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Assessment and Current Status of Offshore Surf Clam, Spisula solidissima Populations off the Middle Atlantic Coast of the United States - Autumn 1982

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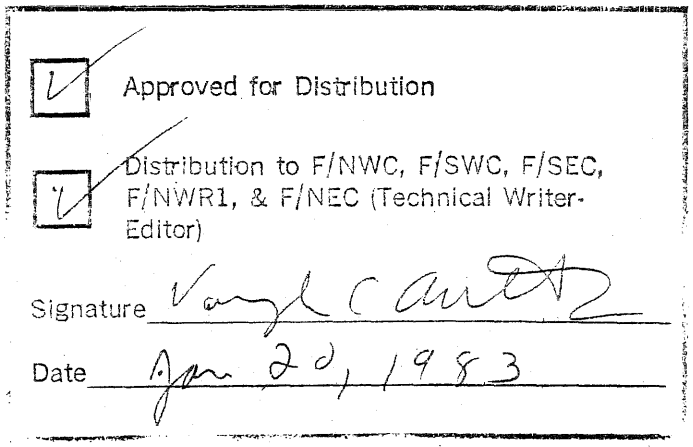

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SUMMARY

Atlantic surf clam, Spisula solidissima, populations inhabiting offshore (Fishery Conservation Zone) waters of the United States East Coast have been managed since November 1977 under provisions of the Magnuson Fishery Conservation and Management Act (MFCMA). Prior to enactment of the comprehensive management plan, stock abundance and total commercial landings declined; landings decreased from 96.1 million pounds of shucked meats in 1974 to 49.1 million pounds in 1976. Regulation of the fishery has proceeded with one objective being the re-building of Middle Atlantic offshore stocks. Various regulatory devices to attain this and other objectives have included annual landings quotas, a moratorium on new vessel entrants, closure of areas to protect pre-recruit sized clams, effort restrictions, and, most recently, a minimum clam size. This report provides an updated stock status review for Middle Atlantic waters (through December 1982) based on commercial vessel logbook data and catch sampling and the results of research vessel surveys conducted by the Northeast Fisheries Center.

Total surf clam landings during 1981 increased to 46.1 million pounds, up 22% from the 1980 level of 37.7 million pounds. The proportion of landings taken from the Fishery Conservation Zone (FCZ) in 1981, however, decreased to 81% of total landings reflecting a large (189%) increase in catches from state waters (primarily New Jersey). Through November 1982, FCZ landings were 27.6 million pounds or 75% of the total 1981 FCZ catch. Thus, it is likely that 1982 FCZ surf clam landings will decline from the 1981 level, and will not approach the 1982 annual catch quotas of 40 million pounds.

Significant changes in the areal distribution of fishing effort and offshore landings began in late 1980. Prior to that time, and for several successive years, between 80 and 90% of the offshore landings were derived from the Delmarva Region. Delmarva landings in 1981, however, declined to 48%, while those off Northern New Jersey, Southern New Jersey and Southern Virginia-North Carolina accounted for 48, 1, and 3%, respectively, of the offshore total. Through November 1982, Delmarva landings remained relatively constant at 47%, while the proportion from Northern New Jersey declined to 40%, and Southern New Jersey and Southern Virginia-North Carolina landings increased to 7 and 6% of the total. The decline in landings from Northern New Jersey during 1982 is at least partially explained by the relatively large numbers of pre-recruit sized clams. Expansion of fishing activity off Southern New Jersey, Southern Virginia-North Carolina, and Southern New England during 1982 in part represented searching activities for dense beds of harvestable sized clams.

Decreased rates of harvest (as measured by commercial vessel catch per effort) between the third quarter of 1981 and third quarter of 1982 resulted partially from implementation of the minimum clam size regulation ($5\frac{1}{2}$ inches, shell length). Relatively strong year classes off New Jersey and the Delmarva Peninsula were only partially recruited to harvestable size. Thus, culling of catches to meet the minimum size requirement was intensive, particularly off New Jersey.

Abundant pre-recruit sized resources currently exist off Northern New Jersey and Delmarva. Portions of the relatively strong 1976 year class off Northern New Jersey recruited to harvestable size during 1982, resulting in a 40% increase in the research vessel survey biomass index for clams $\geq 5\frac{1}{2}$ inches between the 1981 and 1982 surveys. Biomass of harvestable sizes off Delmarva, however, increased only moderately (9%), as much of the strong 1977 year class remained below the minimum size.

Growth rate projections for the 1976 and 1977 year classes (off Northern New Jersey and Delmarva, respectively) indicate that the harvestable-size biomass during 1983 will increase substantially off Northern New Jersey, but only moderately off Delmarva. Significant increases in the exploitable resource of Delmarva will probably occur beginning in 1984.

Surf clam resources off Southern New Jersey remain dominated by large clams; survey indices of pre-recruit sizes show no substantial improvement. Although abundance of harvestable size clams is low relative to previous years, the large average size of clams caught off Southern New Jersey has resulted in an increase in effort there, since catches do not have to be culled as extensively to meet the minimum size requirement.

Several high-density beds of surf clams exist in the Southern-Virginia-North Carolina area, however, most of the resource in the region is composed of clams smaller than the minimum legal size. Increased catches off SVA-NC in 1982 are probably reflective of exploratory operations; significant increases in SVA-NC catches are not anticipated during 1981.

Although the absolute size of pre-recruit resources off New Jersey, Delmarva, and Southern-Virginia-North Carolina are not known, it is clear that adequate resource currently exists to support the fishery at current levels (40 million pounds of shucked meats annually) until the late 1980's-early 1990's. However, as the quota is increased in the short term (1983-1985) the risk of a resource shortfall in later years is increased due to the lack of additional new recruitment until at least 1987-1988. The effects of significant increases in the quota during 1983 will be to reduce the long-term utilization of pre-recruits off Northern New Jersey and Delmarva, due to increased levels of discarding.

INTRODUCTION

Surf clam (Spisula solidissima) populations inhabiting the Fishery Conservation Zone (FCZ:3-200 n. miles from the US coast) are currently regulated under a fishery management plan (FMP) for Atlantic Surf Clam and Ocean Quahog Fisheries first implemented in November 1977. Objectives of the initial FMP were: (1) "to rebuild declining surf clam populations to allow eventual harvesting approaching the 50 million pound level, which is the present best estimate of the maximum sustainable yield (MSY), based on the average yearly catch from 1960-1976," (2) "to minimize short term economic dislocations to the extent possible consistent with objective 1," and (3) "prevent the harvest of ocean quahog from exceeding maximum sustainable yield and direct the fishery toward maintaining optimum yield" (Mid-Atlantic Fishery Management Council 1977). Various regulatory devices used to attain these goals have included annual and quarterly landing quotas, weekly fishing effort restrictions, a moratorium on new vessel entrants, closures of specific areas to protect small clams (future recruitment), and most recently (26 July 1981), a minimum clam size of $5\frac{1}{2}$ inches. Appendix I summarizes management actions taken to regulate the fishery since adoption of the initial FMP.

This report presents an updated assessment of the status of surf clam resources in offshore Middle Atlantic areas of the FCZ. Previous resource evaluations were presented in the following assessment documents: Brown et al. 1977; Serchuk et al. 1979; Murawski and Serchuk 1979; Serchuk and Murawski 1980; and Murawski and Serchuk 1981. Research vessel survey data, commercial vessel performance, and biological characteristics of the catch during 1982 are analyzed in an historical context to provide measures of

relative resource abundance, recruitment levels, and the potential impacts of various management strategies.

COMMERCIAL FISHERY

Total surf clam landings during 1981 increased to 46.1 million pounds of shucked meats, up 22% from the 1980 level of 37.7 million pounds (Table 1). The proportion of total landings taken from the FCZ during 1981 decreased to 81% (from 92% in 1980), primarily because of a 189% increase in landings from territorial waters (primarily New Jersey). The dramatic increase in 1981 landings from New Jersey state waters was primarily due to recruitment of the relatively strong 1976 year class, which dominates offshore populations off Northern New Jersey as well.

Total FCZ landings for 1982 as of 6 December (as reported in mandatory logbook submissions) were 27.6 million pounds. It is likely, therefore, that the 1982 FCZ surf clam landings will decline from the 1981 level and will not reach the 1982 annual quota of 40 million pounds of shucked meats (2.35 million bushels at 17 pounds of meat per bushel). The decline in 1982 FCZ landings is reflective of the decreased rates of surf clam harvest, in part as a result of adoption of the minimum clam size ($5\frac{1}{2}$ inches shell length), effective 26 July 1981. Prior to that date, 1981 surf clam catches were dominated by small clams from the relatively strong 1976 and 1977 year classes off New Jersey and the Delmarva Peninsula, respectively. Following the third calendar quarter of 1981, FCZ surf clam catch rates (as measured by commercial catch per unit of effort) declined significantly and remained relatively low during most of 1982. The other major factor contributing to reduced FCZ catches in 1982 was economic conditions within the surf clam industry's processing sector.

Enforcement of the minimum size regulation necessitated that most small clams be culled from catches. Because of the dominance of small clams in populations inhabiting Northern New Jersey and Delmarva Peninsula waters, significant fishing effort during 1982 was shifted to other areas, particularly off Southern New England and most recently in the Southern Virginia-North Carolina area, in an attempt to locate commercial concentrations of large clams.

A portion of the area off Atlantic City, New Jersey, originally closed to protect high density areas of small surf clams, was re-opened on 3 October 1982. However, the relatively large proportion of sub-legal sized clams in catches from the re-opened area resulted in many vessels fishing elsewhere. Resultantly, catch rates in the Northern New Jersey assessment area increased only slightly during the final quarter of 1982.

Commercial Vessel Performance Data

Commercial vessel performance data (number of trips, areas fished, landings, hours fished, and catch per effort) were derived from the mandatory weekly logbook submissions. These data were grouped by vessel size category (1-50 GRT: Class 1; 51-100 GRT: Class 2, 101+ GRT: Class 3) and analyzed within each of four assessment areas, by calendar quarter. These areas, along with the LORAN coordinates defining them, are given in Figure 1B. Assessment areas generally reflect homogeneous regions with respect to the dynamics of clams populations inhabiting them, and relatively distinct fishery production areas. Tables 2-6 and Figures 2-6 summarize logbook data available since the inception of the mandatory record keeping program.

The total number of vessel trip records amendable for analysis increased from 3,466 in 1978 to 4,488 in 1979, declined to 3,893 in 1980, and 3,420 in 1981, and subsequently increased to 3,661 through 6 December 1982. This pattern generally reflects the pattern of vessel effort limitations (hours of available fishing time per week, see Appendix I).

During 1978-1980, greater than 80% of trips, catch, and fishing effort was generated in the Delmarva assessment area. Within these areas, percentage of trips, catch, and effort has generally increased with vessel size indicating the dominance of large vessels working in that area. Contrariwise, the proportion of trips generally decreased with vessel size in Northern and Southern New Jersey areas, due to the concentration of small vessels that fish in New Jersey state waters.

The Delmarva area accounted for 85-92% of the total Middle Atlantic landings from 1978 through 1980 (Table 6; Figure 6). However, the percentage of landings from Delmarva declined sharply to 48% in 1981, and 47% in 1982. Northern New Jersey landings accounted for less than 3% of the total during 1978-1980, but subsequently increased to 48% in 1981, and 40% in 1982. Southern New Jersey landings declined from 6% in 1978 to 1% in 1981, increasing to 7% in 1982. The Southern Virginia-North Carolina area accounted for less than 1% of landings from 1978-1980, increasing to 3% in 1981 and 6% in 1982.

Tonnage class 3 vessels (101+ GRT) annually accounted for between 70-79% of Middle Atlantic landings from 1978-1982 (average 74%). The percentage increased from 70 to 79% between 1978 and 1980, and declined to 75 and 72% in 1981 and 1982. Class 2 vessels (51-100 GRT) generated 22% of landings during the period (18-26% on an annual basis), while class 1 vessels (1-50

GRT) accounted for 4% (2-6%) of landings. During 1982 the proportion of landings generated by class 2 vessels increased to 23% (from 22%) in 1981, while class 1 vessels accounted for 6% of the catch (an increase of 3% from 1981 levels).

Commercial Vessel Abundance Indices

Indices of relative vessel performance were computed as the mean number of bushels landed per hour fishing (C/E); computations were made for each calendar quarter and vessel class. To the extent that fishing power within vessel class has remained constant over the past five years, C/E data will reflect relative resource abundance (Tables 2-5, Figures 2-5). Analyses of temporal trends in C/E are present below for each assessment area separately.

Northern New Jersey

Catch per effort calculations for the Northern New Jersey (NNJ) assessment area are based on 102, 129, 314, 1645, and 1644 vessel trips for the years 1978-1982 respectively. Significant increases in the number (and percentage of total) vessel trips within the NNJ area are notable beginning in the fourth calendar quarter of 1980 (Table 2; Figure 2). Clearly, shift of effort from the Delmarva (DMV) and to a lesser extent the Southern New Jersey (SNJ) areas was in response to greatly increased catch per effort values in NNJ. Between the second and third quarters of 1980 C/E increased 43%, 31%, and 219% for vessel classes 1-3 respectively, indicative of a relatively strong recruitment in the area (see "Research Vessel Surveys"). Catch per effort of class 1 vessels peaked in the fourth quarter of 1980 at

69.1 bushels/hour, and subsequently declined to 28.7 bushels/hour in the third calendar quarter of 1981. Catch per effort for Class 2 and 3 vessels peaked in the second and third quarters of 1980, respectively. However, these data do not necessarily indicate a significant decline in resource abundance during 1981. Rather, they may represent statistical artifacts of increased sample size (second quarter vessel trips increased 6.5 fold between 1980 and 1981).

Average catch/effort (C/E) figures were 39.0, 43.4, and 75.2 bushels/hour during 1980 for vessel classes 1-3, and 31.1, 49.4, and 64.4 bushels/hour through the third quarter of 1981. During 1980, and through the third quarter of 1981, average C/E for all vessel classes operating in NNJ was significantly greater than corresponding values from SNJ, DMV, and Southern Virginia-North Carolina (SVA-NC). After 26 July 1981 (effective date of implementation of the $5\frac{1}{2}$ inch minimum size) C/E values for the various vessel classes declined 3, 23, and 6% respectively from second quarter values. Fourth quarter C/E figures declined 21, 38, and 19% from corresponding third quarter catch rates. Average C/E generally continued to decline through the first two quarters of 1982. The decrease in average catch per effort associated with implementation of the size limit was primarily due to the fact that virtually all of the Northern New Jersey offshore surf clam resource consisted of a single year class (spawned in 1976), much of which was (and remains) below the minimum legal size (see "Research Vessel Surveys").

Catch per effort values for all vessel size classes increased during the fourth calendar quarter off Northern New Jersey, primarily in response to a partial re-opening of the Atlantic City closed area. However, catch rates in the fourth quarter were substantially below those exhibited prior to enactment of the minimum size regulation (Table 2; Figure 2).

Southern New Jersey

Catch per effort calculations for the Southern New Jersey assessment area are based on 292, 398, 239, 75, and 353 vessel trips for the years 1978-1982 respectively. Average annual C/E values for class 3 vessels increased steadily from 1978 through 1980, remained stable in 1981, and declined slightly in 1982. Indices for the other vessel size classes are more variable, probably as a result of the limited number of vessel trip records available for analysis. Average C/E figures for class 2 vessels exhibited a declining trend from 1978 through 1980, with a subsequent increase in 1981-1982. C/E values from class 1 vessels declined sharply between the third and fourth quarters of 1979 and have since stabilized. The differing trends in annual C/E values for class 3 vessels vs. classes 1 and 2 may reflect differential patterns in resource utilization (e.g. class 1 and 2 vessels may not have fished in the same areas as class 3 vessels) or differing changes in relative fishing power during the study period. During this time, some larger vessels (i.e., class 3) added a second dredge ("double rigging") while class 1 and some class 2 vessels were incapable of such conversions.

