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ASSESSMENT AND CURRENT STATUS
OF OFFSHORE SURF CLAM, Spisula solidissima
POPULATIONS OFF THE MIDDLE ATLANTIC
COAST OF THE UNITED STATES

by

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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 management plan for Atlantic Surf Clam and Ocean Quahog Fisheries first implemented during November 1977. Objectives of the initial Fishery Management Plan (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 effect these goals have included annual and quarterly landings 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.

At the time of the adoption of the FMP (1977) abundance of offshore surf clam resources of Middle Atlantic area was generally low. A period of intensive fishery exploitation during the early and mid-1970's and a massive mortality of surf clams resulting from anoxic hydrographic conditions off the Northern and Central Coasts of New Jersey (traditionally important fishing areas), resulted in the diminution of exploitable surf clam resources. (U.S. Dept. of Comm. 1979).

With the collapse of the fishery centered off the mouth of the Chesapeake Bay, during the mid-1970's, landings fell dramatically and fishing

effort became concentrated off the Delmarva Peninsula. Prospects for short-term recovery of surf clam populations in the Northern and Southern New Jersey areas to former levels of abundance appeared limited. Concern for the surf clam industry as a whole prompted efforts by the Mid-Atlantic Fishery Management Council to implement comprehensive fishery regulation under provisions of the (Magnuson) Fishery Conservation and Management Act of 1976.

This report presents an updated assessment of the status of surf clam resources in offshore Middle Atlantic areas of the FCZ. Most recent available information with respect to research vessel surveys, commercial vessel performance, and commercial catch composition is analyzed in an historical context to provide measures of relative resource abundance, recruitment levels, and the potential impacts of various management strategies. Previous resource evaluations are presented in the following assessment documents: Brown et al. 1977; Serchuk et al. 1979; Murawski and Serchuk 1979; and Serchuk and Murawski 1980. Because of relatively recent shifts in the areal distribution of fishing effort/landings and improved recruitment prospects in the Northern New Jersey and Delmarva areas, commercial vessel logbook records and associated biological sampling data are presented through the third calendar quarter of 1981. Results from the most recent synoptic research vessel survey (August-September 1981) are also presented and discussed.

COMMERCIAL FISHERY

Total USA surf clam landings during 1980 increased to 37.7 million pounds of meat, up 8% from the 1979 level of 34.9 million pounds (Table 1). The proportion of total USA landings taken from the FCZ during 1980 increased to 92%, reflecting a 19% increase in total FCZ landings, and a 48% decline in landings from territorial waters of individual states (primarily New Jersey). As of 25 September 1981, FCZ landings were 32.4 million pounds, slightly less than the 1980 total, but in excess of the annual landings quota for FCZ waters of 30.6 million pounds (1.8 million bushels at 17 pounds of meat per bushel).

The increased rate of resource harvest through July 1981 was due to increased resource abundance in the Northern New Jersey and Delmarva assessment areas, as evidenced by increased catch per effort figures since the fourth quarter of 1980 (see "commercial vessel performance data"). Total effort in the Northern New Jersey area increased substantially between 1980 and 1981. The minimum size regulation (5½" shell length), and more restrictive vessel effort regulations effective 26 July 1981, have resulted in recent declines in average catch per effort values, and in the total rate of harvest.

Commercial Vessel Performance Data

With the adoption of the FMP, vessel operators have been required to submit weekly logbook records detailing the area and time spent fishing, total catch of surf clams and ocean quahogs, and other data not considered explicitly here. Fishing locations were generally recorded as LORAN-C coordinates, thus the following rates were used to allocate individual vessel trip records to Middle Atlantic assessment areas for further analysis:

<u>Assessment Area</u>	<u>LORAN C 9960-y</u>
Northern New Jersey	43700-42850
Southern New Jersey	42849-42650
Delmarva	42649-41350

Logbook records were totaled by calendar quarter, and by vessel categories recognized in the FMP:

<u>Vessel Class</u>	<u>GRT Range</u>
1	1-50
2	51-100
3	101+

Tables 2-7 and Figures 1-3 summarize logbook data available since the inception of the mandatory record keeping program. Data presented include the number of vessel trips by quarter and vessel class, total catch and hours fished, mean catch per effort (bushels/hour) and the percent of total quarterly trips, catch, and effort from each of the three Middle Atlantic assessment areas for each vessel category.

The total number of vessel trip records amenable for analysis increased from 3,456 in 1978 to 4,449 in 1979, but subsequently declined to 3,561 in 1980, and 2,493 through 9/14/81. During 1978-1980, greater than 80% of trips, catch, and fishing effort was generated in the Delmarva assessment area. The percent of trips, catch, and effort in the Delmarva area generally increased from vessel class 1-3. Contrariwise, the proportion of trips etc. generally decreased with vessel size in the Northern and Southern New Jersey areas.

The Delmarva area accounted for 87-93% of the total Middle Atlantic landings from 1978 through the third quarter of 1980. However, since the

fourth quarter of 1980 the proportion of landings from Delmarva has declined to less than 40% in the third quarter of 1981. Northern New Jersey landings accounted for less than 3% of the total during 1978 and 1979, but have increased steadily since mid-1980 to nearly 60% of the total during the third quarter of 1981. Southern New Jersey landings declined from 6-7% of the total in 1978-1979 to less than 2% in 1981.

Tonnage class 3 vessels (101+ GRT) annually accounted for between 70-79% of Middle Atlantic landings from 1978-1980 (average 74%). 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 3% (2-4%) of landings. During 1981 the proportion of landings generated by Class 2 vessels increased to 23% (from 18% in 1980) while class 3 vessels yielded 75% of the catch (down from 79%), and class 1 vessels accounted for 3% (an increase of one percent from 1980 levels).

Commercial Vessel Abundance Indices

Indices of relative vessel performance were computed as the mean number of bushels landed per hour fishing; computations were made for each calendar quarter and vessel class. To the extent that fishing power of vessels in the three vessel classes operating in various assessment areas has remained constant through the study period, C/E data will reflect relative resource abundance (Tables 2, 4, 6, Figures 1-3). Analyses of temporal trends in catch per unit fishing effort 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, and 1028 vessel trips for the years 1978-1981 respectively. Significant increases in the number (and percentage of total) vessel trips allocated to the NNJ area are notable beginning in the third calendar quarter of 1980 (Tables 2 and 3). 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. Although these calculations are based on only 3, 20, and 38 vessel trips for classes 1-3, the greatly increased C/E values were indicative of a relatively strong incoming year class 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 27.8 bushels/hour in the third calendar quarter of 1981. 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 figures were 39.0, 43.4, and 75.2 bushels/hour during 1980 for vessel classes 1-3, and 31.2, 51.8, and 65.6 bushels/hour through the third quarter of 1981. During 1980 and 1981 average C/E for all vessel classes operating in NNJ was significantly greater than corresponding values from SNJ and DMV. After 26 July 1981 (effective date of implementation of the 5½ inch minimum size) C/E values for the various vessel classes declined 3, 23, and 6% respectively from second quarter values. The decline in catch/effort associated with enforcement of the

size limit is probably due to the fact that much of the Northern New Jersey surf clam resource, virtually representing a single year class, remains below the legal length (14 cm or 5½" shell length, see "research vessel surveys").

Southern New Jersey

Catch per effort calculations for the Southern New Jersey assessment area are based on 292, 398, 239, and 49 vessel trip reports for the years 1978-1981 respectively. Average annual C/E values for class 3 vessels increased steadily through the time period from 23.0 to 43.2 bushels/hour. Indices for the other vessel classes are more variable, probably as a result of the limited number of vessel trips available for analysis. Average C/E figures for class 2 vessels exhibit a declining trend from 1978 through 1980, with a seemingly anomalous value for the first quarter of 1981 and relatively low values during quarters two and three. Data from class 1 vessels have indicated a general declining trend since the second quarter of 1979. The differing trends in annual C/E values for class 3 vessels vs classes 1 and 2 may reflect patterns in resource utilization (e.g. class 1 and 2 vessels may not fish in the same areas as class 3 vessels) or differential changes in relative fishing power during the study period. During this time larger vessels (i.e. class 3) were known in some circumstances to have added a second dredge ("double rigging") while class 1 and some class 2 vessels were incapable of such conversions.

not significant. The decreasing proportion of total landings taken from this area is associated with the relatively low C/E values in the SNJ area compared with other Middle Atlantic fishing areas.

Catch per effort values after 26 July 1981 declined 13 and 32% respectively from second quarter indices for vessel classes 1 and 3 respectively. C/E for class 2 increased 75%, but was based on only one vessel trip.

Delmarva

The numbers of trips analyzed from the Delmarva assessment area were 3062, 3922, 3322, and 1416 for the years 1978-1981. Average catch per effort values remained relatively stable through the third quarter of 1980 for vessel classes 1 and 2. C/E values for class 3 vessels exhibited an increasing trend from 1978-1981, probably in part due to increases in fishing power over the period. All vessel classes showed increases in C/E during the fourth quarter of 1980. During 1981, average C/E values were 60, 33, and 41% above corresponding 1980 levels for vessel classes 1-3. Although C/E off Delmarva did increase during this period, there was a coincident shift of fishing effort to the Northern New Jersey area probably because C/E levels were greater there, and recruiting surf clams were larger (see "Biological Fishery Sampling" and "Research Vessel Surveys").

Average C/E since 26 July declined 17, 22, and 14% for the three vessel classes from second quarter 1981 values. These declines are generally greater than those off NNJ, reflecting the greater reliance of the fishery, prior to that date, on clams less than 5½ inches (see "Biological Fishery Sampling"). Pre-recruit resources in the Delmarva region also appear to be composed primarily of one year class (as off NNJ), however, the bulk of Delmarva pre-recruits appear to be one year younger than those off Northern New Jersey (1977 year class).

Biological Fishery Sampling

Length frequency sampling of commercial clam landings is routinely conducted in the major fishing ports of the Middle Atlantic. Along with relevant biological data the port samplers record the area and depth zone from which the landings were derived, thus, samples can be allocated to the assessment area from which they were caught. The sampling protocol is to measure 30 clams from each vessel trip sampled. 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-August 1981 are presented in Figures 4-6. The numbers of clams sampled, allocated by assessment area and year are also given. Commercial length frequencies from all assessment areas were unimodal during the period 1976-1979, with most landed clams being in the 15-18 cm range. Prior to 1980 virtually all surf clams landed were greater than 12 cm. A significant increase in the proportion of clams under 12 cm (shell length) was noted in the Delmarva assessment area during 1981.

During the period 1976-1980 a relatively small proportion of sampled landings were comprised of clams smaller than the current legal minimum size ($5\frac{1}{2}$ inches or 14 cm). (1980 data from Northern New Jersey are the exception, but are derived from only two samples.) Data from 1981, however, indicate a significant increase in the proportion of small clams landed, particularly off Delmarva, where about 48% of the landings were below $5\frac{1}{2}$ inches. A smaller proportion of landings from the NNJ and SNJ areas were below 14 cm (14 and 7% respectively) perhaps reflecting the larger average size of recruiting classes in the New Jersey area.

RESEARCH VESSEL SURVEYS

Research vessel shellfish assessment surveys in offshore Mid-Atlantic waters have been conducted since 1965 (Table 8). In each survey, standard tows of four or five minute duration were performed at pre-selected sampling locations with an hydraulic clam dredge. Since dredge knife width and time of tow varied among surveys prior to 1980, all individual station catch data were standardized to a 1.2 cm (48-inch) dredge towed for 4 minutes.

Since 1978, a stratified random sampling design has been used in the shellfish surveys with the survey area stratified into geographical zones based on water depth and latitude (Murawski and Serchuk 1979: Figure 1). Sampling stations were allotted to strata in general proportion to the area of each stratum; within strata, stations were randomly assigned to specific locations. Survey data from 1965-1977, obtained using a grid-type sampling design, were post-stratified before analysis into the sampling strata used in the most recent surveys.

Survey strata were grouped into three sets corresponding to the geographical boundaries of the principal offshore surf clam fishery areas (i.e., Northern New Jersey, Southern New Jersey, and Delmarva) to facilitate comparisons with the commercial fishery data. For each strata set, relative abundance indices were calculated in terms of stratified mean number and mean weight per tow. Length frequency data and shell length-meat weight relationships were used to derive catch per tow indices for clams below $5\frac{1}{2}$ " (14 cm), those of exploitable size (≥ 14 cm, shell length) and total clams caught.

