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Review and Assessment of the Georges Bank, Mid-Atlantic and Gulf of Maine Atlantic Sea Scallop (*Placopecten magellanicus*) Resources

by

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Summary

The USA Atlantic sea scallop fishery is one of the most important commercial fisheries along the eastern coast of the United States. Total annual USA landings during 1977-1981 from the Georges Bank, Mid-Atlantic, and Gulf of Maine resources attained record levels, averaging 12,800 metric tons of meats, the highest for any five-year period. In 1980 (latest data available), USA scallop landings generated 110.4 million dollars in ex-vessel revenues, an all time record. Despite recent increases in landings and total revenues, analyses of both commercial and research survey data indicate that resource abundance in almost all fishery areas has begun to decline. This report reviews recent fishery and resource conditions within each principal fishery region and provides an evaluation of these conditions relative to historical patterns and likely future events.

Georges Bank

Total international (USA and Canada) commercial landings in 1981 were 16,200 tons, 49% higher than in 1980, and the third highest annual catch ever. USA 1981 landings were 8,200 tons, an increase of 46% from 1980, and the highest yearly harvest in 18 years. Canadian 1981 landings totalled 8,000 tons, 53% greater than in 1980. More than 80% of the combined 1981 catch was derived from the Northern Edge and Peak region of Georges Bank. USA 1981 landings from this region were 4,306 tons, the highest since 1962, and accounted for 62% of the USA Georges Bank landings, nearly twice the proportional representation in the 1980 landings (34.5%). All of the 1981 Canadian catch was taken from the Northern Edge and Peak. Research vessel survey and commercial data indicate that exceptional recruitment of the 1977 year class, localized principally on the Northern Edge region, sustained the 1981 fishery. This year class was heavily exploited upon recruitment as evinced by the rapid rise and decline of commercial catch rates during January-September 1981 and the prevalence of smaller sized scallops throughout this period in both USA and Canadian catch samples. The mean size of scallops sampled in 1981 from USA landings was the smallest in the 1965-1981 time series, implying a significant reduction in cull size in the commercial fishery.

Total effort in the Georges Bank fishery during 1980 was the highest ever. Preliminary effort statistics for 1981 suggest that effort has remained high. Commercial catch per unit of effort (CPUE) of both fleets, however, declined by about 50% between 1977 and 1980; the 1980 USA CPUE index was the third lowest value in 37 years. Both USA and Canadian CPUE declines indicate that, prior to recruitment of the 1977 year class in 1981, resource abundance had sharply diminished as a consequence of high fishing mortality rates. Fishing mortality is thought to have continued at high levels during 1981 in spite of exceptional recruitment from the 1977 cohort.

USA and Canadian research survey total catch per tow indices declined in all areas on Georges Bank between 1980 and 1981. Survey indices from the South Channel and Southeast Part regions of the Bank declined by over 50%; the 1981 total catch per tow value for each of these regions was the lowest in the 1975-1981 time series.

Pre-recruit indices in both areas were also relatively low. On the Northern Edge and Peak, the 1981 survey data indicate that the 1978 year class is above-average in strength and will provide significant recruitment to the Northern Edge fishery in 1982. However, the 1978 cohort is believed to be only half as large as the 1977 year class and hence, under current fishing practices, will not sustain the level of landings supported by the 1977 year class.

Given the disparity in scallop abundance between the Northern Edge region and all other areas on Georges Bank, it is likely that both USA and Canadian fleets will continue to concentrate their fishing activities during 1982 in this area of Georges Bank. Under 1981 culling practices, this would result in meat counts in the 1982 fishery as high as those observed in 1981, although the implementation of a USA sea scallop fishery management plan in May 1982 is aimed at ameliorating this situation by constraining the harvest of small scallops through meat count and shell size restrictions. Continuation of fishing strategies focused upon incoming recruitment will result in losses in both yield per recruit and reproductive potential, increasing the losses associated with growth overfishing and elevating the probability of recruitment overfishing.

Mid-Atlantic

Total commercial 1981 Mid-Atlantic sea scallop landings were 2,100 tons, 59% less than in 1980, and the lowest annual harvest since 1975. Commercial CPUE in 1980 was 34% lower than in 1979, 64% lower than the peak 1977 index, and the third lowest value in the 1965-1980 USA time series. Despite the sequential annual decline in commercial catch rates since 1977, effort in the Mid-Atlantic has continued to increase reaching a record high in 1980. During 1981, Mid-Atlantic catch rates declined further precipitating a transfer of vessel operations to the Georges Bank fishery.