Average 1982 C/E values for the SNJ assessment area were lower than NNJ, DMV, and SVA-NC values for vessel classes 1 and 3, and were approximately equal to NNJ and DMV values for vessel class 2. In spite of the relatively low catch rates in the SNJ area during 1982, the proportion of total Middle Atlantic surf clam landings derived from SNJ increased from 1% in 1981 to 7% in 1982. This seeming ambiguity is explained by the fact that surf clam populations off SNJ during 1982 were dominated by individuals greater than the minimum legal size (see "Research Vessel") and hence required much less culling to land clams consistently with the minimum size requirement than in the NNJ and DMV areas.

Delmarva

The numbers of trips analyzed from the Delmarva assessment area were 3062, 3922, 3322, 1611, and 1548 for the years 1978-1982 respectively. Average catch per effort values for vessel classes 1 and 2 remained relatively stable from 1978 through the third quarter of 1980; C/E values for class 3 vessels exhibited an increasing trend during the same period, probably in part due to increases in fishing power of class 3 vessels (Table 4; Figure 4). All vessel classes showed increases in C/E during the fourth quarter of 1980 which persisted through the third quarter of 1981. Subsequent to the enactment of the minimum size regulation (July 1981) catch per effort indices declined for all vessel classes and remained depressed through the fourth quarter of 1982. Although C/E off Delmarva increased during late 1980-1981, there was a coincident shift of effort from the Delmarva area to Northern New Jersey, where C/E values were even higher and recruiting clams were larger (see "Biological Fishery Sampling" and "Research Vessel Surveys"). During the first three quarters of 1982 the proportion of Middle Atlantic surf clam catch and associated fishing effort derived in the Delmarva region increased for all vessel size classes (Figure 4). However, with the partial re-opening of the Atlantic City closed area (October 1981) and increase in effort in the Southern Virginia-North Carolina area, the Delmarva proportion of total catch and effort again declined.

Southern Virginia-North Carolina

Catch per effort computations for the Southern Virginia-North Carolina assessment area are based on 10, 39, 18, 89, and 116 vessel trips for 1978-1982 respectively. Virtually all (95%) of all vessel trips in the

SVA-NC area during 1978-1982 were class 2 and 3 vessels, 65% were class 3 vessel trips. The numbers of vessel trips by class and calendar quarter (Table 5) during 1978-1980 were so few that C/E indices are probably not reliable indices of relative clam abundance. The proportion of Middle Atlantic surf clam landings derived from the SVA-NC assessment area increased sharply during the final two quarters of 1982, primarily due to increasing effort in the region by class 3 vessels (Figure 5). Average catch per effort values for the SVA-NC area were substantially greater than corresponding indices in the three other assessment regions (Table 5). However, these catches consisted of a large proportion of clams below minimum legal size (47% of clams sampled from these catches were below $5\frac{1}{2}$ inches shell length, see "Biological Sampling of the Fishery"). Thus, the apparent high abundance of surf clams in the SVA-NC assessment area (as measured by commercial C/E statistics) is probably an artifact of the lack of culling of catches from the region in 1982. Results of research vessel surveys confirm the relatively large numbers of sub-legal sized clams in the SVA-NC area (see "Research Vessel Surveys").

BIOLOGICAL SAMPLING OF COMMERCIAL FISHERY

Length frequency sampling of commercial clam landings is routinely conducted in the major surf clam fishing ports of the Middle Atlantic (Atlantic City and Cape May-Wildwood, NJ; Ocean City, MD; Chincoteague, VA). Samples are analyzed based on assessment area from which they were caught. The sampling protocol is to measure 30 clams from each vessel trip. Since there are often large differences in the catches of individual vessels sampled, length frequencies are weighted by the number of bushels landed in each trip.

Weighted yearly length frequency data for the period 1976-December 1982 are presented in Figures 7-9. Commercial length frequencies from all assessment areas were unimodal during the period 1976-1979, with most landed clams being in the 15-18 cm (6-inch) range. Prior to 1980 virtually all surf clams landed were larger than 12 cm (4-3/4 inches). During the period 1976-1979 a relatively small proportion of sampled landings were comprised of clams smaller than the current minimum legal size ($5\frac{1}{2}$ inches or 14 cm). However, beginning in 1980 and 1981, strong incoming year classes off Northern New Jersey and the Delmarva Peninsula resulted in a general decline in the average size of surf clams being landed.

Samples from the Northern New Jersey area during 1980 were entirely comprised of small clams (8-13 cm), however, the number of individual sampled from the NNJ area during 1980 was small (N = 60, Figure 7). During 1981, samples were comprised of relatively large clams (over 80% $\geq 5\frac{1}{2}$ inches). Much of the 1981 surf clam catch off NNJ was derived from an area known as Barnegat Ridge, where relatively rapid growing individuals of the 1976 year class were abundant. During 1982 the size distribution of surf clams from the NNJ area shifted to smaller individuals (45% were in the 14 cm size group, or between $5\frac{1}{2}$ and 5-7/8 inches), reflecting declining catches from the Barnegat Ridge area, and the increasing importance of smaller clams from the 1976 year class from other NNJ areas. After 3 October 1982 much of the NNJ landings were derived from the re-opened portion of the Atlantic City closure area, where the average size of clams were the smallest in the NNJ area.

Size distributions of SNJ clams changed little during 1976-1982 (Figure 8). Only a small proportion of clams (less than 1%) were under

5½ inches during 1982, reflecting the dominance of large sized individuals in populations inhabiting the SNJ region. This is consistent with size distribution data of the SNJ resource derived from research vessel sampling (see "Research Vessel Surveys").

During the period 1976-1979, the size distribution of surf clams from the Delmarva assessment area remained relatively stable with most clams in the 15-17 cm range (Figure 9). However, beginning in the latter portion of 1981, a larger proportion of catches were comprised of clams smaller than 5½ inches. Samples during 1981 were about equally divided among clams less than, and greater than 5½ inches (47%-53%). Sampled catches of small clams during 1982, however, declined to about 12%, indicative of increased enforcement of the minimum size regulation.

Landings of surf clams caught in the Southern Virginia-North Carolina assessment area were first sampled during 1982. Clams sampled from the region (N = 762) were about equally divided between those less than 5½ inches (47%) and those greater than or equal to the minimum legal size (53%). These data are consistent with size distribution of the clam population inhabiting the SVA-NC region as interpreted from research vessel surveys (57% less than 5½ inches in shell length).

RESEARCH VESSEL SURVEYS

Research vessel shellfish assessment surveys in offshore Mid-Atlantic waters have been conducted since 1965 (Table 7). Sampling procedures, design, and gear specifications have previously been described in Murawski and Serchuk (1981).

Survey strata were grouped into four sets corresponding to the geographical boundaries of the principal offshore surf clam fishery areas (i.e., Northern New Jersey, Southern New Jersey, Delmarva, Southern Virginia-North Carolina; Figure 1A) to facilitate comparisons with the commercial fishery data. Strata set groupings, areas, and depth ranges of the various individual strata are given in Table 8. For each strata set, relative abundance indices were calculated in terms of stratified mean number and mean weight per tow, standardized to a 1.5 m (60 inch) wide dredge towed for five minutes (see Murawski and Serchuk 1979 for appropriate computational formulae). Length frequency data and shell length-meat weight relationships were used to derive survey catch per tow indices (numbers, meat weight) (Serchuk and Murawski 1980). Weight per tow indices for the SVA-NC area are not presented due to the lack of a reliable length-weight equation for this region.

Additionally, abundance indices (in numbers) were calculated utilizing a logarithmic transformation, and measures (standard deviation, SD) of the within-stratum variability of survey abundance indices for each survey cruise were derived (see Appendixes II-VII for data from NNJ, SNJ and DMV assessment areas).

Survey estimates of relative abundance from several of the assessment areas (NNJ, DMV) have become more variable in recent years (Appendices II and VII) primarily as a result of the contagious nature of the distribution of individual year classes (highly aggregated). Large increases in the variability (as measured by SD) of abundance measures have occurred in survey strata where these small clams are particularly abundant (strata 88 off NNJ, and strata 85 and 9 off DMV). In the case of stratum 88, SD's increased two orders of magnitude between the January 1978 survey and the August 1982 survey. Similar increases in variability occurred in stratum 85 and to a

lesser extent in stratum 9. In order to stabilize the variance within the survey strata, a logarithmic transformation of the catch data ($l_n(X+1)$, where X represents individual survey catches in numbers was performed (Elliott 1977). This transformation ideally produces an abundance index less subject to influence by large but infrequent individual survey samples catches.

Catch per tow indices for the entire time-series are presented in Tables 9-12. Included are percentages of the catch data (numbers and weight) above the current minimum harvestable size (5½ inches). Survey length frequency distributions for NNJ, SNJ, and DMV, 1976-1982, are given in Figures 10-12.

Northern New Jersey

Stratified number per tow indices declined steadily between May 1965 and April 1976, and more abruptly between 1976 and 1977 (Table 9). From May 1965 to April 1976 total numbers declined 66% while clams 5½ inches or greater dropped in abundance by 53%, and those less than 5½ inches by 85%. The proportion of total numbers per tow comprised of clams ≥ 5½ inches increased from 59% in May 1965 to 82% in 1976, indicative of poor recruitment during this period. Biomass indices of clams < 5½ inches declined 90% during the period. Primarily as a result of the hypoxic water event off the New Jersey coast during 1976, the total number per tow index declined 81% between 1976 and 1977; total biomass 89%. Numbers and weight per tow further declined from 1977 to January 1978. The December 1978 survey revealed significant new recruitment in the NNJ assessment area. Subsequent age and growth analyses indicate that these clams were spawned in 1976.

Surveys conducted after 1978 have confirmed the presence of this cohort and provide data to track growth rate of this year class (Figure 10).

Total mean number per tow increased from 2.06 during the January 1978 survey to 44.88 in December 1978. In four subsequent surveys, total numbers per tow have averaged 59.29. Although the August 1982 indices increased from August 1981 values (particularly for clams < 5½ inches) most of the differences result from the variability of the index due to the highly aggregated nature of the strong 1976 year class off NNJ. Since transformed abundance indices [stratified mean ($l_n(x+1)$ numbers per tow] increased only slightly between 1981 and 1982 (2.47 to 2.57), the relative abundance (numbers) of clams < 5½ inches has probably changed little, since only a portion of the 1976 year class has grown to harvestable size (Figure 10). Weight indices have, however, increased markedly due to growth.

Current mean abundance levels off Northern New Jersey (total numbers per tow, all sizes) are equivalent to the period 1965-1969 (Table 9). The present resource is, however, comprised mostly of clams less than 5½ inches (90.1% in August 1982), while in 1965-1969, the population was primarily composed of clams greater than 5½ inches (average 78%).

Total weight per tow indices have increased since Jaunary 1978 (August 1980-82 average 5.25 kg/tow) to levels equivalent to the mid-late 1960's, primarily due to the large proportion of small clams in recent survey samples. Weight per tow of commercial sized clams increased 40% between August 1981 and August 1982 survey samples, as significant quantities of the 1976 year class reached harvestable size. However, biomass of harvestable size clams remains significantly below levels of the mid-late 1960's (the 1982 biomass index of 1.67 kg/tow is 38% of the 1965-1969 average of 4.40 kg/tow).

Year classes spawned from 1977-1980 appear relatively weak with respect to the 1976 cohort off Northern New Jersey. Since clams first recruit to the survey gear at about age 2, evaluations of the strength of 1981 and 1982 year classes cannot presently be performed.

The single year class nature of the pre-commercial size resource off NNJ allows for validation of growth curves originally derived from specimens taken during the December 1978 survey (see Serchuk and Murawski 1980 for a comprehensive discussion of age and growth data). Modal length frequency progressions of the 1976 cohort off NNJ are virtually identical to those predicted from von Bertalanffy growth equations, notwithstanding changes in the average density of clams in the survey area as a whole. Nevertheless, the question of density dependent growth has not been comprehensively investigated.

Southern New Jersey

Total stratified mean number and weight per tow indices for the Southern New Jersey assessment area declined from 1965-1970, increased in 1974, and subsequently dropped to the lowest observed values in 1977 (Table 10; Figure 11). Since 1980 total indices have stabilized, but at a level considerably below that observed during the mid to late 1960's. The August 1981 and August 1982 number per tow indices were 87 and 74% less than the 1965-1969 average, respectively. Similarly, weight per tow values observed in the August 1981 and 1982 surveys were 79 and 64% less than the 1965-1969 average (9.64 kg/tow). Pre-recruit indices for the SNJ area were highest in 1965. Although slight improvement in pre-recruit indices was observed in the 1978-1980 surveys, the average number per tow of < 5½ inch surf

clams off SNJ during December 1978-1980 surveys (3.31) was 8% of the comparable average off Northern New Jersey. Pre-recruit indices in weight and numbers from the August 1982 cruise remained low, indicative of a relatively poor pre-recruit resource in the SNJ area. Since 1966 clams $\geq 5\frac{1}{2}$ inches have dominated the number and weight per tow indices (generally greater than 80%). Virtually the entire SNJ surf clam resource (83%) is currently greater than the minimum legal size. Hence, although the abundance of clams in the SNJ area is relatively low, their large size has been responsible for recent increases in commercial effort in SNJ, since much less culling of catches to meet the minimum size regulation is required.

Total number and weight per tow indices for the 1982 survey increased 97 and 70% respectively from 1981 survey results. However, the coefficient of variation of the SNJ index increased from 1981 to 1982 (by about 12%) indicating the differences in abundance indices were in part due to a relatively few large survey catches. The lack of significant improvement in pre-recruit indices prior to 1982 suggests that increases in the abundance of harvestable size clams in 1982 is more apparent than real.

Delmarva

Indices of total numbers per tow were relatively stable between 1965 and 1976, but declined by approximately half between surveys conducted in 1977 and January 1978 (Table 11; Figure 12). Total catch/tow values (in numbers) for the last five surveys (1978-1982), however, have been the largest observed in the time-series. Relatively large variations in recent pre-recruit catch per tow indices (since December 1978) are due primarily

to a few survey tows yielding extremely large number of young clams (primarily in Strata 85 and 9). Abundance indices of exploitable sized clams have not exhibited such variability. As in Northern New Jersey, the relatively high pre-recruit indices in Delmarva reflect the successful settlement of a single year class. In this case, however, size frequency data and ageing analyses indicate the Delmarva pre-recruit resource to be primarily composed of the 1977 year class.

The August 1982 number and weight per tow indices for harvestable sizes increased 10 and 9% respectively from 1981 survey values. Since these increases are probably not statistically significant, the stable survey indices reflect a decline in total commercial catch from the area, coupled with some recruitment to harvestable size from the strong 1977 year class.

Surf clam stocks off Delmarva continued to be dominated by individuals smaller than the minimum harvestable size (94% $\leq 5\frac{1}{2}$ inches in 1982 survey samples), primarily from the 1977 cohort. Based on growth rate data for Delmarva, it is expected that a small portion of these pre-recruit sized clams will reach harvestable size during 1983, but the bulk will not reach $5\frac{1}{2}$ inches until 1984 (Figure 12).

Abundance indices for total and pre-recruit numbers and weights have fluctuated greatly among the five cruises between 1978 and 1982. Much of this variability is due to the high density aggregations of pre-recruit sized clams. Log mean abundance indices for DMV survey strata (Appendix VI) are significantly more stable than the stratified mean linear index, emphasizing the influence of some relatively large but infrequent survey catches of pre-recruit clams on the survey abundance computations.