Catch per tow indices for the entire time-series are presented in Tables 9-14 and Figures 7 and 8. Included are percentages of the catch data (numbers and weight) that were above the current minimum size ($5\frac{1}{2}$ inches). Stratified mean catches per tow (numbers) at length for 1976-1981 are given in Figures 9-11. Catch data are reviewed in detail for each assessment area separately.

Northern New Jersey

Stratified number per tow indices declined steadily between May 1965 and April 1976, and more abruptly between 1976 and 1977. From May 1965 to April 1976 total numbers declined 66% while clams $5\frac{1}{2}$ inches or greater dropped in abundance by 53%, and those less than $5\frac{1}{2}$ inches by 85%. The proportion of total numbers per tow comprised of clams $\geq 5\frac{1}{2}$ inches increased from 59% in May 1965 to 82% in 1976, indicative of poor recruitment during this period. Biomass indices of clams $< 5\frac{1}{2}$ " declined 89% 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 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 7).

Total mean number per tow increased from 1.32 during the January 1978 to 28.8 in December 1978. In three subsequent surveys, numbers per tow have averaged 25.9. These data are comparable to the 1965-1966 period when numbers

per tow averaged 22.3. The current resource, however, is comprised mostly of clams less than 5½ inches (87% in August 1981), while in 1965-1966, the resource was primarily composed of clams greater than 5½ inches (75%).

Weight per tow indices have increased since January 1978 (1980-81 average 1.77 kg of meats per tow), but are about half of the 1965-1966 average (57%) due to the large proportion of small clams in the most recent samples. Weight per tow indices of commercial sized clams in 1980-1981 surveys averaged .41 kg/tow, about 15% of 1965-1966 values.

Year classes spawned from 1977-1979 appear relatively weak with respect to the 1976 cohort off Northern New Jersey. Since clams have to be about two years of age to be taken in significant numbers by the clam dredge system, evaluations of the strength of 1980 and 1981 year classes will await future survey activities. 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 used in this assessment). Modal length frequency progressions of the 1976 cohort off NNJ are virtually identical to those predicted growth rates from von Bertalanffy growth equations (Table 15), notwithstanding changes in the average density of clams in the area.

Southern New Jersey

Total stratified mean number and weight per tow indices for the Southern New Jersey assessment area declined steadily from 1965-1970, increased in 1974, and subsequently dropped to the lowest observed values in 1977. Since 1980 total indices have essentially stabilized, but at a level considerably below

that observed during the mid to late 1960's. The August 1980 and August 1981 number per tow indices were 83 and 88% below the 1965-1969 average, respectively. Similarly, weight per tow values observed in the August 1980 and 1981 surveys were 74 and 79% less than the 1965-1969 average. Pre-recruit indices for the SNJ area were greatest during 1965. Although slight improvement in pre-recruit indices was observed in the 1978-1980 surveys, the average number per tow of $<5\frac{1}{2}$ inch surf clams off SNJ during December 1978-1980 surveys was 8% of comparable indices off Northern New Jersey. Since 1966 clams $>5\frac{1}{2}$ inches have dominated the number and weight per tow indices (generally greater than 80%). Pre-recruit indices in weight and numbers from the August 1981 cruise were the lowest values recorded in the time-series for the SNJ area. Virtually the entire SNJ surf clam resource is greater than the minimum legal size.

Delmarva

Indices of total numbers per tow were relatively stable between 1965 and 1976, but declined by approximately half during 1977 and 1978. Catch/tow values for the last four surveys (1978-1981), 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 numbers of young clams. Numbers and weights per tow of exploitable sized clams have not exhibited such variability. As with Northern New Jersey, the relatively high pre-recruit indices off Delmarva are almost entirely due to 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 1981 number per tow index for recruit-sized clams (9.04) was 54% greater than the August 1980 value. However, rather than representing a real increase in resource abundance this figure probably represents an aberrant data value. The previous five number per tow indices for recruit sized clams were between 35 and 74 percent of the August 1981 value, and it is unlikely that 1977 year class clams contributed to this index (a distinct bimodality is indicated in the length frequency distribution of 1981 catches, the left hand mode being primarily the 1977 year class). Nevertheless, including the August 1981 value, average recruit-sized weight per tow indices for 1980-81 are 35% less than the average indices for 1965-1974.

YIELD PER RECRUIT

Yield per recruit analyses were conducted for surf clam populations off New Jersey, and Delmarva employing the allometric model of Paulik and Gales (1964). Population growth parameters were significantly different among New Jersey and Delmarva surf clams to warrant separate analyses (Tables 15-17 and Figure 12; see Serchuk and Murawski 1980 for documentation of the sources of these data). For New Jersey and Delmarva populations, the following input parameters were used in the model:

<u>Parameter</u>	<u>New Jersey</u>	<u>Delmarva</u>
W_{∞}	189.9 g	155.8 g
K	.2731	.2984
t_0	-.0255 yr	.0794 yr
t_r	.25 yr	.25 yr
t_{λ}	24 yr	24 yr
M	.25	.25
F	.1-2.0	.1-2.0

Transverse isopleth sections were calculated for ages at entry corresponding to clam sizes of 4½", 5", 5½", and 6" (Figures 13 and 14).

For both New Jersey and Delmarva populations modeled values of age (size) at entry to the exploitable population resulted in asymptotic shaped yield per recruit curves. In all cases F values in excess of 0.7 resulted in proportionately little increase in yield-per-recruit, F_{\max} for both populations and all ages at entry were between 1.9 and 2.0 (88 to 89% annual mortality rate).

Of the four minimum sizes at entry considered in the analysis, greatest yield per recruit values for the New Jersey population were realized at 4½ inches. A five inch minimum size resulted in values relatively close to those at 4½ inches; yield per recruit at F_{\max} for a 5½ inch minimum size was 88 and 89% of the F_{\max} values for 4½ and 5 inch sizes at entry respectively. A 6 inch size at entry resulted in yield per recruit values significantly lower than other sizes considered, at all F values. Conclusion from the yield per recruit analyses of Delmarva populations were essentially similar to those from New Jersey, although the absolute value of yield per recruit was slightly greater for the more northern area.

Maximum yield per recruit values were generally realized at F levels near 2.0. However, such intense fishing levels may have serious impacts on the age composition of the spawning population, and on total reproductive potential. At relatively high F values, few clams greater than the minimum size (5½ inches) survive to spawn. Although 5½ inch clams have typically spawned 5-6 times, the proportional contribution of spawning products by these clams is probably considerably greater than those of smaller (younger) individuals.

Moderate F levels may also be desirable to maintain a heterogenous age distribution in the spawning population as a buffer against successive poor year classes.

CURRENT STATUS AND PROJECTED FISHERY IMPACTS

Significant changes in the areal distribution of fishing effort and landings occurred starting during the fourth calendar quarter of 1980. Prior to that time, and for several successive years, between 80 and 90% of offshore landings were derived from the Delmarva region. Through the third quarter of 1981, however, the Delmarva proportion of total landings declined to 58% while Northern New Jersey accounted for 41% of landings, and Southern New Jersey 1%. A progressive shift of fishing effort to the Northern New Jersey area was apparent throughout 1981. The distribution of landings in the third calendar quarter (through 9/14/81) were: Northern New Jersey 60%, Southern New Jersey 1%, Delmarva 40%.

Recent shifts in the areal distribution of landings are primarily in response to improved resource conditions off Northern New Jersey. Significant quantities of 1976 year class clams were taken beginning in the fourth quarter of 1980. These clams generally represented the largest, fastest growing individuals of a cohort with a modal size of about 12 cm (4.7 inches) in August of 1980 and 1981 samples. Throughout most of 1981 (until 26 July) a minimum clam size did not apply to the fishery. Resultingly, a significant proportion of 1981 landings off Northern New Jersey were 1976 year class clams. With the adoption of a minimum size provision (5½ inches shell length) catch per effort indices (bushels per hour) declined for all vessel classes operating off Northern New Jersey.

Pre-recruit indices for the Northern New Jersey assessment area remained relatively high during the 1981 survey (third highest in numbers, second highest in weight) indicative of the strong 1976 year class. Indices for recruit-sized clams ($>5\frac{1}{2}$ inches) increased 58% in numbers and 38% in weight over August 1980 values. However, these values remain substantially below the levels of the mid and 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 2.82 kg/tow. The most recent index of Northern New Jersey recruit abundance (0.44 kg) is 16% of the earlier average.

Projected growth rates of the 1976 year class of Northern New Jersey indicate that although recruit-size biomass should increase substantially during 1982, the bulk of the 1976 year class will remain below the $5\frac{1}{2}$ inch minimum size. Based on growth equations derived from clams sampled in December 1978, and subsequently validated by modal progression of the 1976 year class, average size of clams in the 1976 year class should reach recruit size in early-mid 1983 (age 6.6 years based on an October 1 birthdate).

Recruit biomass during 1982 will increase as the fastest growing individuals of the 1976 year class reach harvestable size. However, even if recruit size biomass doubles or triples during 1982 it will remain well below levels of the mid and late 1960's. Doubling of recruit biomass in 1982 will result in a harvestable stock of about 31% of the 1965-1969 average, tripling during 1982 will result in about 47% of the earlier level. 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 at levels equivalent to the earlier period, harvest levels from the Northern New Jersey

area during 1982 should be 7.2-10.8 million pounds assuming a doubling or tripling of recruit sized biomass. Landings in 1982 considerably in excess of 10.8 million pounds will probably reduce recruit-sized biomass, off Northern New Jersey and increase dependence on the incoming 1976 year class during 1983.

Harvestable biomass levels off Southern New Jersey declined 16% from 1980-1981, but have generally stabilized at values higher than in the mid-late 1970's. However, average recruit-sized biomass during 1980-1981 surveys was 29% of the 1965-1969 value. Prospects for significant new recruitment to the Southern New Jersey area during 1982-1983 are poor as indicated by the August 1981 pre-recruit weight per tow index (lowest on record). Average annual landings from the Southern New Jersey area were 1.8 million pounds during 1978-1980. To maintain exploitation rates at 1978-1980 levels, landings of about 2.0 million pounds during 1982 are indicated.

During 1981 a significant portion of Delmarva landings were comprised of clams from the relatively strong 1977 year class. Because the modal size of this year class was smaller than the 1976 cohort off Northern New Jersey, a larger proportion of clams less than 5½ inches was evident in commercial length frequency distributions from Delmarva (Figure 6). With the adoption of the minimum size regulation commercial C/E indices generally declined, reflecting the importance of 10-13 cm clams to the 1981 fishery off Delmarva.

The average weight per tow index of recruit-sized surf clams off Delmarva during the August 1981 survey increased 47% from the corresponding August 1980 value. However, because only a relatively small proportion of the 1977 year-

class would have grown to 5½ inches by the August 1981 survey date, the increase in recruit weight per tow probably represents a sampling anomaly. This conclusion is supported by the apparent increased reliance on small clams in the Delmarva fishery during 1981 (Figure 6). Pre-recruit indices from the 1981 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 modestly during 1982 due to recruitment of the fastest growing individuals of the cohort. However, the bulk of the year class will probably not reach the 5½ inch minimum size until late 1983-early 1984. The degree to which recruitment, from the 1977 year class will influence harvestable biomass during 1982-1983 remains problematic. Harvest rates equivalent to the 1978-1980 annual average (28.3 million pounds) could probably be taken from the Delmarva region during 1982 recognizing that the accumulated stock of older recruit sized individuals will decline, increasing the reliance in future years on the 1977 year class.

Results from the most recent research vessel survey (August 1981) suggest that 1977, 1978, and 1979 year classes off Northern New Jersey and 1978 and 1979 year classes off Delmarva are relatively weak. Even if the 1980 year classes were relatively strong they probably could not be detected until late 1982. Thus for at least the next 5-6 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.

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Table 1. Total USA commercial landings of surf clams ($\times 10^{-3}$ lbs of meat), total USA commercial landings from the Fishery Conservation Zone (3-200 miles), and the annual percentage of total USA commercial landings taken beyond 3 miles from shore.

Year	Total Landings	>3 Miles	Percent Caught >3 Miles ¹ from Shore
1965	44,088	33,000	74.9
1966	45,113	32,400	71.8
1967	45,054	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 ²		32,402	

¹ Proration for 1971-1980 are based on data presented in Fisheries of the United States, 1971-1980. Earlier data are based on interview information by the US Bureau of Commercial Fisheries.

² Through 25 Sept. 1981, data are preliminary based on commercial vessel logbook records.

