.0%	0.0%	10.5%	0.0%	0.0%	0.0%	100.0%
SHB-00-090	0.0%	0.0%	1.8%	3.7%	0.0%	0.0%	33.3%	66.7%
SHB-00-091	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%
SHB-00-093	0.0%	0.0%	0.0%	6.7%	0.0%	0.0%	0.0%	100.0%
SHB-00-094	10.8%	4.8%	3.0%	8.7%	36.4%	27.3%	18.2%	18.2%
SHB-00-095	10.3%	5.6%	0.0%	2.3%	50.0%	33.3%	0.0%	16.7%
SHB-00-096	50.0%	0.0%	0.0%	19.4%	12.5%	0.0%	0.0%	87.5%
SHB-00-097	33.3%	0.0%	0.0%	2.0%	50.0%	0.0%	0.0%	50.0%
Average	9.5%	6.2%	5.3%	6.6%	17.6%	14.9%	23.1%	34.2%
Variance	3.4%	2.1%	1.5%	0.8%	7.2%	4.4%	8.3%	12.6%
SEM	1.9%	1.5%	1.2%	0.9%	2.7%	2.1%	2.9%	3.6%

- How to read this table: Mortality I describes the mortality within one specific size class - for example: for SHB-00-001, sublegals, littlenecks and cherrystones experienced 0.0% mortality, while 21.4% of chowders expired. Mortality II describes the mortality at a given station among all size classes. For example, 100% of the mortality seen at SHB-00-001 came from chowders.

Table 16. Mortality* indices (%) by commercial size class and across all size classes for relay and depuration harvest areas in Raritan and Sandy Hook bays.

Area	Mortality I				Mortality II				Total Mortality
	Sublegals	Littlenecks	Cherrystones	Chowders	Sublegals	Littlenecks	Cherrystones	Chowders	(all size classes)
12B Average	0.5%	5.8%	7.4%	5.3%	0.6%	23.5%	39.7%	14.8%	6.8%
12B Var	0.0%	0.7%	1.7%	0.9%	0.1%	10.9%	18.5%	6.6%	0.6%
12B SEM	0.5%	2.2%	3.5%	2.6%	0.6%	8.8%	11.5%	6.8%	2.0%
12A Average	7.0%	5.8%	4.4%	13.0%	16.1%	16.8%	13.1%	34.0%	12.9%
12A Var	5.0%	1.4%	1.3%	3.8%	10.2%	9.7%	6.0%	15.8%	4.4%
12A SEM	5.0%	2.7%	2.5%	4.4%	7.2%	7.0%	5.5%	8.9%	4.7%
11A Average	0.0%	0.0%	5.0%	16.7%	0.0%	0.0%	50.0%	50.0%	10.0%
11A Var	0.0%	0.0%	0.5%	5.6%	0.0%	0.0%	50.0%	50.0%	0.9%
11A SEM	0.0%	0.0%	5.0%	16.7%	0.0%	0.0%	50.0%	50.0%	6.7%
11B Average	0.0%	0.0%	0.0%	16.7%	0.0%	0.0%	0.0%	16.7%	16.7%
11B Var	0.0%	0.0%	0.0%	16.7%	0.0%	0.0%	0.0%	16.7%	16.7%
11B SEM	0.0%	0.0%	0.0%	16.7%	0.0%	0.0%	0.0%	16.7%	16.7%
11C Average	9.6%	5.4%	7.8%	7.0%	15.7%	17.4%	19.2%	35.9%	6.1%
11C Var	3.0%	1.5%	5.7%	0.3%	3.6%	7.5%	4.3%	7.6%	0.5%
11C SEM	4.2%	2.9%	5.8%	1.4%	4.6%	6.6%	5.0%	6.7%	1.7%
11D Average	25.0%	2.1%	3.1%	19.0%	7.3%	8.3%	8.3%	76.0%	17.0%
11D Var	8.3%	0.2%	0.4%	1.2%	0.7%	2.8%	2.8%	8.6%	0.9%
11D SEM	14.4%	2.1%	3.1%	5.5%	4.3%	8.3%	8.3%	14.7%	4.9%
11E Average	25.0%	10.0%	13.8%	7.1%	12.5%	25.0%	29.2%	33.3%	14.4%
11E Var	12.5%	2.0%	0.8%	1.0%	3.1%	12.5%	0.3%	22.2%	0.9%
11E SEM	25.0%	10.0%	6.2%	7.1%	12.5%	25.0%	4.2%	33.3%	6.7%
10A Average	0.0%	20.6%	1.6%	3.5%	0.0%	23.5%	3.1%	16.3%	3.8%
10A Var	0.0%	13.8%	0.2%	0.4%	0.0%	14.7%	0.7%	7.9%	0.3%
10A SEM	0.0%	14.0%	1.6%	2.2%	0.0%	14.5%	3.1%	10.7%	1.9%

* See report text and/or Table 14 for explanation of Mortality I and/or Mortality II.

Table 16. Mortality* indices (%) by commercial size class and across all size classes for relay and depuration harvest areas in Raritan and Sandy Hook bays.

Area	Mortality I				Mortality II				Total Mortality
	Sublegals	Littlenecks	Cherrystones	Chowders	Sublegals	Littlenecks	Cherrystones	Chowders	(all size classes)
10B Average	10.5%	2.9%	1.8%	2.8%	52.6%	22.7%	7.2%	17.4%	4.2%
10B Var	0.9%	0.1%	0.1%	0.2%	15.9%	5.4%	1.8%	9.3%	0.1%
10B SEM	2.8%	0.9%	1.0%	1.2%	11.5%	6.7%	3.8%	8.8%	0.8%
10C Average	13.5%	6.2%	2.6%	5.2%	11.1%	5.6%	50.0%	33.3%	3.5%
10C Var	7.1%	1.8%	0.1%	0.6%	4.1%	0.7%	17.8%	7.8%	0.1%
10C SEM	10.9%	5.5%	1.0%	3.2%	8.2%	3.5%	17.2%	11.4%	1.2%
10D Average	12.3%	4.7%	5.0%	4.6%	32.1%	23.2%	28.2%	11.3%	6.5%
10D Var	2.0%	0.4%	0.2%	0.6%	8.8%	6.3%	11.1%	6.2%	0.2%
10D SEM	3.2%	1.4%	1.1%	1.8%	6.8%	5.8%	7.6%	5.7%	0.9%
10E Average	0.7%	9.7%	7.0%	5.8%	2.8%	11.7%	40.9%	44.6%	11.1%
10E Var	0.0%	3.0%	0.4%	0.6%	0.6%	3.0%	13.0%	18.7%	1.2%
10E SEM	0.7%	6.1%	2.4%	2.7%	2.8%	6.1%	12.8%	15.3%	3.8%
10F Average	8.5%	2.2%	1.4%	3.3%	21.9%	15.8%	24.0%	38.3%	3.0%
10F Var	1.4%	0.1%	0.0%	0.1%	5.4%	4.3%	12.8%	16.3%	0.0%
10F SEM	4.5%	1.1%	0.5%	1.2%	8.8%	7.9%	13.5%	15.3%	0.7%
2A Average	22.2%	14.9%	16.9%	7.6%	6.5%	11.3%	28.6%	20.2%	12.0%
2A Var	16.3%	6.8%	4.1%	1.3%	1.1%	1.8%	5.5%	5.4%	2.4%
2A SEM	16.5%	10.6%	8.3%	4.6%	4.4%	5.4%	9.6%	9.5%	6.3%
2B Average	0.0%	0.0%	4.5%	9.7%	0.0%	0.0%	32.5%	67.5%	6.9%
2B Var	0.0%	0.0%	0.2%	0.5%	0.0%	0.0%	7.3%	7.3%	0.1%
2B SEM	0.0%	0.0%	1.9%	3.0%	0.0%	0.0%	12.1%	12.1%	1.4%
2C Average	7.5%	1.1%	25.9%	5.8%	6.3%	8.3%	33.3%	27.1%	27.5%
2C Var	2.3%	0.0%	24.4%	0.6%	1.6%	2.8%	22.2%	23.8%	23.4%
2C SEM	7.5%	1.1%	24.7%	3.9%	6.3%	8.3%	23.6%	24.4%	24.2%

Table 16. Mortality* indices (%) by commercial size class and across all size classes for relay and depuration harvest areas in Raritan and Sandy Hook bays.

Area	Mortality I				Mortality II				Total Mortality
	Sublegals	Littlenecks	Cherrystones	Chowders	Sublegals	Littlenecks	Cherrystones	Chowders	(all size classes)
1A Average	16.4%	10.8%	1.6%	3.0%	11.1%	14.3%	15.9%	44.4%	3.9%
1A Var	13.7%	3.7%	0.1%	0.0%	2.5%	4.1%	4.4%	9.0%	0.1%
1A SEM	14.0%	7.2%	0.9%	0.7%	5.9%	7.7%	7.9%	11.3%	1.4%
1B Average	0.0%	3.6%	5.3%	15.9%	0.0%	8.3%	20.8%	70.8%	9.0%
1B Var	0.0%	0.5%	0.6%	0.6%	0.0%	2.8%	6.3%	11.8%	0.0%
1B SEM	0.0%	3.6%	3.8%	3.7%	0.0%	8.3%	12.5%	17.2%	0.7%
1C Average	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	100.0%	50.0%
1C Var	**-	-	-	-	-	-	-	-	-
1C SEM	-	-	-	-	-	-	-	-	-
W. W. RB Average	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
W. W. RB Var	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
W. W. RB SEM	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
E. W. RB Average	0.0%	0.6%	0.5%	1.5%	0.0%	5.9%	5.9%	11.8%	0.9%
E. W. RB Var	0.0%	0.1%	0.0%	0.2%	0.0%	5.9%	5.9%	11.0%	0.0%
E. W. RB SEM	0.0%	0.6%	0.5%	1.0%	0.0%	5.9%	5.9%	8.1%	0.4%
Grand Average	7.0%	5.1%	4.8%	6.7%	12.8%	14.0%	19.9%	27.5%	7.6%
Grand Var	3.1%	1.5%	1.7%	1.6%	6.2%	6.0%	8.6%	12.2%	2.0%
Grand SEM	1.3%	0.9%	1.0%	0.9%	1.8%	1.8%	2.2%	2.7%	1.1%

** = Not available due to n = 1.

Figure 1. Location of the 2000 shellfish inventory sampling area.

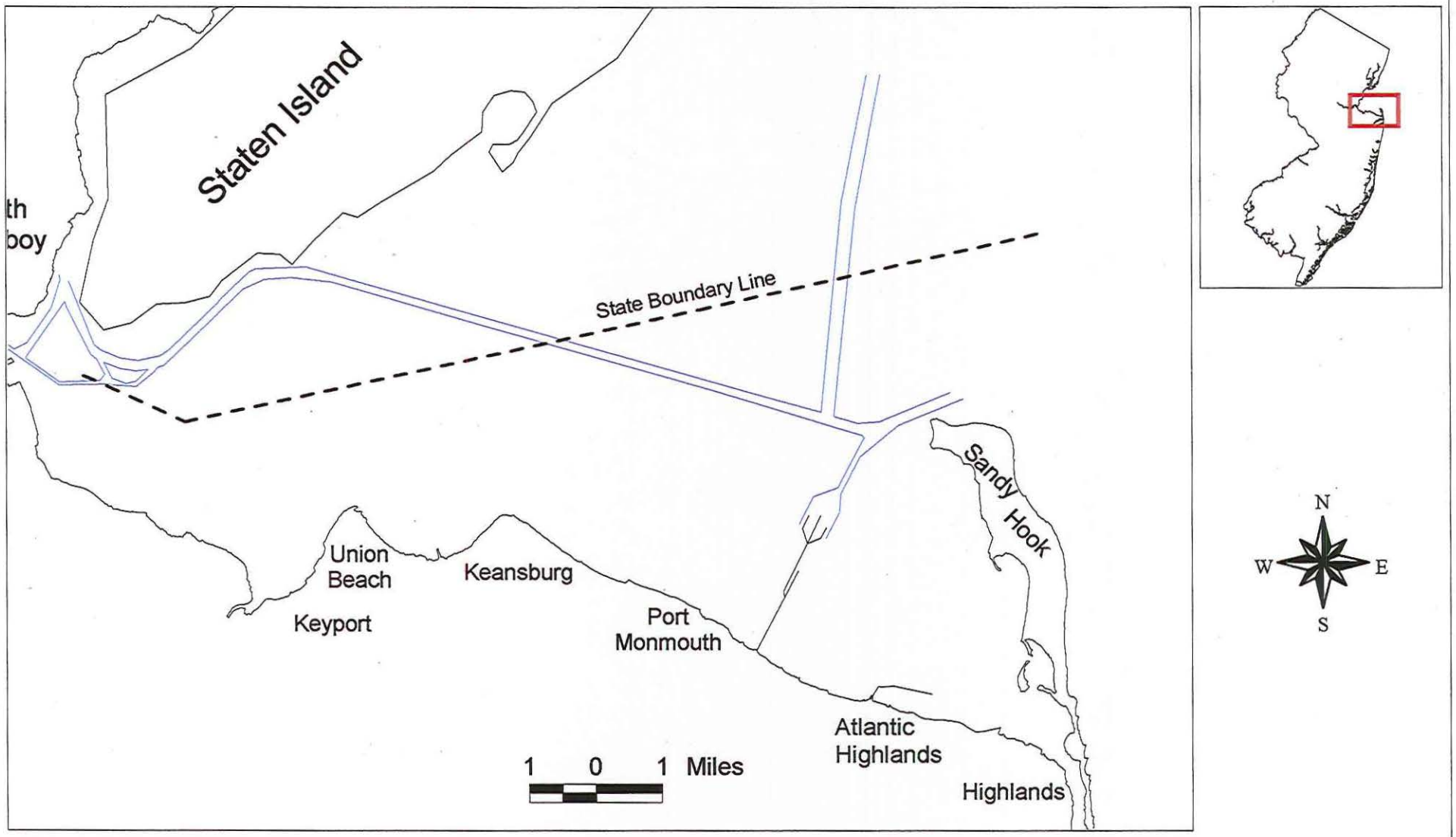


Figure 2. 1983 Shellfish Inventory: Raritan and Sandy Hook bay substrate distribution.

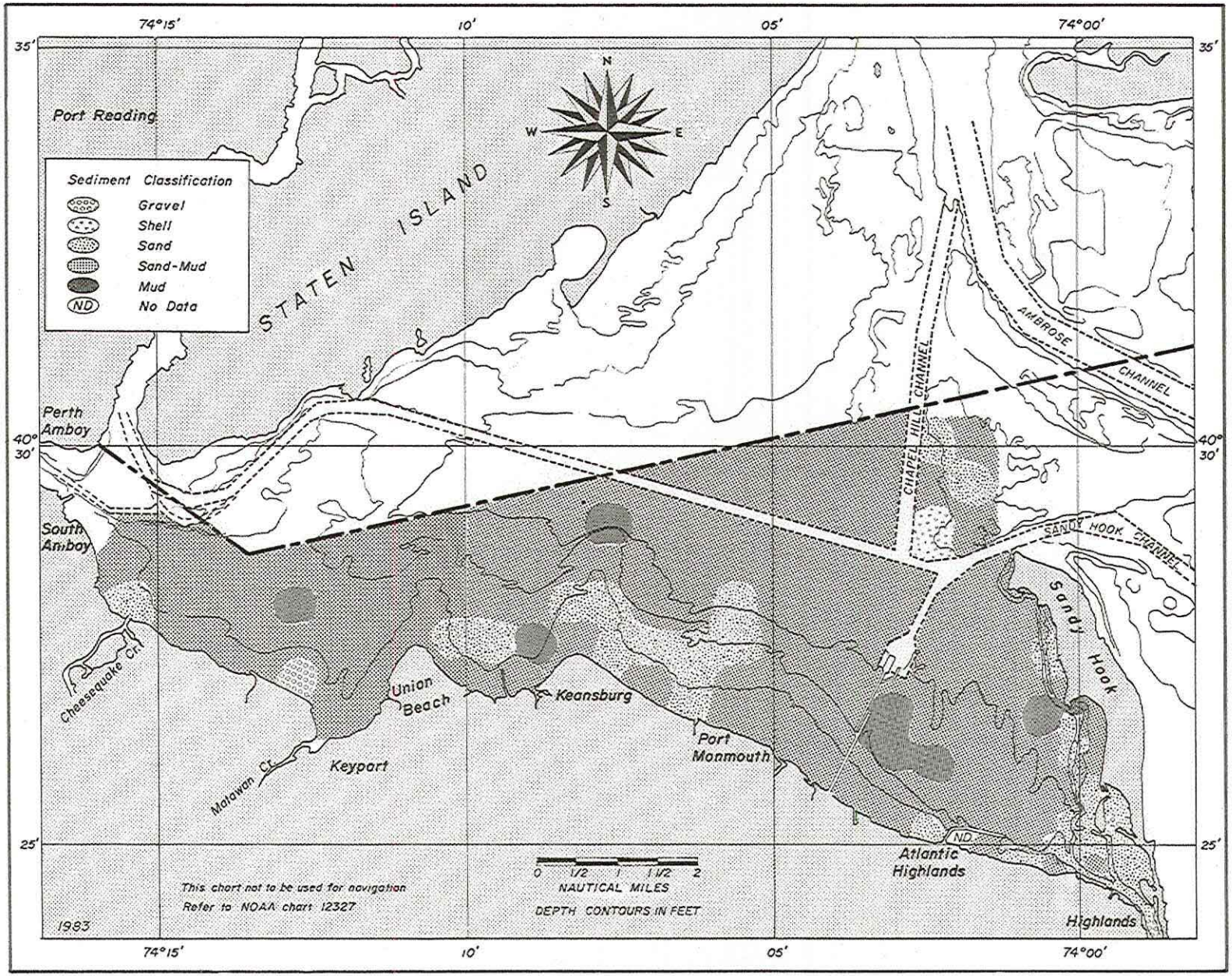


Figure 3. 2000 Shellfish Inventory: Raritan Bay station locations.

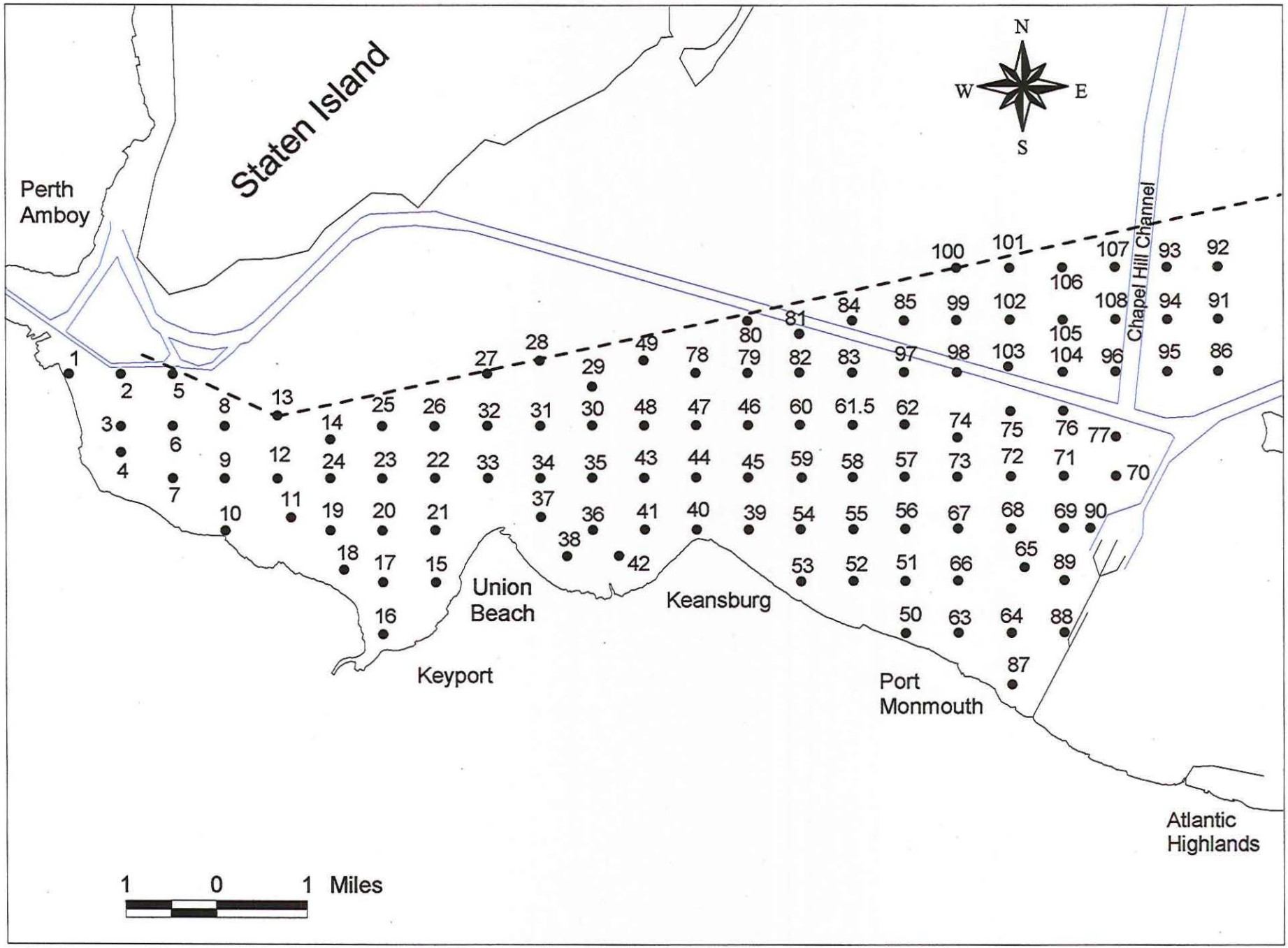


Figure 4. 2000 Shellfish Inventory: Sandy Hook Bay station locations.