Southern Virginia-North Carolina

Stratified mean number per tow indices for the 11 survey cruises during which the SVA-NC assessment area was surveyed are given in Table 12. Indices were computed for pre-recruit and harvestable sizes separately. However, indices in weight were not calculated due to the lack of a reliable length-weight equation for the region. Log abundance indices and standard deviations are not included herein because only a portion of the SVA-NC survey strata was sampled during several of the cruises (Table 12). Nevertheless, survey abundance indices document the most significant historical resource changes in the region. Relative abundance of pre-recruit sized clams peaked during the June 1969 cruise, probably the result of a discrete spawning in the mid-1960's. Abundance of harvestable-sized clams was greatest in 1974, and declined rapidly thereafter. The Southern Virginia-North Carolina surf clam resource supported intensive exploitation during the early-mid 1970's, when total USA surf clam landings increased from 53 to 96 million pounds of meat (1971-1974). The rapid decline in the SVA-NC survey abundance indices during the mid-late 1970's is consistent with the collapse of the fishery in that region and the coincident decline in USA landings from 96 to 49 million pounds during 1974-1976.

Although survey abundance indices during 1980 and 1981 surveys were relatively high, they were based on few survey tows and only partial sampling of the region. Nevertheless, it is apparent from data collected during 1980-1982 that there are some discrete high-density surf clam areas in the SVA-NC assessment region. Most of the clams sampled from the region (92%) during 1980-1982 were, however, less than the current minimum legal size. This is consistent with sampling of commercial landings derived from the SVA-NC area (see "Biological Sampling of the Fishery").

CURRENT STATUS AND PROJECTED FISHERY IMPACTS

Significant changes in the areal distribution of offshore surf clam fishing effort and landings occurred starting in the fourth calendar quarter of 1980. Prior to this time, and for several successive years, between 80 and 90% of offshore landings were derived from the Delmarva Peninsula region. During 1981, however, the Delmarva proportion of total landings declined to 48%, while Northern New Jersey increased from 10% in 1980 to 48% in 1981. The proportion of landings from the Southern New Jersey and Southern Virginia-North Carolina areas remained relatively low and constrant during 1980-81.

The shift of effort from Delmarva to Northern New Jersey resulted primarily from recruitment to harvestable size of a portion of the relatively strong 1976 year class of which virtually the entire NNJ offshore surf clam resource was comprised. Another strong year class exists off the Delmarva Peninsula but is one year younger (1977) and hence of a smaller modal size than off Northern New Jersey (Figures 10 and 12).

Implementation of the minimum clam size regulation (26 July 1981) resulted in a rapid decline in the proportion of total clam catch derived from Northern New Jersey (Figure 2), and a concomitant increase in the proportion of landings taken from the other three assessment areas (Figures 2-5). The decline in Northern New Jersey landings during the latter portion of 1981 and the first two quarters of 1982 was primarily the result of the amount of culling necessary to land clams of legal size from that region. Increased activity in the three other Middle Atlantic assessment areas, and in Southern New England waters during summer 1982, primarily reflected

the search for denser aggregations of legal-sized clams with a larger proportion of legal sizes than were available in areas previously fished. The decline in overall catch rates and total FCZ landings between 1981 and 1982 was in part due to the increased searching time and on-board culling procedures imposed by the clam size regulation.

Catch per unit effort increased during the final quarter of 1982 with the re-opening of a portion of the closure area off Atlantic City, New Jersey. However, a significant proportion of clams within the re-opened portion of the closure area remain below the legal size ($5\frac{1}{2}$ inches, shell length). Thus, catch rates from the region are currently lower than would be expected without the minimum size regulation.

Pre-recruit indices for the Northern New Jersey assessment area remained relatively high during the 1982 survey (highest in numbers and weight in the survey time-series) indicative of the strong 1976 year class. Indices for recruit-sized clams ($\geq 5\frac{1}{2}$ inches) increased 40% in numbers and weight over August 1981 values. However, biomass of harvestable sizes remains substantially below the levels of the mid-late 1960's when fishing was relatively intense off Northern New Jersey. The average weight per tow index for recruit-sized clams off Northern New Jersey in 1965-1969 surveys was 4.40 kg/tow (meats). The most recent index of Northern New Jersey recruit abundance (1.67 kg) is 38% of the earlier average.

Projected growth rates of the 1976 year class off Northern New Jersey (Figure 10) indicate that both pre-recruit and recruit-sized biomass should increase during 1983. However, the growth in pre-recruit size biomass is not likely to increase in near-future years due to the increasing proportion of the year class becoming legal-sized. Further, total biomass levels (all sizes) are likely to stabilize as growth of the year class in biomass

is balanced by mortality due to natural and man-induced causes (i.e., landings and discards). Yield per recruit (see Murawski and Serchuk 1981) for the Northern New Jersey stock is maximized for moderate F levels at a size of about 4-3/4 inches (12 cm), which is about the current modal size of the 1976 cohort.

If biomass of harvestable sizes off Northern New Jersey during 1983 increases 50-100% over 1982 values, it will be 57 to 76% of levels exhibited in the mid-late 1960's. Harvests in the Northern New Jersey area during 1965-1969 were about 23.1 million pounds per year (Serchuk and Murawski 1980). Thus, to maintain exploitation rates on harvestable size clams at levels equivalent to the mid-late 1960's, harvests from NNJ during 1983 would be 13 to 18 million pounds. Because of the predominance of sub-legal clams off Northern New Jersey (over 80%), and the fact that harvestable sizes are not (necessarily) segregated from small clams, significant discard mortality will occur during the next several years. Only a portion of clams dredged and subsequently returned to the sea bed survive. As an increasing proportion of the year class reaches harvestable size (1984 and 1985) this impact will be reduced. Thus, the effects of significant increases in Northern New Jersey landings in the short term will be to reduce the size of pre-recruit resources, due to discarding mortality.

Harvestable biomass levels off Southern New Jersey increased slightly from 1981-1982, but these increases are probably not statistically significant. Average harvestable biomass off Southern New Jersey remains well below that of the mid-late 1960's (Table 10). Significant pre-recruit size resources in the region also are not evident. Thus, because of the recent increases in effort in the Southern New Jersey area, due to the large

size of clams there, abundance of harvestable size clams will decline during 1983.

During 1981 a significant portion of Delmarva landings was comprised of clams from the relatively strong 1977 year class. With implementation of the minimum size regulation, however, the fraction of small clams in landings was sharply reduced (Figure 9). The proportion of total FCZ surf clam landings derived from Delmarva increased during the first three quarters of 1982, as discarding associated with the minimum size regulation was not as intense as off Northern New Jersey. This is primarily due to the spatial segregation of harvestable-sized clams and the pre-recruits (1977 year class) off Delmarva. However, as portions of the 1977 year class grow to exploitable size (1983-1984), discarding will become more frequent off Delmarva.

The weight per tow index of harvestable surf clams off Delmarva during the August 1982 survey increased 9% from the corresponding August 1981 value, indicating a stabilization of the declining trend in harvestable biomass from the mid-1970's. Pre-recruit indices from the 1982 survey continue to substantiate a relatively strong incoming 1977 year class.

Analyses of the growth rates of the 1977 year class off Delmarva indicate that biomass of recruit-sized surf clams should increase somewhat during 1983 due to recruitment of the fastest growing individuals of the cohort. The bulk of the year class, however, will probably not reach the 5½ inch minimum size until 1984. The degree to which recruitment, from the 1977 year class, will influence harvestable biomass during 1983-1984 remains problematic, but the increase in exploitable sizes is not likely to exceed 25% during 1983. Thus, landings from Delmarva during 1983 equivalent to those in 1981 and 1982 (about 16.7 million pounds per year)

should result in continued stability of the harvestable portion of the resource. Significant rebuilding of the harvestable portion of the Delmarva surf clam stock should begin in 1984.

Landings of offshore surf clams from the Southern Virginia-North Carolina assessment area increased abruptly during the last half of 1982, primarily as a result of discarding problems in the NNJ and DMV regions. Clam catches from the SVA-NC area were, however, also dominated by small individuals. Thus, considering the long travel time to the SVA-NC grounds, and the lack of significant quantities of exploitable sized clams, it is likely that fishing effort and landings from the SVA-NC area will not increase significantly during 1983 (about 2 million pounds were landed from the SVA-NC region in 1982).

Results from the most recent research vessel survey (August 1982) suggest that 1977, 1978, 1979, and 1980 year classes off Northern New Jersey and 1978, 1979, and 1980 year classes off Delmarva are relatively weak. Even if the 1981 or 1982 year classes were relatively strong, they probably could not be detected until late 1983-1984. Thus, for at least the next 6-7 years, Middle Atlantic offshore landings will be sustained from accumulated stock in all regions and the 1976 and 1977 year classes off Northern New Jersey and Delmarva respectively.

The impacts of future harvest quota levels on the abundance and productivity of surf clam resources in offshore Mid-Atlantic waters can be inferred from relative abundance indices (based on research surveys) and fishery performance data. Significant short-term (1983) increases in the quota (1982: 40 million pounds of shucked meats) will likely reduce the long-term potential yields of pre-recruit resources (off NNJ, DMV, and

SVA-NC) due to current intensive discarding necessary to land legal-sized clams. The inability of the fishery to harvest the entire 1982 quota is in part due to relatively low abundance of legal clams, coupled with their coincident distribution with pre-recruits (particularly off NNJ). Significant increases in the 1983 quota from the 1982 level will serve to exacerbate the discarding problem, and it is likely that the quota will similarly not be achieved. Harvestable biomass will increase moderately off NNJ during 1983 as modal size of the 1976 year class approaches the minimum legal size. Catch per effort in the NNJ area will likely increase in 1983 (particularly since a portion of the closure area off Atlantic City has been re-opened). Thus, adequate harvestable size resource will probably be present in 1983 to support a 40 million pound quota given current fishing practices (effort levels and discarding practices). Catch per effort levels in other areas (SNJ, DMC, SVA-NC), however, will not increase significantly, due to minimal recruitment in 1983.

Harvestable biomass off both NNJ and DMV will likely increase significantly in 1984. Thus, quota increases in future years (i.e., 1984, 1985) are likely to result in greater utilization of the productivity potential of the two strong cohorts than quota increases in the short-term (1983), because of decreased mortality on pre-recruit sizes.

Although the absolute size of pre-recruit resources off NNJ and DMV and SVA-NC are not known, it is clear that adequate resource currently exists to support the fishery at current levels until the late 1980's - early 1990's. However, as the quota is increased in the short-term (1983-1985) the risk of a resource shortfall in later years is increased due to the lack of additional new recruitment until at least 1987-1988.

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Table 1. Total USA commercial landings of surf clam ($X10^{-3}$ lbs of meat), total landings from the Fishery Conservation Zone (FCZ,3-200 miles), and annual percentage of landings taken from the FCZ.

Year	Total Landings	FCZ Landings	Percent landed[1] from FCZ
1965	44,088	33,000	74.9
1966	45,113	32,400	71.8
1967	40,054	24,700	54.8
1968	40,552	20,000	49.3
1969	49,575	15,900	32.1
1970	67,318	14,100	20.9
1971	52,535	50,053	95.3
1972	63,371	55,272	87.1
1973	82,370	72,579	88.1
1974	96,110	74,430	77.4
1975	86,956	44,270	50.9
1976	49,133	42,558	86.6
1977	51,036	42,968	84.2
1978	39,237	31,393	80.0
1979	34,912	29,070	83.3
1980	37,737	34,718	92.0
1981	46,100	37,361	81.0
1982[2]		27,635	

[1]Prorations for 1971-1981 based on data presented in Fisheries of the United States, CFS No. 8200. Earlier data are based on interviews conducted by the U.S. Bureau of Commercial Fisheries.

[2]Preliminary data based on logbook records received through 6 December 1982.

Table 2. Commercial surf clam catch and effort statistics for the Northern New Jersey Assessment area, 1978-1982. Data are presented by calendar quarter for each of three vessel size classes (see text), and were derived from vessel trip logbook reports.

Year-Quarter	Number of Trips Analyzed			Total Catch (Bushels)			Total Hours Fished			Mean Bushels/Hour		
	Vessel Class			Vessel Class			Vessel Class			Vessel Class		
	1	2	3	1	2	3	1	2	3	1	2	3
1978												
1	-	2	-	-	384	-	-	16.0	-	-	24.0	-
2	-	11	13	-	1782	6517	-	104.0	270.5	-	17.1	24.1
3	-	37	12	-	4774	3370	-	385.5	159.0	-	12.4	21.2
4	-	14	13	-	2290	3217	-	79.0	167.0	-	29.0	19.3
Total	-	64	38	-	9230	13104	-	584.5	596.5	-	15.8	22.0
1979												
1	6	17	8	1674	4363	2423	56.0	141.5	57.0	29.9	30.8	42.5
2	3	26	27	1248	5754	5406	36.0	213.25	279.0	34.7	27.0	19.4
3	-	6	6	-	1202	2257	-	70.0	56.5	-	17.2	45.3
4	2	8	20	388	1475	12558	15.0	107.0	277.0	25.9	13.8	45.3
Total	11	57	61	3310	12794	22944	107.0	531.75	669.5	30.9	24.1	34.3
1980												
1	26	12	17	490	3374	8366	62.0	118.0	196.5	7.9	28.6	42.6
2	6	31	23	1050	14600	11089	40.0	368.0	323.5	26.3	39.7	34.3
3	3	20	38	902	9279	29916	24.0	178.0	273.5	37.6	52.1	109.4
4	9	51	78	5663	21001	53733	82.0	449.0	577.5	69.1	46.8	93.0
Total	44	114	156	8105	48254	103104	208.0	1113.0	1371.0	39.0	43.4	75.2
1981												
1	24	134	150	7132	51009	81567	184.0	1147.8	1451.75	38.8	44.4	56.2
2	39	225	186	10360	99540	117067	350.0	1817.5	1767.5	29.6	54.8	66.2
3	42	200	267	10924	89405	192508	380.5	1895.0	2858.0	28.7	47.2	67.4
4	28	108	242	6467	32983	143842	258.0	1120.0	2638.5	22.7	29.5	54.5
Total	133	667	845	34883	272937	534984	1172.5	5980.3	8715.75	29.8	45.6	61.4
1982												
1	72	212	252	16199	58544	117164	651.0	2142.5	2786.5	24.9	27.3	42.0
2	48	213	275	10533	49391	122900	519.0	2366.0	3184.0	20.3	20.9	38.6
3	61	222	114	11084	47938	57322	559.75	2300.5	1267.5	19.8	29.8	45.2
4[1]	29	103	43	6992	30807	21899	276.0	998.0	428.5	25.3	30.9	51.1
Total[2]	210	750	684	44808	186680	319285	2005.75	7807.0	7666.5	22.3	23.9	41.7

[1]Data are for logbook reports through 12/1/82.

[2]Not including data as noted above.

Table 3. Commercial surf clam catch and effort statistics for the Southern New Jersey Assessment area, 1978-1982. Data are presented by calendar quarter for each of three vessel size classes (see text), and were derived from vessel trip logbook reports.