Table 2. Distribution of commercial surf clam catch and effort for the Northern New Jersey assessment area, 1978-1981. Data are presented by calendar quarter and vessel size class (see text). Data are derived from commercial vessel trip logbooks.

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	2557	-	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												
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 ¹	27	125	118	6710	61561	90574	241.5	1126.0	1189.0	27.8	54.7	76.2
4 ²												
Total ³	90	484	454	24202	212110	289208	775.5	4091.3	4408.25	31.2	51.8	65.6

¹Data available through 9/14/81

²Data not available

³Not including data as noted above

Table 3. Percent of commercial surf clam catch (bushels), effort (hours fished) and fishing trips from the Northern New Jersey assessment area by year and calendar quarter. Data are derived from commercial logbook records.

Year-Quarter	Percent of Analyzed Trips				Percent of Analyzed Catch				Percent of Analyzed Effort			
	1	Vessel Class 2	3	Σ	1	Vessel Class 2	3	Σ	1	Vessel Class 2	3	Σ
1978												
1	0.0	4.7	0.0	1.5	0.0	3.0	0.0	.6	0.0	2.4	0.0	.6
2	0.0	2.7	2.3	2.3	0.0	1.5	2.1	1.9	0.0	1.7	2.3	2.0
3	0.0	8.2	1.8	4.0	0.0	4.6	1.2	2.1	0.0	7.2	1.8	3.5
4	0.0	3.8	2.2	2.6	0.0	2.5	1.4	1.6	0.0	1.8	2.1	1.9
Total	0.0	5.1	2.0	3.0	0.0	2.9	1.5	1.8	0.0	3.6	2.0	2.4
1979												
1	12.8	7.5	1.5	3.8	21.8	8.3	1.2	3.2	13.4	5.4	.8	2.4
2	3.1	5.3	3.6	4.2	6.5	5.9	1.9	3.0	3.3	4.2	2.9	3.3
3	0.0	1.2	.8	.9	0.0	1.2	0.8	0.8	0.0	1.2	.6	.8
4	3.6	2.6	3.7	3.3	4.1	2.3	4.6	4.2	2.3	2.9	3.6	3.3
Total	3.7	3.7	2.3	2.9	5.9	3.8	2.1	2.6	3.3	3.0	2.0	2.4
1980												
1	35.6	3.8	3.4	6.1	6.0	5.5	3.4	3.9	10.6	3.3	2.7	3.3
2	8.5	12.6	4.1	6.8	11.8	23.0	3.6	7.0	6.3	12.0	3.8	6.0
3	6.1	4.3	5.3	4.9	11.8	8.8	8.2	8.4	4.8	3.6	3.1	3.3
4	33.3	24.5	12.5	16.0	61.1	36.6	16.6	20.6	31.1	21.6	8.9	12.6
Total	20.0	9.2	6.5	8.1	23.9	16.7	8.5	10.2	10.5	8.1	4.4	5.8
1981												
1	68.6	54.3	25.1	35.0	83.9	64.8	25.4	34.3	67.6	48.5	22.6	30.7
2	59.1	61.5	26.2	39.4	64.4	69.8	25.7	36.9	53.8	55.4	23.1	34.0
3 ¹	73.0	75.3	44.0	57.3	71.0	84.6	49.4	59.8	66.8	72.1	41.9	53.7
4 ²												
Total ³	65.2	62.1	28.8	41.2	71.1	72.1	30.1	40.8	60.4	56.7	26.1	36.5

¹Includes data through 9/14/81

²Data not available

³Not including data as noted above

Table 4. Distribution of commercial surf clam catch and effort for the Southern New Jersey assessment area, 1978-1981. Data are presented by calendar quarter and vessel size class (see text). Data are derived from commercial vessel trip logbooks.

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	17652	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	-	1	3	-	70	1752	-	4.0	36.0	-	17.5	48.7
4 ²												
Total ³	16	10	23	1233	3090	11008	144.0	86.0	255.0	8.6	35.9	43.2

¹Data available through 9/14/81

²Data not available

³Not including data as noted above

Table 5. Percent of commercial surf clam catch (bushels), effort (hours fished) and fishing trips from the Southern New Jersey assessment¹ area by year and calendar quarter. Data are derived from commercial logbook records.

Year-Quarter	Percent of Analyzed Trips				Percent of Analyzed Catch				Percent of Analyzed Effort			
	Vessel Class				Vessel Class				Vessel Class			
	1	2	3	Σ	1	2	3	Σ	1	2	3	Σ
1978												
1	16.7	23.3	13.4	16.8	18.0	18.2	7.4	9.8	21.1	23.9	11.2	14.8
2	6.5	9.4	6.3	7.5	7.1	7.2	4.9	5.6	6.9	9.1	6.6	7.4
3	24.1	7.1	4.1	7.0	13.1	6.6	3.6	4.8	18.9	6.5	4.4	6.3
4	30.0	9.5	7.7	10.1	21.7	8.7	6.7	7.8	25.1	8.2	7.0	8.4
Total	20.7	9.1	6.3	8.4	13.2	7.8	5.2	6.2	16.4	8.5	6.3	7.7
1979												
1	6.3	4.9	9.8	8.3	9.4	3.8	7.9	7.1	5.9	3.8	9.1	7.5
2	2.1	7.7	10.4	8.8	3.8	5.0	6.1	5.9	2.1	5.0	9.7	7.7
3	20.6	17.2	4.7	10.5	26.4	14.7	4.1	7.8	19.1	16.3	4.5	9.8
4	7.1	11.4	5.0	7.3	5.2	8.4	5.0	5.6	7.5	10.1	4.5	6.4
Total	9.8	11.2	7.5	8.9	12.8	9.0	5.6	6.7	9.4	10.2	7.0	8.2
1980												
1	4.1	6.3	4.5	5.2	4.6	4.7	5.1	5.0	5.3	6.3	4.4	5.1
2	11.2	17.1	5.1	8.9	10.1	13.9	4.2	6.0	10.6	16.3	4.4	7.7
3	10.2	13.6	2.0	6.8	7.3	8.6	2.2	3.7	10.5	13.2	1.4	5.9
4	3.7	9.2	1.7	3.6	1.1	7.0	1.3	2.1	3.7	8.8	1.5	3.2
Total	7.7	11.7	3.2	6.2	5.7	8.6	2.8	4.1	8.1	11.5	3.0	5.6
1981												
1	14.3	3.2	2.7	3.3	2.2	3.8	2.1	2.4	11.1	3.0	2.8	3.1
2	16.7	.2	.5	.4	6.5	.1	.6	.6	17.6	.3	.5	1.4
3	0.0	.6	1.1	.9	0.0	.1	.9	.7	0.0	.3	1.3	.9
4												
Total	11.6	1.3	1.5	2.0	3.6	1.1	1.2	1.2	11.2	1.2	1.5	1.9

¹ Includes data through 9/14/81

² Data not available

³ Not including data as noted above

Table 6. Distribution of commercial surf clam catch and effort for the Delmarva assessment area, 1978-1981. Data are presented by calendar quarter and vessel size class (see text). Data are derived from commercial vessel trip logbooks.

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	889.95	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	30797.8	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	215347	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	10	40	147	2749	11140	91128	120.0	431.0	1610.5	22.9	25.8	56.6
Total ³	32	285	1099	8611	78795	659523	364	3035.5	12237.5	23.7	26.0	53.9

¹Data available through 9/14/81

²Data not available

³Not including data as noted above

Table 7. Percent of commercial surf clam catch (bushels), effort (hours fished) and fishing trips from the Delmarva assessment area by year and calendar quarter. Data are derived from commercial logbook records.

Year-Quarter	Percent of Analyzed Trips				Percent of Analyzed Catch				Percent of Analyzed Effort			
	1	2	3	Σ	1	2	3	Σ	1	2	3	Σ
1978												
1	83.3	72.1	86.6	81.7	82.0	78.8	92.6	89.6	78.9	73.7	88.8	84.6
2	93.5	87.9	91.4	90.2	92.9	91.3	93.0	92.5	93.1	89.2	91.1	90.6
3	75.9	84.6	94.1	89.0	86.9	88.8	95.2	93.1	81.1	86.3	93.8	90.2
4	70.0	86.7	90.1	87.3	78.3	88.8	91.9	90.6	74.9	90.0	90.9	89.7
Total	79.3	85.9	91.7	88.6	86.8	89.3	93.3	92.0	83.6	87.9	91.7	89.9
1979												
1	80.9	87.6	88.7	87.9	68.8	87.9	90.9	89.7	80.7	90.8	90.1	89.9
2	94.8	87.0	86.0	87.0	89.7	89.1	92.0	91.1	94.6	90.8	87.4	89.0
3	79.4	81.6	94.5	88.6	73.6	84.1	95.1	91.4	80.9	82.5	94.9	89.4
4	89.3	86.0	91.3	89.4	90.7	89.3	90.4	90.2	90.2	87.0	91.9	90.3
Total	86.5	85.1	90.2	88.2	81.3	87.2	92.3	90.7	87.3	86.7	91.0	89.4
1980												
1	60.3	89.9	92.1	88.7	89.4	89.8	91.5	91.1	84.1	90.4	92.9	91.6
2	80.3	70.3	90.8	84.3	78.1	63.1	92.2	87.0	83.1	71.7	91.8	86.3
3	83.7	82.1	92.7	88.3	80.9	82.6	89.6	87.9	84.7	83.2	95.5	90.8
4	63.0	66.3	85.8	80.4	37.8	56.4	82.1	77.3	65.2	69.6	89.6	84.2
Total	72.3	79.1	90.3	85.7	70.4	74.7	88.7	85.7	81.4	80.4	92.6	88.6
1981												
1	17.1	42.5	72.2	61.7	13.9	31.4	72.5	63.3	21.3	48.5	74.6	66.2
2	24.2	38.3	73.3	59.2	29.1	30.1	73.7	62.5	28.6	44.3	76.4	64.6
3 ¹	27.0	24.1	54.9	41.8	29.0	15.3	49.7	39.5	33.2	27.6	56.8	45.4
4 ²												
Total ³	23.2	36.6	69.7	56.8	25.3	26.8	68.7	58.0	28.4	42.1	72.4	61.6

¹Includes data through 9/14/81

²Data not available

³Not including data as noted above

Table 8. 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	374	5.1
Undaunted	10-11/65	76	5	217	5.1
ALBATROSS IV	8/66	76	5	240	5.1
ALBATROSS IV	6-7/69	76	5	278	5.1
DELAWARE II	8/70	122	4	199	3.0
DELAWARE II	6/74	76	5	241	5.1
DELAWARE II	4-5/76	122	4	259	3.0
DELAWARE II	1-3/77	122	4	224	3.0
DELAWARE II	1-2/78	122	4	324	3.0
DELAWARE II	12/78	122	4	163	2.5
DELAWARE II	1-2/80	152	5	229	5.1
DELAWARE II	8-9/80	152	5	231	5.1
DELAWARE II	8/81	152	5	261	5.1

^a portion of dredge where catch is accumulated.

Table 9. Stratified mean number per standardized tow of surf clams from NMFS surveys off Northern New Jersey, 1965-1981.

Survey	Total No. Per Tow	Number <5½"	Number ≥5½"	% ≥5½"
May 1965	24.40	9.90	14.50	59.4
Oct 1965	22.90	3.96	18.94	82.7
Aug 1966	19.51	3.49	16.02	82.1
Jun 1969	21.96	2.52	19.44	88.5
Aug 1970	16.49	3.10	13.39	81.2
Jun 1974	13.72	1.76	11.96	87.2
Apr 1976	8.28	1.53	6.75	81.5
Jan 1977	1.57	.89	.68	43.2
Jan 1978	1.32	.95	.37	28.3
Dec 1978	28.77	28.11	.65	2.3
Jan 1980	20.32	17.64	2.67	13.2
Aug 1980	34.33	32.47	1.86	5.4
Aug 1981	23.11	20.18	2.94	12.7

Table 10. Stratified mean weight (meats, kg) per standardized tow of surf clams from NMFS surveys off Northern New Jersey, 1965-1981.

Survey	Total Weight (kg) per tow	Weight <5½"	Weight ≥5½"	% ≥5½"
May 1965	3.07	.75	2.32	75.6
Oct 1965	3.38	.33	3.05	90.3
Aug 1966	2.89	.23	2.66	92.1
Jun 1969	3.44	.19	3.25	94.4
Aug 1970	2.64	.19	2.45	92.9
Jun 1974	2.16	.12	2.03	94.3
Apr 1976	1.32	.08	1.24	94.0
Jan 1977	.15	.03	.12	81.4
Jan 1978	.10	.04	.07	64.9
Dec 1978	.77	.66	.11	14.8
Jan 1980	1.25	.78	.48	38.1
Aug 1980	2.40	2.08	.32	13.5
Aug 1981	1.66	1.23	.44	26.4

Table 11. Stratified mean number per standardized tow of surf clams from NMFS surveys off Southern New Jersey, 1965-1981.