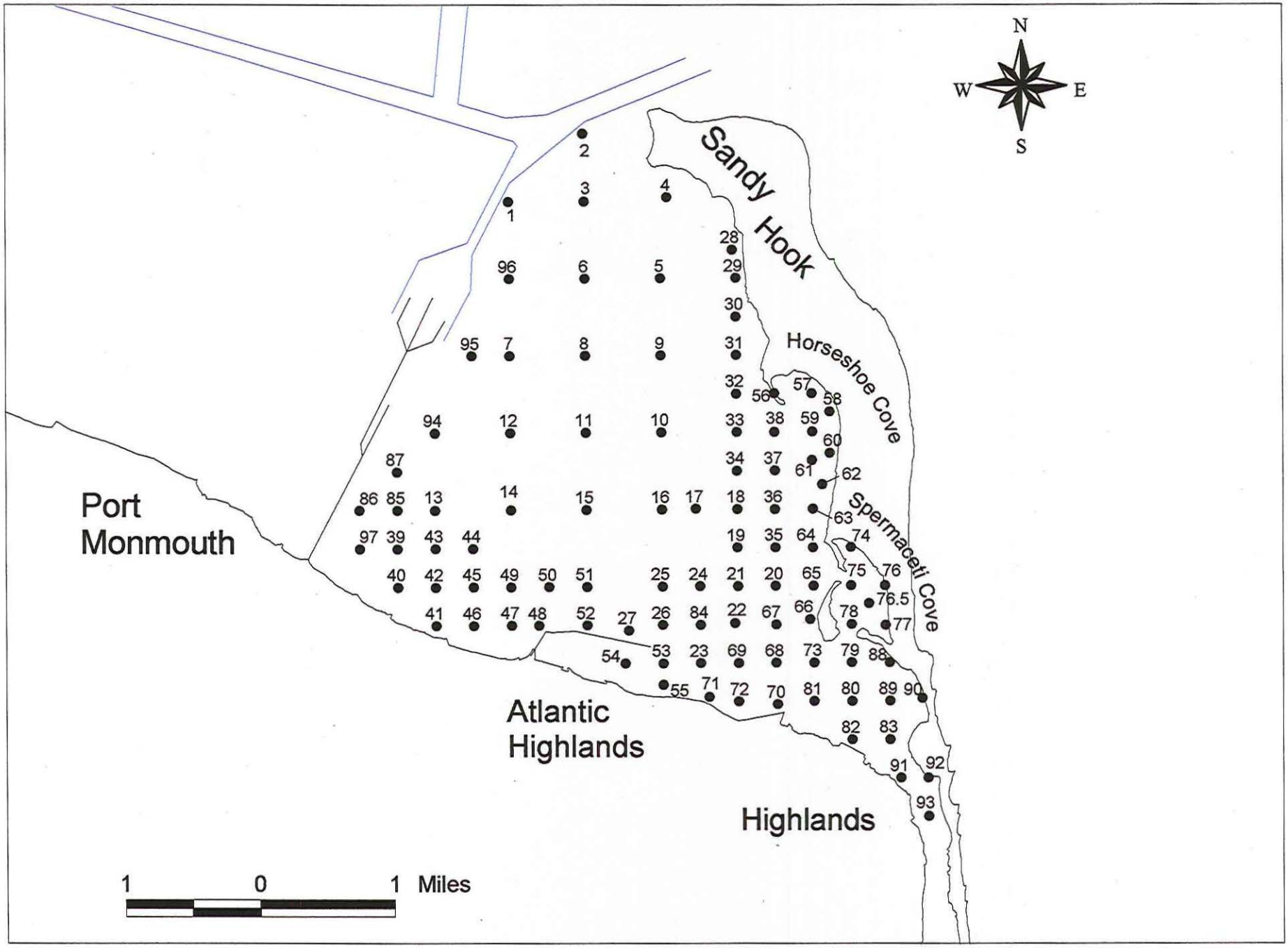


Figure 5. 1983 Shellfish Survey: Raritan and Sandy Hook bay distribution and abundance of the hard clam, Mercenaria mercenaria.

Figure 6. 2000 Shellfish Survey: Raritan and Sandy Hook bay distribution and abundance of the hard clam, Mercenaria mercenaria.

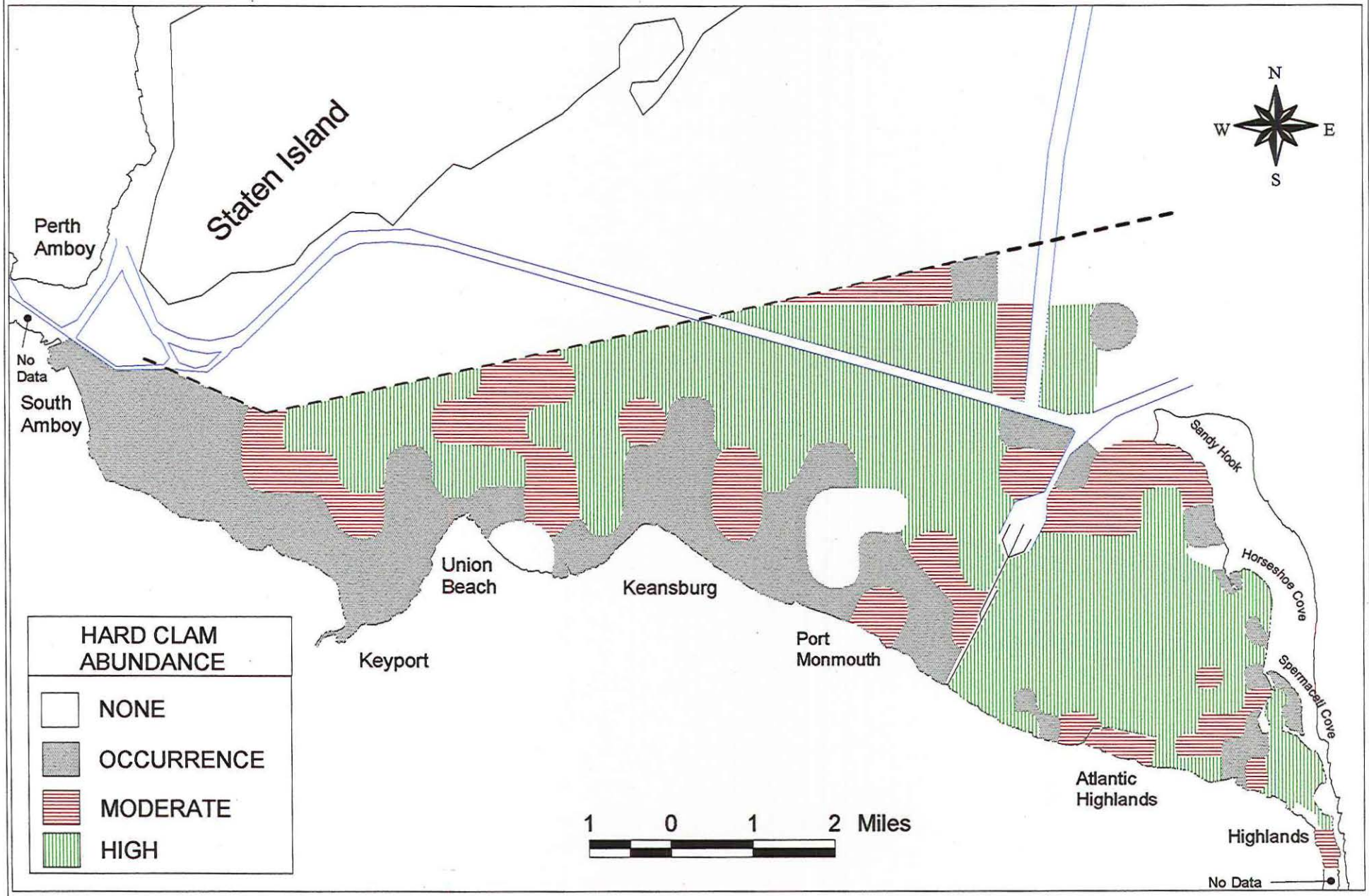
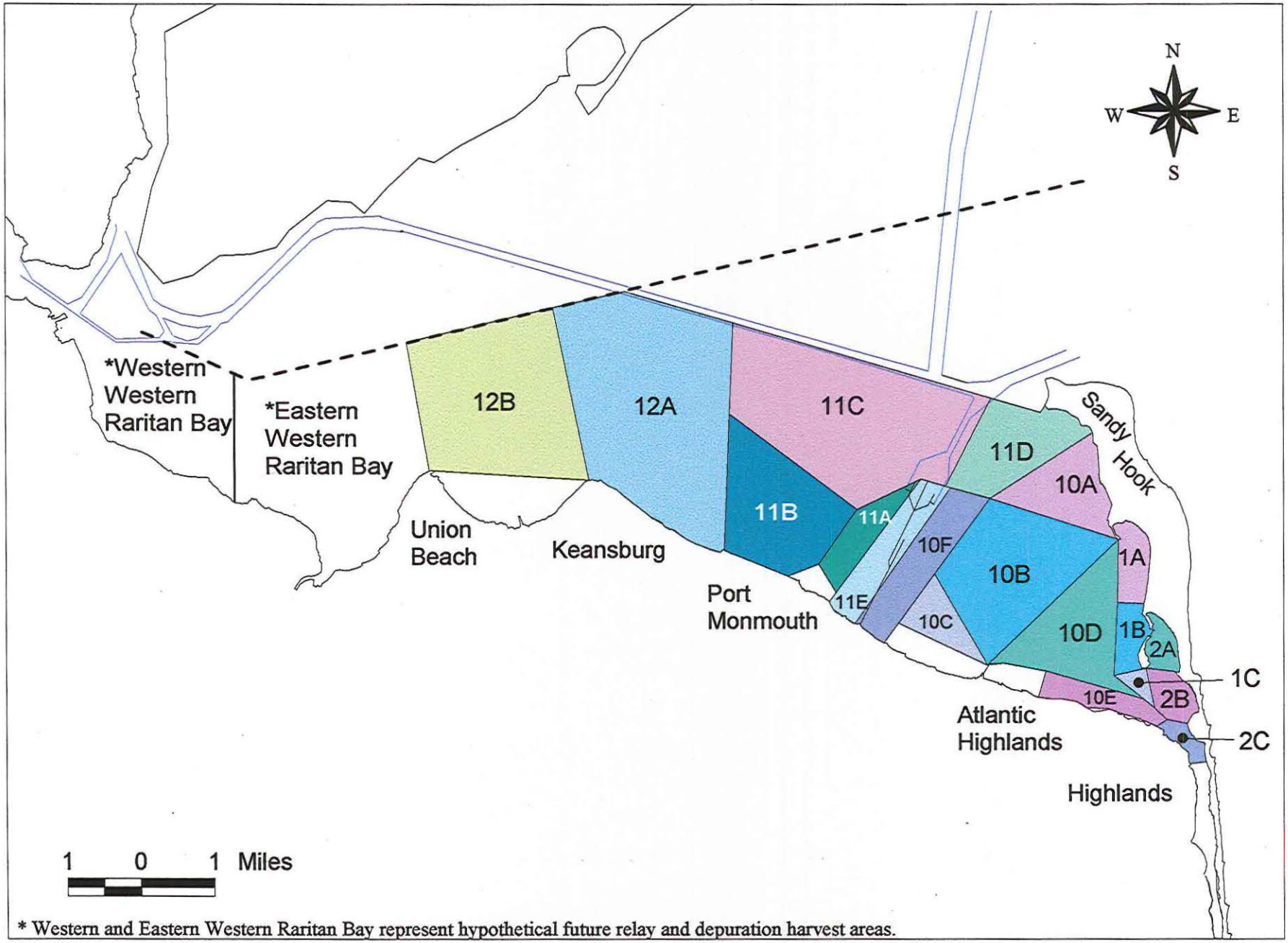


Figure 7. 2000 relay and depuration harvest areas in Raritan and Sandy Hook bays.



* Western and Eastern Western Raritan Bay represent hypothetical future relay and depuration harvest areas.

Figure 8. Stock estimates (+/- 1 SEM) of hard clams in relay and depuration harvest areas of Raritan and Sandy Hook bays.

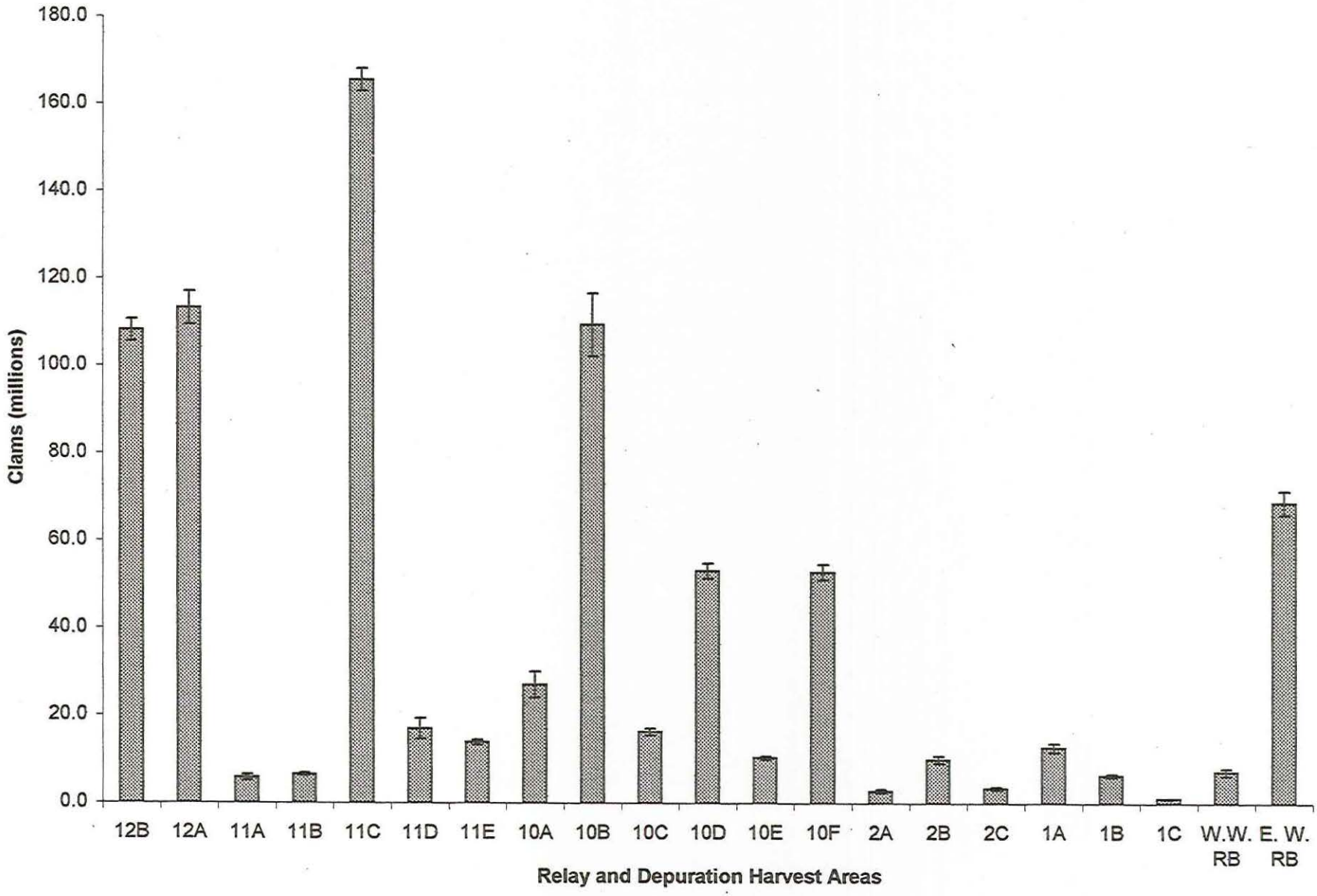


Figure 9. Mean hard clam abundances (+/- 1 SEM) in relay and depuration harvest areas of Raritan and Sandy Hook bays.

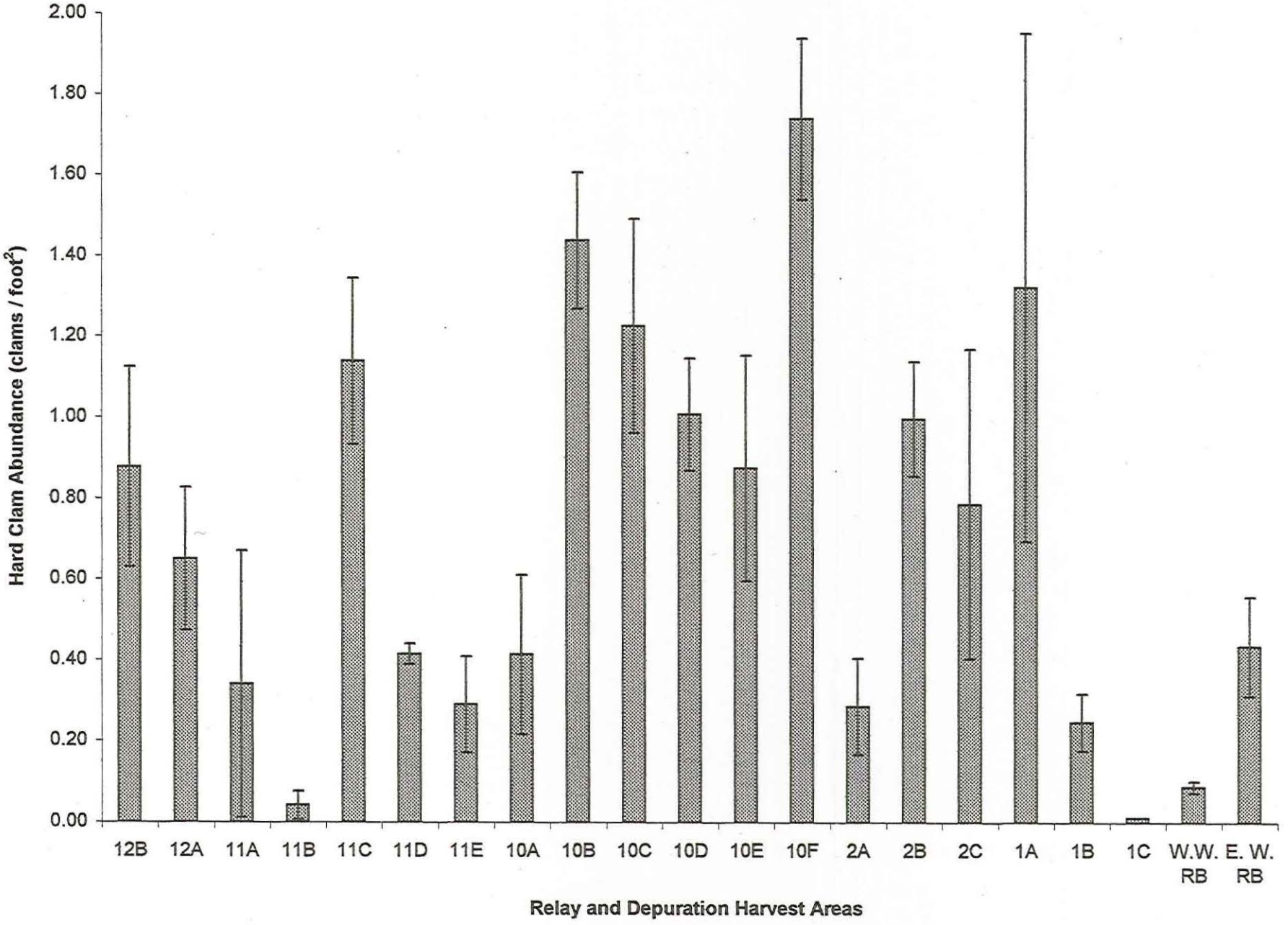


Figure 10. Results of the Student-Newman-Keuls (SNK) multiple comparison test on *Mercenaria* abundances by relay and depuration harvest areas.