Year-Quarter	Number of Trips Analyzed			Total Catch (Bushels)			Total Hours Fished			Mean Bushels/Hour		
	Vessel Class			Vessel Class			Vessel Class			Vessel Class		
	1	2	3	1	2	3	1	2	3	1	2	3
1978												
1	1	10	11	258	2354	3841	22	157	205.3	11.7	15.0	18.7
2	5	38	35	1243	8464	14862	77	542	760.5	16.1	15.6	19.5
3	27	32	28	2628	6720	9714	238.5	344.5	398	11.0	19.5	24.4
4	24	35	46	2585	7806	15910	199	360	561	13.0	21.7	28.4
Total	57	115	120	6714	25344	44327	536.5	1403.5	1924.8	12.5	18.1	23.0
1979												
1	3	11	53	716	2020	16418	26	99.5	675.5	27.5	20.3	24.3
2	2	38	78	727	5459	17562	23	253	943.5	31.6	21.6	18.7
3	20	90	37	5188	17089	13589	209.75	951	406	24.7	18.0	33.5
4	4	35	27	490	5339	13534	48	367	352	10.2	14.5	38.4
Total	29	174	195	7121	29907	61193	306.75	1770.5	2377	23.2	16.9	25.7
1980												
1	3	20	23	368	2958	12263	31.5	230	315	11.7	12.9	38.9
2	8	42	29	894	8827	13133	67	503	378	13.3	17.5	34.7
3	5	64	14	560	9072	8139	52	659	129	10.8	13.8	63.1
4	1	19	11	100	4010	4016	10	183	94.5	10.0	21.9	42.5
Total	17	145	77	1922	24867	37551	160.5	1575	916.5	12.0	15.8	41.0
1981												
1	5	8	16	186	2920	6683	30.0	72.0	178.0	6.2	40.6	37.5
2	11	1	4	1047	100	2573	114.0	10.0	41.0	9.2	10.0	62.8
3	2	4	4	160	1238	2392	20.0	35.0	43.0	8.0	35.4	55.6
4	10	5	5	707	1679	930	78.0	53.0	46.0	9.0	31.7	20.2
Total	28	18	29	2100	5937	12578	242.0	170.0	308.0	8.7	34.9	40.8
1982												
1	1	11	13	128	2083	5175	12.0	112.0	160.0	10.0	18.6	32.3
2	38	48	18	3946	13638	7132	388.5	646.0	197.5	10.2	21.1	36.1
3	41	53	73	4494	13495	32517	372.5	478.0	910.0	12.1	28.2	35.7
4[1]	6	30	11	912	11585	3374	46.0	295.0	129.0	19.8	39.3	26.2
Total[2]	86	152	115	9480	40801	48198	819.0	1531.0	1396.5	11.6	26.7	34.5

[1]Data are for logbook reports through 12/1/82.

[2]Not including data as noted above.

Table 4. Commercial surf clam catch and effort statistics for the Delmarva Assessment area, 1978-1982. Data are presented by calendar quarter for each of three vessel size classes (see text), and were derived from vessel trip logbook reports.

Year-Quarter	Number of Trips Analyzed			Total Catch (Bushels)			Total Hours Fished			Mean Bushels/Hour		
	Vessel Class			Vessel Class			Vessel Class			Vessel Class		
	1	2	3	1	2	3	1	2	3	1	2	3
1978												
1	5	31	71	1173	10165	47827	82.5	485.25	1632.5	14.2	20.9	29.3
2	72	357	509	16152	107092	282544	1044	5359.75	10511.15	15.5	20.0	26.9
3	85	380	641	17454	91566	256737	1022	4601.7	8451.75	17.1	19.9	30.4
4	56	319	536	9347	80159	216309	592.8	3961.1	7302.5	15.8	20.2	29.6
Total	218	1087	1757	44126	288982	803417	2741.3	14407.8	27897.9	16.1	20.1	28.8
1979												
1	38	198	477	5279	46509	188967	343.8	2377.2	6657.8	15.4	19.6	28.4
2	91	430	645	17146	92048	264054	1033.5	4628.3	8509	16.6	19.9	31.0
3	77	426	732	14428	96483	311218	899.95	4815	8520.5	16.2	20.0	36.5
4	50	265	493	8552	56922	244433	578	3166.75	7110.5	14.8	18.0	34.4
Total	256	1319	2347	45405	291962	1008672	2845.25	14987.25	20797.8	16.0	19.5	32.8
1980												
1	44	285	467	7248	55550	223366	494.0	3259.75	6693.5	14.7	17.0	33.4
2	57	173	515	6918	40101	284974	526.75	2207.5	7826.0	13.1	18.2	36.4
3	41	386	662	6197	87325	328747	421.0	4137.0	8471.5	14.7	21.1	38.8
4	17	138	537	3507	32371	265268	172.0	1448.75	5803.0	20.4	22.3	45.7
Total	159	982	2181	23870	217347	1102355	1613.75	11053.0	28794.0	14.8	19.5	38.3
1981												
1	6	105	431	1181	24731	232333	58.0	1148.5	4783.5	20.4	21.5	48.6
2	16	140	521	4683	42924	336062	186.0	1456.0	5843.45	25.2	29.5	57.5
3	16	45	185	5055	12277	117823	186.0	484.0	2036.5	27.2	25.4	57.9
4	1	45	100	252	9030	51767	10.0	428.5	1083.5	25.2	21.1	47.8
Total	39	335	1237	11171	88962	737985	440.0	3517.0	13746.95	25.4	25.3	53.7
1982												
1	8	75	337	1148	18495	154187	84.0	801.5	3792.5	13.7	23.1	40.7
2	37	109	383	8144	30697	191685	425.0	1245.0	4458.0	19.2	24.7	43.0
3	51	85	356	10622	21048	165641	544.5	955.5	3986.5	19.5	22.0	41.6
4[1]	8	14	85	1989	2578	36650	84.0	141.6	965.0	23.7	18.1	38.0
Total[2]	104	283	1161	21903	72818	548163	1137.5	3143.6	13202.0	19.3	23.2	41.5

[1]Data are for logbook reports through 12/1/82.

[2]Not including data as noted above.

Table 5. Commercial surf clam catch and effort statistics for the Southern Virginia-North Carolina Assessment area, 1978-1982. Data are presented by calendar quarter for each of three vessel size classes (see text), and were derived from vessel trip logbook reports.

Year-Quarter	Number of Trips Analyzed			Total Catch (Bushels)			Total Hours Fished			Mean Bushels/Hour		
	Vessel Class			Vessel Class			Vessel Class			Vessel Class		
	1	2	3	1	2	3	1	2	3	1	2	3
1978												
1	-	-	-	-	-	-	-	-	-	-	-	-
2	-	2	5	-	356	1175	-	34.0	106.0	-	10.5	16.8
3	-	1	1	-	74	420	-	9.0	15.0	-	8.2	28.0
4	-	-	1	-	-	147	-	-	12.0	-	-	12.3
Total	-	3	7	-	430	2342	-	43.0	133.0	-	10.0	17.6
1979												
1	1	3	1	272	482	123	17.0	39.0	6.0	16.0	12.4	20.5
2	9	3	3	2151	932	1446	86.0	36.0	27.5	25.1	25.9	52.6
3	3	8	1	759	2364	530	45.5	112.0	12.0	16.7	10.9	44.2
4	1	2	4	526	688	1192	36.0	36.0	57.0	14.6	19.1	20.9
Total	14	16	9	3708	4466	3291	184.5	224.0	102.5	20.1	19.9	32.1
1980												
1	-	2	3	-	241	480	-	14.0	33.0	-	17.2	14.6
2	-	-	2	-	-	690	-	-	30.0	-	-	23.0
3	-	1	7	-	148	2918	-	5.0	82.0	-	29.6	35.6
4	-	-	5	-	-	1666	-	-	48.0	-	-	34.7
Total	-	3	15	-	389	5754	-	19.0	193.0	-	20.5	29.8
1981												
1	-	4	5	-	667	2912	-	38.0	84.5	-	17.6	34.5
2	-	22	24	-	11603	14105	-	256.0	264.0	-	45.3	53.4
3	-	12	9	-	6040	4589	-	144.0	106.0	-	41.9	43.3
4	-	1	12	-	522	6797	-	12.0	127.0	-	43.5	53.5
Total	-	39	50	-	18832	28403	-	450.0	581.5	-	41.9	48.8
1982												
1	-	-	16	-	-	5342	-	-	175.0	-	-	30.5
2	-	-	14	-	-	6540	-	-	183.5	-	-	35.6
3	-	13	34	-	7425	25072	-	156.0	411.0	-	47.6	61.0
4[1]	-	8	31	-	5830	26580	-	96.0	380.0	-	60.7	70.0
Total[2]	-	21	95	-	13255	63534	-	252.0	1149.5	-	52.6	55.3

[1]Data are for logbook reports through 12/1/82.

[2]Not including data as noted above.

Table 6. Estimated proportion of Middle Atlantic FCZ surf clam landings derived from each of 4 assessment areas, 1978-1982. Data were derived from vessel trip logbook reports.

AREA	YEAR				
	1978	1979	1980	1981	1982[1]
Northern New Jersey	0.018	0.026	0.101	0.482	0.402
Southern New Jersey	0.062	0.066	0.041	0.012	0.072
Delmarva	0.918	0.900	0.854	0.479	0.470
Southern Virginia-North Carolina	0.002	0.008	0.004	0.027	0.056

[1]Data through 12/1/82.

Table 7. Summary of research vessel cruises used in the analysis of surf clam population dynamics, 1965-1980.

Research Vessel	Dates of Cruise	Dredge Knife Width (cm)	Time of Tow (min)	Number of Stations	Ring Size or[a] Bar Space (cm)
UNDAUNTED	5/ 6/65	76	5	375 (293)[b]	5.1
UNDAUNTED	10/11/65	76	5	217 (158)	5.1
ALBATROSS IV	8/ /66	76	5	240 (210)	5.1
ALBATROSS IV	6/ 7/69	76	5	278 (166)	5.1
DELAWARE II	8/ /70	122	4	199 (133)	3.0
DELAWARE II	6/ /74	76	5	241 (142)	5.1
DELAWARE II	4/ 5/76	122	4	259 (133)	3.0
DELAWARE II	1/ 3/77	122	4	224 (92)	3.0
DELAWARE II	1/ 2/78	122	4	324 (192)	3.0
DELAWARE II	12/ /78	122	4	163 (105)	2.5
DELAWARE II	1/ 2/80	152	5	229 (156)	5.1
DELAWARE II	8/ 9/80	152	5	231 (114)	5.1
DELAWARE II	8/ /81	152	5	261 (119)	5.1
DELAWARE II	8/ /82	152	5	272 (151)	5.1

[a]Portion of dredge where catch is accumulated.

[b]Number of stations located in surf clam assessment areas.

Table 8. Designations of NMFS surf clam survey strata comprising four assessment areas in the Middle Atlantic Bight, New Jersey to Cape Hatteras, North Carolina (see Figure 1.).

Assessment Area	Stratum Number	Area (N.Miles^2)	Depth Range Fathoms	Depth Range Meters
Northern New Jersey	90	182	5-15	9-27
	89	382	5-15	9-27
	88	578	5-15	9-27
	25	648	15-25	27-46
	21	1650	15-25	27-46
Southern New Jersey	87	479	5-15	9-27
	17	749	15-25	27-46
Delmarva	86	203	5-15	9-27
	85	382	5-15	9-27
	84	417	5-15	9-27
	83	241	5-15	9-27
	82	180	5-15	9-27
	14	219	25-30	46-55
	13	1127	15-25	27-46
	10	152	25-30	46-55
	9	2171	15-25	27-46
Southern Virginia-North Carolina	81	360	5-15	9-27
	80	767	5-15	9-27
	6	62	25-30	46-55
	5	453	15-25	27-46
	2	175	25-30	46-55
	1	1163	15-25	27-46

Table 9. Stratified mean number and weight (meats only, kg) per tow of surf clams from NMFS surveys off Northern New Jersey, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes.

	Total Index		<5½"		≥5½"		%≥5½"	
Survey	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
May 1965	38.07	4.79	15.44	1.17	22.62	3.62	59.4	75.6
Oct 1965	35.73	5.27	6.18	0.51	29.55	4.76	82.7	90.3
Aug 1966	30.44	4.51	5.44	0.36	24.99	4.15	82.1	92.1
Jun 1969	34.26	5.37	3.93	0.30	30.33	5.07	88.5	94.4
Aug 1970	25.73	4.12	4.84	0.30	20.89	3.82	81.2	92.9
Jun 1974	21.40	3.37	2.75	0.19	18.66	3.17	87.2	94.3
Apr 1976	12.92	2.06	2.39	0.12	10.53	1.93	81.5	94.0
Jan 1977	2.45	0.23	1.39	0.05	1.06	0.19	43.2	81.4
Jan 1978	2.06	0.16	1.48	0.06	0.58	0.11	28.3	64.9
Dec 1978	44.88	1.20	43.85	1.03	1.01	0.17	2.3	14.8
Jan 1980	31.70	1.95	27.52	1.22	4.17	0.75	13.2	38.1
Aug 1980	53.56	3.74	50.66	3.24	2.90	0.50	5.4	13.5
Aug 1981	39.10	3.23	31.15	2.04	8.03	1.19	20.5	36.0
Aug 1982	112.79	8.78	101.53	7.11	11.26	1.67	9.9	19.0

Table 10. Stratified mean number and weight (meats only, kg) per tow of surf clams from NMFS surveys off Southern New Jersey, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes.

Survey	Total Index		<5½"		≥5½"		%≥5½"	
	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
May 1965	105.98	8.88	78.08	4.37	27.93	4.49	26.4	50.7
Oct 1965	82.84	10.64	33.32	2.73	49.52	7.93	59.8	74.4
Aug 1966	69.55	9.95	14.62	1.39	54.93	8.56	79.0	86.0
Jun 1969	59.73	9.08	5.46	0.42	54.27	8.66	90.9	95.3
Aug 1970	16.18	2.65	2.73	0.20	13.45	2.45	83.1	92.1
Jun 1974	49.31	8.85	2.22	0.16	47.10	8.69	95.5	98.2
Apr 1976	5.20	0.97	0.64	0.03	4.57	0.94	87.8	96.1
Jan 1977	2.25	0.23	1.22	0.03	1.03	0.20	45.5	89.3
Jan 1978	14.91	2.23	3.85	0.22	11.06	2.00	74.2	89.9
Dec 1978	8.60	0.97	4.45	0.23	4.15	0.75	48.3	76.4
Jan 1980	13.59	2.29	2.53	0.22	11.06	2.09	81.4	90.7
Aug 1980	14.57	2.59	2.95	0.20	11.62	2.39	79.7	92.0
Aug 1981	10.47	2.06	0.56	0.03	9.91	2.03	94.7	98.5
Aug 1982[1]	20.61	3.51	3.62	0.19	16.99	3.32	82.5	94.7

[1] Index does not include 1 survey tow made at a depth of 7 meters that yielded 500 surf clams.

Table 11. Stratified mean number and weight (meats only, kg) per tow of surf clams from NMFS surveys off Delmarva, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes.

	Total Index		<5½"		≥5½"		%≥5½"	
Survey	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
May 1965	27.68	2.26	15.82	0.83	11.86	1.44	42.8	63.3
Oct 1965	28.02	2.81	10.76	0.58	17.25	2.23	61.6	79.3
Aug 1965	32.53	3.54	10.75	0.64	21.78	2.90	67.0	81.9
Jun 1969	26.26	2.78	8.03	0.50	18.22	2.28	69.4	82.0
Aug 1970	19.64	2.34	4.71	0.30	14.93	2.04	76.0	87.5
Jun 1974	36.66	4.59	6.68	0.42	29.98	4.17	81.8	90.7
Apr 1976	21.93	2.37	7.30	0.25	14.63	2.12	66.7	89.6
Jan 1977	11.37	1.40	2.68	0.09	8.69	1.31	76.4	93.2
Jan 1978	11.61	1.15	4.90	0.17	6.71	1.00	57.7	85.4
Dec 1978	621.33	6.02	616.44	5.32	4.88	0.72	0.8	88.2
Jan 1980	68.50	3.17	58.07	1.62	10.44	1.54	15.2	48.7
Aug 1980	48.53	2.64	39.39	1.26	9.14	1.37	18.8	52.2
Aug 1981	162.89	6.91	156.86	6.02	6.02	0.89	3.7	12.9
Aug 1982	109.14	5.68	102.53	4.71	6.61	0.97	6.1	17.0

Table 12. Stratified mean number per tow of surf clams from NMFS surveys off Southern Virginia - North Carolina, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes.