Survey	Total No. Per Tow	Number <5½"	Number ≥5½"	% ≥5½"
May 1965	67.93	50.05	17.90	26.4
Oct 1965	53.10	21.36	31.74	59.8
Aug 1966	44.58	9.37	35.21	79.0
Jun 1969	38.29	3.50	34.79	90.9
Aug 1970	10.37	1.75	8.62	83.1
Jun 1974	31.61	1.42	30.19	95.5
Apr 1976	3.33	.41	2.93	87.8
Jan 1977	1.44	.78	.66	45.5
Jan 1978	9.56	2.47	7.09	74.2
Dec 1978	5.51	2.85	2.66	48.3
Jan 1980	8.71	1.62	7.09	81.4
Aug 1980	9.34	1.89	7.45	79.7
Aug 1981	6.67	.34	6.33	94.9

Table 12. Stratified mean weight (meats, kg) per standardized tow of surf clams from NMFS surveys off Southern New Jersey, 1965-1981.

Survey	Total Weight (kg) per tow	Weight <5½"	Weight ≥5½"	% ≥5½"
May 1965	5.69	2.80	2.88	50.7
Oct 1965	6.82	1.75	5.08	74.4
Aug 1966	6.38	.89	5.49	86.0
Jun 1969	5.82	.27	5.55	95.3
Aug 1970	1.70	.13	1.57	92.1
Jun 1974	5.67	.10	5.57	98.2
Apr 1976	.62	.02	.60	96.1
Jan 1977	.15	.02	.13	89.3
Jan 1978	1.43	.14	1.28	89.9
Dec 1978	.62	.15	.48	76.4
Jan 1980	1.47	.14	1.34	90.7
Aug 1980	1.66	.13	1.53	92.0
Aug 1981	1.31	.02	1.29	98.3

Table 13. Stratified mean number per standardized tow of surf clams from NMFS surveys off Delmarva, 1965-1981.

Survey	Total No. Per Tow	Number <5½"	Number ≥5½"	% ≥5½"
May 1965	17.74	10.14	7.60	42.8
Oct 1965	17.96	6.90	11.06	61.6
Aug 1966	20.85	6.89	13.96	67.0
Jun 1969	16.83	5.15	11.68	69.4
Aug 1970	12.59	3.02	9.57	76.0
Jun 1974	23.50	4.28	19.22	81.8
Apr 1976	14.06	4.68	9.38	66.7
Jan 1977	7.29	1.72	5.57	76.4
Jan 1978	7.44	3.14	4.30	57.7
Dec 1978	398.27	395.14	3.13	.8
Jan 1980	43.91	37.22	6.69	15.2
Aug 1980	31.11	25.25	5.86	18.8
Aug 1981	93.51	84.48	9.04	9.7

Table 14. Stratified mean weight (meats kg) per standardized tow of surf clams from NMFS surveys off Delmarva, 1965-1981.

Survey	Total Weight (kg) per tow	Weight <5½"	Weight ≥5½"	% ≥5½"
May 1965	1.45	.53	.92	63.3
Oct 1965	1.80	.37	1.43	79.3
Aug 1966	2.27	.41	1.86	81.9
Jun 1969	1.78	.32	1.46	82.0
Aug 1970	1.50	.19	1.31	87.5
Jun 1974	2.94	.27	2.67	90.7
Apr 1976	1.52	.16	1.36	89.6
Jan 1977	.90	.06	.84	93.2
Jan 1978	.74	.11	.64	85.4
Dec 1978	3.86	3.41	.46	88.2
Jan 1980	2.03	1.04	.99	48.7
Aug 1980	1.69	.81	.88	52.2
Aug 1981	4.72	3.43	1.29	27.3

Table 15. Calculated mean shell lengths (mm) and drained meat weights (g) at age for offshore Middle Atlantic surf clam populations^e.

AGE	New Jersey		Delmarva	
	Shell Length ^a	Meat Weight ^b	Shell Length ^c	Meat Weight ^d
1	40.7	3.5	40.0	3.0
2	70.8	16.9	72.6	15.7
3	93.7	37.3	96.8	34.8
4	111.1	60.5	114.8	55.7
5	124.4	83.2	128.1	75.5
6	134.5	103.7	138.0	92.7
7	142.2	121.3	145.3	107.0
8	148.0	135.9	150.8	118.5
9	152.5	147.8	154.8	127.5
10	155.9	157.2	157.8	134.4
11	158.4	164.7	160.0	139.7
12	160.4	170.5	161.7	143.8
13	161.9	175.0	162.9	146.8
14	163.0	178.5	163.8	149.8
15	163.9	181.2	164.5	150.8
16	164.5	183.3	165.0	152.1
17	165.0	184.8	165.4	153.0
18	165.4	186.0	165.6	153.7
19	165.7	187.0	165.8	154.2
20	165.9	187.7	166.0	154.6
21	166.1	188.2	166.1	154.9
22	166.2	188.6	166.2	155.1
23	166.3	188.9	166.3	155.3
24	166.4	189.2	166.3	155.4

^aCalculated from: $L_t = 166.64 [1 - e^{-.2731(t+.0255)}]$

^bCalculated from: $W = .000100SL^{2.8251}$

^cCalculated from: $L_t = 166.43 [1 - e^{-.2984(t-.0794)}]$

^dCalculated from: $W = .000111SL^{2.7675}$

^eSurf clams are spawned in Late summer-autumn thus an October 1 birthdate is assumed.

Table 16. Statistics describing regression equations between shell length (mm) and drained meat weight (g) for surf clams obtained in January 1980 NMFS research vessel shellfish assessment survey.

Area	Regression Statistics			
	Intercept (a)	Slope (b)	Correlation Coefficient (c)	Sample Size (d)
So. New England - Long Island	-7.9726	2.5779	.924	132
New Jersey	-9.2061	2.8251	.987	461
Delmarva	-9.1063	2.7675	.986	525
North Carolina	-7.0583	2.3033	.985	25
All Areas	-9.1936	2.8049	.982	1143

Table 17. Calculated drained meat weight (g) at shell length (mm) for offshore Middle Atlantic surf clam populations derived from shell length -meat weight regression equations.

Shell Length (mm)	Calculated Mean Weight (g)				
	SNE-LI	NJ	DMV	NC	ALL
30	2.2	1.5	1.4	2.2	1.4
40	4.7	3.4	3.0	4.2	3.2
50	8.3	6.3	5.6	7.0	5.9
60	13.2	10.6	9.3	10.7	9.9
70	19.7	16.4	14.2	15.3	15.2
80	27.8	23.9	20.5	20.8	22.1
90	37.6	33.3	28.4	27.3	30.8
100	49.4	44.9	38.0	34.8	41.4
110	63.1	58.7	49.5	43.3	54.1
120	79.0	75.1	63.0	52.9	69.1
130	97.1	94.2	78.6	63.6	86.4
140	117.5	116.1	96.5	75.5	106.4
150	140.4	141.1	116.8	88.5	129.1
160	165.8	169.3	139.7	102.7	154.7
170	193.8	200.9	165.2	118.0	183.4
180	224.6	236.2	193.5	134.6	215.3
190	258.2	275.1	224.7	152.5	250.6
200	294.7	318.0	259.0	171.6	289.4

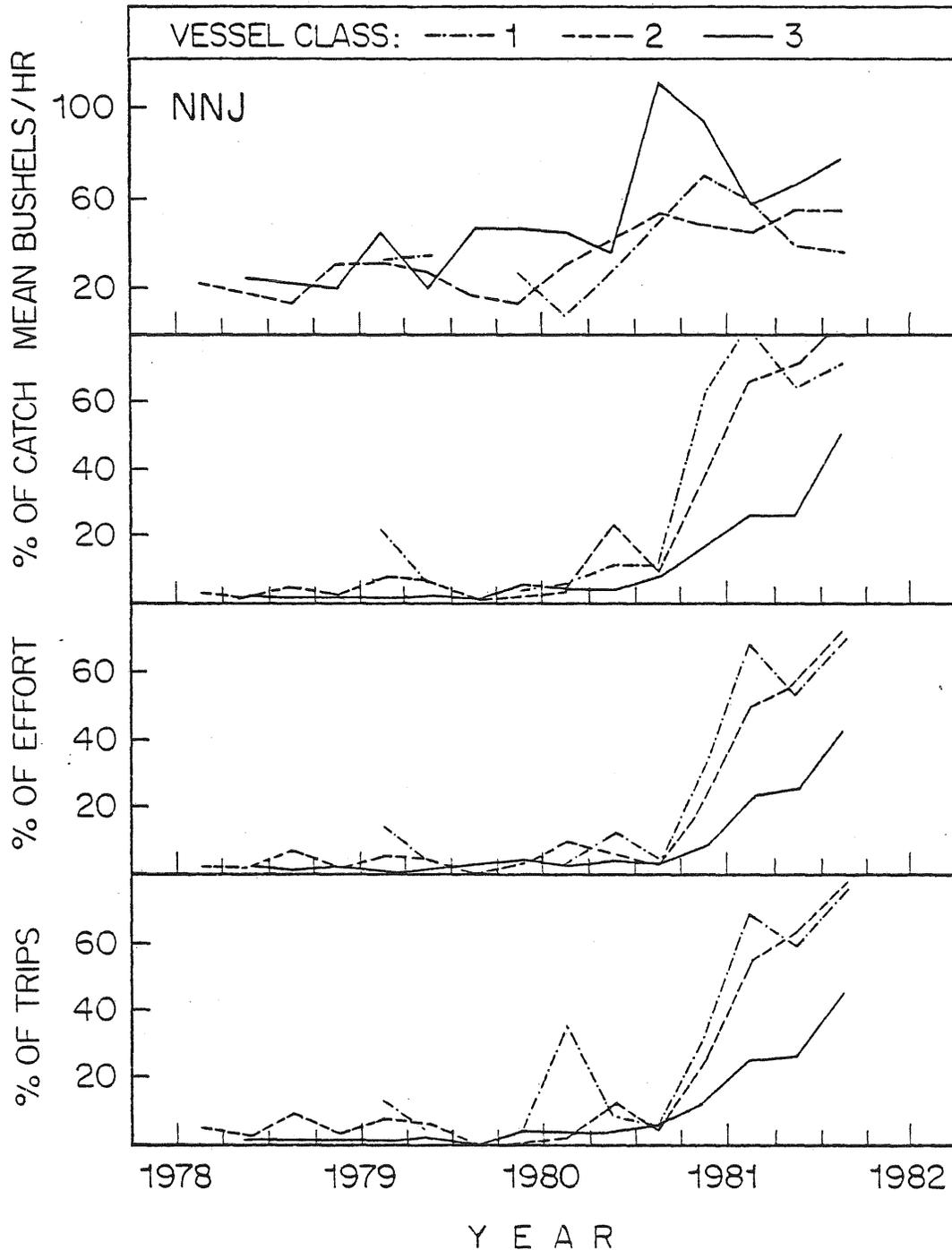


Figure 1. Mean catch per effort (bushels per hour fishing) and percent of Middle Atlantic FCZ surf clam catch, effort, and vessel trips taken in the Northern New Jersey assessment area, by vessel class and calendar quarter, 1978-1981. Data are derived from commercial vessel logbook records.