Alpha (α)	0.05
Error Degrees of Freedom	157
Error Mean Square	0.498619
Harmonic Mean of Cell Sizes	4.688953

Means with the same letter are not significantly different.

SNK Grouping		Mean*	N	Sub Area
	A	1.7414	7	10F
	A			
B	A	1.4392	12	10B
B	A			
B	A	1.3229	7	1A
B	A			
B	A	1.2250	6	10C
B	A			
B	A	1.1400	17	11C
B	A			
B	A	1.0100	19	10D
B	A			
B	A	1.0000	5	2B
B	A			
B	A	0.8771	14	12B
B	A			
B	A	0.8750	8	10E
B	A			
B	A	0.7875	4	2C
B	A			
B	A	0.6490	20	12A
B	A			
B	A	0.4353	17	EW_RB
B	A			
B	A	0.4129	7	10A
B	A			
B	A	0.4125	4	11D
B	A			
B	A	0.3400	2	11A
B	A			
B	A	0.2900	2	11E
B	A			
B	A	0.2867	6	2A
B	A			
B	A	0.2450	4	1B
B				
B		0.0890	10	WW_RB
B				
B		0.0417	6	11B
B				
B		0.0100	1	1C

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

*Differences in mean abundance between Figure 10 and Appendix I are due to rounding.

Figure 11. Hard clam stock estimates (+ / - 1 SEM) by commercial size class and harvest area in Raritan and Sandy Hook bays.

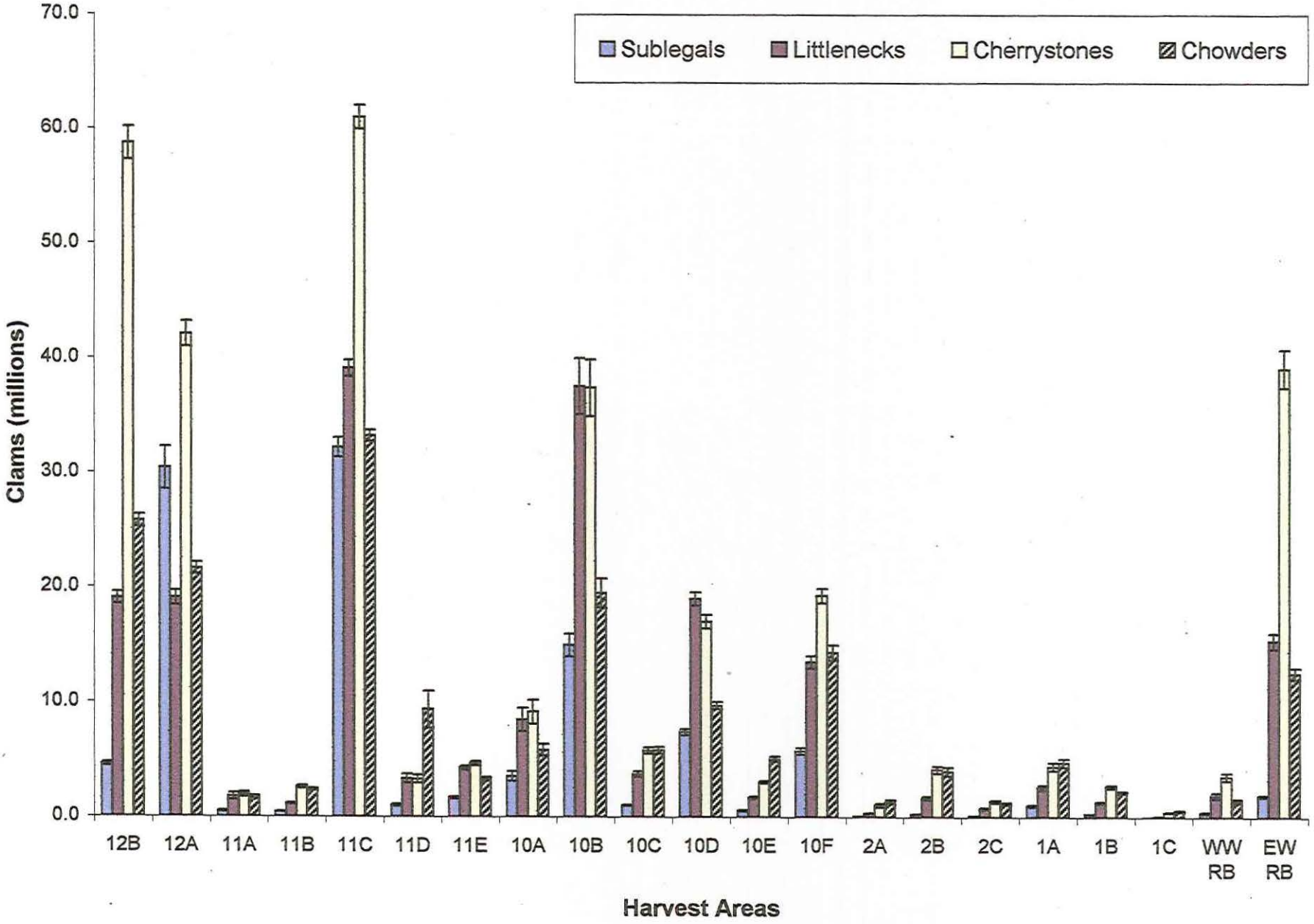


Figure 12. 2000 Shellfish Inventory: composite length-percent-frequency distribution graph for Raritan Bay.

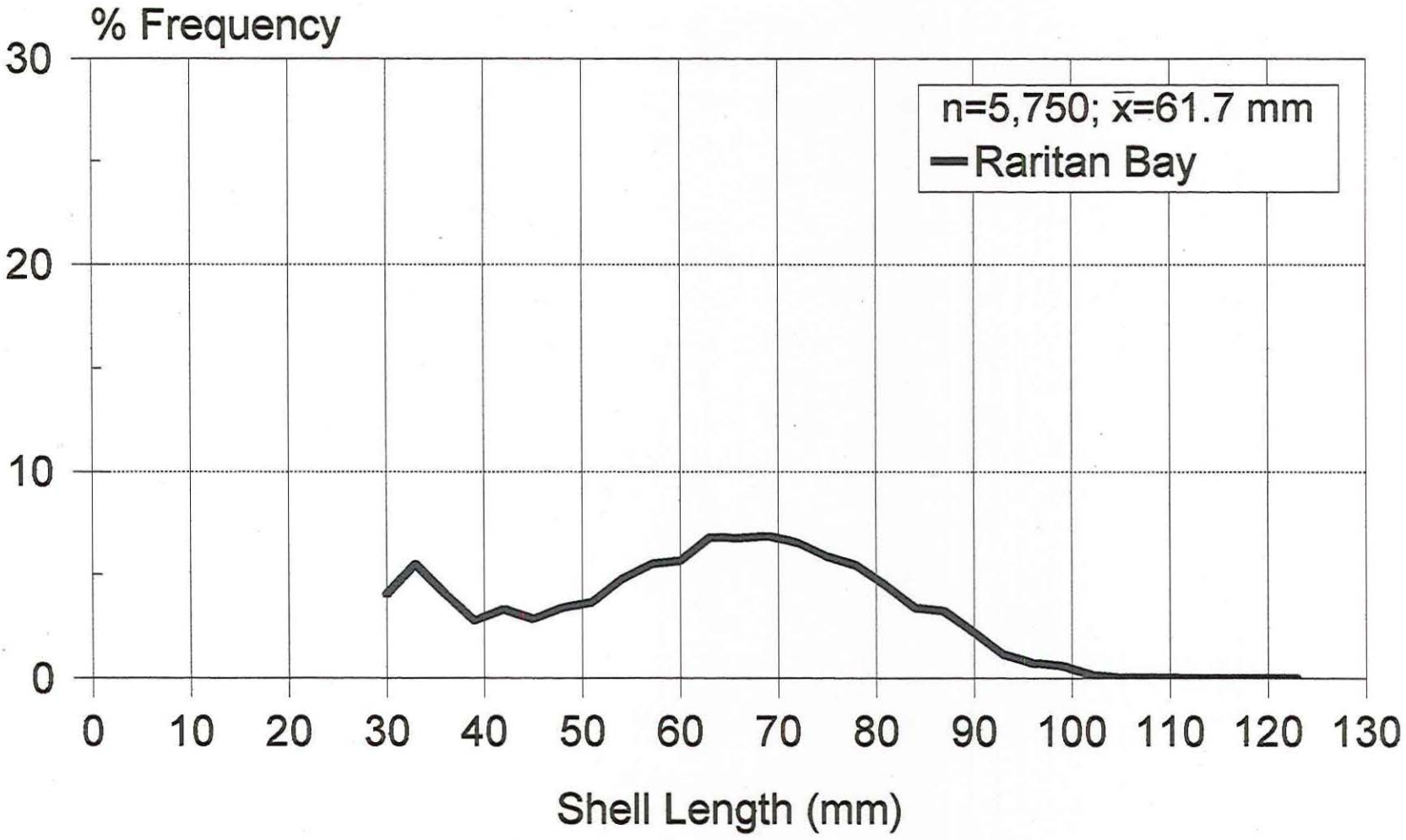


Figure 13. 2000 Shellfish Inventory: composite length-percent-frequency distribution graph for Sandy Hook Bay.

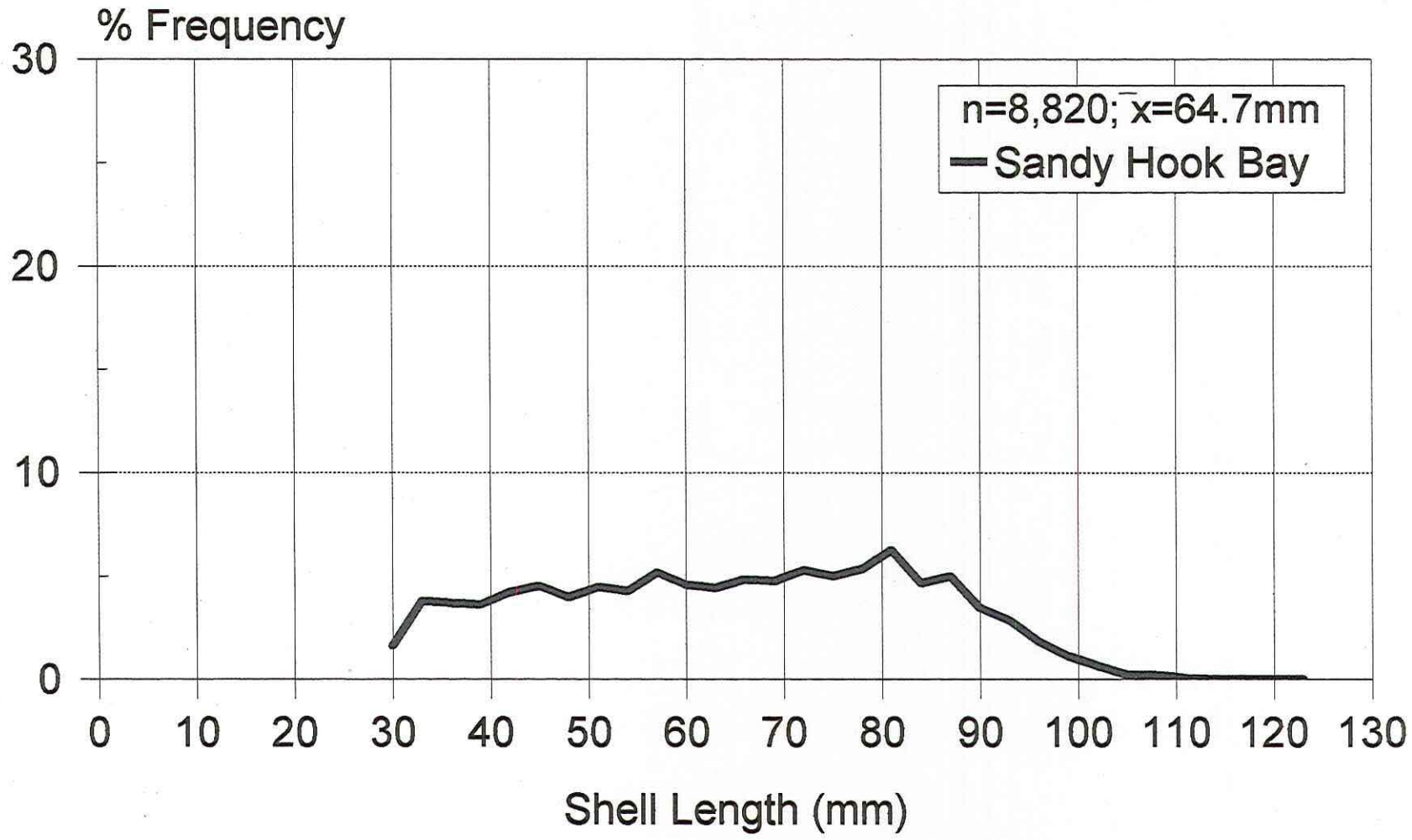


Figure 14. 2000 Shellfish Inventory: recruitment indices (%) in Raritan Bay at stations with moderate and high abundances of hard clams.

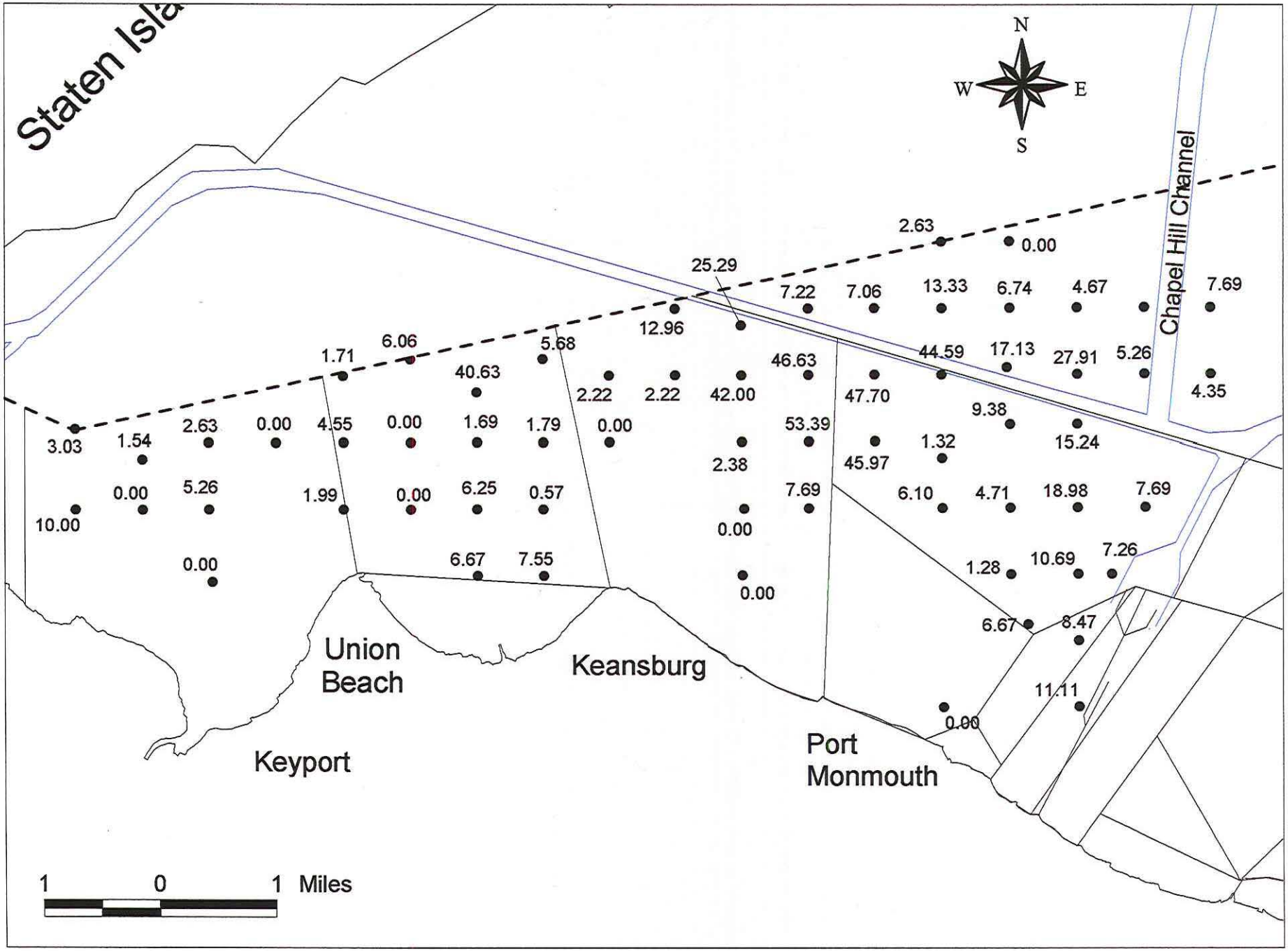


Figure 15. 2000 Shellfish Inventory: recruitment indices (%) in Sandy Hook Bay at stations with moderate and high abundances of hard clams.

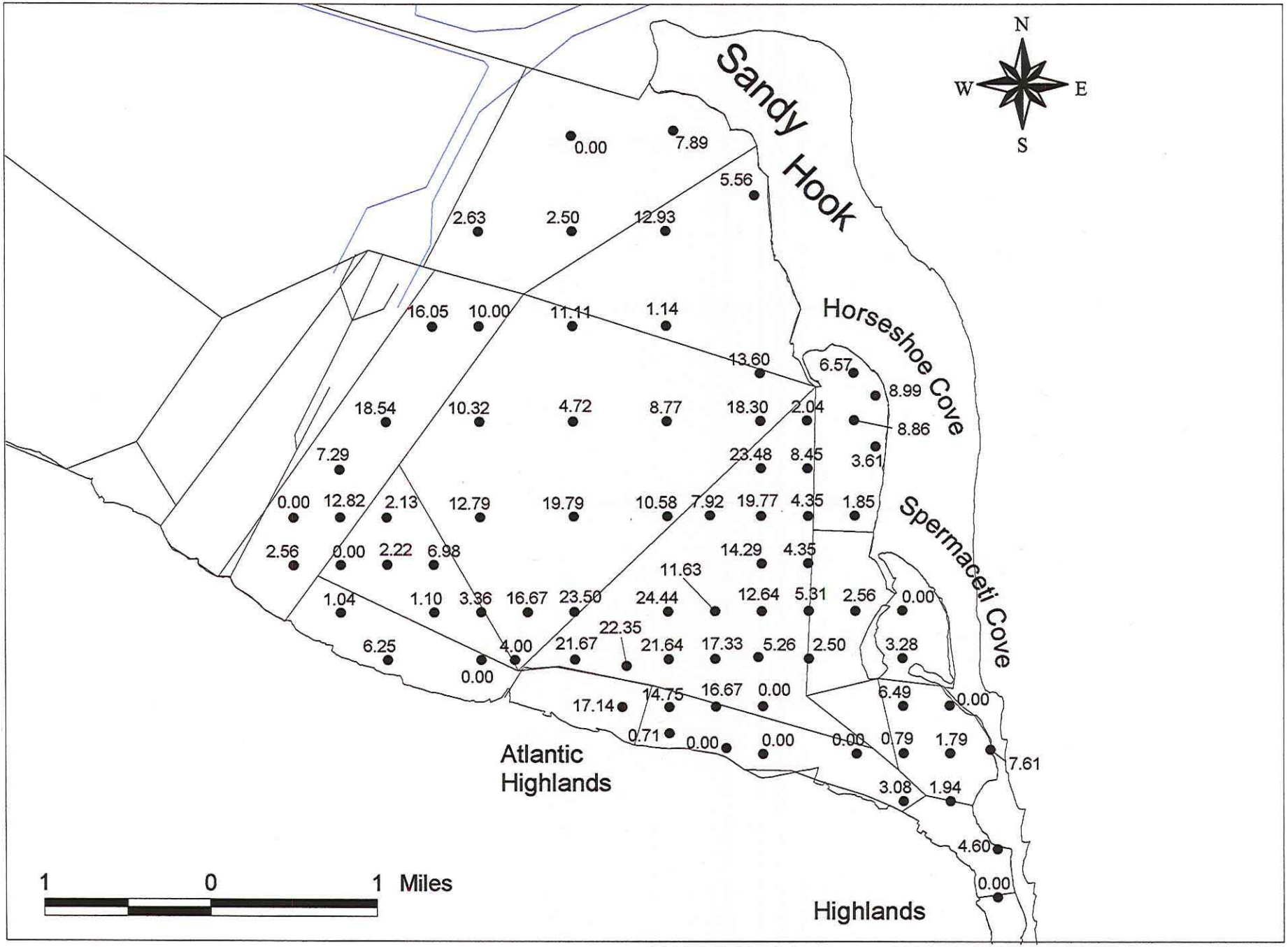


Figure 18. Results of the Student-Newman-Keuls (SNK) multiple comparison test on *Mercenaria* mortality indices by relay and depuration harvest areas.