Survey	Total Index	<5½"	≥5½"	% ≥5½"
May 1965	3.77	2.87	0.90	23.9
Oct 1965[1]	11.93	11.81	0.12	1.0
Aug 1966[1]	17.56	16.28	1.27	7.3
Jun 1969	80.02	78.68	1.34	1.7
Aug 1970[1]	3.20	0.74	2.46	76.7
Jun 1974	30.09	12.66	17.42	57.9
Apr 1976	6.21	1.11	5.10	82.2
Jan 1978	3.24	1.06	2.18	67.3
Jan 1980[1]	87.02	86.15	0.87	1.0
Aug 1981[1]	25.89	17.97	7.92	30.6
Aug 1982[1]	2.06	1.18	0.88	42.6

[1]Only a small portion of the total Southern Virginia - North Carolina area was surveyed.

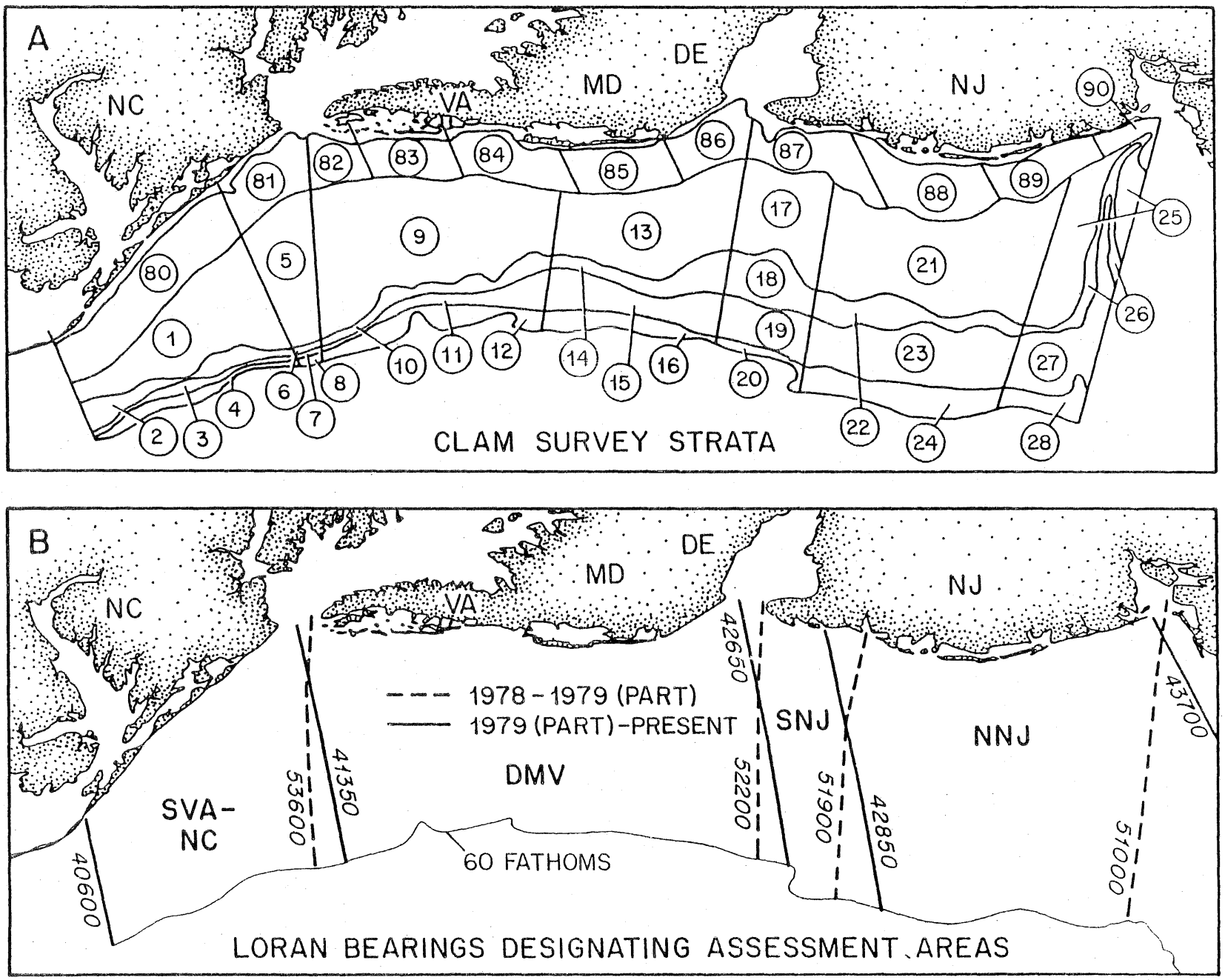

Figure 1. Offshore surf clam survey strata (A) in the Middle Atlantic Bight, New Jersey-North Carolina; and LORAN bearings designating four surf clam assessment area (B).

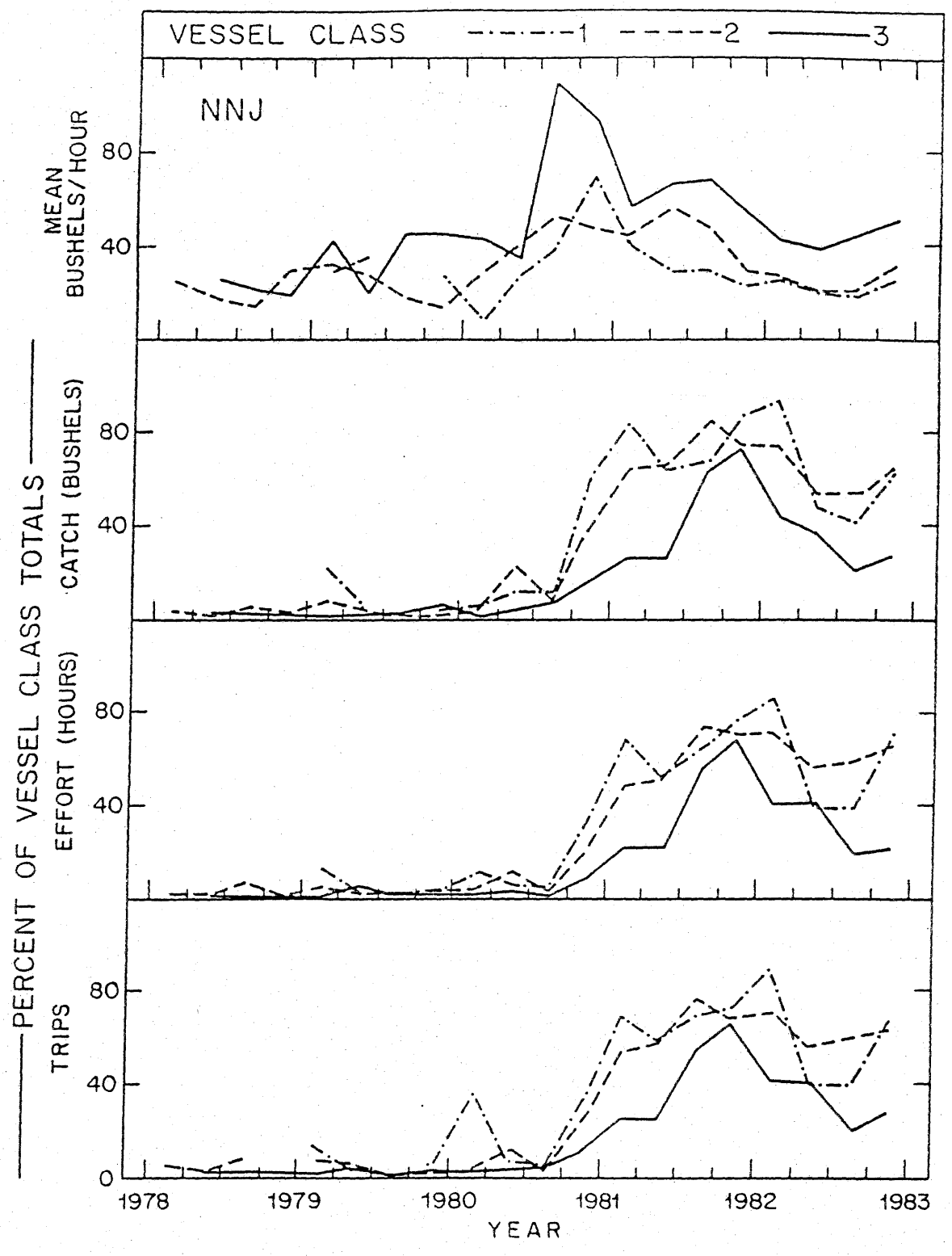

Figure 2. Quarterly mean catch per effort (bushels per hour) of surf clams taken in the Northern New Jersey Assessment area 1978-1982. The percentages of catch, effort, and vessel trips allocated to the Northern New Jersey area (by vessel size class) are also given.

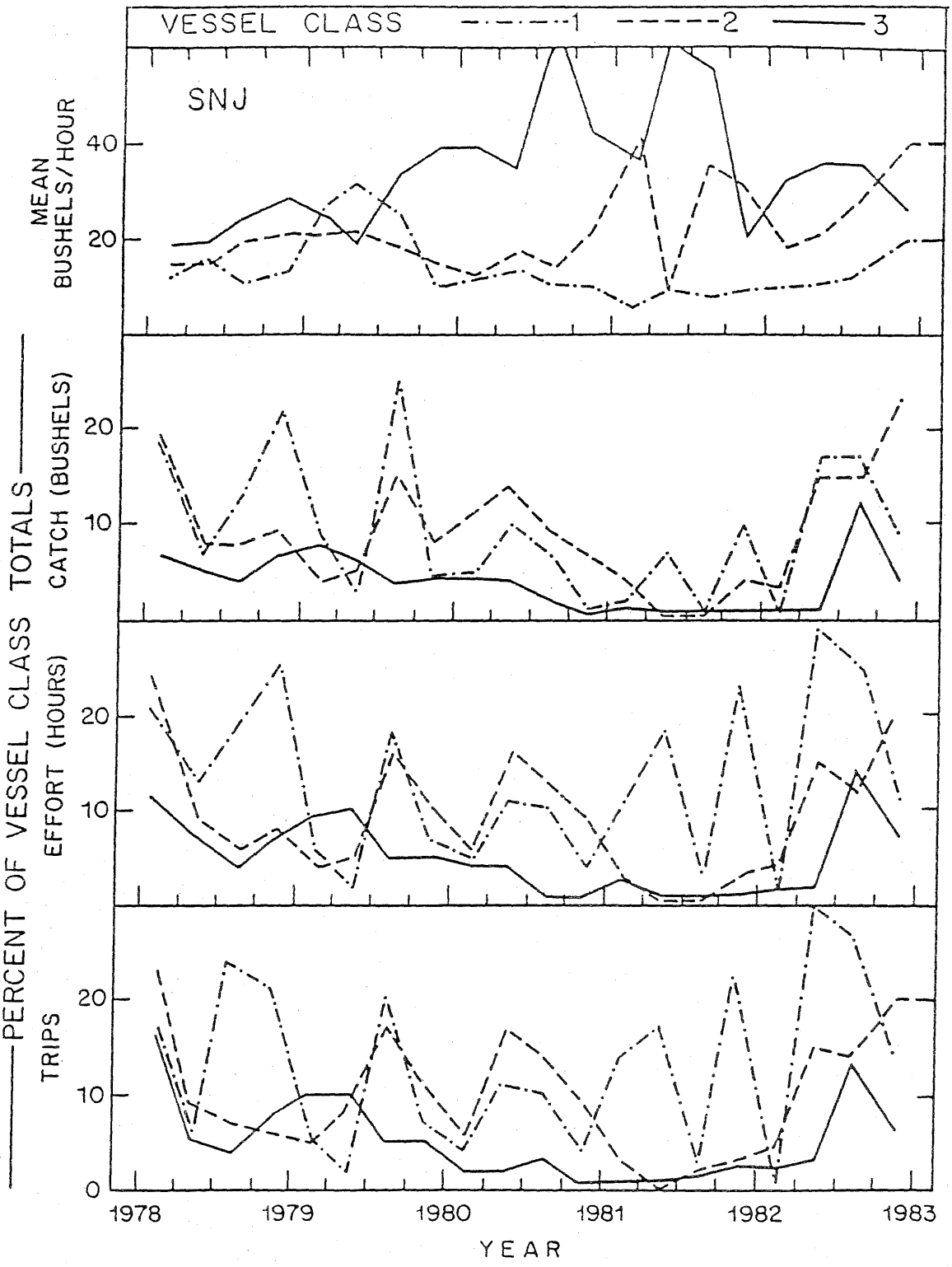

Figure 3. Quarterly mean catch per effort (bushels per hour) of surf clams taken in the Southern New Jersey Assessment area, 1978-1982. The percentages of catch, effort, and vessel trips allocated to the Southern New Jersey area (by vessel size class) are also given.

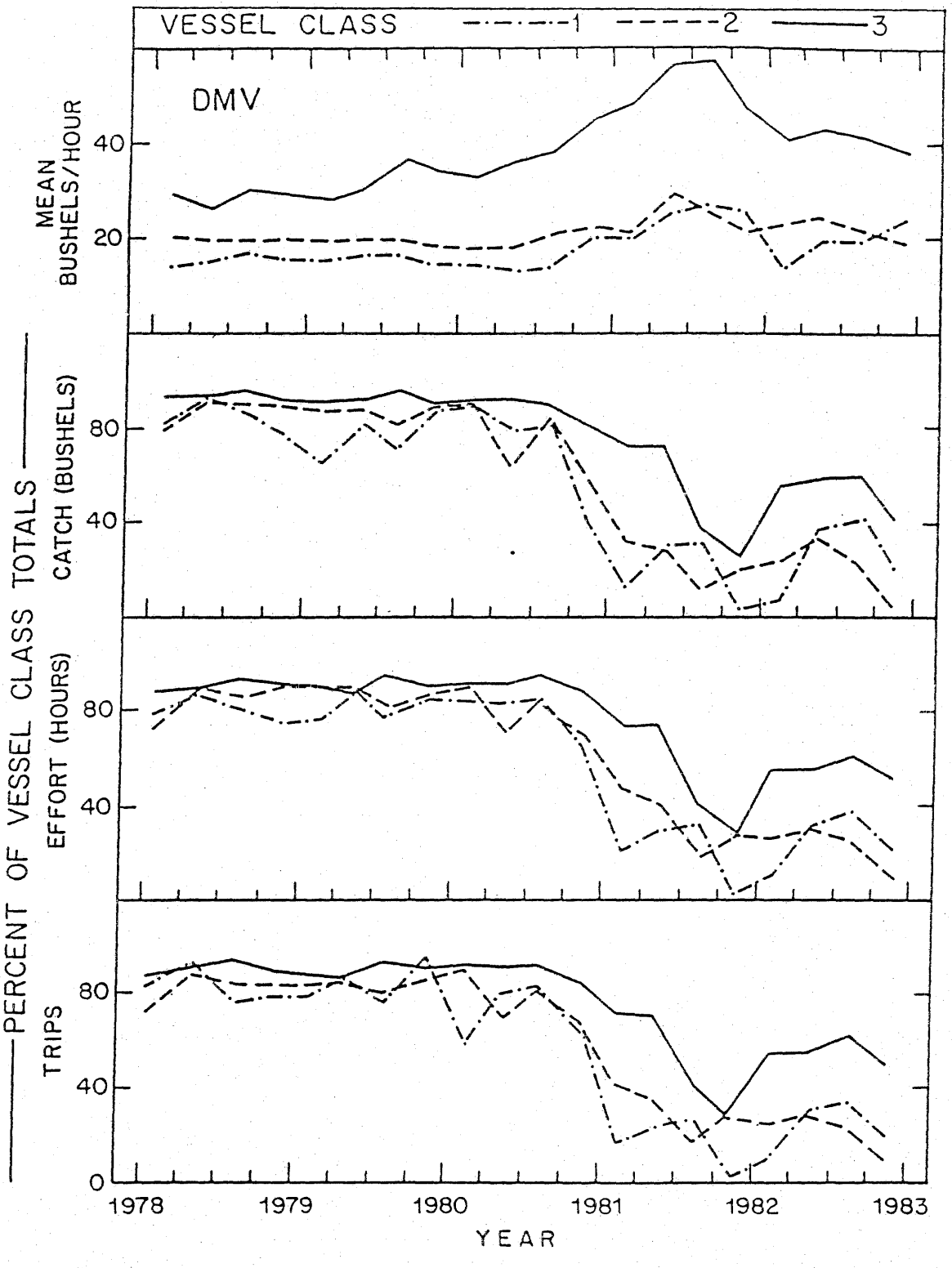

Figure 4. Quarterly mean catch per effort (bushels per hour) of surf clams taken in the Delmarva assessment area, 1978-1982. The percentages of catch, effort, and vessel trips allocated to the Delmarva assessment area (by vessel size class) are also given.