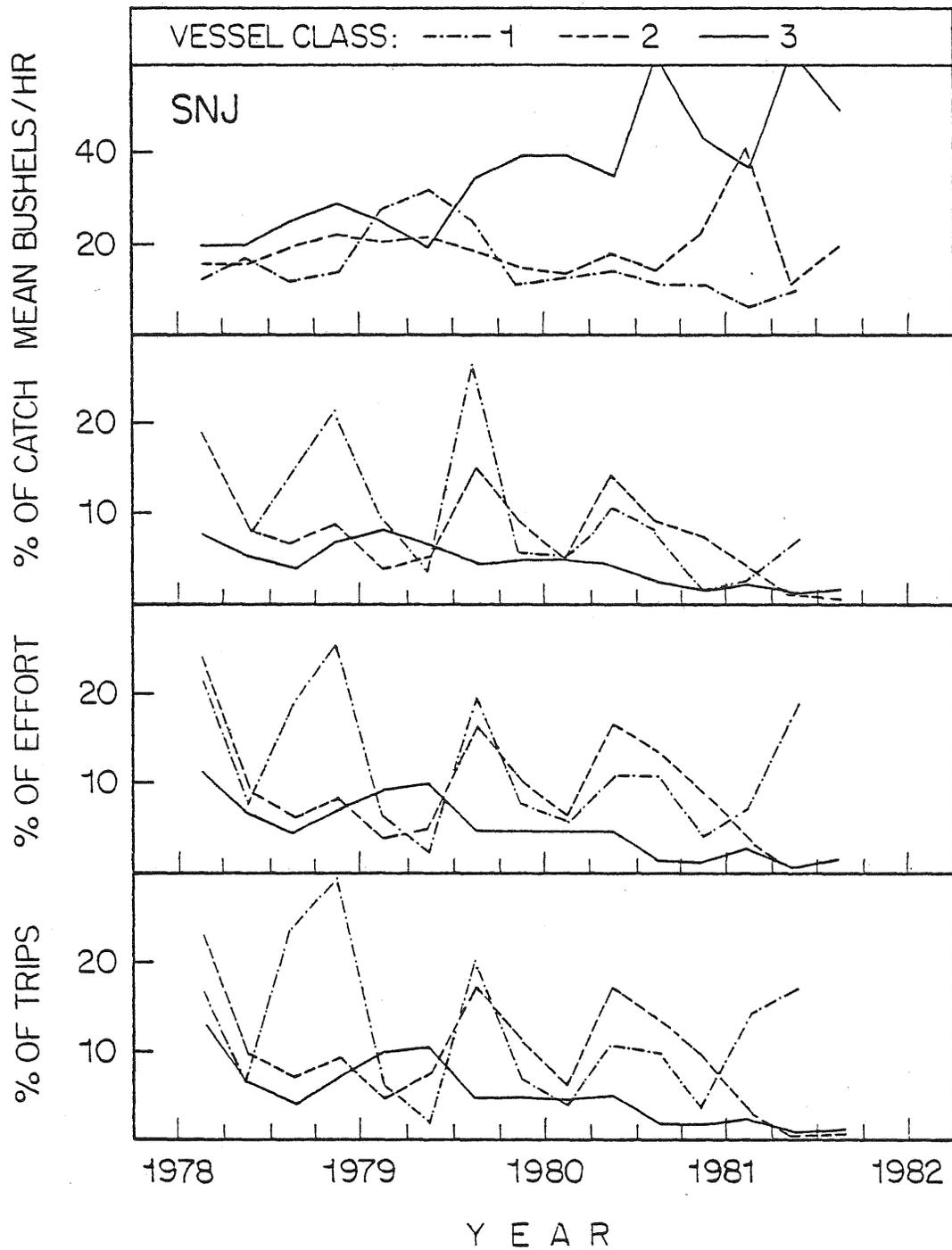


Figure 2. Mean catch per effort (bushels per hour fishing) and percent of Middle Atlantic FCZ surf clam catch, effort, and vessel trips taken in the Southern New Jersey assessment area by vessel class and calendar quarter, 1978-1981. Data are derived from commercial vessel logbook records.

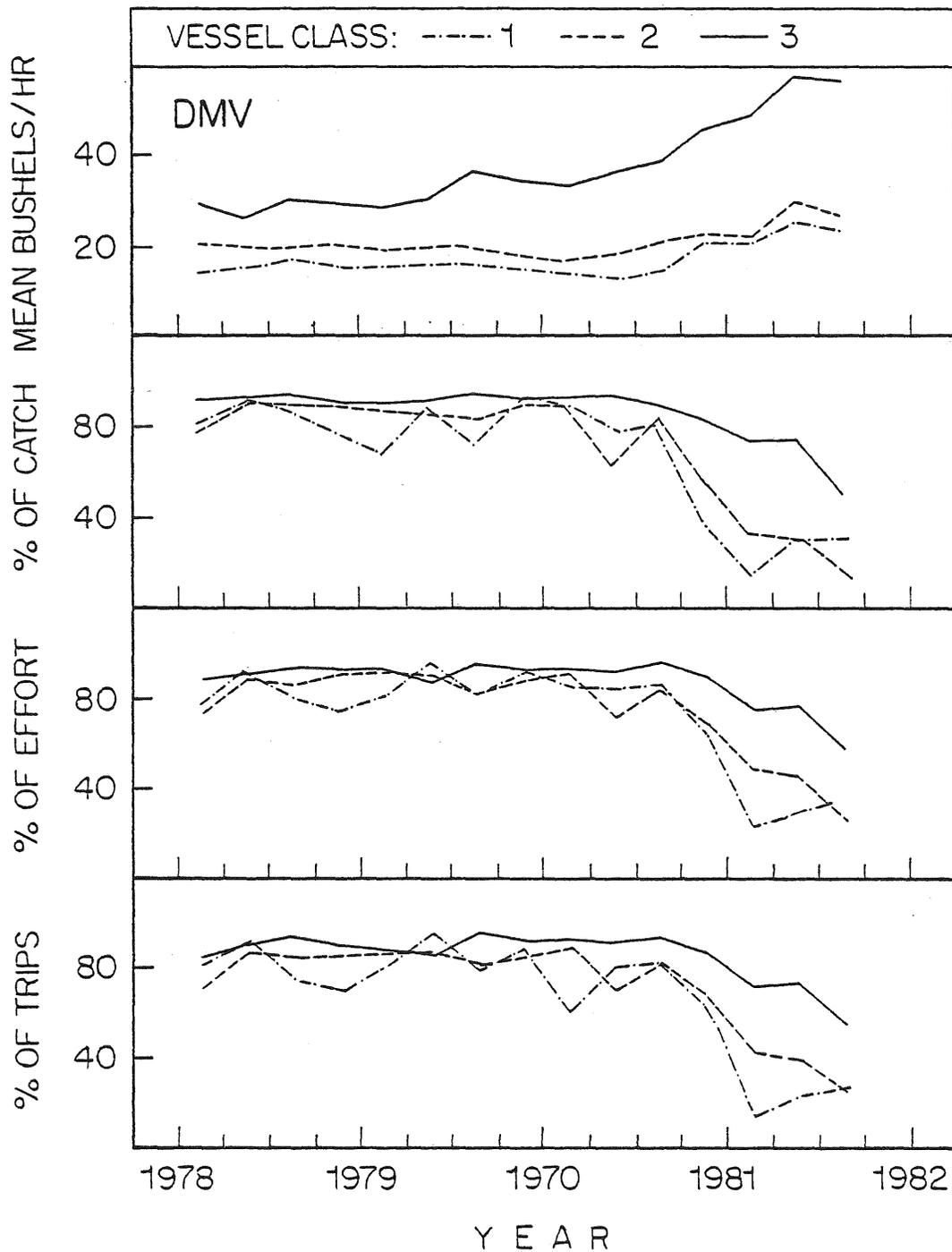


Figure 3. Mean catch per effort (bushels per hour fishing) and percent of Middle Atlantic FCZ surf clam catch, effort, and vessel trips taken from the Delmarva assessment area, by vessel class and calendar quarter, 1978-1981. Data are derived from commercial vessel logbook records.

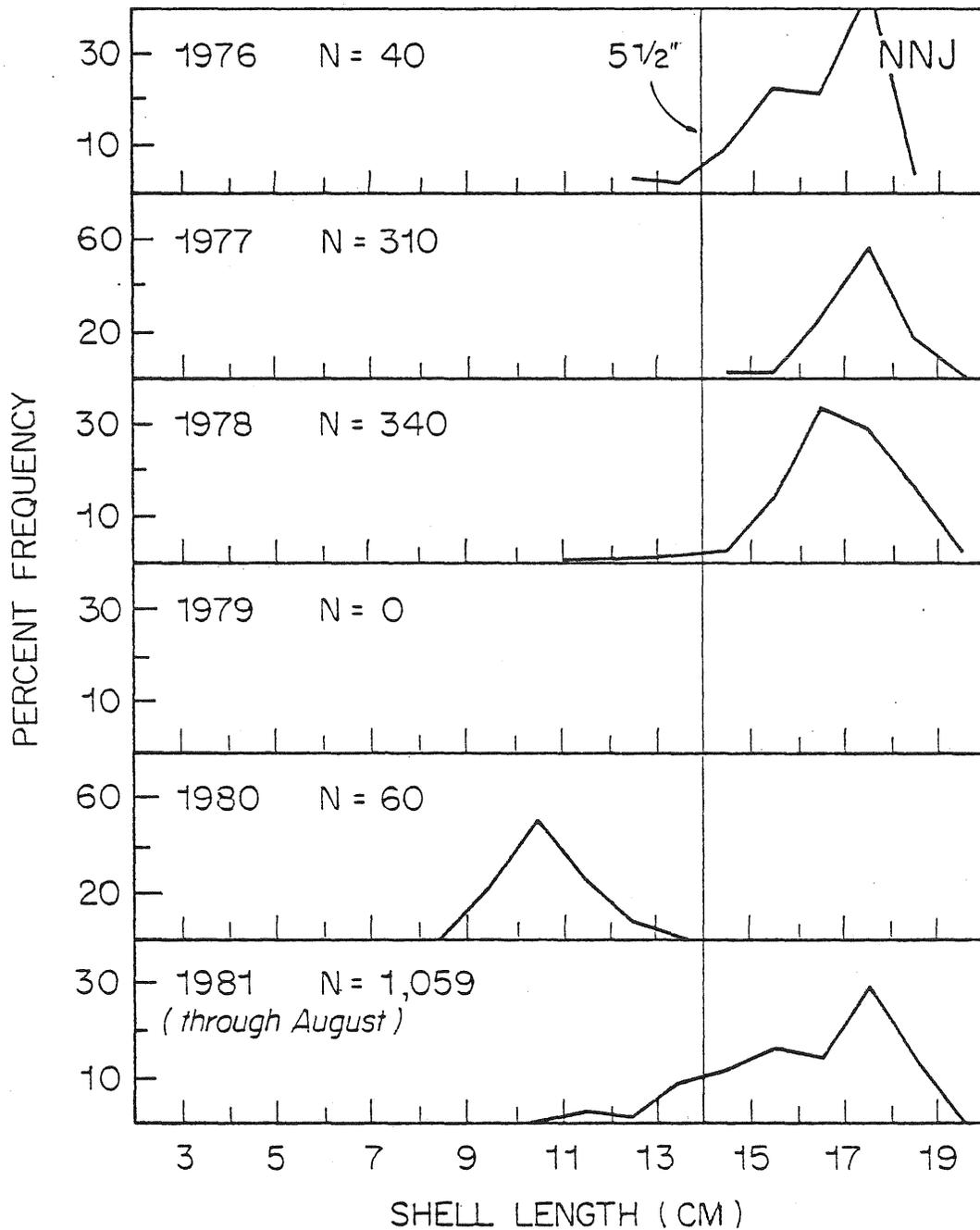


Figure 4. Length frequency distributions of surf clams sampled from commercial vessels operating off Northern New Jersey, 1976-1981.