Alpha (α)	0.10
Error Degrees of Freedom	628
Error Mean Square	183.2813
Harmonic Mean of Cell Sizes	18.75581

Means with the same letter are not significantly different.

SNK Grouping		Mean	N	Harvest Area
	A	15.411	24	2A
	A			
B	A	13.998	8	11E
B	A			
B	A	12.500	4	1C
B	A			
B	A	12.303	16	11D
B	A			
B	A	10.082	16	2C
B	A			
B	A	7.946	28	1A
B	A			
B	A	7.548	80	12A
B	A			
B	A	7.461	68	11C
B	A			
B	A	6.873	24	10C
B	A			
B	A	6.660	76	10D
B	A			
B	A	6.397	28	10A
B	A			
B	A	6.193	16	1B
B	A			
B	A	5.808	32	10E
B	A			
B	A	5.416	8	11A
B	A			
B	A	4.743	56	12B
B	A			
B	A	4.493	48	10B
B	A			
B	A	4.167	24	11B
B	A			
B	A	3.856	28	10F
B	A			
B	A	3.563	20	2B
B				
B		0.628	68	EW_RB
B				
B		0.000	40	WW_RB

NOTE: This test controls the Type I experimentwise error rate under the complete null hypothesis but not under partial null hypotheses.

Figure 19. 2000 Shellfish Inventory: mortality indices (%) in Raritan Bay at all stations.

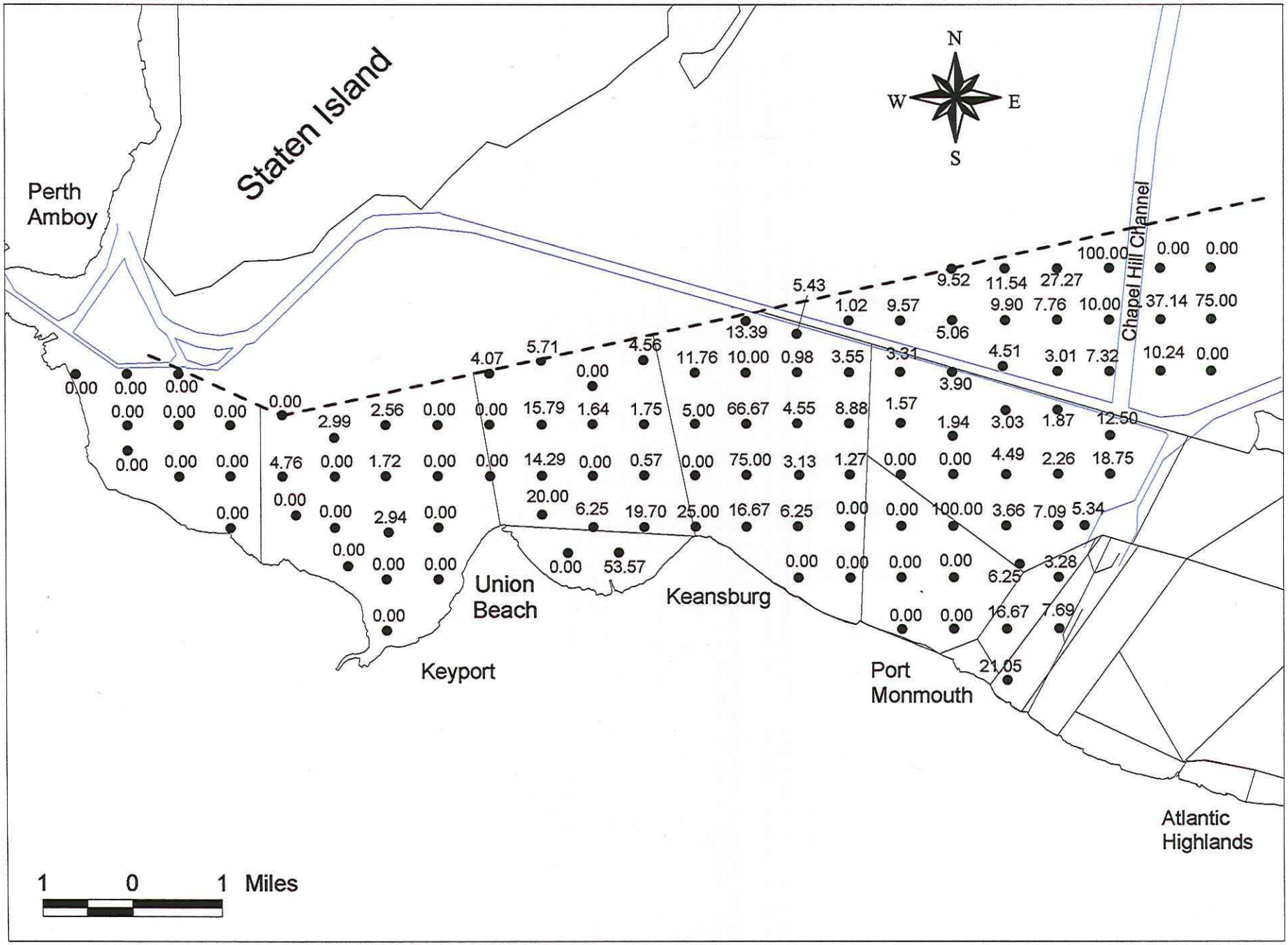


Figure 20. 2000 Shellfish Inventory: mortality indices (%) in Sandy Hook Bay at all stations.

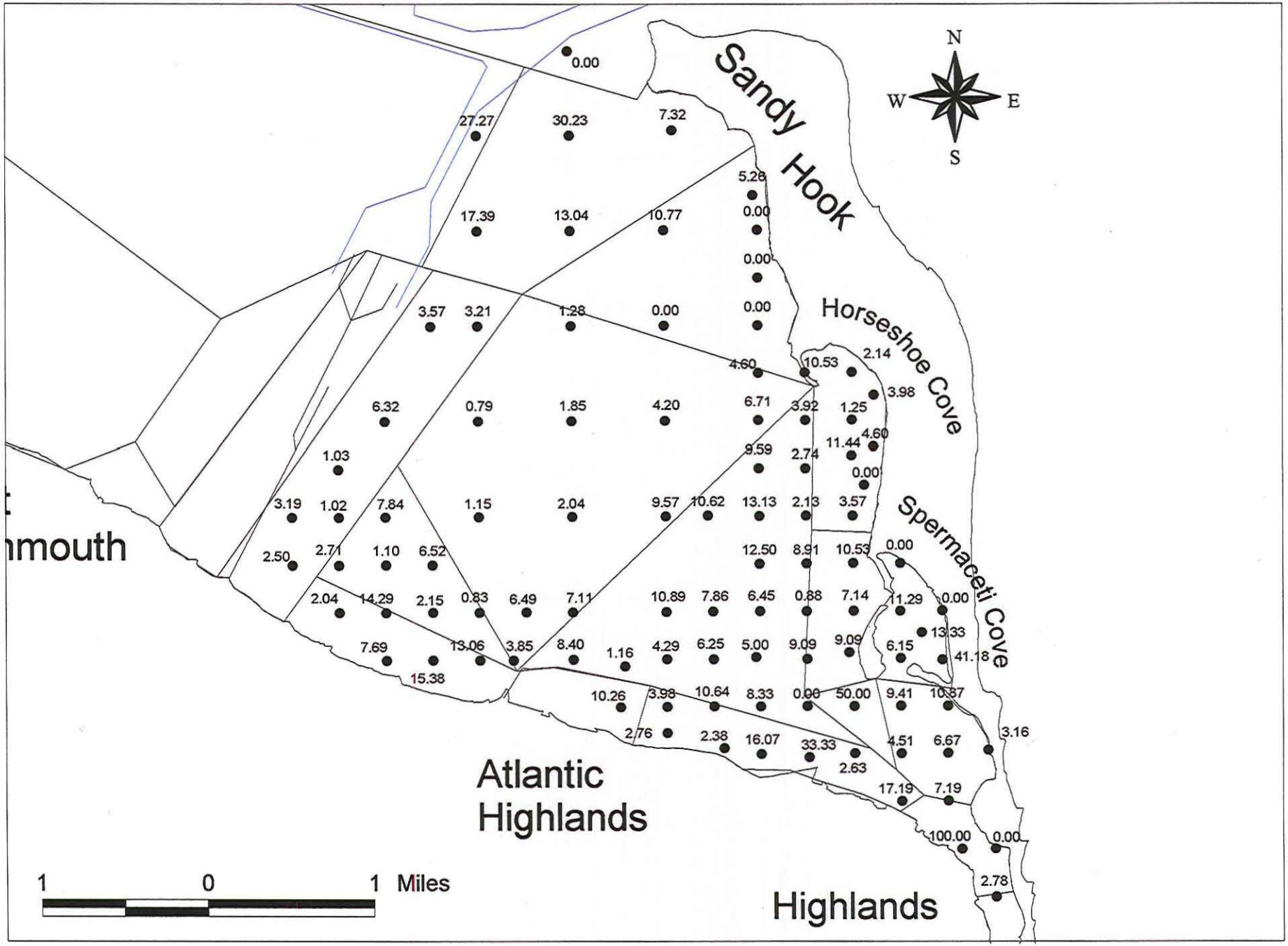


Figure 21. 2000 Shellfish Inventory: Raritan and Sandy Hook bay distribution of blue mussels, *Mytilus edulis*.

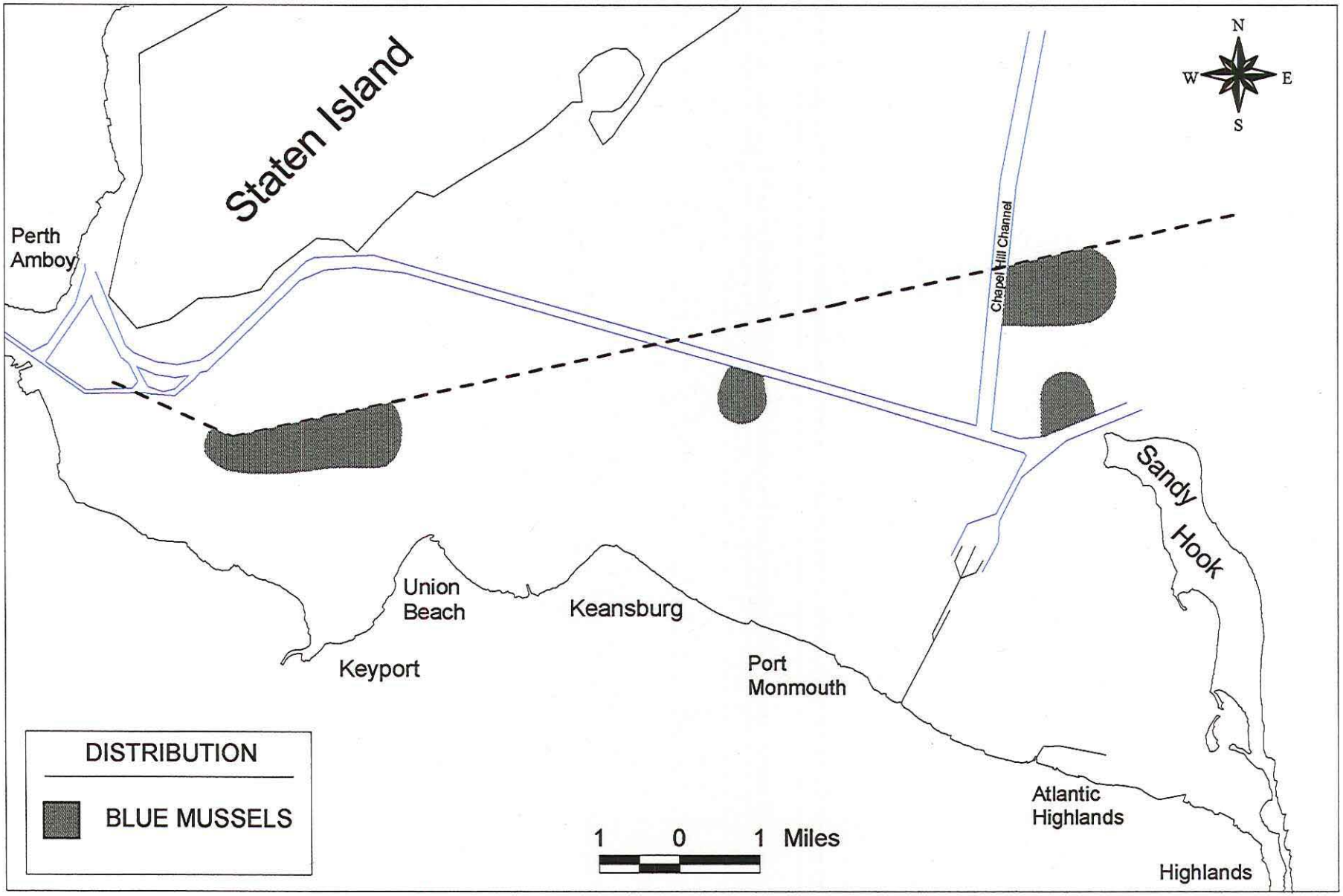


Figure 22. 1983 Shellfish Inventory: Raritan and Sandy Hook bay distribution of blue mussels, Mytilus edulis, and oysters, Crassostrea virginica.

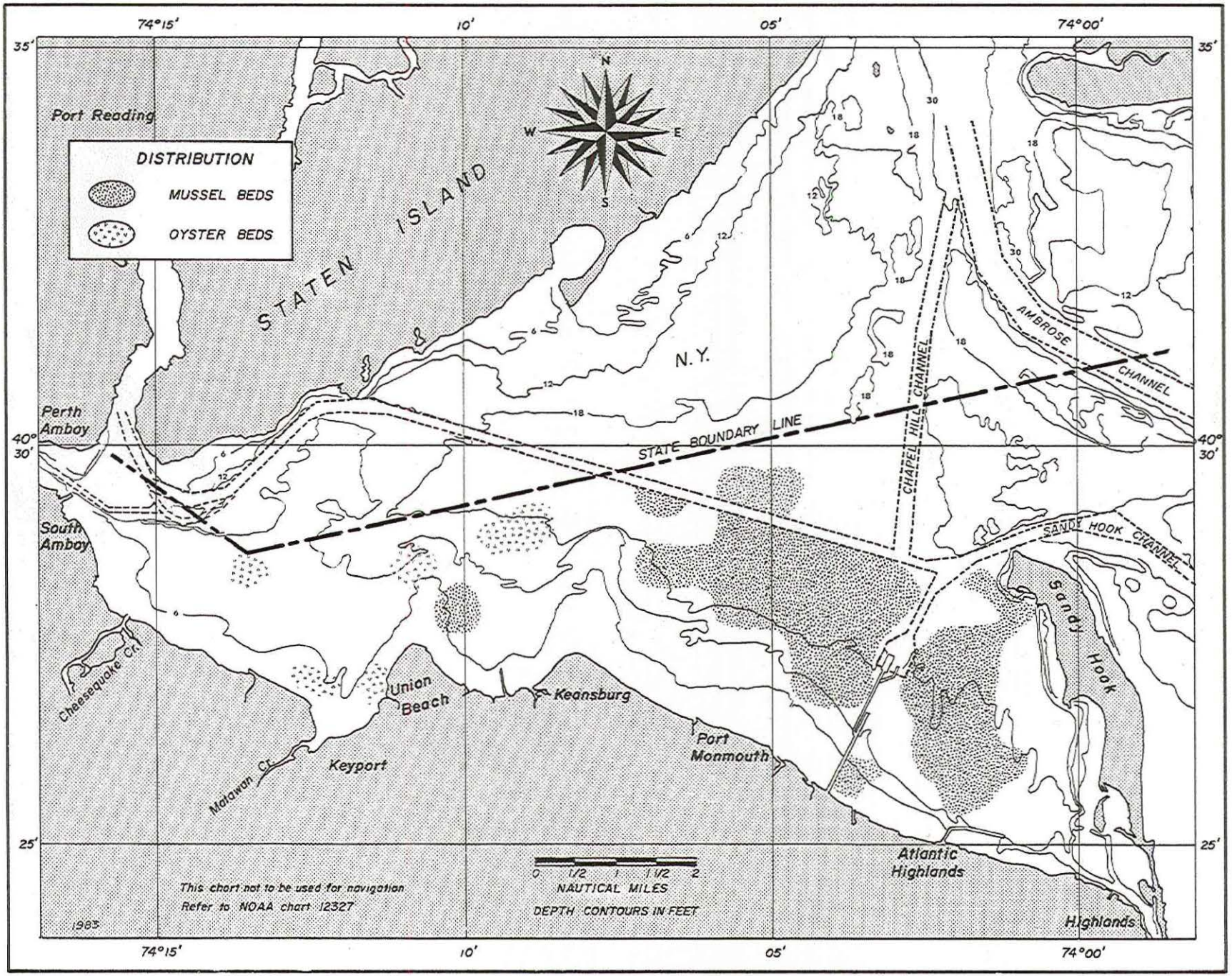


Figure 23. 2000 Shellfish Inventory: Raritan and Sandy Hook bay distribution of surf clams, Spisula solidissima, and soft clams, Mya arenaria.