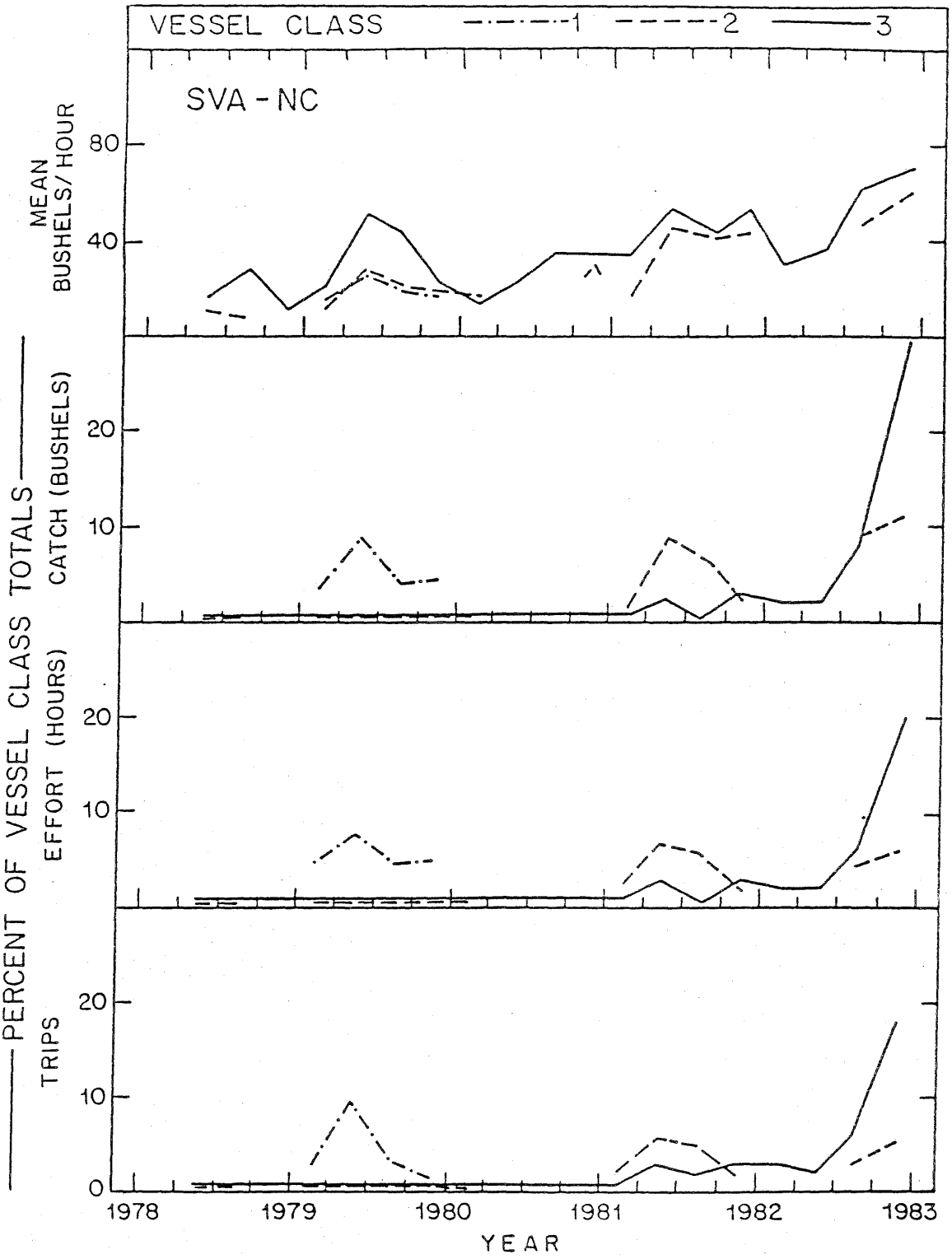

Figure 5. Quarterly mean catch per effort (bushels per hour) of surf clams taken in the Southern Virginia-North Carolina assessment area, 1978-1982. The percentages of catch, effort, and vessel trips allocated to the Southern Virginia-North Carolina assessment area (by vessel size class) are also given.

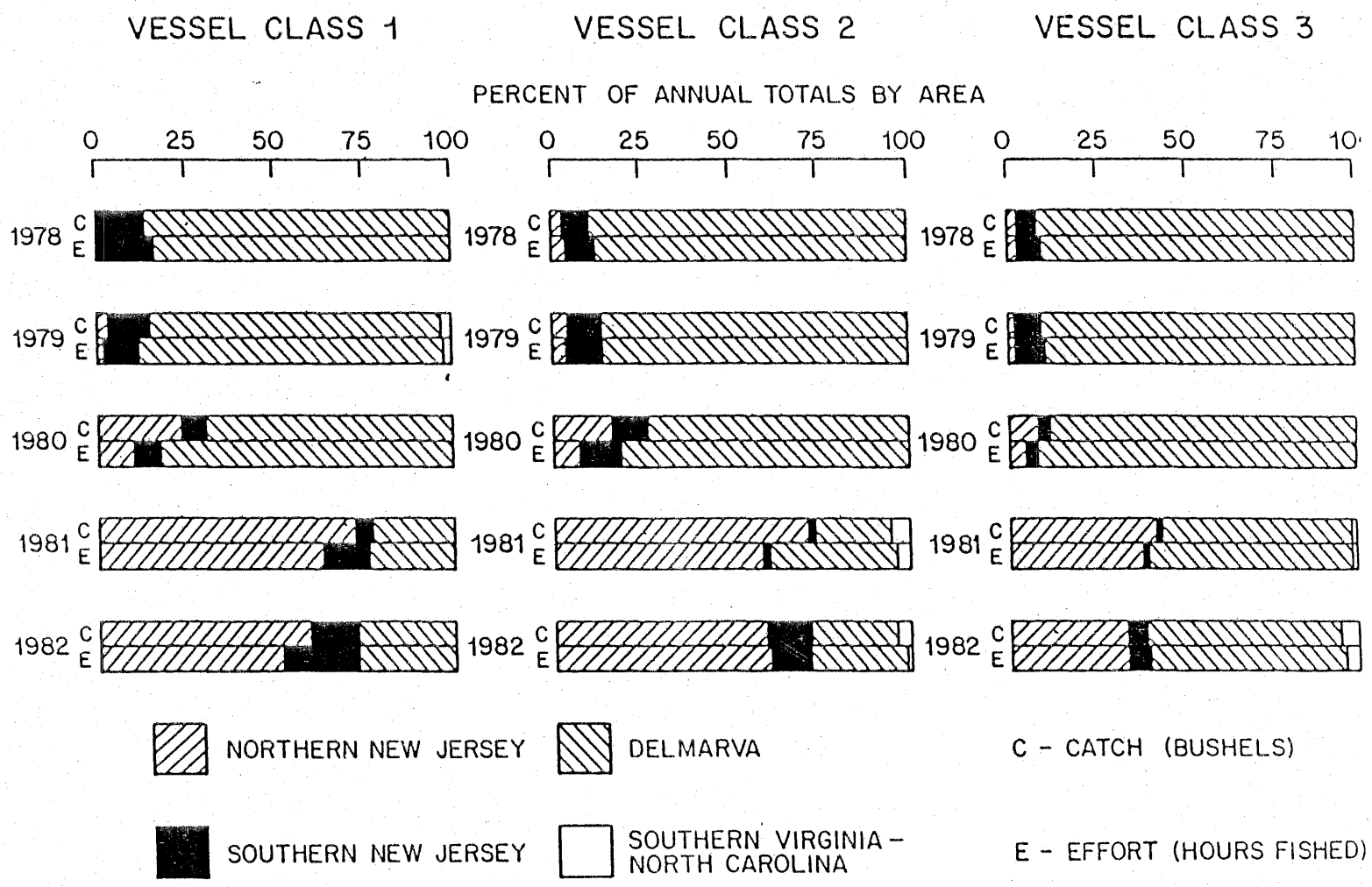

Figure 6. Annual percentages of offshore (FCZ) Middle Atlantic surf clam catch taken in each of four assessment areas, 1978-1982. Data are presented by vessel size class (class 1:1-50 GRT; class 2:51-100 GRT; class 3:>100 GRT).

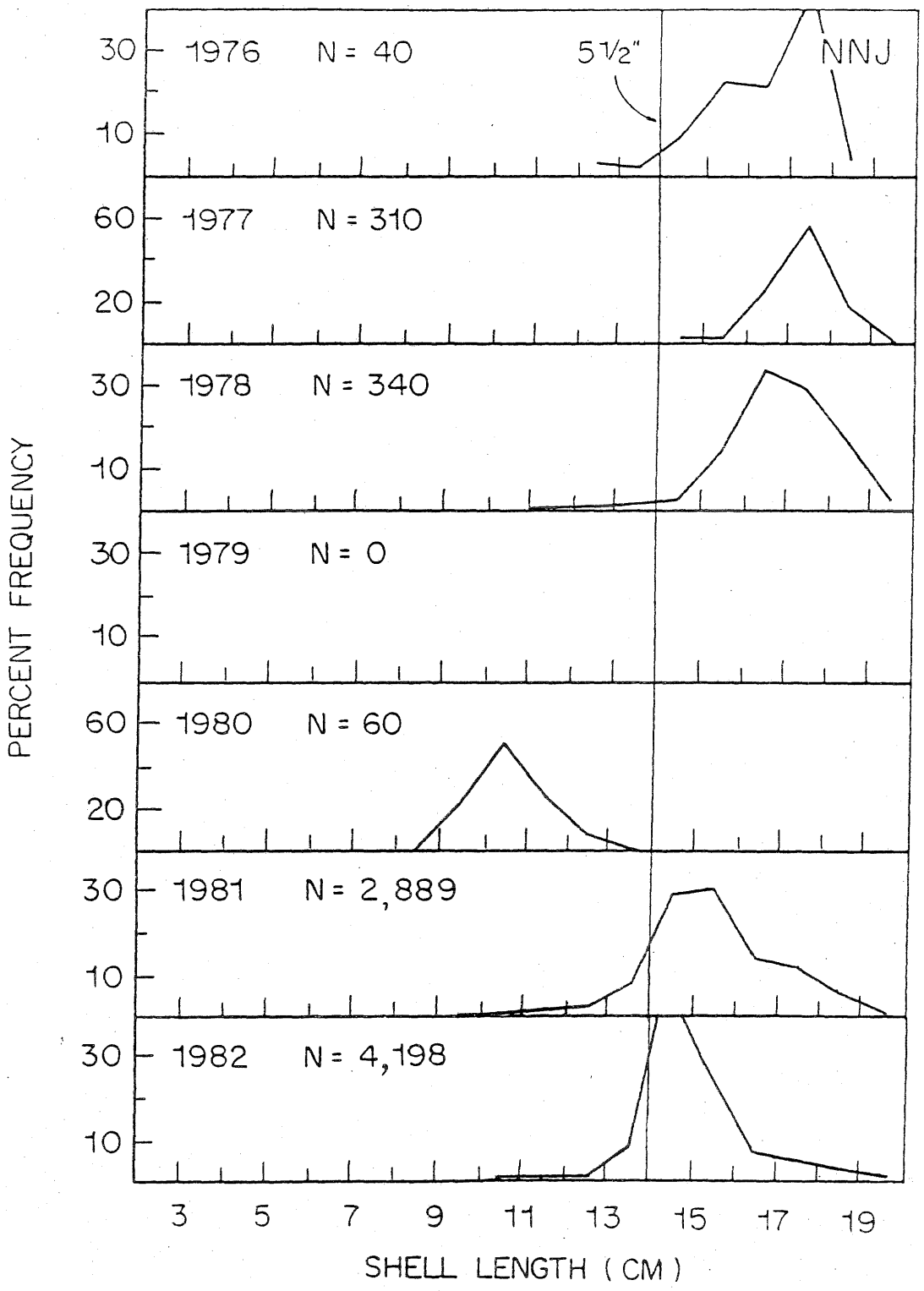

Figure 7. Length frequency distributions of surf clams sampled from commercial vessels operating off Northern New Jersey, 1976-1982. Data for 1982 are complete through the second week of December.

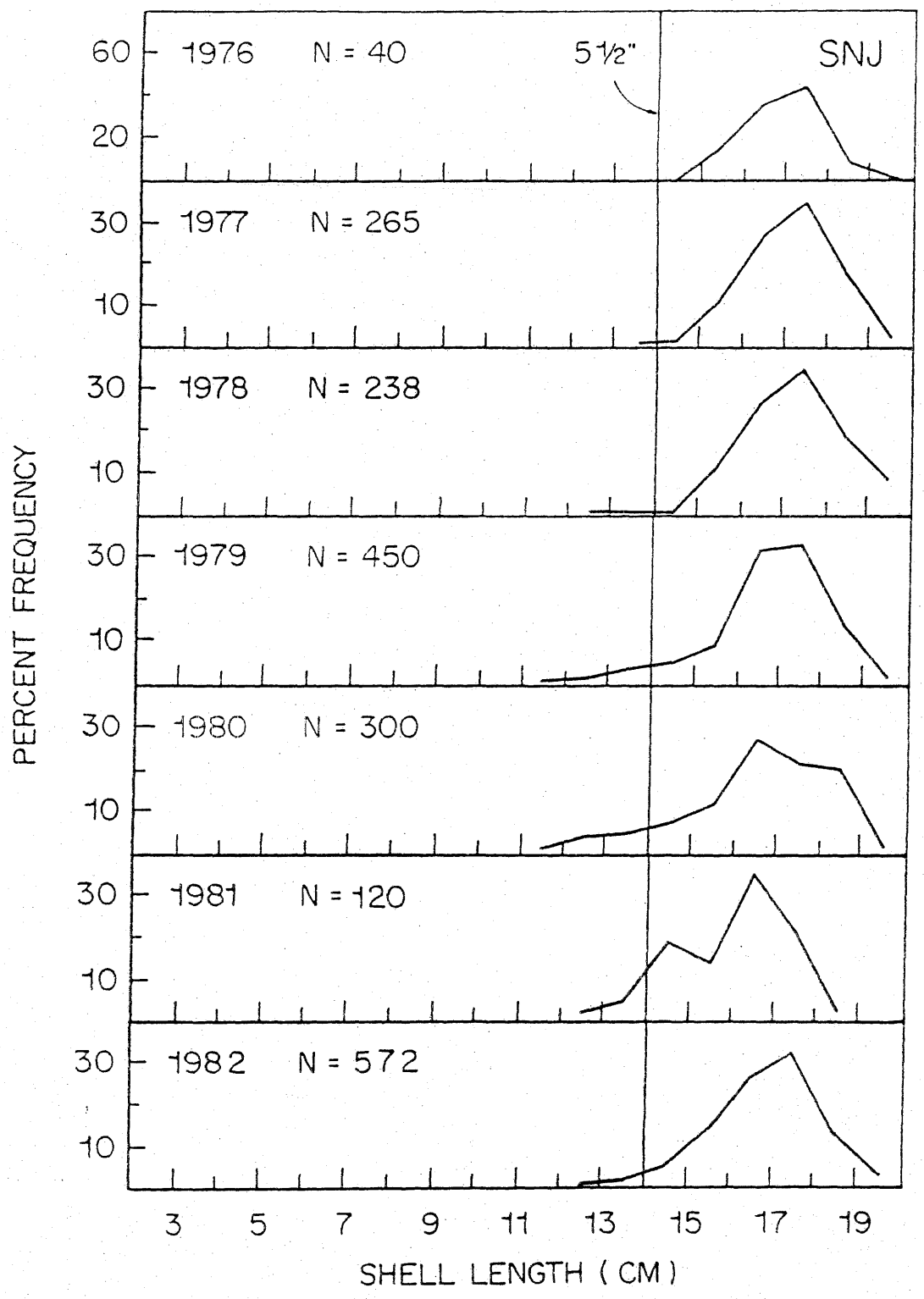

Figure 8. Length frequency distributions of surf clams sampled from commercial vessels operating off Southern New Jersey, 1976-1982. Data for 1982 are complete through the second week of December.