Commercial size frequency sampling data indicate a continued dependence in the fishery on larger-sized scallops (>110 mm shell height), reflecting the lack of any significant recruitment of the magnitude that sustained record landings during 1976-1980. Concomitantly, the extremely low 1981 commercial catch rates suggest that population abundance has substantially been reduced as a result of high fishing mortality rates during the past four years.

Research survey catch per tow indices during 1980 and 1981 exhibited similar trends. In the Delmarva and Virginia-North Carolina regions, survey values have sequentially declined; the 1981 indices for both areas were the lowest in the 1975-1981 time series. Recruitment of the 1977 and 1978 year classes is relatively low in Delmarva and poor off Virginia-North Carolina. No evidence of successful recruitment of the 1979 year class was observed in survey tows in either area. Survey total catch per tow indices in the New York Bight region in 1980 and 1981 were about half of the 1975 index, and among the lowest values in the survey series. Pre-recruit indices in both years suggest low to moderate recruitment from the 1977 and 1978 year classes. Recruitment of the 1979 year class may be better than these preceding cohorts since scallops from this year class were taken in the 1981 survey. Normally, two-year-old scallops are rarely captured with the survey gear.

The absence of significant recent recruitment throughout the Mid-Atlantic area, in conjunction with high effort levels in the Mid-Atlantic fishery, will continue to impede improvement of resource abundance in the near future. Unless reductions in fishing effort are effected, overall scallop abundance is expected to further decline.

Gulf of Maine

Commercial Gulf of Maine sea scallop landings in 1981 were 1,100 tons, 537 tons less than in 1980, but still the second highest annual catch ever. As in 1980, most of the landings (~70%) were derived from offshore, FCZ waters from newly discovered beds. However, landings in 1981 were taken from beds much further northeastward then those exploited in 1980. This shift in areal distribution of landings connotes that fishery mortality in 1980 resulted in a rapid diminution of standing stock biomass in the areas exploited. Commercial effort in 1980 and 1981 attained record levels, primarily due to increased activity by Class 3 and 4 vessels. During 1965-1979, these vessel classes accounted for less than 10% of the annual Gulf of Maine landings; in 1980, however, combined class 3 and 4 landings comprised more than 60% of the annual catch. Preliminary 1981 data suggest a similar pattern as in 1980. Reliance of the Gulf of Maine fishery on offshore populations is a recent phenomenon. Before 1950, all landings were derived from inshore, territorial waters. During 1970-1978, inshore landings accounted for greater than 87% of the Gulf of Maine commercial sea scallop catch.

In 1980, commercial size frequency sampling data indicated that the offshore fishery was sustained primarily by recruitment of the 1975 year class. Although 1981 data show a substantial increase in the average size of scallop landed, it is likely that this increase is apparent rather than real due to low sampling intensity.

USA spring and autumn offshore bottom trawl survey relative abundance indices indicate differential scallop abundance in waters between 30-60 fm and 61-100 fm. In the former depth zone, catch per tow indices have been relatively stable since 1974. The 1980 and 1981 surveys indicate that the 1975 and 1976 year classes dominate the population. Most of the 1980-1981 offshore exploitation is thought to have occurred in depths between 30-60 fm since the 1975 and 1976 year classes were predominant in commercial size frequency samples obtained in these two years.

In the 61-100 fm region, survey catch per tow indices in 1980 and 1981 markedly increased from former years. Survey size frequency data indicate that abundance has improved due to a successful 1974 year class. Recruitment of the 1975 and 1976 year classes also appear to be above average.

Although the long-term productivity of scallop populations in the 61-100 fm region is unknown at present, the extremely high 1980-1981 survey indices suggest that current densities may be sufficient to support development of commercial exploitation. Given that recent offshore landings have been largely supported by one or two year classes, and have been achieved by significant increases in fishing mortality, it appears unlikely that current catch levels can be sustained unless additional high density beds are located.

Introduction

The Atlantic sea scallop, Placopecten magellanicus (Gmelin), is an epibenthic bivalve mollusk distributed in western North Atlantic continental shelf waters from the Northern Gulf of St. Lawrence to Cape Hatteras, North Carolina (Posgay 1957; Serchuk et al. 1979). Throughout their range, sea scallops support significant commercial fisheries. Currently, the USA commercial fishery is one of the most economically important fisheries along the eastern coast of the United States. During 1977-1981, USA sea scallop landings averaged 12,800 tons[1] annually, an all-time high. In 1980, domestic scallop landings generated a record 110.4 million dollars in ex-vessel revenue (United States Department of Commerce 1981).