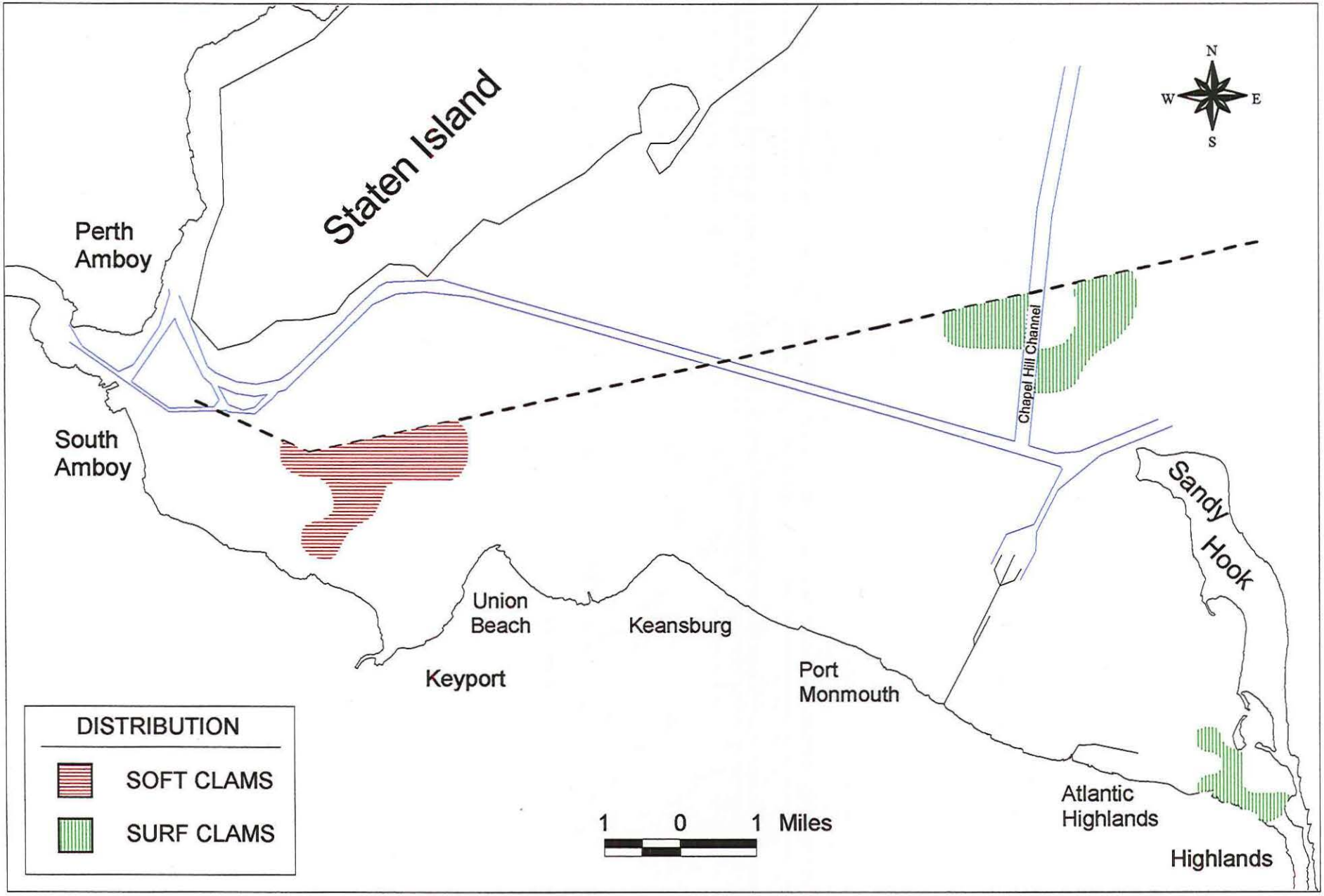
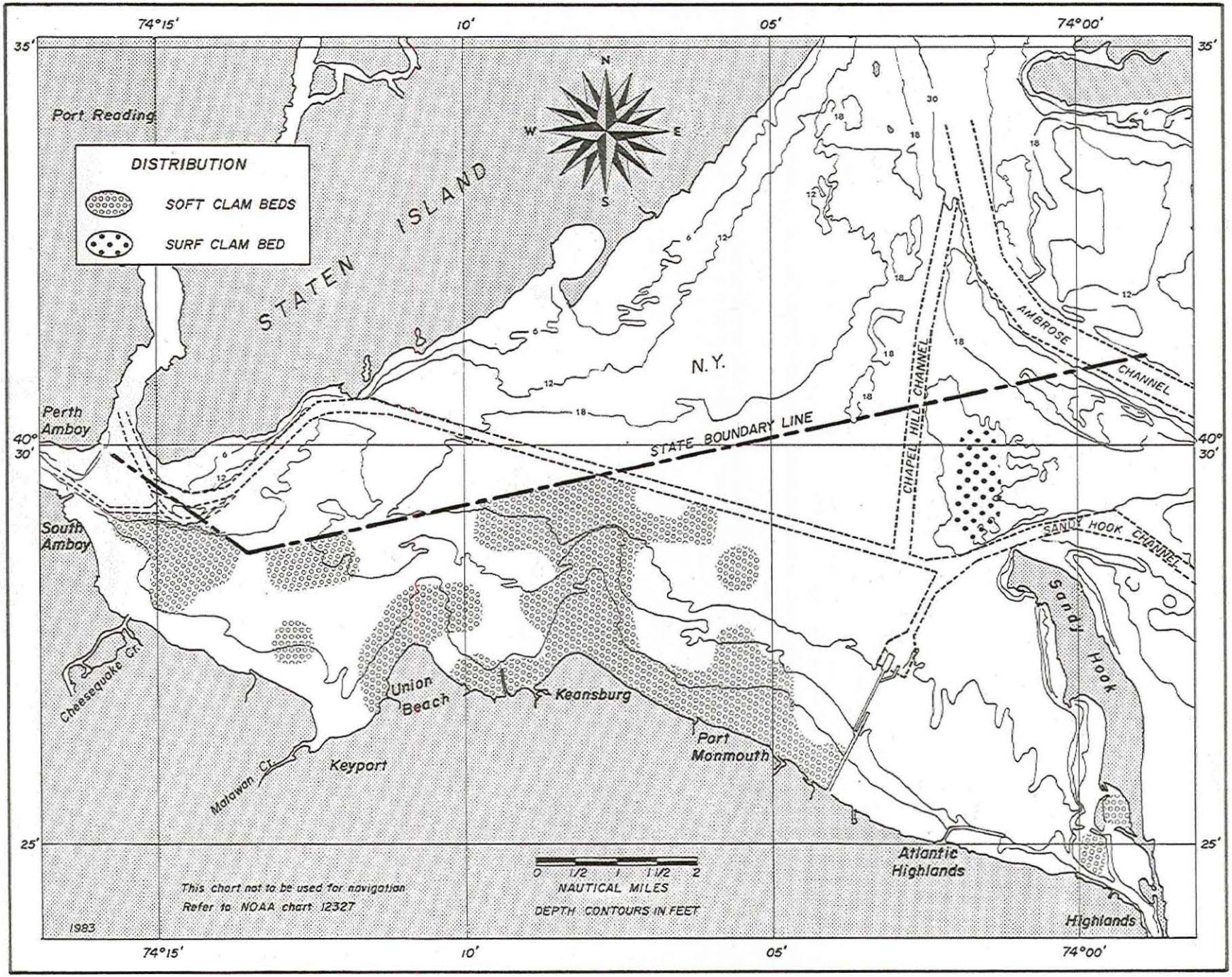


Figure 24. 1983 Shellfish Inventory: Raritan and Sandy Hook bay distribution of surf clams, Spisula solidissima, and soft clams, Mya arenaria.



APPENDIX I.

Appendix I. Hard clam stock estimates and abundances with means, variances and standard errors for relay and depuration sub- and main harvest areas for the 2000 hard clam stock assessment of Raritan and Sandy Hook bays.

Harvest Sub-area	Stock Estimate (Clams)				Abundance (Clams foot^{-2})			
	Sum	Mean	Variance	SEM	Abundance*	Mean**	Variance	SEM
12B	108,065,831	8,312,756	8.42E+13	2.54E+06	0.92	0.88	0.86	0.25
12A	113,179,152	9,431,596	1.73E+14	3.79E+06	0.67	0.65	0.63	0.18
11A	5,778,850	1,155,770	2.38E+12	6.90E+05	0.34	0.34	0.22	0.33
11B	6,470,599	647,060	8.64E+11	2.94E+05	0.10	0.04	0.01	0.04
11C	165,617,968	9,200,998	1.16E+14	2.54E+06	1.21	1.14	0.72	0.21
11D	16,958,490	3,391,698	2.84E+13	2.38E+06	0.42	0.42	0.00	0.03
11E	13,828,371	1,728,546	2.62E+12	5.72E+05	0.62	0.29	0.03	0.12
10A	27,007,619	3,858,231	6.25E+13	2.99E+06	0.85	0.41	0.27	0.20
10B	109,474,284	10,947,428	5.17E+14	7.19E+06	1.39	1.44	0.34	0.17
10C	16,303,315	2,037,914	4.69E+12	7.66E+05	1.07	1.23	0.42	0.27
10D	53,178,822	3,323,676	4.97E+13	1.76E+06	1.09	1.01	0.37	0.14
10E	10,322,993	1,146,999	1.23E+12	3.69E+05	0.76	0.88	0.62	0.28
10F	52,855,870	5,872,874	2.94E+13	1.81E+06	1.61	1.74	0.28	0.20
2A	2,761,450	460,242	9.03E+11	3.88E+05	0.41	0.29	0.09	0.12
2B	9,978,076	1,663,013	3.66E+12	7.82E+05	1.00	1.00	0.10	0.14
2C	3,361,290	672,258	4.64E+11	3.05E+05	0.67	0.79	0.59	0.38
1A	12,676,445	2,535,289	5.01E+12	1.00E+06	1.02	1.32	2.77	0.63
1B	6,309,841	788,730	9.57E+11	3.46E+05	0.62	0.25	0.02	0.07
1C	1,049,814	174,969	5.16E+10	9.27E+04	0.31	0.01	--	--
***W.W. RB	7,154,836	1,788,709	2.67E+12	8.18E+05	0.08	0.09	0.00	0.01
****E. W. RB	68,881,963	6,261,997	8.26E+13	2.74E+06	0.42	0.44	0.26	0.12
*****Grand Total	735,179,079							

Statistics: all size classes combined

* Abundance = Total number of clams estimated in a harvest area divided by the total area of the harvest area.

** Mean = Average abundance of individual stations within a harvest area.

*** W. W. RB = Western portions of western Raritan Bay (see Figure 6).

**** E. W. RB = Eastern portions of western Raritan Bay (see Figure 6).

***** Grand Total EXCLUDES W. and E. western Raritan Bay.

Appendix I. Hard clam stock estimates and abundances with means, variances and standard errors for relay and depuration sub- and main harvest areas for the 2000 hard clam stock assessment of Raritan and Sandy Hook bays.

Harvest Main Area	Stock Estimate (Clams)				Abundance (Clams foot^{-2})			
	Sum	Mean	Variance	SEM	Abundance*	Mean**	Variance	SEM
12 Total	221,244,983	8,849,799	1.22E+14	2.21E+06	0.77	0.74	0.71	0.14
11 Total	208,654,278	4,535,963	6.20E+13	1.16E+06	0.74	0.73	0.62	0.14
10 Total	269,142,903	4,561,744	1.15E+14	1.39E+06	1.22	1.12	0.49	0.09
2 Total	16,100,815	947,107	1.85E+12	3.30E+05	0.74	0.66	0.29	0.14
1 Total	20,036,100	1,054,532	2.40E+12	3.55E+05	0.77	0.86	1.86	0.39
W. & E. W. RB	76,036,799	5,069,120	6.38E+13	2.06E+06	0.31	0.31	0.19	0.08
*****Grand Total	735,179,079							

Statistics: all size classes combined

* Abundance = Total number of clams estimated in a harvest area divided by the total area of the harvest area.

** Mean = Average abundance of station groupings within a harvest area.

*** W. W. RB = Western portions of western Raritan Bay (see Figure 6).

**** E. W. RB = Eastern portions of western Raritan Bay (see Figure 6).

***** Grand Total EXCLUDES W. and E. western Raritan Bay.

APPENDIX II.

Appendix II. Hard clam stock estimates with means, variances and standard errors for relay and depuration sub and main harvest areas for the 2000 hard clam stock assessment of Raritan and Sandy Hook bays.

Harvest Sub-Area		Stock Estimate (Clams)			
		Sublegals	Littlenecks	Cherrystones	Chowders
12B	clams	4,536,413	19,035,831	58,724,370	25,770,284
	mean*	348,955	1,464,295	4,517,259	1,982,330
	variance	3.69E+11	3.81E+12	2.70E+13	3.74E+12
	SEM	168,367	541,230	1,441,054	536,509
	% of total	4.2%	17.6%	54.3%	23.8%
12A	clams	30,407,410	19,064,223	42,080,080	21,625,701
	mean	2,533,951	1,588,685	3,506,673	1,802,142
	variance	4.14E+13	4.81E+12	1.44E+13	3.22E+12
	SEM	1,857,124	633,230	1,093,990	518,373
	% of total	26.9%	16.8%	37.2%	19.1%
11A	clams	463,040	1,759,215	1,915,368	1,641,203
	mean	92,608	351,843	383,074	328,241
	variance	1.77E+10	3.73E+11	2.19E+11	1.22E+11
	SEM	59,517	273,123	209,238	156,266
	% of total	8.0%	30.4%	33.1%	28.4%
11B	clams	416,805	1,132,207	2,577,481	2,343,857
	mean	41,681	113,221	257,748	234,386
	variance	4.58E+09	2.85E+10	1.44E+11	1.26E+11
	SEM	21,400	53,417	120,004	112,336
	% of total	6.4%	17.5%	39.8%	36.2%
11C	clams	32,203,589	39,114,741	61,050,988	33,250,690
	mean	1,789,088	2,173,041	3,391,722	1,847,261
	variance	1.32E+13	9.14E+12	1.95E+13	4.21E+12
	SEM	854,863	712,575	1,039,502	483,606
	% of total	19.4%	23.6%	36.9%	20.1%
11D	clams	985,732	3,324,355	3,288,266	9,360,170
	mean	197,146	664,871	657,653	1,872,034
	variance	5.32E+10	7.45E+11	6.30E+11	1.32E+13
	SEM	103,168	386,043	355,061	1,624,044
	% of total	5.8%	19.6%	19.4%	55.2%
11E	clams	1,667,780	4,238,795	4,652,983	3,269,061
	mean	208,473	529,849	581,623	408,633
	variance	6.74E+10	2.72E+11	2.93E+11	2.07E+11
	SEM	91,765	184,319	191,268	160,684
	% of total	12.1%	30.7%	33.6%	23.6%
10A	clams	3,532,956	8,487,723	9,156,439	5,831,038
	mean	504,708	1,212,532	1,308,063	833,005
	variance	1.28E+12	7.42E+12	7.50E+12	1.85E+12
	SEM	428,048	1,029,594	1,035,068	513,963
	% of total	13.1%	31.4%	33.9%	21.6%

Appendix II. Hard clam stock estimates with means, variances and standard errors for relay and depuration sub and main harvest areas for the 2000 hard clam stock assessment of Raritan and Sandy Hook bays.

Harvest Sub-Area		Stock Estimate (Clams)			
		Sublegals	Littlenecks	Cherrystones	Chowders
10B	clams	14,963,550	37,563,755	37,437,056	19,511,530
	mean	1,496,355	3,756,376	3,743,706	1,951,153
	variance	1.04E+13	6.01E+13	6.11E+13	1.60E+13
	SEM	1,021,201	2,451,933	2,471,493	1,265,650
	% of total	13.7%	34.3%	34.2%	17.8%
10C	clams	1,001,987	3,706,262	5,786,868	5,807,971
	mean	125,248	463,283	723,359	725,996
	variance	2.79E+10	4.86E+11	5.47E+11	6.69E+11
	SEM	59,024	246,513	261,559	289,081
	% of total	6.1%	22.7%	35.5%	35.6%
10D	clams	7,396,365	19,014,957	17,046,660	9,721,014
	mean	462,273	1,188,435	1,065,416	607,563
	variance	1.03E+12	5.88E+12	5.91E+12	1.64E+12
	SEM	253,430	606,237	607,870	319,907
	% of total	13.9%	35.8%	32.1%	18.3%
10E	clams	554,363	1,677,314	3,043,664	5,047,446
	mean	61,596	186,368	338,185	560,827
	variance	2.24E+10	1.77E+11	7.39E+10	4.72E+11
	SEM	49,876	140,170	90,601	228,934
	% of total	5.4%	16.2%	29.5%	48.9%
10F	clams	5,729,732	13,490,936	19,310,398	14,325,938
	mean	636,637	1,498,993	2,145,600	1,591,771
	variance	7.98E+11	2.79E+12	3.63E+12	4.05E+12
	SEM	297,789	556,681	634,934	671,087
	% of total	10.8%	25.5%	36.5%	27.1%
2A	clams	69,409	342,707	1,021,009	1,328,280
	mean	11,568	57,118	170,168	221,380
	variance	5.37E+08	1.09E+10	1.43E+11	1.99E+11
	SEM	9,463	42,610	154,368	182,106
	% of total	2.5%	12.4%	37.0%	48.1%
2B	clams	253,638	1,634,695	4,116,336	3,973,324
	mean	42,273	272,449	686,056	662,221
	variance	3.31E+09	1.90E+11	6.08E+11	7.70E+11
	SEM	23,500	177,941	318,218	358,260
	% of total	2.5%	16.4%	41.3%	39.8%
2C	clams	127,022	718,213	1,355,871	1,160,183
	mean	25,404	143,643	271,174	232,037
	variance	1.00E+09	5.41E+10	7.98E+10	6.72E+10
	SEM	14,149	104,034	126,349	115,974
	% of total	3.8%	21.4%	40.3%	34.5%

Appendix II. Hard clam stock estimates with means, variances and standard errors for relay and depuration sub and main harvest areas for the 2000 hard clam stock assessment of Raritan and Sandy Hook bays.

Harvest Sub-Area		Stock Estimate (Clams)			
		Sublegals	Littlenecks	Cherrystones	Chowders
1A	clams	983,201	2,568,303	4,392,872	4,732,225
	mean	196,640	513,661	878,574	946,445
	variance	3.92E+10	2.75E+11	5.72E+11	6.00E+11
	SEM	88,576	234,699	338,213	346,450
	% of total	7.8%	20.3%	34.7%	37.3%
1B	clams	283,436	1,250,028	2,640,545	2,135,741
	mean	35,430	156,254	330,068	266,968
	variance	2.56E+09	5.87E+10	1.75E+11	8.79E+10
	SEM	17,899	85,673	147,879	104,837
	% of total	4.5%	19.8%	41.8%	33.8%
1C	clams	15,391	58,790	427,495	548,139
	mean	2,565	9,798	71,249	91,356
	variance	9.63E+06	5.57E+07	8.45E+09	1.71E+10
	SEM	1,267	3,046	37,535	53,367
	% of total	1.5%	5.6%	40.7%	52.2%
West W. RB	clams	362,367	1,870,366	3,514,685	1,407,348
	mean	90,592	467,592	878,671	351,837
	variance	3.28E+10	2.54E+11	4.64E+11	1.45E+11
	SEM	90,592	252,157	340,742	190,136
	% of total	5.1%	26.1%	49.1%	19.7%
East W. RB	clams	1,843,469	15,375,896	39,137,216	12,524,715
	mean	167,588	1,397,809	3,557,929	1,138,610
	variance	4.40E+10	5.18E+12	3.03E+13	2.48E+12
	SEM	63,235	686,390	1,659,508	474,897
	% of total	2.7%	22.3%	56.8%	18.2%

Appendix II. Hard clam stock estimates with means, variances and standard errors for relay and depuration sub and main harvest areas for the 2000 hard clam stock assessment of Raritan and Sandy Hook bays.

Harvest Area		Stock Estimate (Clams)			
		Sublegals	Littlenecks	Cherrystones	Chowders
12	clams	34,943,823	38,100,054	100,804,450	47,395,985
	mean	1,397,753	1,524,002	4,032,178	1,895,839
	variance	2.04E+13	4.11E+12	2.03E+13	3.36E+12
	SEM	903,207	405,633	902,134	366,460
	% of total	15.8%	17.2%	45.6%	21.4%
11	clams	35,736,947	49,569,313	73,485,087	49,864,982
	mean	776,890	1,077,594	1,597,502	1,084,021
	variance	5.66E+12	4.42E+12	9.63E+12	3.44E+12
	SEM	350,894	309,896	457,538	273,376
	% of total	17.1%	23.8%	35.2%	23.9%
10	clams	33,178,954	83,940,947	91,781,085	60,244,936
	mean	562,355	1,422,728	1,555,612	1,021,101
	variance	2.35E+12	1.34E+13	1.36E+13	4.10E+12
	SEM	199,699	476,740	480,793	263,652
	% of total	12.3%	31.2%	34.1%	22.4%
2	clams	450,068	2,695,615	6,493,217	6,461,788
	mean	26,475	158,566	381,954	380,105
	variance	1.63E+09	8.51E+10	3.10E+11	3.66E+11
	SEM	9,795	70,750	135,003	146,688
	% of total	2.8%	16.7%	40.3%	40.1%
1	clams	1,282,029	3,877,121	7,460,912	7,416,105
	mean	67,475	204,059	392,680	390,321
	variance	1.62E+10	1.24E+11	2.99E+11	2.95E+11
	SEM	29,211	80,875	125,498	124,556
	% of total	6.4%	19.4%	37.2%	37.0%
Western** RB	clams	2,205,836	17,246,262	42,651,901	13,932,063
	mean	147,056	1,149,751	2,843,460	928,804
	variance	3.97E+10	3.94E+12	2.32E+13	1.93E+12
	SEM	51,442	512,350	1,244,773	358,951
	% of total	2.9%	22.7%	56.1%	18.3%

* Total number of clams in a harvest sub-area divided by the number of station groupings within the harvest sub-area.

** Includes both western western and eastern western Raritan Bay.

Differences between Appendix II and Appendix I are due to rounding.

APPENDIX III.

Appendix III. 2000 hard clam relay and depuration reported harvest and effort by harvest area.

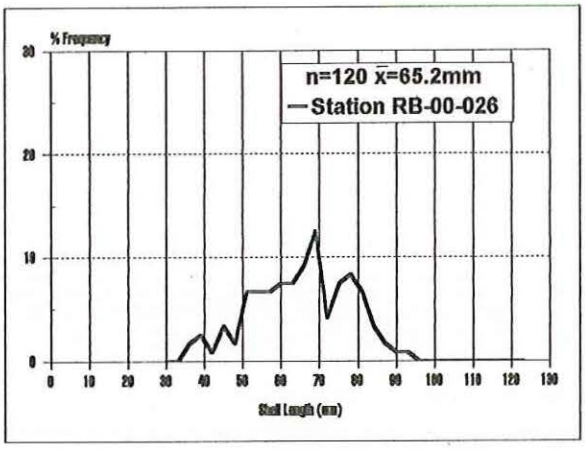
AREA	CLAMS	DAYS	CATCH PER EFFORT (CLAMS/MAN/DAY)	% OF HARVEST
1	0	0.00	0	0.00%
1A	19,100	14.00	1,364	0.06%
1B	7,400	5.00	1,480	0.02%
1C	0	0.00	0	0.00%
Total	26,500	19.00	1,395	0.08%
2	4,193	2.00	2,097	0.01%
2A	3,400	5.00	680	0.01%
2B	5,900	8.00	738	0.02%
2C	0	0.00	0	0.00%
Total	13,493	15.00	900	0.04%
3	0	0.00	0	0.00%
3A	0	0.00	0	0.00%
3B	0	0.00	0	0.00%
3C	0	0.00	0	0.00%
Total	0	0.00	0	0.00%
4	0	0.00	0	0.00%
4A	0	0.00	0	0.00%
4B	0	0.00	0	0.00%
4C	0	0.00	0	0.00%
4D	0	0.00	0	0.00%
Total	0	0.00	0	0.00%
5	6,017	3.25	1,851	0.02%
5A	0	0.00	0	0.00%
5B	0	0.00	0	0.00%
5C	0	0.00	0	0.00%
Total	6,017	3.25	1,851	0.02%
6	7,028	4.50	1,562	0.02%
6A	0	0.00	0	0.00%
6B	0	0.00	0	0.00%
Total	7,028	4.50	1,562	0.02%
7	249	0.25	994	0.00%
7A	0	0.00	0	0.00%
7B	0	0.00	0	0.00%
7C	0	0.00	0	0.00%
Total	249	0.25	994	0.00%
8	497	0.50	994	0.00%
8A	0	0.00	0	0.00%
8B	0	0.00	0	0.00%
8C	0	0.00	0	0.00%
Total	497	0.50	994	0.00%

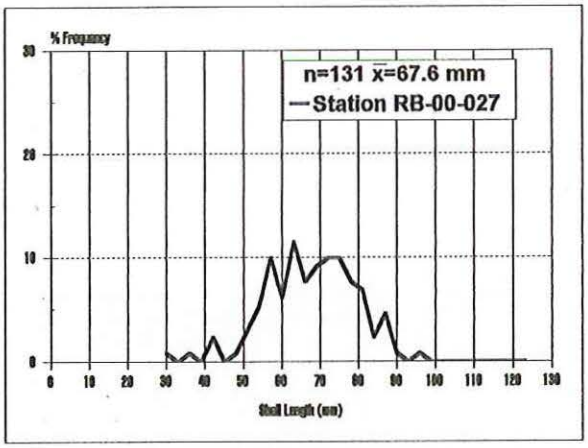
Appendix III. 2000 hard clam relay and depuration reported harvest and effort by harvest area.