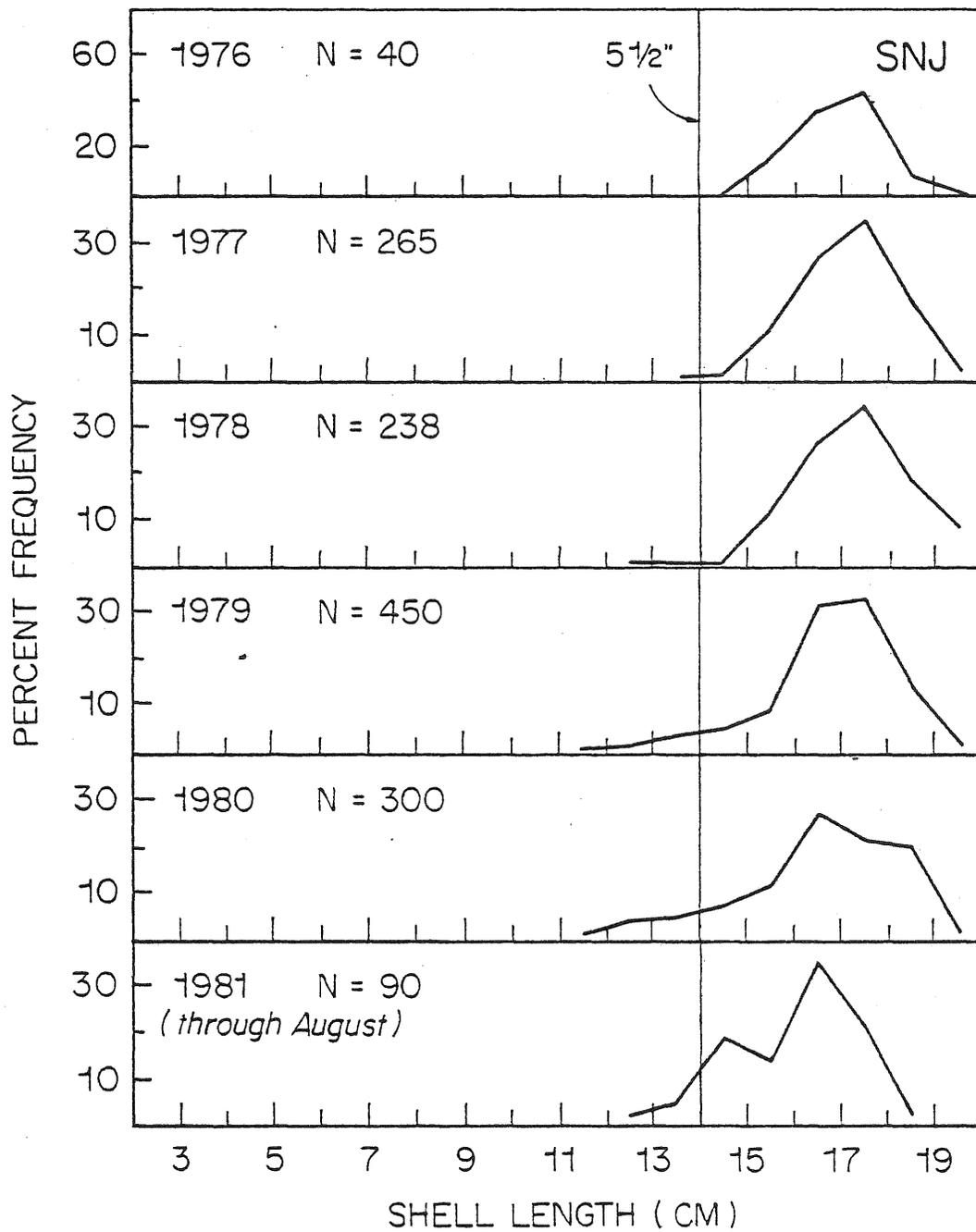


Figure 5. Length frequency distributions of surf clams sampled from commercial vessels operating off Southern New Jersey, 1976-1981.

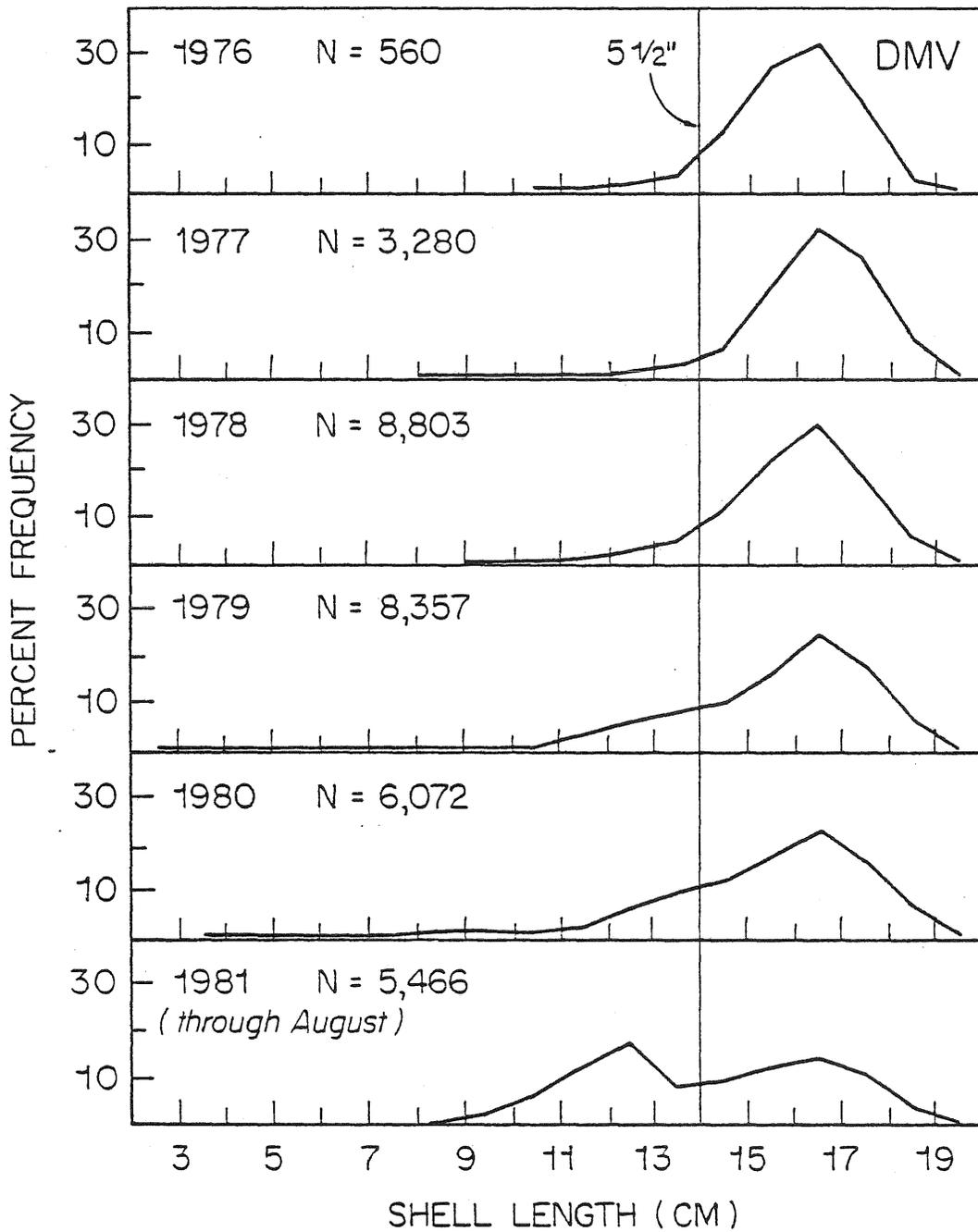


Figure 6. Length frequency distributions of surf clams sampled from commercial vessels operating off Delmarva, 1976-1981.

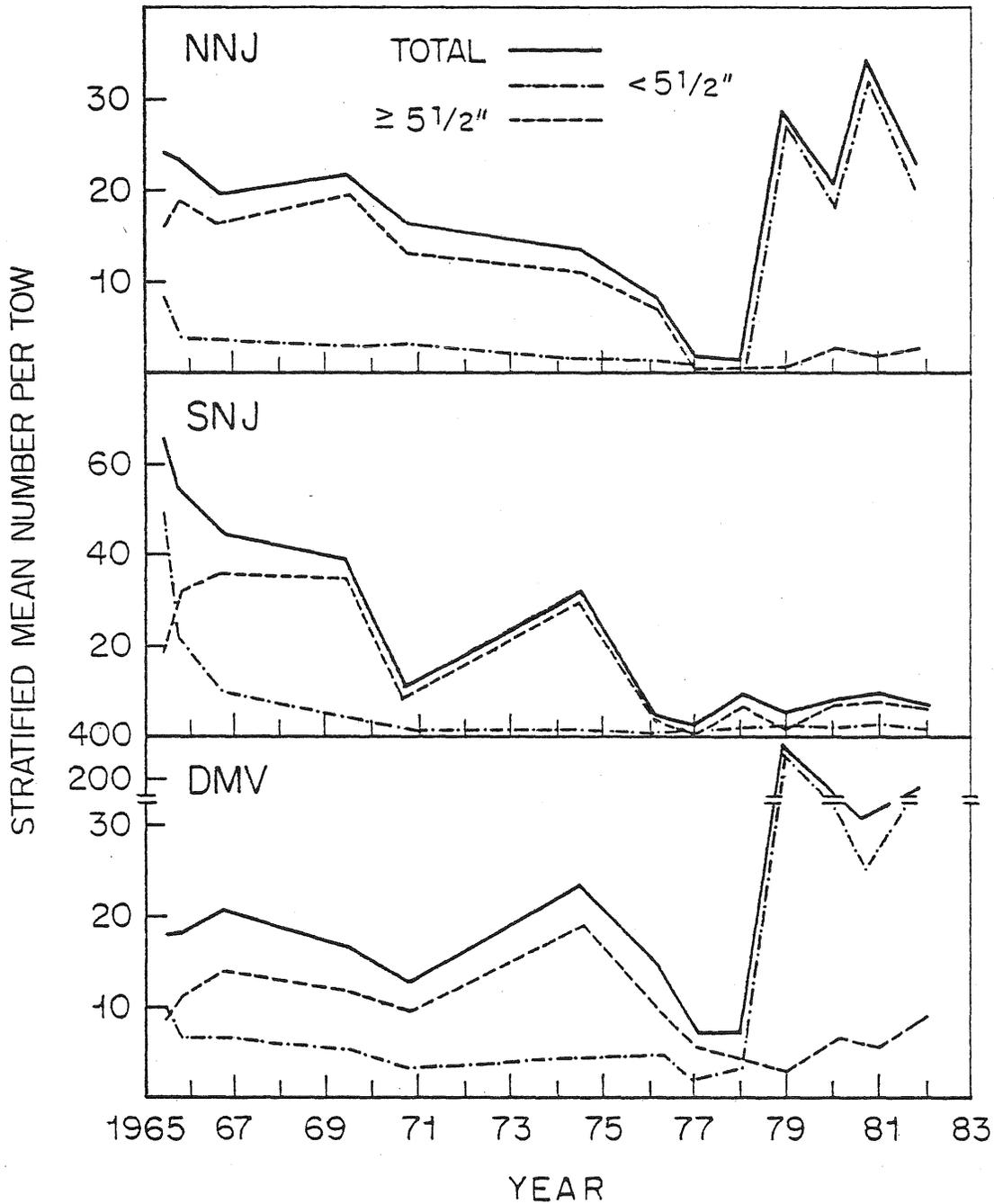


Figure 7: Stratified mean numbers of surf clams per standardized tow in NMFS shellfish surveys, 1965-1981. Data are presented for the three assessment areas. Indices are given for all clams caught (total) and catches below and above the current minimum size (5½ inches).