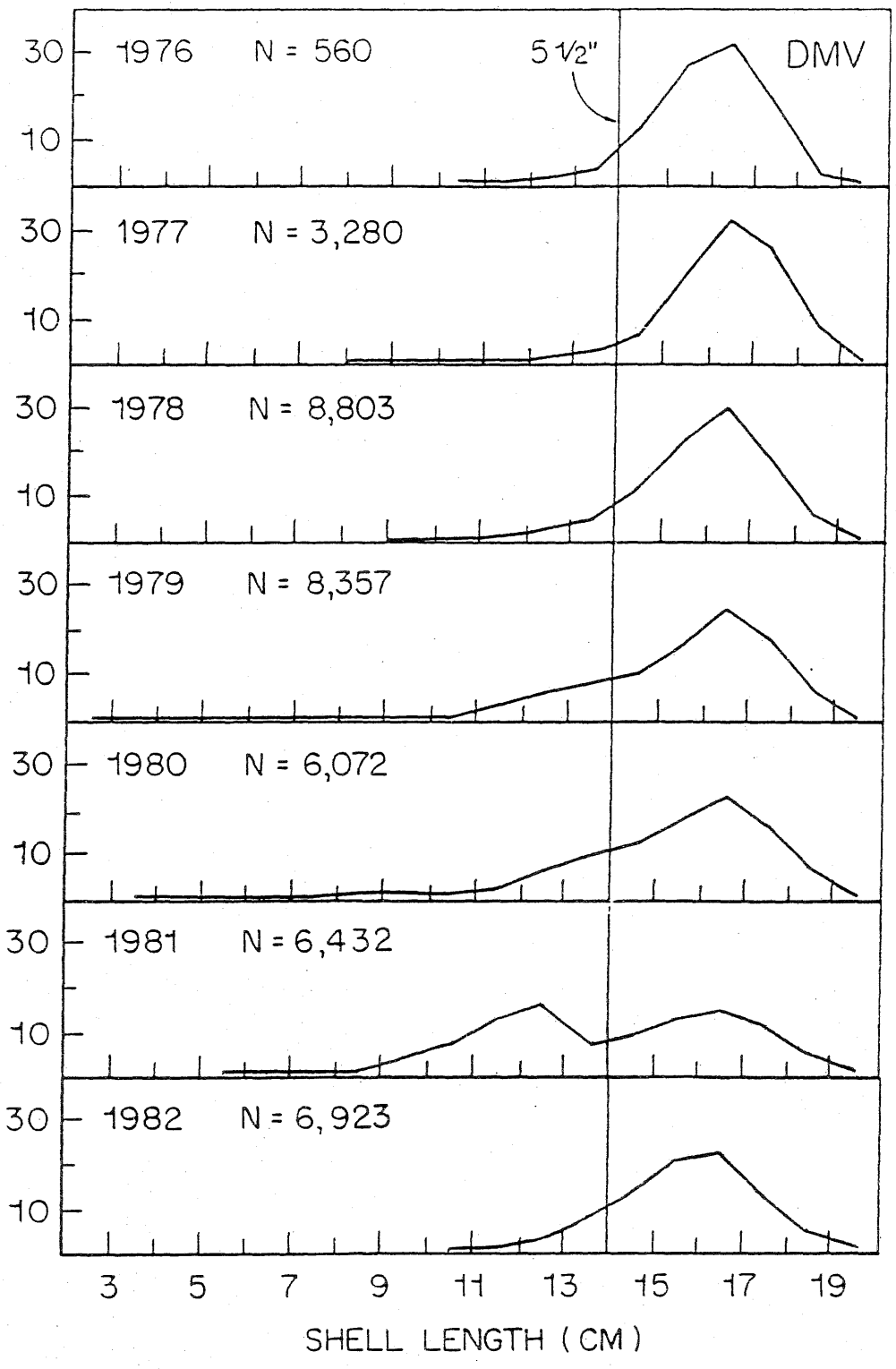

Figure 9. Length frequency distributions of surf clams sampled from commercial vessels operating off Delmarva, 1976-1982. Data for 1982 are complete through the second week of December.

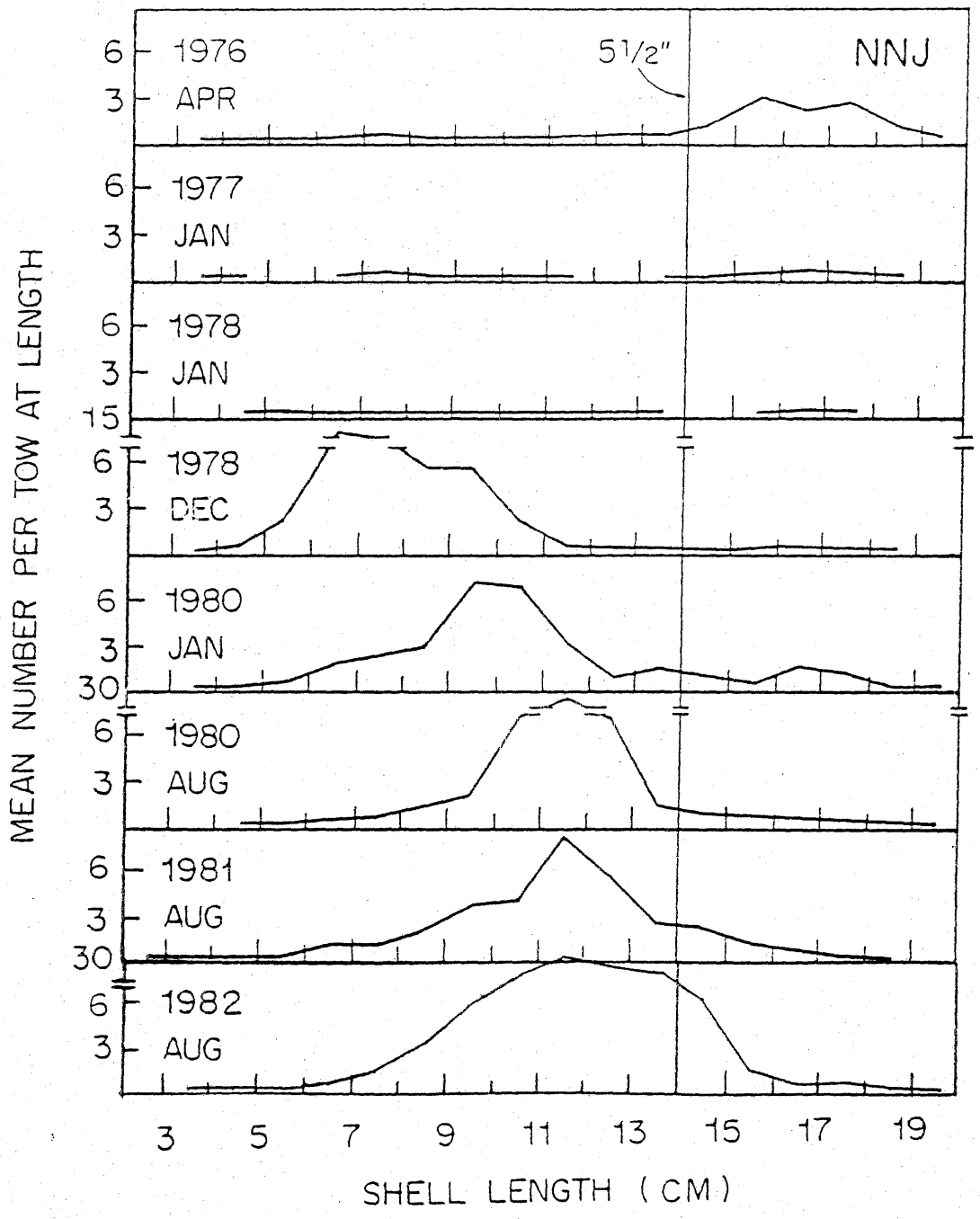

Figure 10. Stratified mean number of surf clams per standardized tow, at length, in NMFS shellfish surveys off Northern New Jersey, 1976-1982.

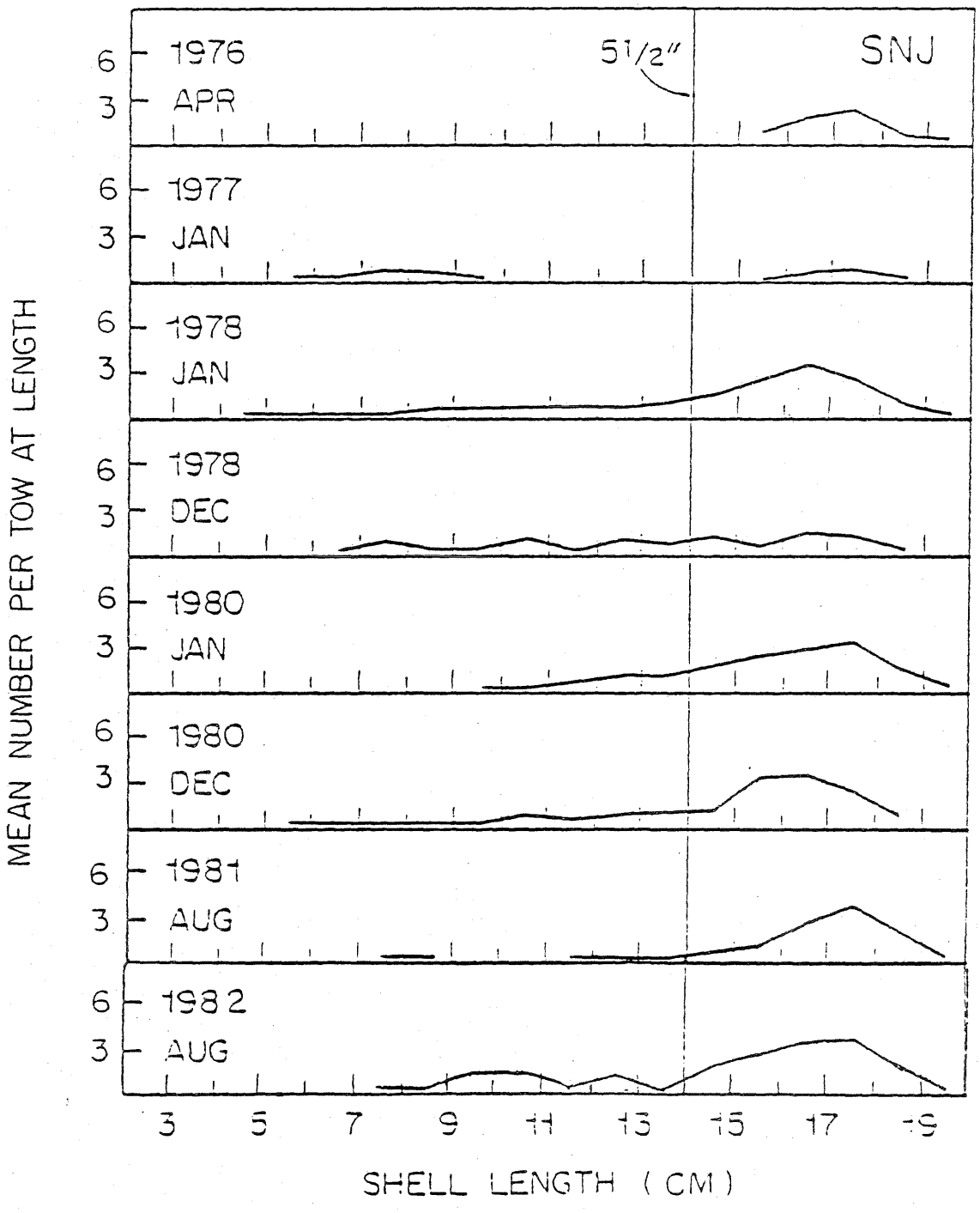

Figure 11. Stratified mean number of surf clams per standardized tow, at length, in NMFS shellfish surveys off Southern New Jersey, 1976-1981.

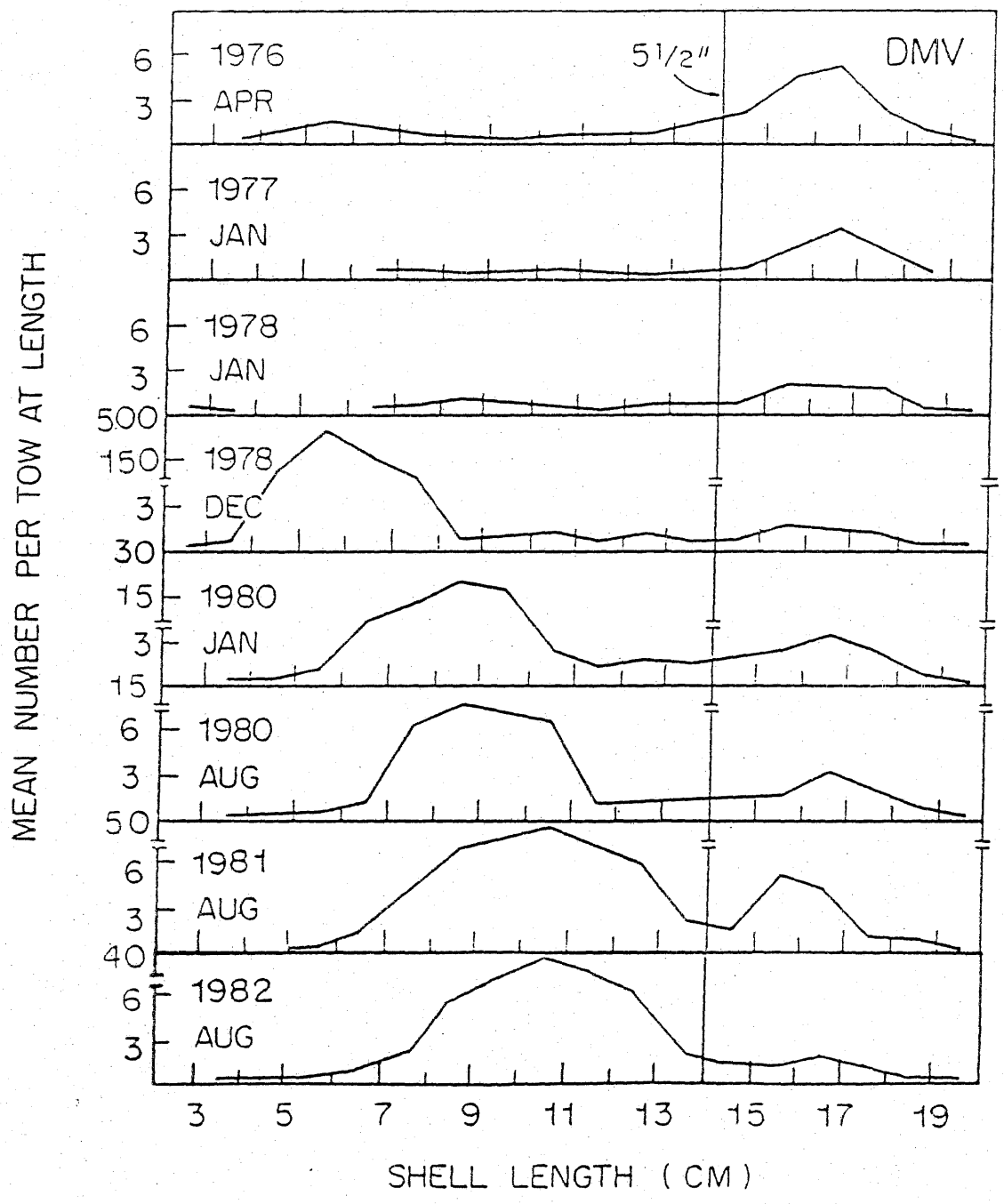

Figure 12. Stratified mean number of surf clams per standardized tow, at length, in NMFS shellfish surveys off Delmarva, 1976-1982.