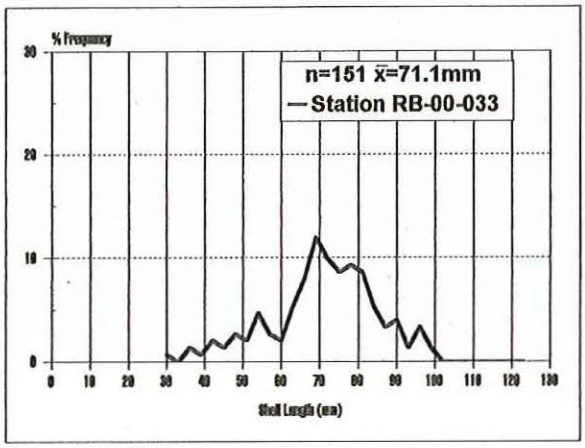
AREA	CLAMS	DAYS	CATCH PER EFFORT (CLAMS/MAN/DAY)	% OF HARVEST
9	0	0.00	0	0.00%
Total	0	0.00	0	0.00%
10	13,388,142	5,578.75	2,400	39.80%
10A	648,105	276.00	2,348	1.93%
10B	4,850,603	2,447.50	1,982	14.42%
10C	12,800	9.00	1,422	0.04%
10D	204,630	107.00	1,912	0.61%
10E	625,269	307.00	2,037	1.86%
10F	1,100	1.00	1,100	0.00%
Total	19,730,649	8,726.25	2,261	58.66%
11	1,750	0.50	3,500	0.01%
11A	112,400	46.00	2,443	0.33%
11B	134,260	57.00	2,355	0.40%
11C	72,025	33.50	2,150	0.21%
11D	0	0.00	0	0.00%
11E	700	0.50	1,400	0.00%
Total	321,135	137.50	2,336	0.95%
12	13,352,107	5,559.25	2,402	39.69%
12A	29,350	20.00	1,468	0.09%
12B	54,725	18.50	2,958	0.16%
Total	13,436,182	5,597.75	2,400	39.94%
Shark River	0	0.00	0	0.00%
Manasquan River	0	0.00	0	0.00%
UNKNOWN Total	95,807	44.00	2,177	0.28%
TOTALS	**33,637,555**	**14,548.0**	**2,312**	**100.00%**
Raritan Bay	13,757,317	5,735.25	2,399	40.90%
Sandy Hook Bay	19,770,642	8,760.25	2,257	58.78%
Navesink River	13,045	7.75	1,683	0.04%
Shrewsbury River	746	0.75	994	0.00%
Manasquan River	0	0.00	0	0.00%
Shark River	0	0.00	0	0.00%
Unknown	95,807	44.00	2,177	0.28%
TOTALS	**33,637,555**	**14,548.0**	**2,312**	**100.00%**

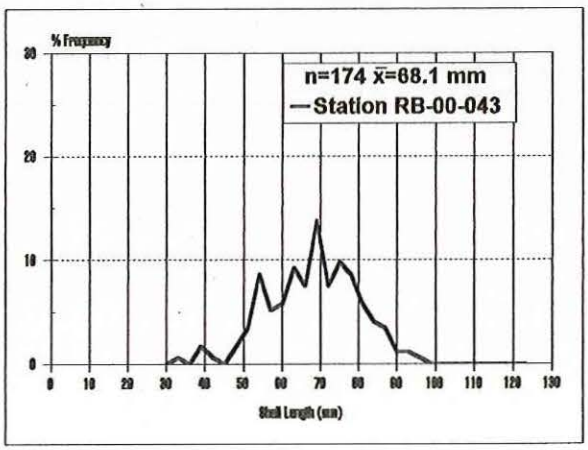
APPENDIX IV.

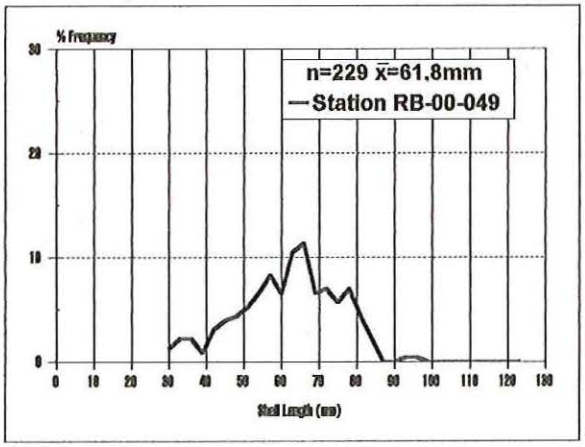
Appendix IV. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geq 100$) in Raritan Bay.

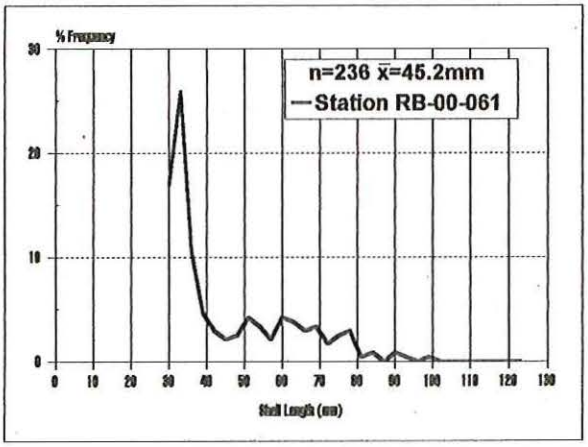




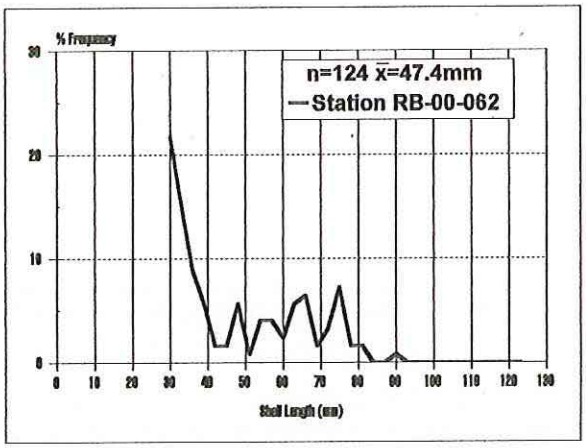


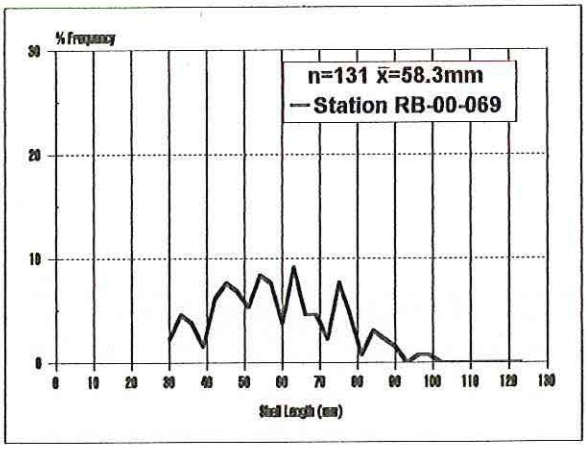


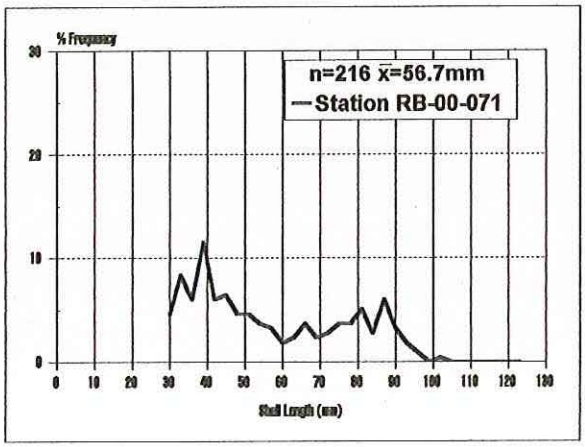


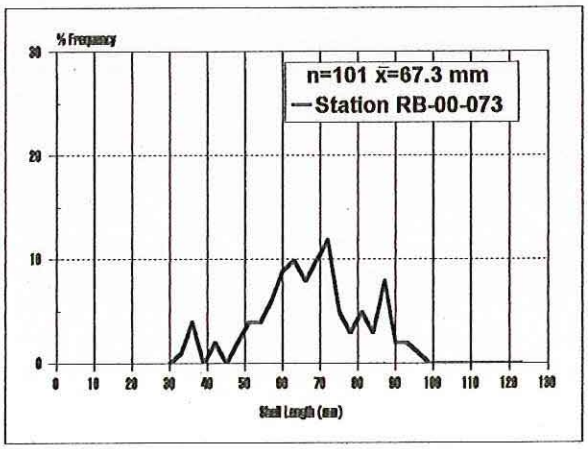


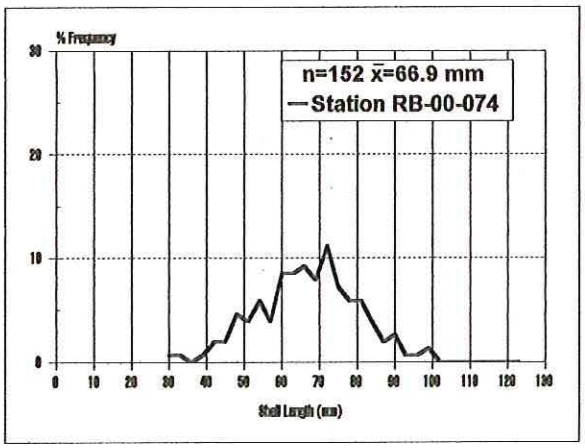
Appendix IV. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geq 100$) in Raritan Bay.

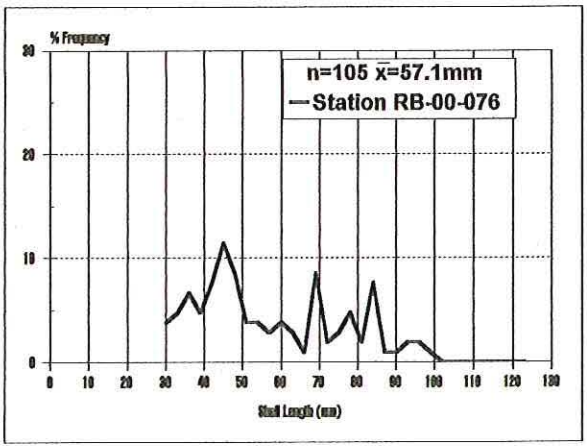




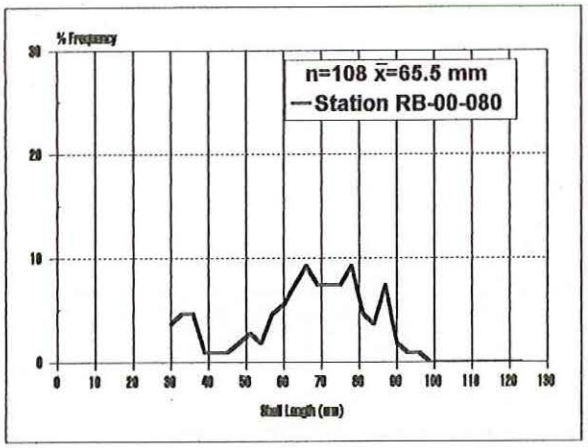


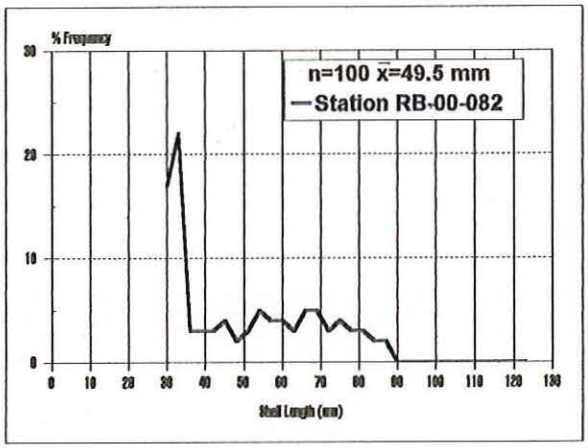


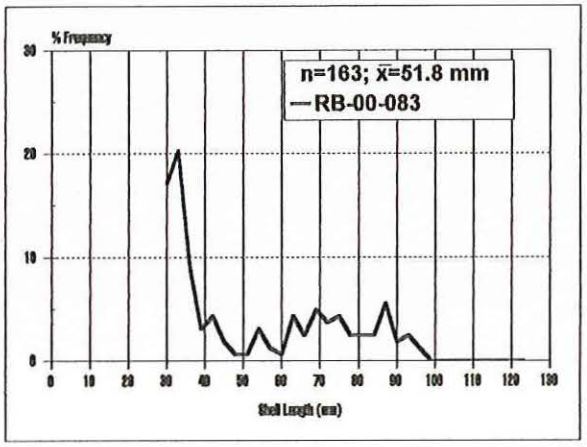


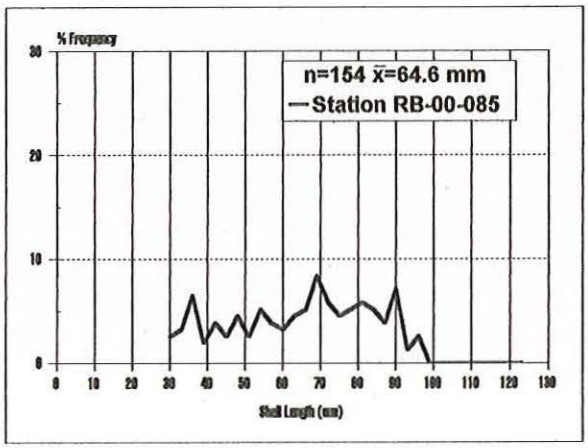


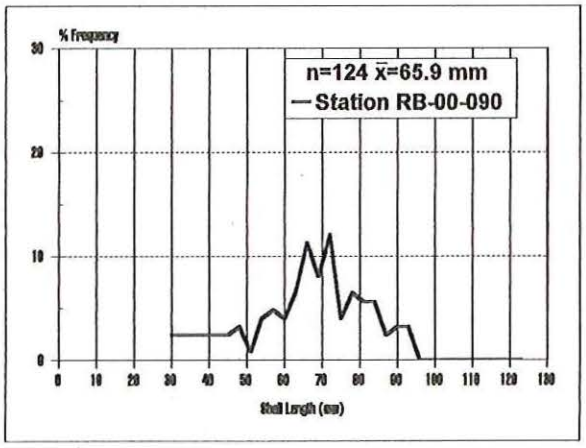
Appendix IV. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geq 100$) in Raritan Bay.

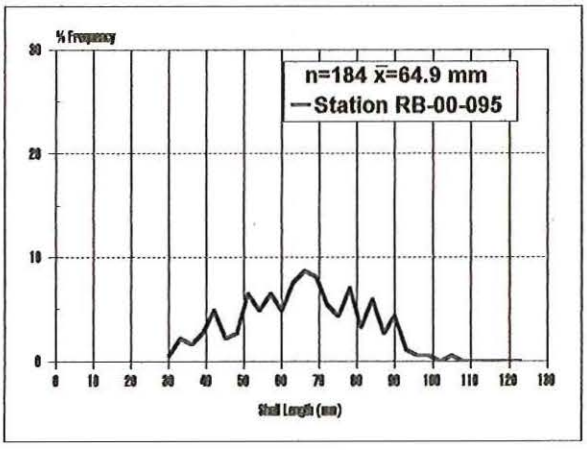




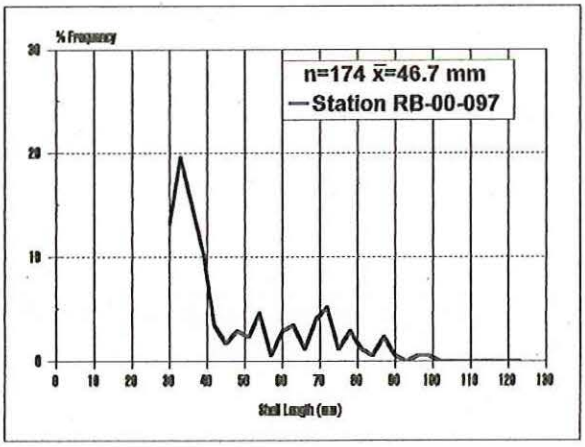


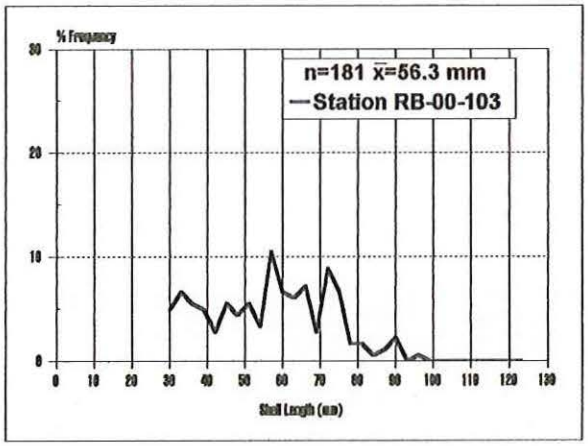


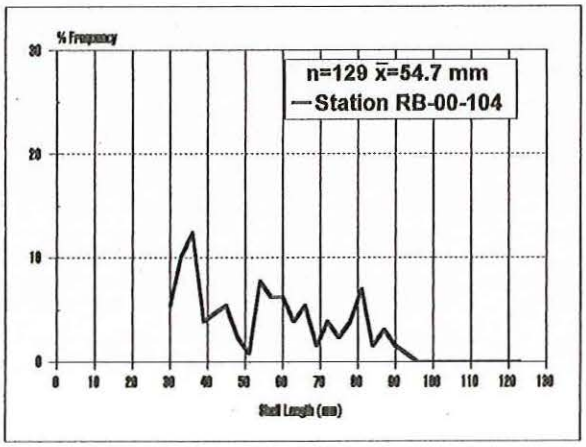


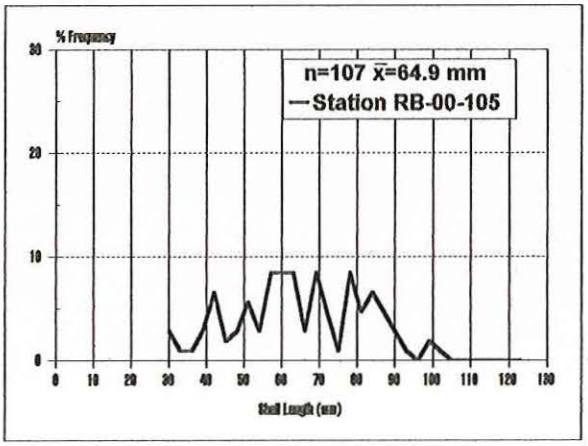


Appendix IV. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geq 100$) in Raritan Bay.