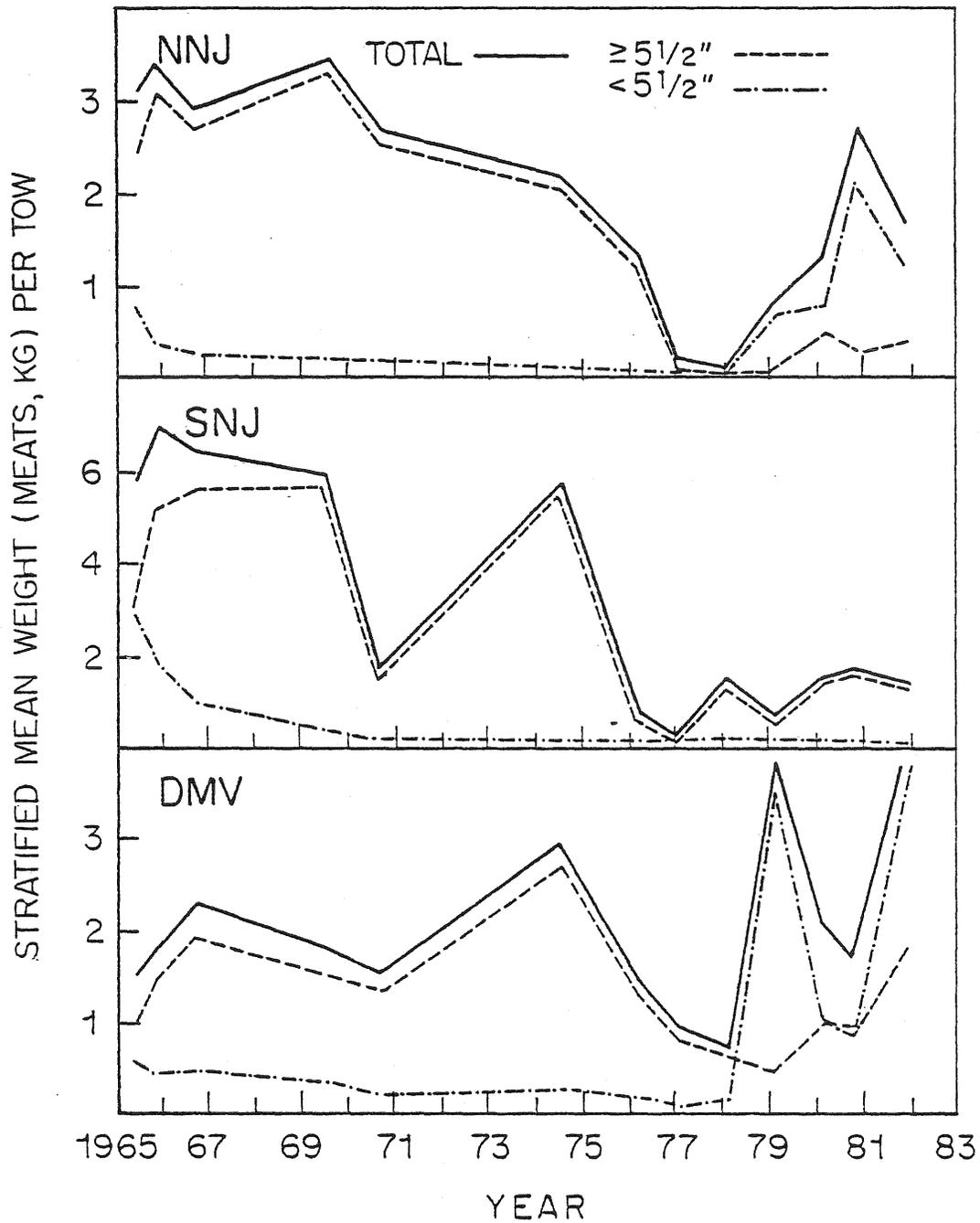


Figure 8. Stratified mean weight (meats, kg) of surf clams per standardized tow in NMFS shellfish surveys, 1965-1981. Data are presented for the three assessment areas. Indices are given for all clams caught (total) and catches below and above the current minimum size (5½ inches).

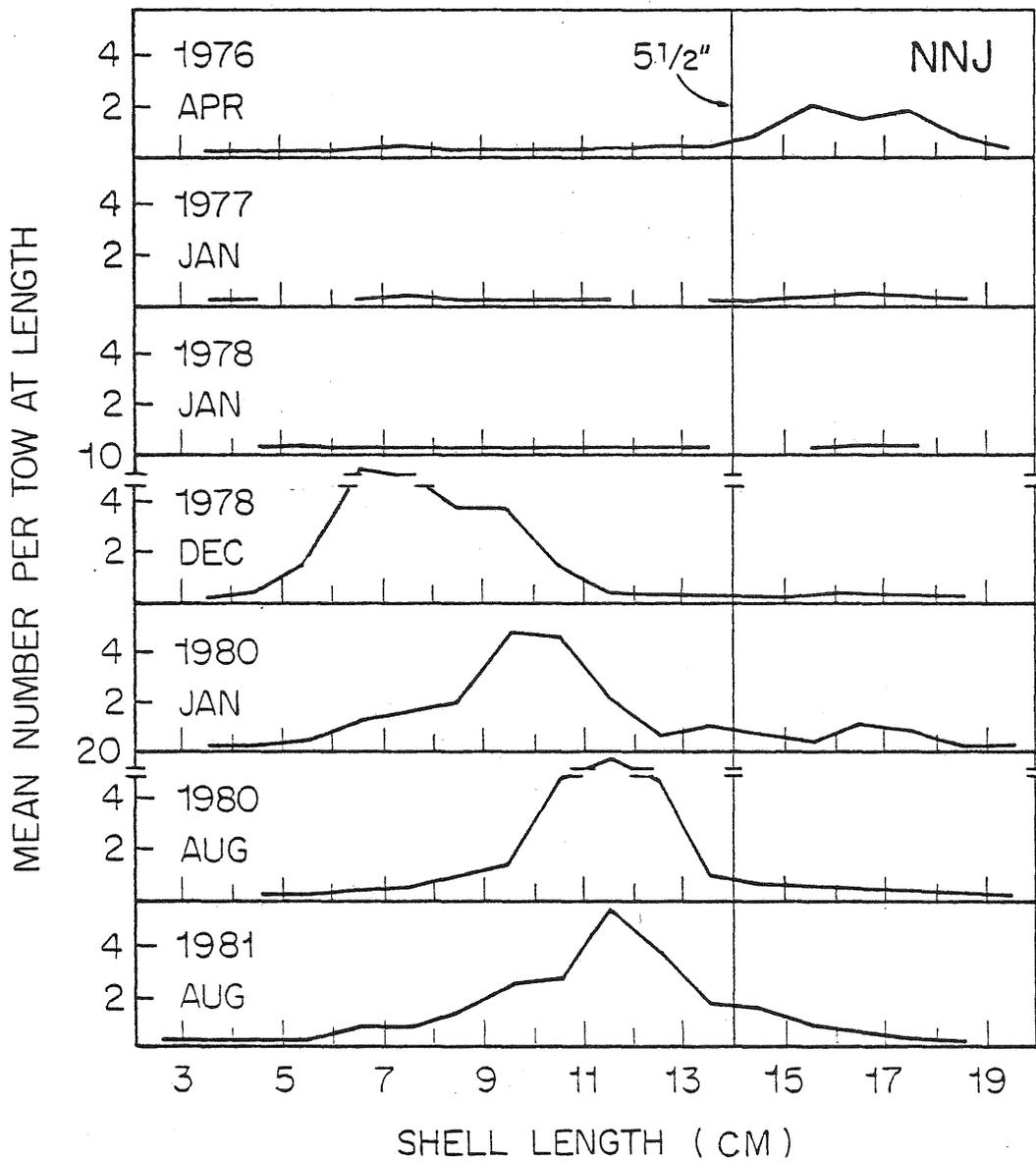


Figure 9. Stratified mean numbers of surf clams per standardized tow, at length, in NMFS shellfish surveys off Northern New Jersey, 1976-1981.

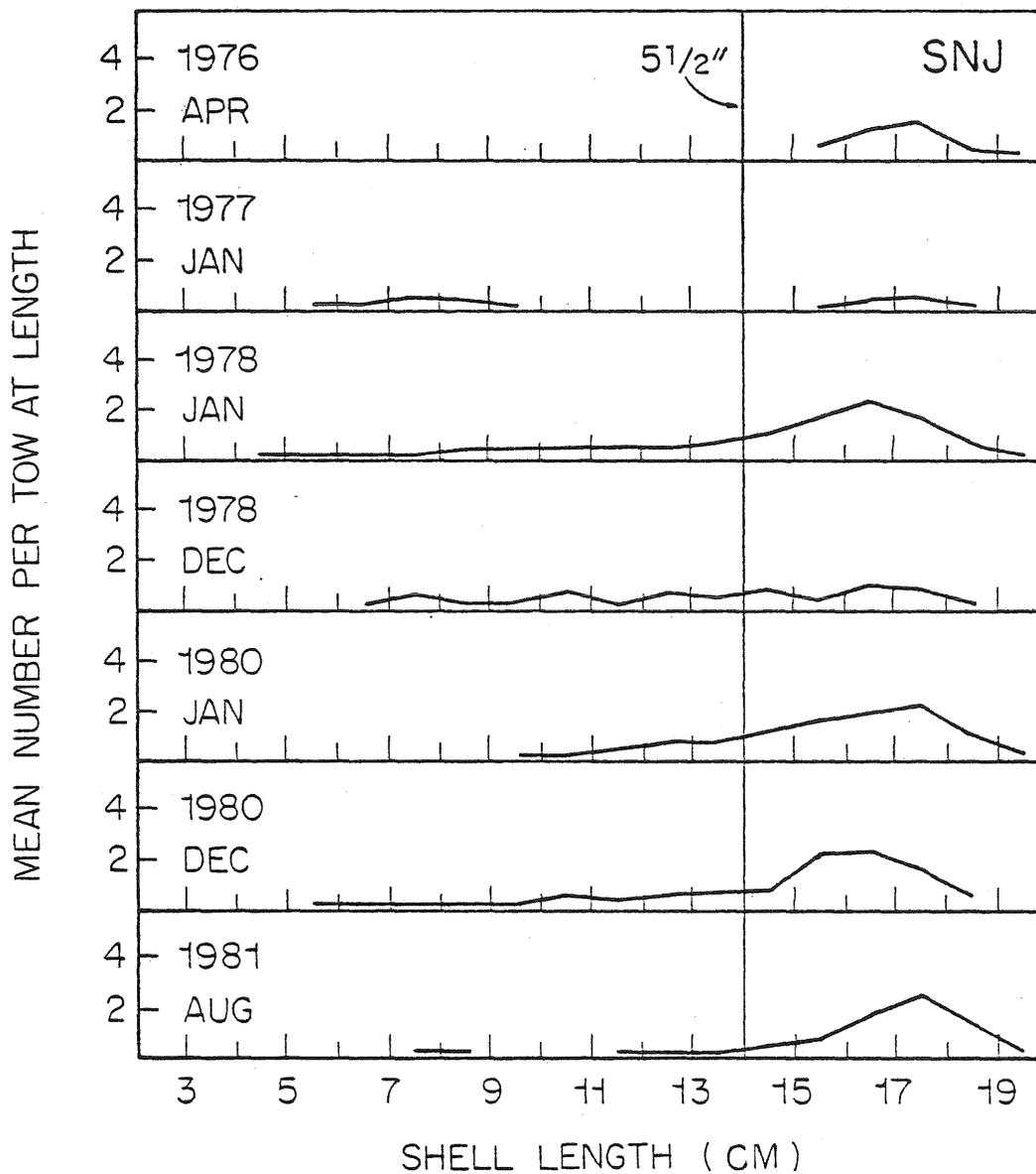


Figure 10. Stratified mean number of surf clams per standardized tow, at length, in NMFS shellfish surveys off Southern New Jersey, 1976-1981.

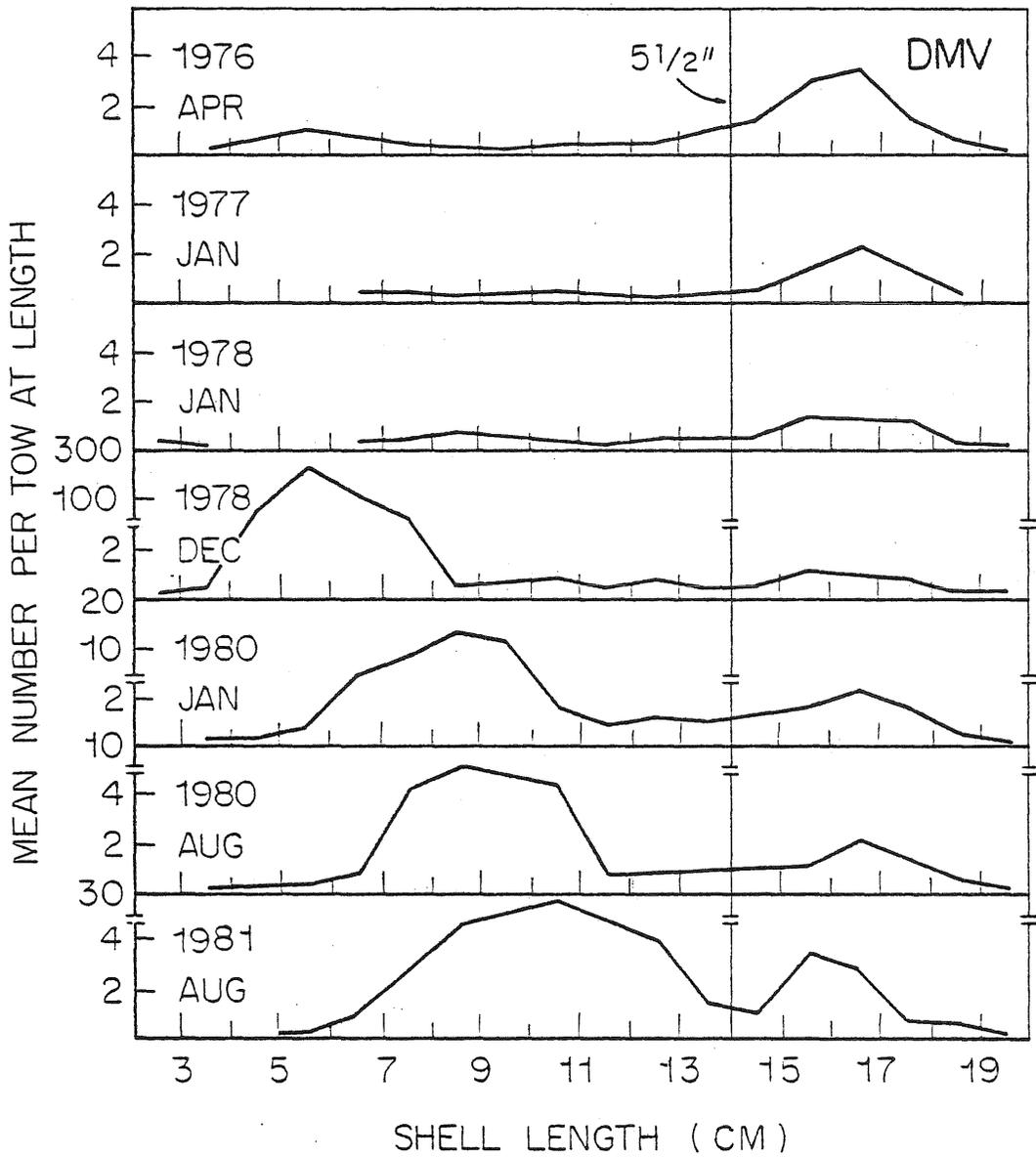


Figure 11. Stratified mean numbers of surf clams per standardized tow, at length, in NMFS shellfish surveys off Delmarva, 1976-1981.