Appendix I. A chronology of significant management actions pertaining to the offshore (FCZ) surf clam fishery, regulated under provisions of the Magnuson Fishery Conservation and Management Act.

Date Published Federal Register	Effective Dates of Action	Action
1 September 1982	3 October 1982	Partial re-opening of Atlantic City closed area.
2 April 1982	3 May 1982	1982 surf clam quotas: Mid-Atlantic - 2.35 million bushels, New England - 50 thousand bushels.
29 January 1982	26 January 1982	Final approval of Amendment No. 3 of the Surf Clam-Ocean Quahog FMP.
27 January 1982	3 January 1982	Increase allowable fishing time from 12 to 24 hours/week.
26 October 1981	24 October-8 December 1981	Emergency interim regulations on quotas, size limit, and aspects of effort control.
9 September 1981	9 September-23 October 1981	Extension of emergency regulation requiring 5½ inch minimum clam size.
13 August 1981	26 July-9 September 1981	Correct duration of minimum size regulation.
21 July 1981	26 July 1981	Reduce allowable fishing time from 24 to 12 hours/week.
17 July 1981	26 July-28 August 1981	Impose minimum clam size of 5½ inches.
6 March 1981	4-31 March 1981	Extend emergency regulation for make-up day.
15 January 1981	18 January-4 March 1981	Allow make-up day for bad weather.
7 January 1981	21 December 1980	Expand closure area off Atlantic City, NJ, to protect small clams.
7 December 1980	9 December 1980	Closure of 130 square mile area off Chincoteague, VA, to protect small clams.

Appendix I. (continued)

Date Published Federal Register	Effective Dates of Action	Action
23 July 1982	20 July-27 September 1980	Increase allowable fishing time to 48 hours/week.
20 May 1980	18 May-27 June 1980	Increase allowable fishing time from 36 to 48 hours/week.
22 April 1980	20 April-27 June 1980	Increase allowable fishing time from 24 to 36 hours/week.
14 February 1980	17 February-31 March 1980	Increase allowable fishing time from 24 to 36 hours/week.
3 January 1980	1 January 1980	Implement amendment No. 2 to surf clam-ocean quahog FMP. Mid-Atlantic quota - 1.8 million bushels.
17 December 1979	15 December 1979	Closure of 25 square mile area off Ocean City, MD, to protect small clams.
30 November 1979		Partial approval of provisions of amendment No. 2 of surf clam-ocean quahog FMP.
9 November 1979		Partial approval of provisions of amendment No. 2 of surf clam-ocean quahog FMP.
18 October 1979	15 October-31 December 1979	Increase allowable fishing time from 24 to 36 hours/week.
3 October 1979	1 October-31 December 1979	Adoption of 24 hours/week fishing time at beginning of 4th calendar quarter.
27 September 1979	1 October-31 December 1979	Extend management plan for 3 months, until 31 December, 1979 (Amendment No. 1).
22 June 1979	1 July 1979	Adoption of fixed ending time for designated fishing periods, and presumption concerning fishing gear in water after end of period.

Appendix I. (continued).

Date Published Federal Register	Effective Dates of Action	Action
5 April 1979	2 April-30 June 1979	Adoption of 24 hour/week fishing for the 2nd quarter of 1979.
27 February 1979	26 February 1979	Adjust 1st quarter quota to 300,000 bushels.
27 February 1979	26 February 1979	Increase allowable fishing time to 36 hours/week.
20 December 1978	22-31 December 1979	Closure of FCZ surf clam fishery.
20 December 1978	1 January-31 March 1979	Adoption of 24 hours/week fishing for 1st quarter of 1979.
22 November 1978	17 November 1978	Continuation of vessel moratorium for 1 year.
21 November 1978	15 November 1978	Adjust 4th quarter 1978 quota to 387,834 bushels.
30 October 1978	30 October-31 December 1978	Reduction of allowable fishing time to 24 hours/week.
5 October 1978	1 October-31 December 1978	Increase allowable fishing time to 36 hours/week.
21 September 1978	20 September 1978	Closure of 35 square mile area off Atlantic City, NJ, to protect small clams.
12 September 1978	11 September 1978	3rd quarter 1978 quota reduced to 523,394 bushels.
26 June 1978	1 July-30 September 1978	Continuation of 24 hours/week fishing time.
5 May 1978	8 May-30 June 1978	Reduce allowable fishing time from 48 to 24 hours/week.
31 March 1978	1 April 1978	Specification of effort regulation procedures and 2nd quarter 1978 quota of 529,107 bushels.

Appendix I. (continued).

Date Published Federal Register	Effective Dates of Action	Action
31 March 1978	13-31 March 1978	Closure of FCZ surf clam fishery.
21 February 1978	20 February-1 April 1978	Reduction of allowable fishing time to 2 days/week.
17 February 1978	17 February 1978	Implementation of Final Regulations for surf clam-ocean quahog FMP.
31 January 1978	30 January-15 February 1978	Emergency amendment to FMP reducing allowable fishing time to 2 days/week.
30 December 1977	1 January-14 February 1978	Extension of emergency regulations for surf clam-ocean quahog FMP.
25 November 1977	17 November 1977	Implementation of surf clam-ocean quahog FMP by emergency regulations.

Appendix II. Log mean number per tow ($ln(x+1)$) of surf clams from NMFS surveys off Northern New Jersey, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes, and are given by stratum. Number of survey tows is given in parentheses.

Survey	Stratum 90	89	88	25	21
May 1965	1.16 (4)	3.06 (10)	2.27 (15)	1.55 (20)	1.92 (36)
Oct 1965	4.41 (1)	3.12 (15)	2.70 (17)	2.78 (5)	2.33 (29)
Aug 1966	1.61 (1)	3.95 (15)	2.78 (5)	2.36 (16)	2.10 (54)
Jun 1969	0.00 (1)	3.67 (19)	3.00 (11)	3.23 (3)	2.37 (25)
Aug 1970	0.00 (1)	2.96 (12)	4.04 (8)	1.96 (6)	1.63 (26)
Jun 1974	0.00 (3)	3.09 (8)	3.78 (11)	0.98 (12)	1.15 (27)
Apr 1976	0.90 (3)	2.22 (5)	2.70 (7)	1.27 (13)	1.19 (14)
Jan 1977	0.57 (2)	0.74 (3)	0.54 (6)	0.47 (5)	0.75 (18)
Jan 1978	1.64 (4)	1.04 (9)	0.31 (12)	0.57 (12)	0.60 (29)
Dec 1978	- (0)	1.87 (8)	4.58 (8)	0.94 (6)	1.09 (14)
Jan 1980	0.80 (2)	2.91 (12)	3.92 (11)	1.60 (11)	1.60 (20)
Aug 1980	0.35 (2)	2.07 (10)	4.06 (10)	1.20 (9)	1.53 (18)
Aug 1981	- (0)	2.80 (10)	4.61 (10)	1.98 (9)	1.84 (18)
Aug 1982	0.00 (2)	2.87 (15)	5.45 (15)	1.00 (9)	2.11 (18)

Appendix III. Standard deviations (SD) of mean number per tow of surf clams from NMFS surveys off Northern New Jersey, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes, and are given by stratum.

Survey	90	89	88	25	21
May 1965	51.00	63.59	172.59	49.36	59.66
Oct 1965	0.00	73.51	51.10	28.89	53.94
Aug 1966	0.00	58.80	49.55	21.32	30.23
Jun 1969	0.00	42.70	48.73	16.65	42.04
Aug 1970	0.00	36.60	55.44	11.14	27.14
Jun 1974	0.00	36.91	61.57	18.09	14.13
Apr 1976	8.12	18.19	22.39	19.30	19.43
Jan 1977	2.20	2.71	5.10	1.40	8.30
Jan 1978	4.51	5.58	4.49	2.35	4.33
Dec 1978	--	57.78	227.73	26.57	11.10
Jan 1980	5.66	61.11	120.61	12.85	17.84
Aug 1980	0.71	14.01	668.86	9.47	15.64
Aug 1981	--	59.02	131.00	6.82	24.49
Aug 1982	0.00	82.72	868.35	13.75	34.02

Appendix IV. Log mean number per tow ($ln(x+1)$) of surf clams from NMFS surveys off Southern New Jersey, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes, and are given by stratum. Number of survey tows is given in parentheses.

	Stratum	
Survey	87	17
May 1965	3.60 (9)	2.57 (11)
Oct 1965	3.36 (2)	2.34 (6)
Aug 1966	3.46 (8)	2.21 (24)
Jun 1969	3.91 (6)	2.75 (11)
Aug 1970	2.72 (5)	0.38 (9)
Jun 1974	2.30 (6)	2.73 (8)
Apr 1976	0.92 (5)	0.77 (7)
Jan 1977	0.99 (3)	0.67 (7)
Jan 1978	2.33(10)	1.51 (16)
Dec 1978	1.03 (6)	2.23 (5)
Jan 1980	2.31 (6)	1.54 (11)
Aug 1980	2.07 (6)	2.02 (11)
Aug 1981	1.29 (6)	1.90 (11)
Aug 1982	2.03 (7)	2.60 (11)

Appendix V. Standard deviations (SD) of mean number per tow of surf clams from NMFS surveys off Southern New Jersey, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes, and are given by stratum.

Survey	Stratum 87	17
May 1965	224.67	37.16
Oct 1965	114.56	173.04
Aug 1966	100.36	77.46
Jun 1969	45.10	68.27
Aug 1970	43.24	3.62
Jun 1974	63.09	50.23
Apr 1976	10.22	12.23
Jan 1977	3.25	3.46
Jan 1978	16.58	18.77
Dec 1978	3.83	10.21
Jan 1980	18.93	13.20
Aug 1980	7.53	21.92
Aug 1981	4.93	10.27
Aug 1982	22.24	32.82

Appendix VI. Log mean number per tow ($ln(x+1)$) of surf clams from NMFS surveys off Delmarva, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes, and are given by stratum. Number of survey tows is given in parentheses.

Survey	Stratum 86	85	84	83	82
May 1965	1.20 (5)	3.61 (7)	1.07 (8)	1.38 (4)	0.00 (2)
Oct 1965	2.45 (4)	3.36 (8)	1.00 (9)	0.16 (7)	0.00 (2)
Aug 1966	0.00 (4)	2.94 (6)	0.43 (7)	0.00 (5)	0.00 (3)
Jun 1969	0.82 (4)	2.36 (7)	0.00 (5)	0.64 (4)	0.00 (1)
Aug 1970	0.00 (2)	2.45 (4)	0.00 (3)	0.00 (3)	0.00 (2)
Jun 1974	0.76 (4)	2.00 (6)	0.78 (6)	0.00 (7)	0.00 (2)
Apr 1976	0.00 (3)	2.55 (5)	0.19 (5)	0.71 (2)	0.00 (1)
Jan 1977	0.47 (2)	1.18 (4)	0.24 (4)	0.00 (2)	0.00 (1)
Jan 1978	0.00 (2)	1.27 (4)	0.00 (5)	0.00 (3)	0.00 (2)
Dec 1978	0.59 (4)	1.95 (7)	0.24 (6)	0.85 (4)	0.35 (4)
Jan 1980	1.76 (2)	0.52 (4)	1.74 (5)	0.54 (3)	0.00 (2)
Aug 1980	0.00 (2)	1.46 (3)	0.00 (4)	1.04 (2)	- (0)
Aug 1981	0.00 (2)	3.68 (3)	0.27 (4)	0.00 (2)	0.00 (1)
Aug 1982	0.00 (2)	1.83 (6)	0.27 (4)	0.90 (2)	1.10 (1)

Survey	Stratum 13	14	10	9
May 1965	2.63 (25)	0.00 (3)	0.27 (4)	2.35 (46)
Oct 1965	2.74 (16)	- (0)	2.83 (1)	1.84 (24)
Aug 1966	3.01 (18)	- (0)	0.00 (2)	2.74 (33)
Jun 1969	2.99 (16)	- (0)	0.00 (1)	2.37 (30)
Aug 1970	2.57 (12)	0.31 (3)	0.00 (1)	1.37 (22)
Jun 1974	3.01 (21)	- (0)	- (0)	2.62 (34)
Apr 1976	2.52 (11)	0.00 (2)	- (0)	2.10 (22)
Jan 1977	2.47 (13)	0.00 (1)	0.00 (1)	1.55 (20)
Jan 1978	2.43 (19)	0.00 (2)	0.31 (3)	1.94 (20)
Dec 1978	2.74 (10)	0.00 (2)	0.87 (2)	1.35 (19)
Jan 1980	2.78 (16)	2.70 (2)	0.00 (2)	2.38 (32)
Aug 1980	2.59 (12)	0.81 (2)	2.17 (2)	2.99 (21)
Aug 1981	2.36 (12)	0.00 (2)	1.04 (2)	2.06 (21)
Aug 1982	1.90 (20)	0.00 (2)	0.00 (2)	3.26 (30)

Appendix VII. Standard deviations (SD) of mean number per tow of surf clams from NMFS surveys off Delmarva, 1965-1982. Data are standardized to a 60 inch wide dredge towed for 5 minutes, and are given by stratum.

	Stratum				
Survey	86	85	84	83	82
May 1965	34.48	76.62	6.82	2.83	0.00
Oct 1965	89.52	40.49	12.65	0.76	0.00
Aug 1966	0.00	69.23	2.27	0.00	0.00
Jun 1969	3.79	63.62	0.00	6.00	0.00
Aug 1970	0.00	70.92	0.00	0.00	0.00
Jun 1974	10.00	27.29	14.56	0.00	0.00
Apr 1976	0.00	101.23	0.70	2.21	0.00
Jan 1977	1.10	0.90	0.78	0.00	0.00
Jan 1978	0.00	3.72	0.00	0.00	0.00
Dec 1978	1.50	19628.96	1.28	2.99	1.56
Jan 1980	23.33	0.50	64.42	2.31	0.00
Aug 1980	0.00	4.16	0.00	4.95	-
Aug 1981	0.00	2213.86	1.00	0.00	0.00
Aug 1982	0.00	230.83	1.00	3.54	0.00

	Stratum			
Survey	13	14	10	9
May 1975	62.60	0.00	1.00	31.12
Oct 1975	64.03	-	0.00	32.39
Aug 1966	62.27	-	0.00	40.49
Jun 1969	44.96	-	0.00	46.62
Aug 1970	52.68	0.90	0.00	36.54
Jun 1974	57.22	-	-	79.44
Apr 1976	41.46	0.00	-	39.84
Jan 1977	34.99	0.00	0.00	18.62
Jan 1978	29.28	0.00	0.90	20.93
Dec 1978	30.51	0.00	3.31	85.82
Jan 1980	27.92	157.68	0.00	456.91
Aug 1980	14.51	2.83	10.61	155.09
Aug 1981	10.51	0.00	4.95	428.10
Aug 1982	30.12	0.00	0.00	489.20