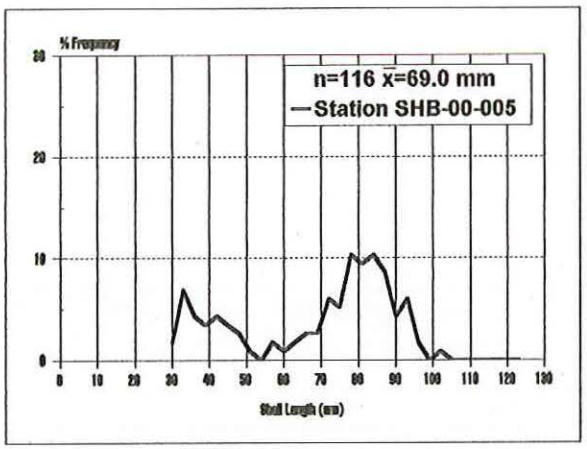


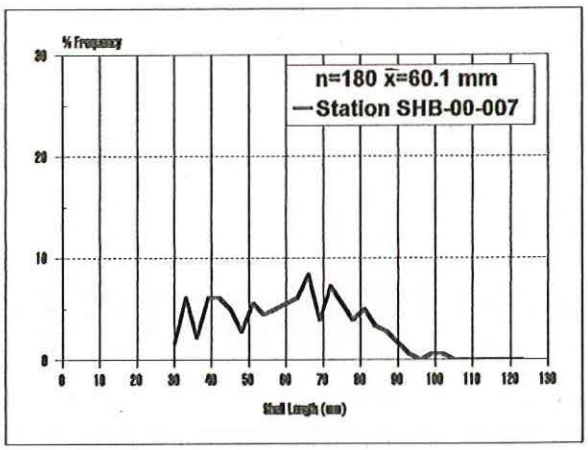


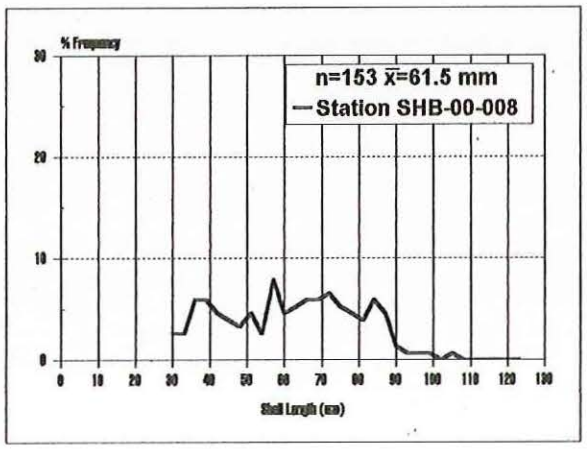


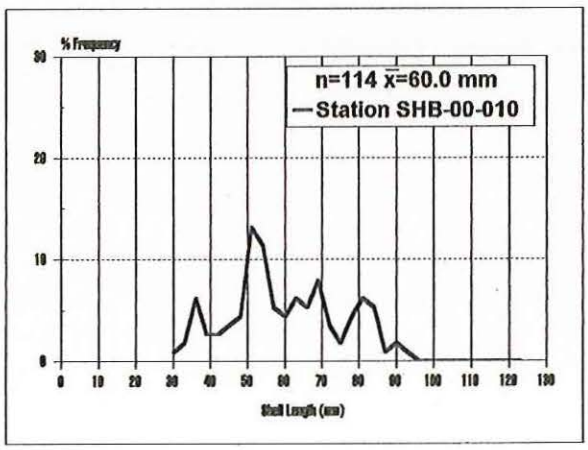
APPENDIX V.

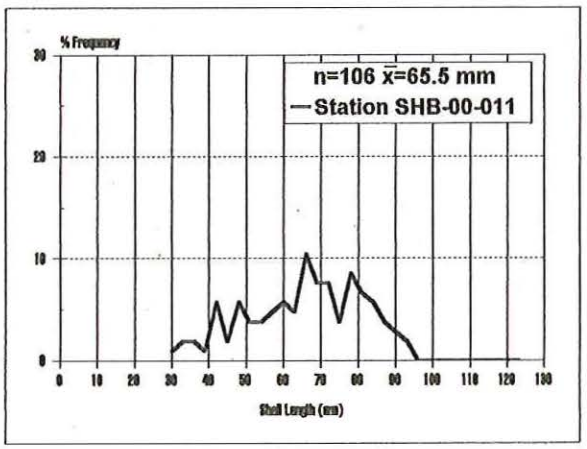
Appendix V. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geq 100$) in Sandy Hook Bay.

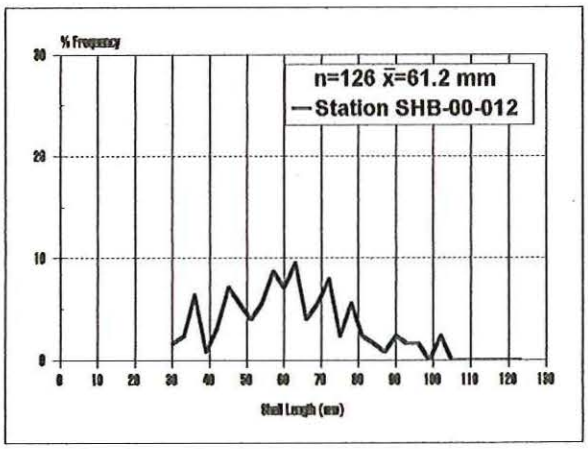




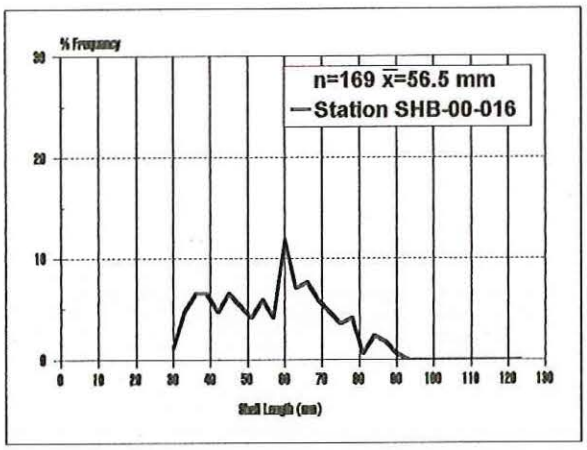


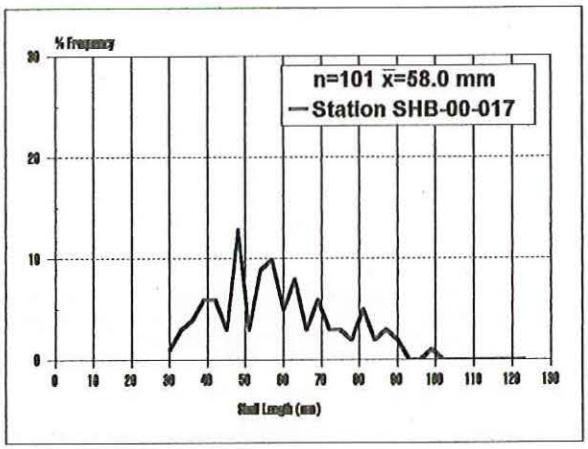


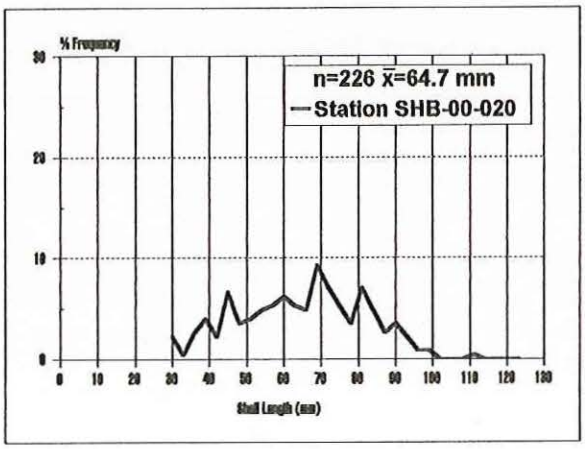


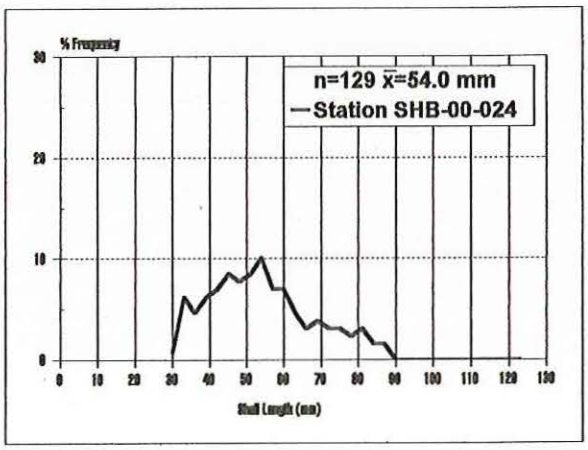


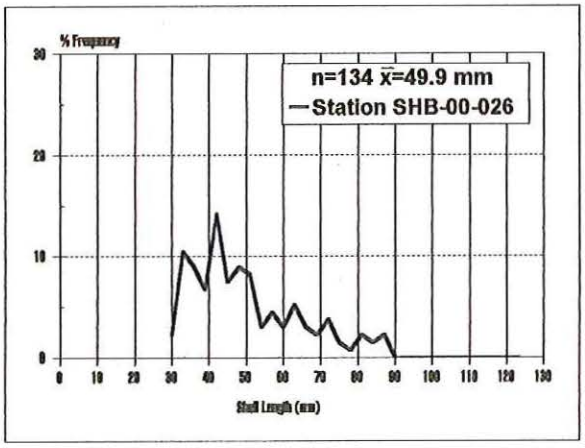
Appendix V. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geq 100$) in Sandy Hook Bay.

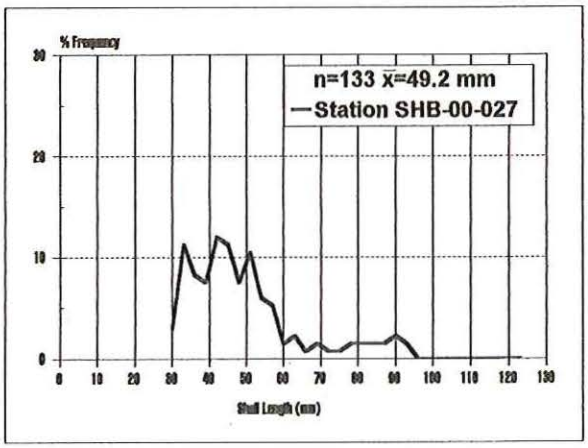




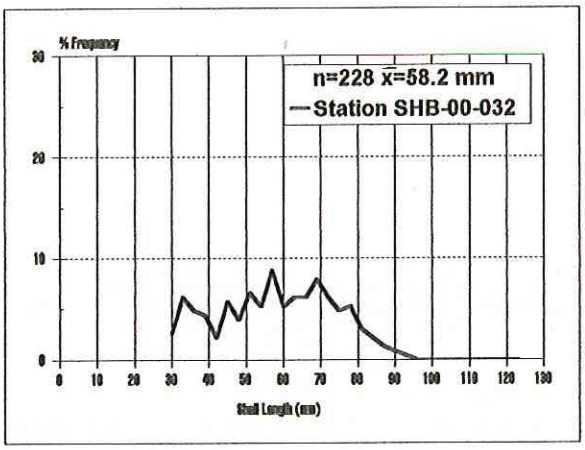


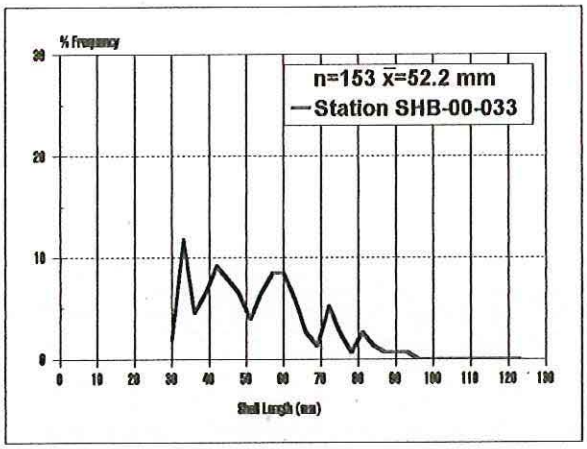


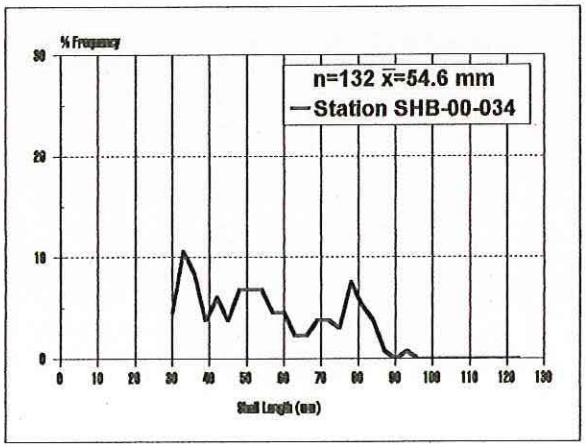


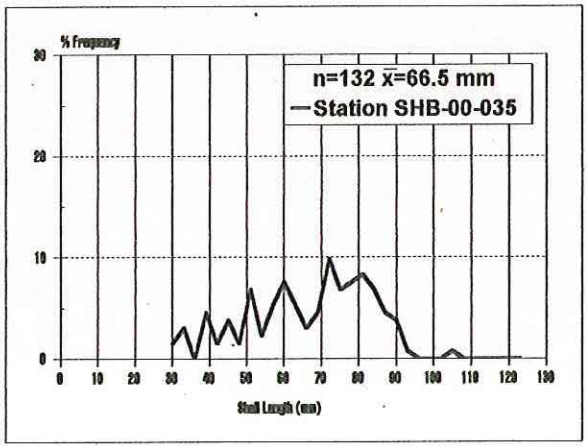


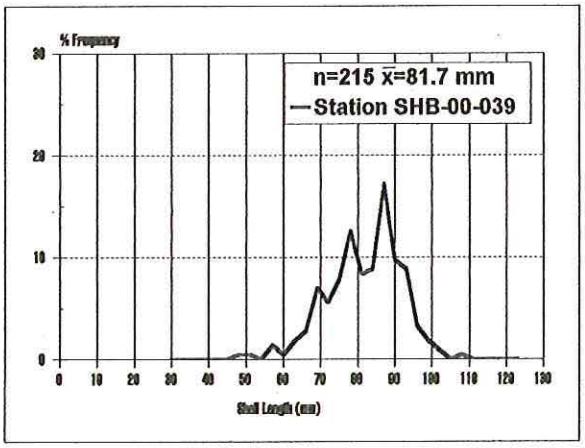
Appendix V. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geq 100$) in Sandy Hook Bay.

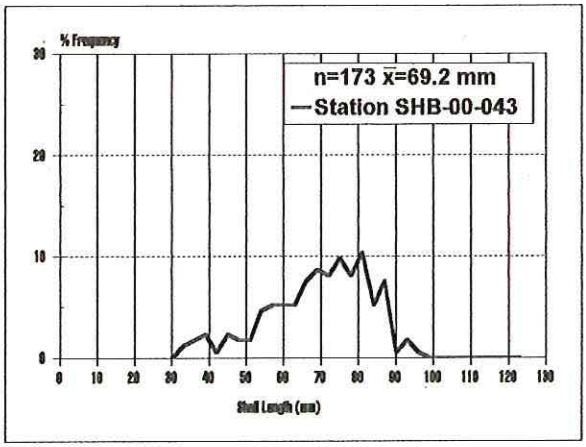




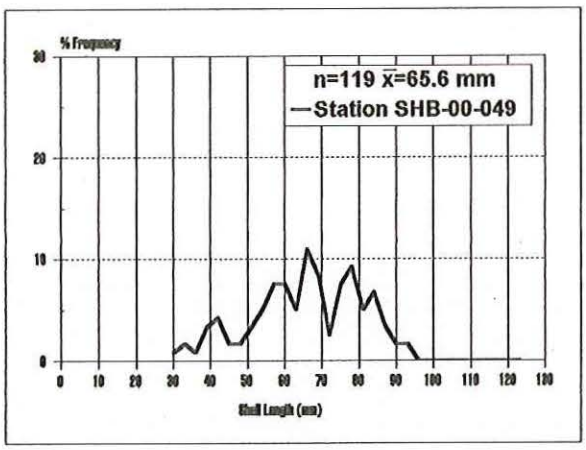


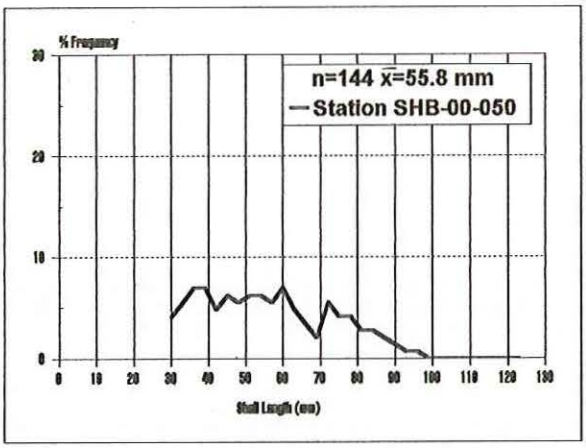


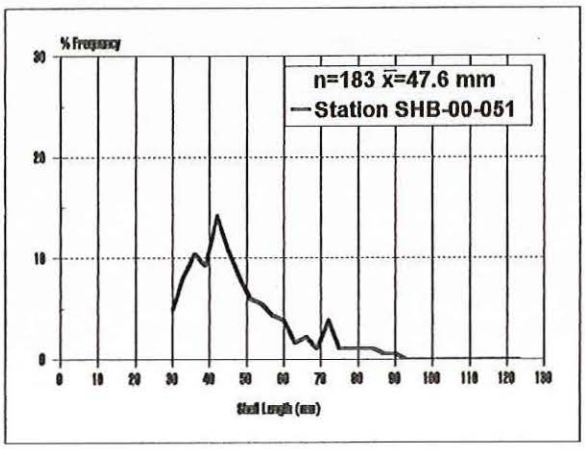


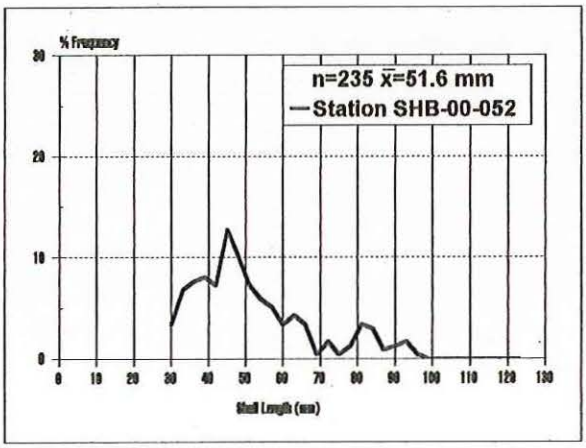


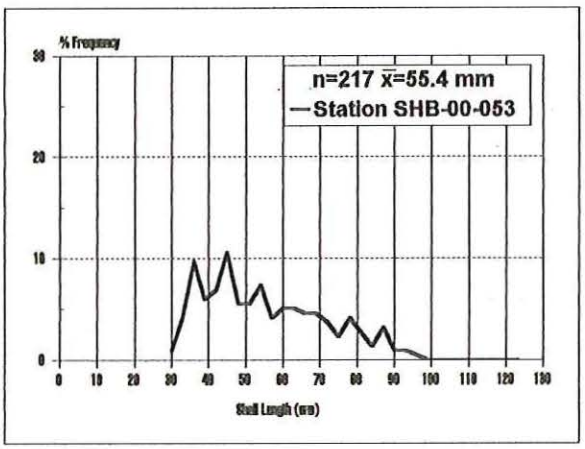
Appendix V. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geq 100$) in Sandy Hook Bay.