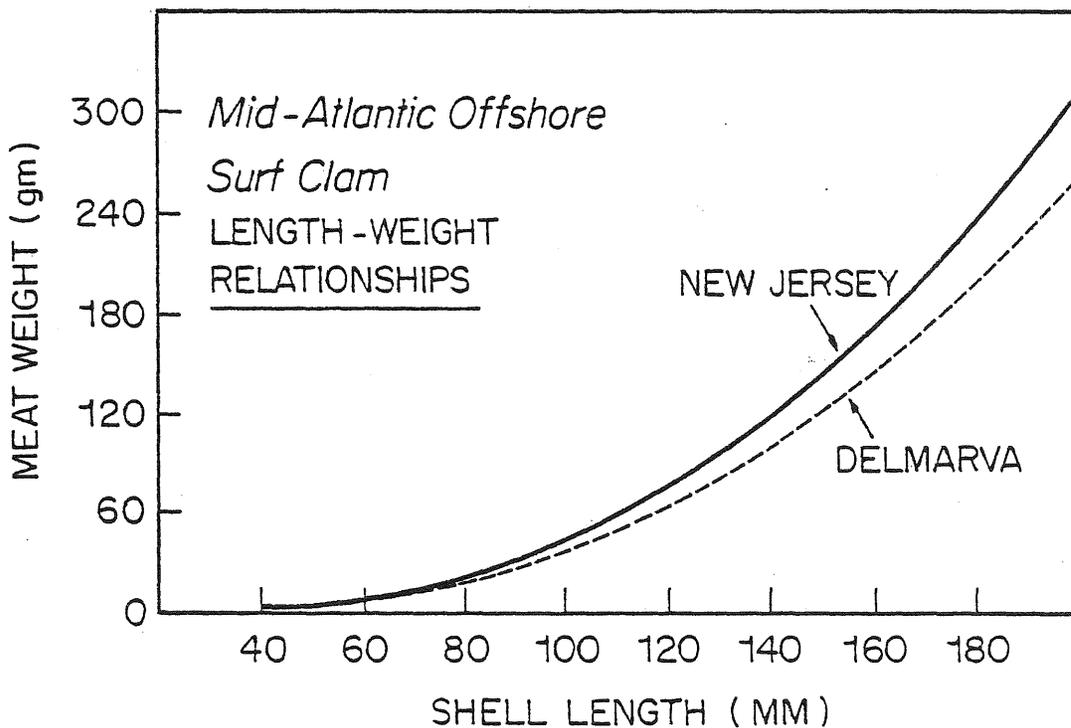
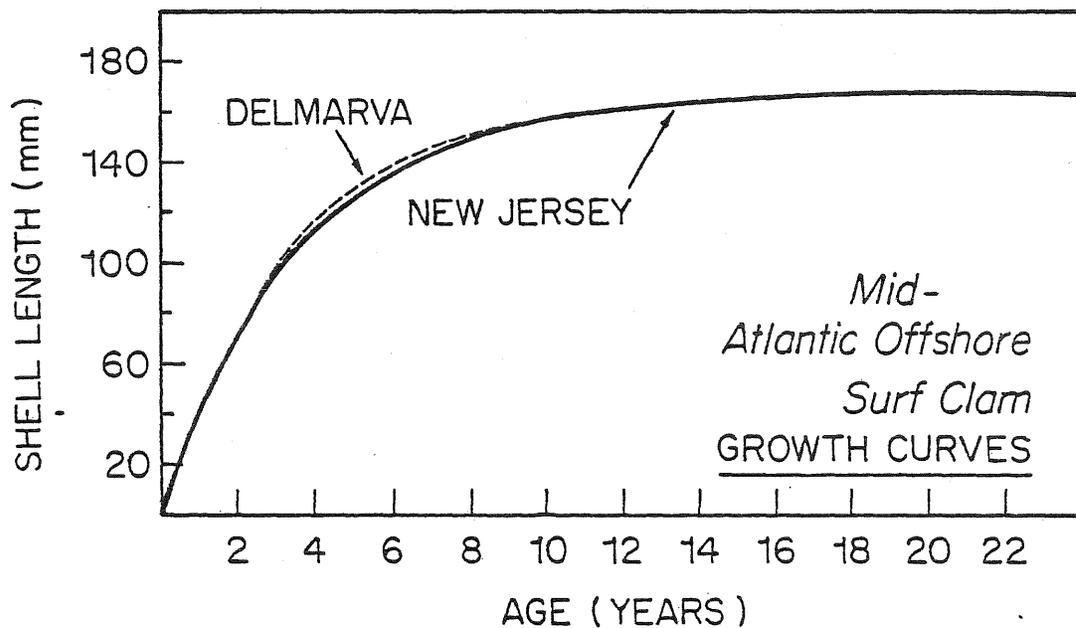


Figure 12. Age-length and length-weight relationships of surf clams from offshore New Jersey and Delmarva areas. Data were derived from the December 1978 NMFS survey.

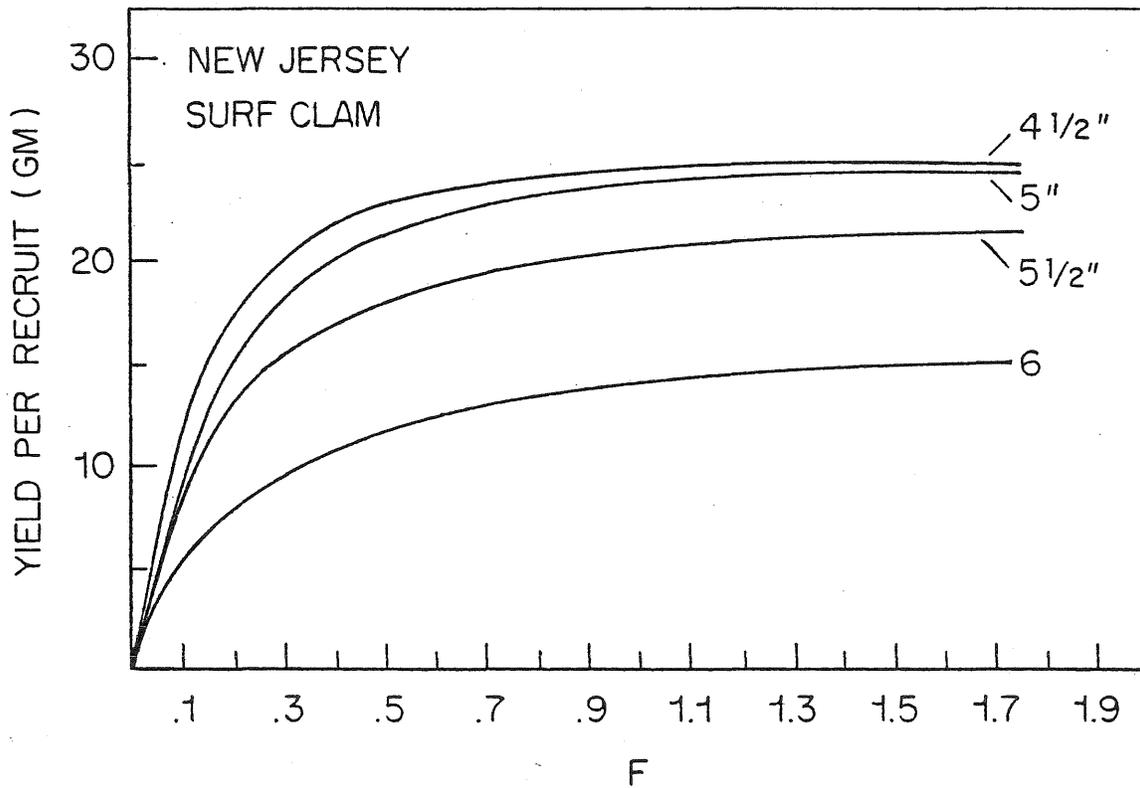


Figure 13. Yield per recruit curves for surf clams off New Jersey, considering four different minimum sizes at entry to the exploited population (4½, 5, 5½, 6 inches).

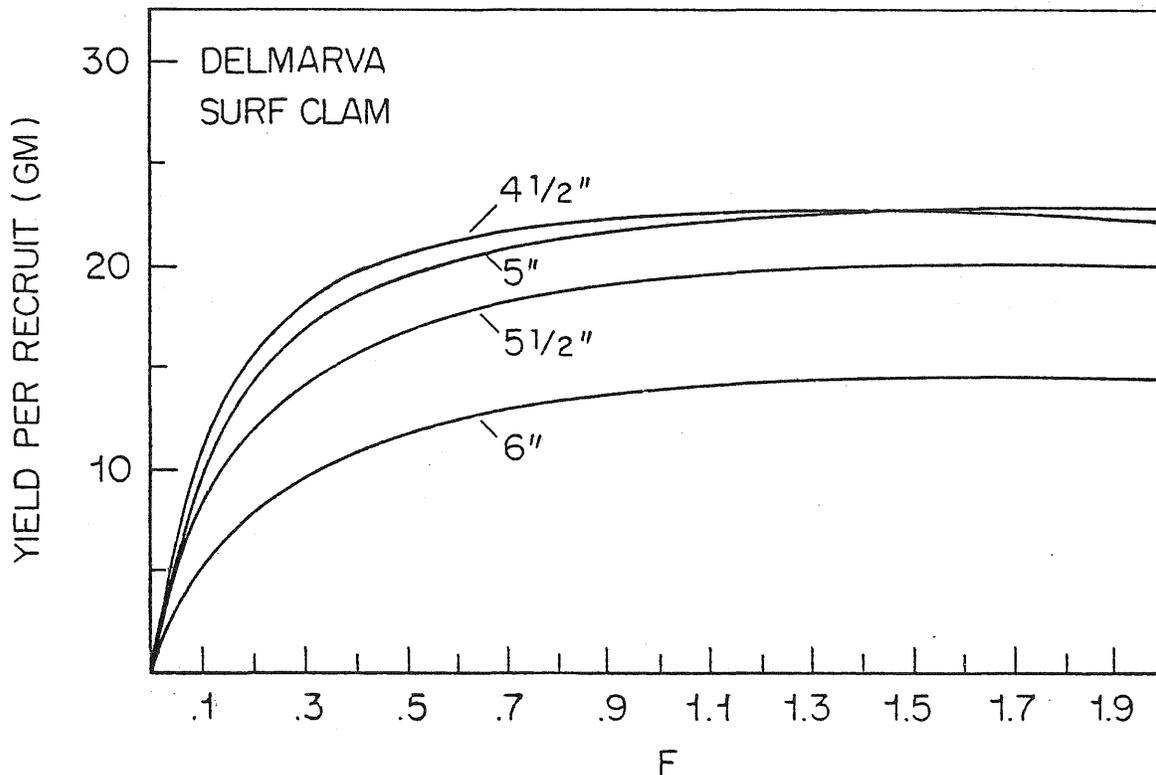


Figure 14. Yield per recruit curves for surf clams off Delmarva, considering four different minimum sizes at entry to the exploited population (4½, 5, 5½, and 6 inches).