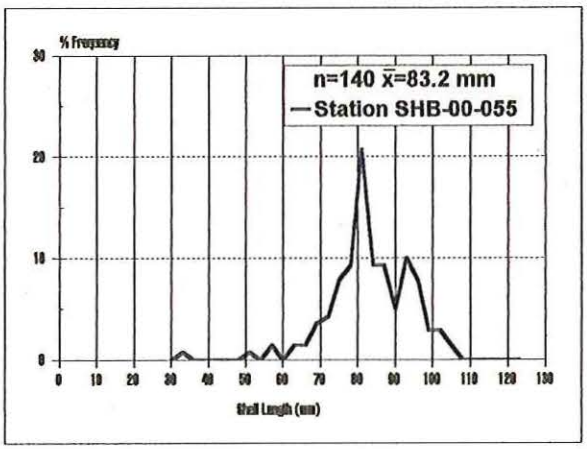




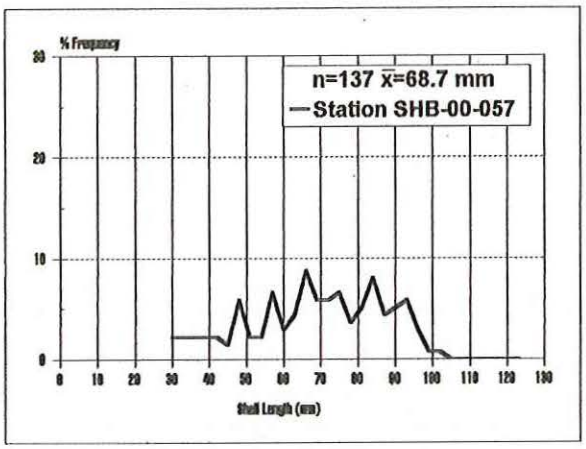


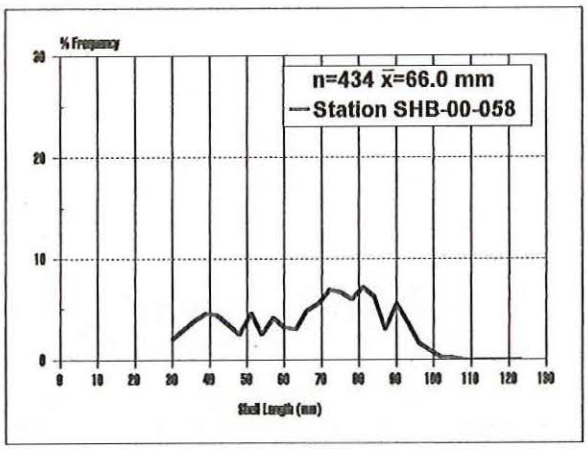


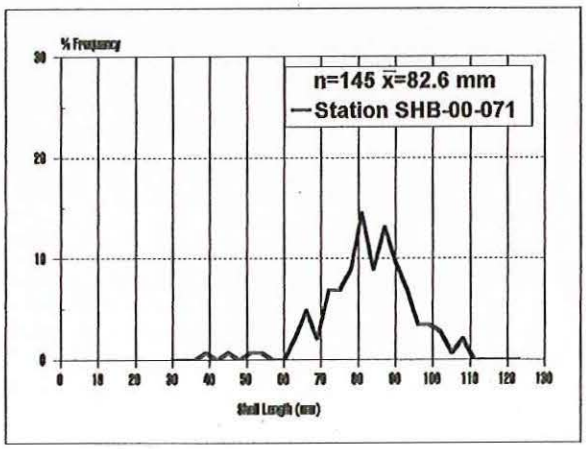


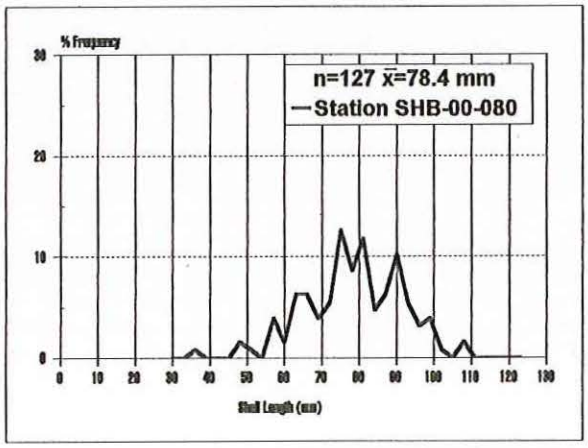


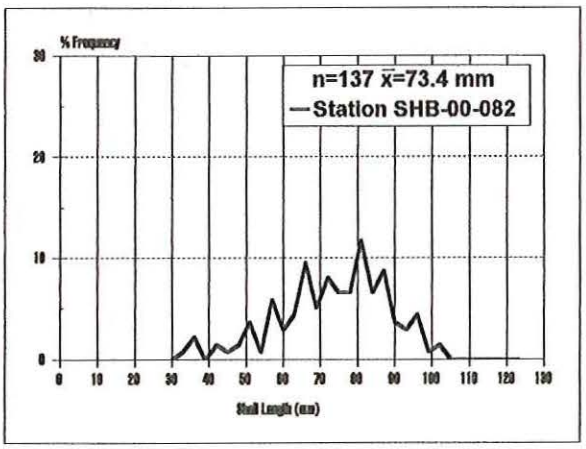
Appendix V. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geqslant 100$) in Sandy Hook Bay.

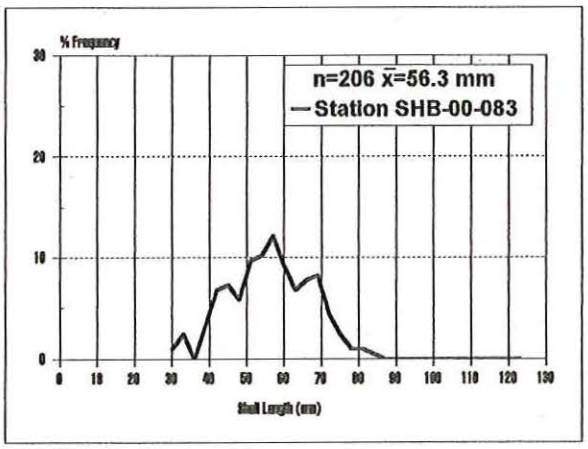




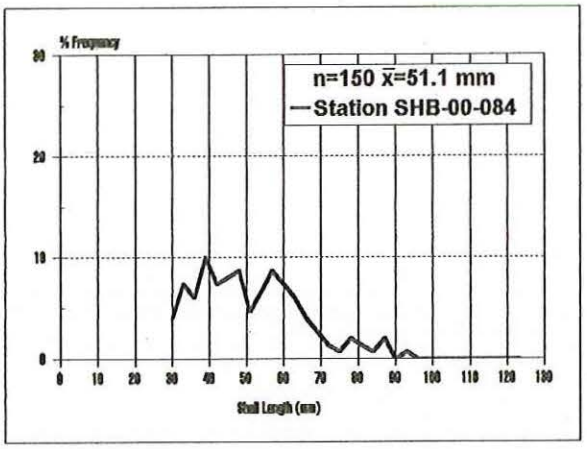


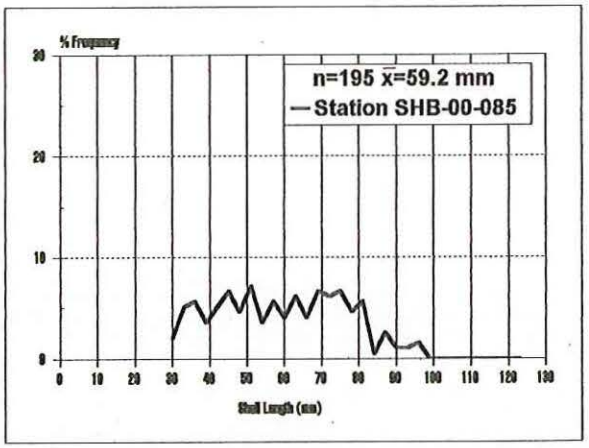


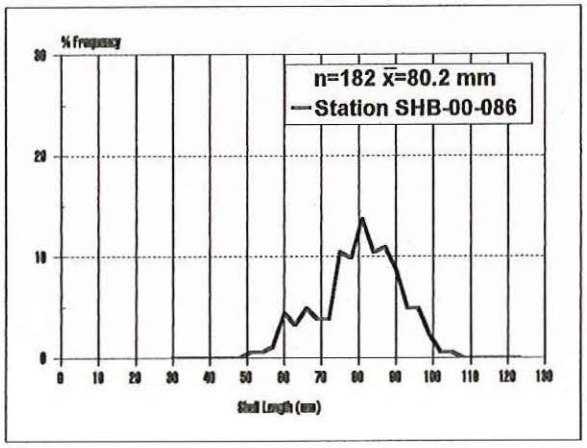


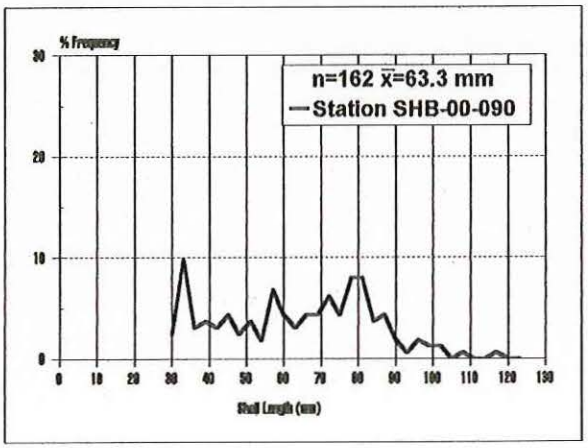


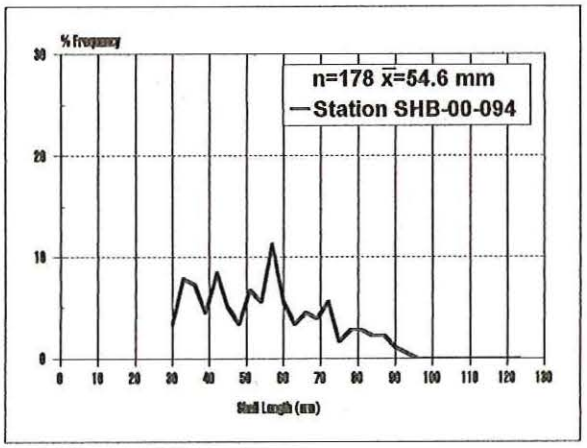
Appendix V. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for individual stations ($n \geq 100$) in Sandy Hook Bay.

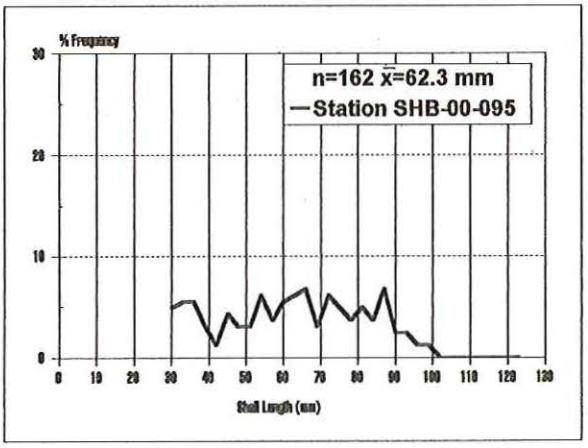






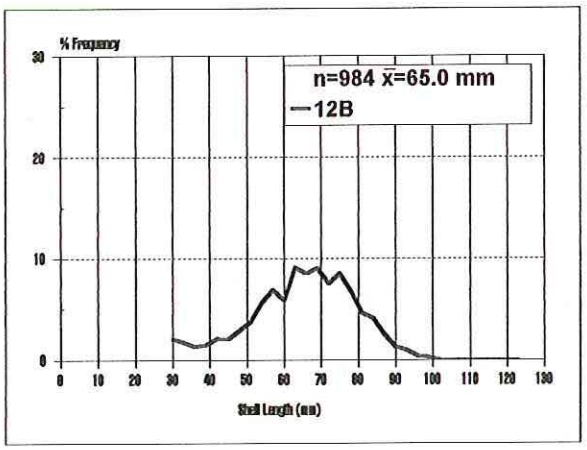


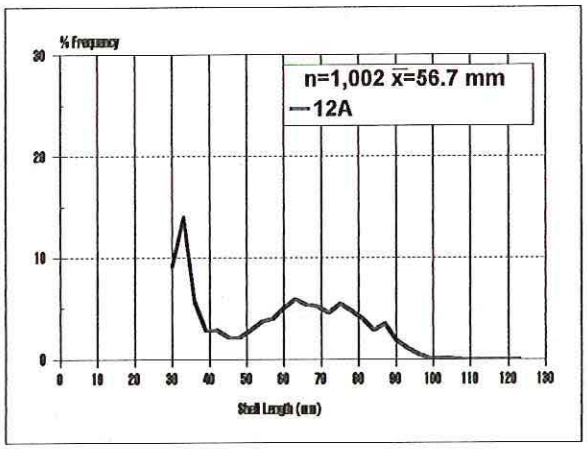


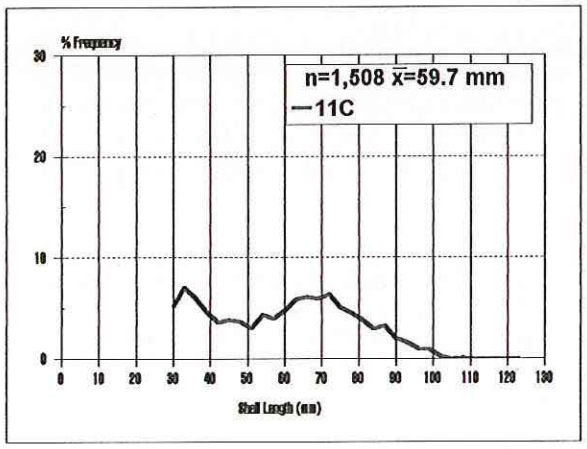


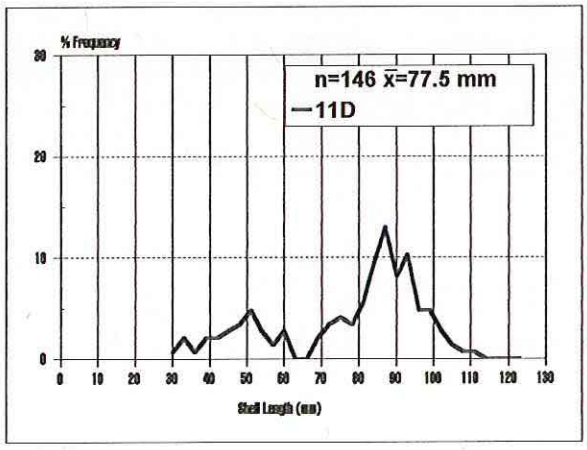
APPENDIX VI.

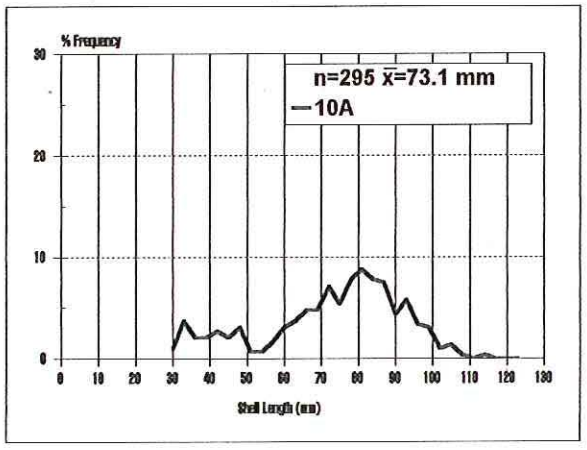
Appendix VI. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for relay and depuration harvest areas (n ⩾ 100) in Raritan and Sandy Hook bays.

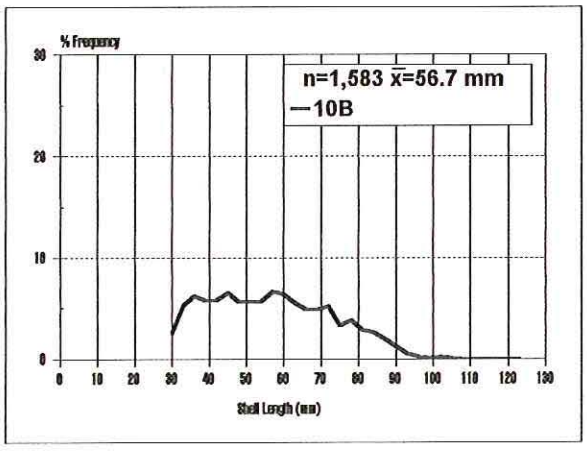




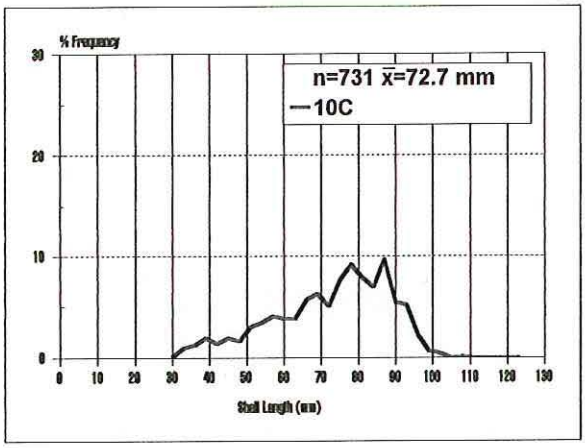


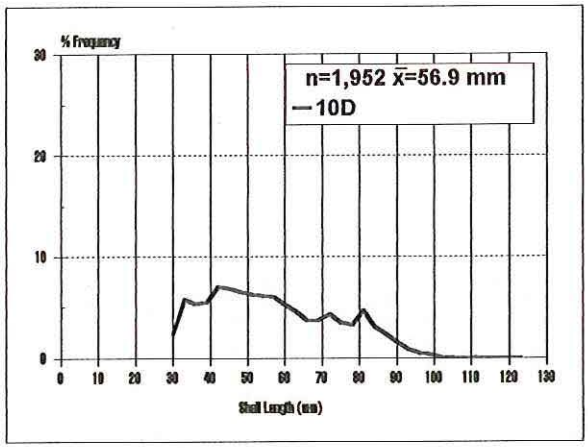


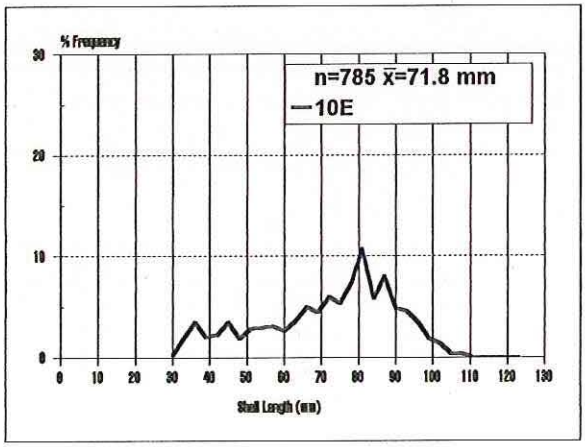


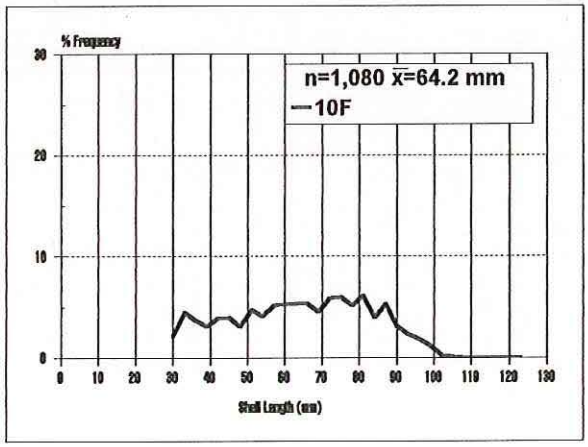


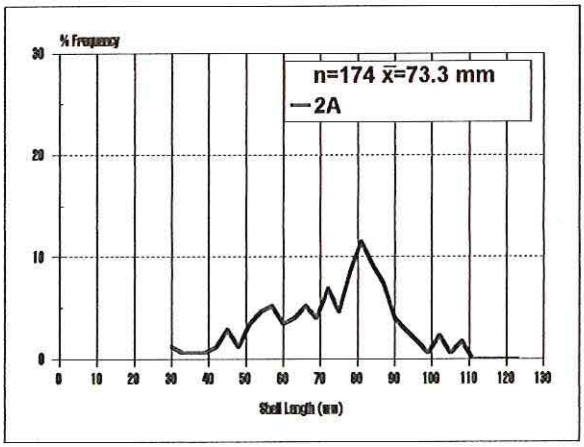
Appendix VI. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for relay and depuration harvest areas (n ⩾ 100) in Raritan and Sandy Hook bays.

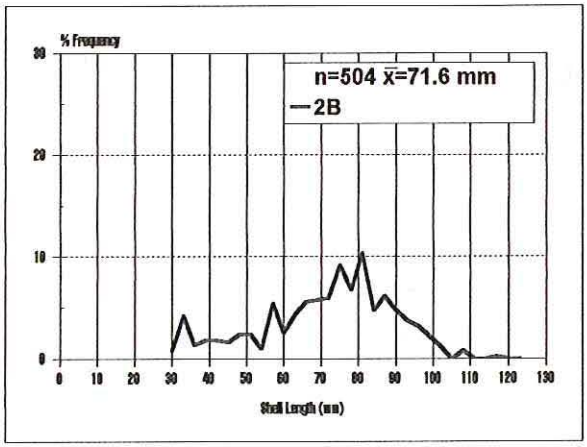












Appendix VI. 2000 Shellfish Inventory: length-percent-frequency distribution graphs for relay and depuration harvest areas (n ⩾ 100) in Raritan and Sandy Hook bays.