Principal USA sea scallop resources are located on Georges Bank, in the Middle Atlantic, and in the Gulf of Maine (NAFO Subdivision 5Ze, Statistical Area 6, and Division 5Y, respectively: Figure 1). Apart from shallow water populations occurring in estuaries and embayments along the Maine coast (Dow 1969), most of the sea scallop resources under USA fisheries jurisdiction are found further offshore, primarily at depths between 40 and 100 m, in waters cooler than 20°C.

No biological evidence presently exists indicating a discrete differentiation of stocks between any of the USA offshore sea scallop populations. Although the major offshore scallop grounds tend to be geographically isolated, sea scallop eggs and larvae are planktonic and can be transported long distances during their pelagic phase. Posgay (1979) has postulated, based on sea surface current patterns and a 35-day larval period, that spatfall of scallops southwest of Georges Bank may result from progeny spawned from parental beds located to the

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[1]Tons in this paper refer to metric tons, meat weight.

northeast. Exchange of scallop larvae between the Gulf of Maine and Georges Bank may also occur due to drift of Gulf of Maine surface water across Georges Bank in the autumn (Bumpus 1976). Since sea scallop larvae have only recently been positively identified in plankton collections (Savage 1980), more definitive evaluation of the inter-mixture of reproductive products between scallop populations cannot presently be tendered.

Formalized management of the offshore sea scallop fisheries was initially attempted under the International Commission for the Northwest Atlantic Fisheries (ICNAF) in 1972, when ICNAF accepted a proposal prohibiting the retention and landing of scallops from Division 5Z (Georges Bank) which were less than 95 mm shell height and resulted in an average meat count of more than 40 scallop meats per pound. However, both Canada and the USA, the sole participants in the fishery, did not adopt these measures until 1976, when an allowance of 10% was provided for both the number of scallops below the size limit and above the average meat count. Subsequently, regulation of the offshore scallop fisheries by both nations has differed. Canada has implemented management measures that include limited entry, vessel trip catch limits, and continuation of meat count controls (Caddy and Jamieson 1977). Apart from the limitation on entry into the Canadian fleet, however, these management measures have not really been restrictive (see Serchuk et al. 1979, p. 185). Through 1981, the USA had not imposed any regulations within its scallop fisheries although in some USA ports union and industry practices have long controlled trip duration, vessel crew size, and shore-side layover time (Royce 1946; Doherty et al. 1964). A Fishery Management Plan for Atlantic Sea Scallops has been developed, however, for managing USA sea scallop resources (New England Fishery Management Council 1982) which includes meat count and minimum shell size restrictions as management measures. This Plan was implemented on an emergency basis on May 15, 1982, to address the immediate need to protect incoming recruitment of small scallops in the Georges Bank fishery during spring-summer 1982.

This report presents an analysis of the status of sea scallop populations in the Georges Bank, Middle Atlantic, and Gulf of Maine offshore regions of the United States. Data presented include commercial (USA and Canada) landings and effort statistics, commercial catch compositions, commercial abundance indices (catch per effort), and research vessel survey size composition and relative abundance indices. Analyses are also provided on sea scallop shell height-meat weight relationships, shell height and meat weight-ovary weight relationships, and yield per recruit. The present document is both an update and amplification of previous assessments and includes some revised data to those reported in Serchuk et al (1979). Evaluations of current resource conditions are presented and interpreted with respect to recent and historical fishing patterns and practices, recruitment prospects, and trends in population abundance levels.

Commercial Fishery

Historical Fishery (1887-1974)

Commercial landings of sea scallops from USA Northwest Atlantic waters have been recorded since 1887 (Lyles 1969; Table 1). Until the development of the Georges Bank fishery during the 1930's, commercial landings never exceeded 1,000 tons, averaging 304 tons per year from 1887-1928. During the earliest years of the USA fishery, most of the landings were harvested from the territorial waters of the State of Maine (until the 1920's) after which scallop beds off of Long Island and in the Mid-Atlantic sustained the majority of the USA catch. Between 1926 and 1935, 58% of the USA scallop landings were derived from Mid-Atlantic populations (Lyles 1969)

By 1937, Georges Bank sea scallop landings accounted for more than half of the total USA scallop catch (Premetz and Snow 1953). For the next 29 years, the Georges Bank resource was the mainstay of the domestic commercial fishery providing

77% of the total USA landings during 1944-1964. In 1965, USA scallop effort was diverted to the Middle Atlantic grounds in response to increased abundance in the southern populations due to exceptional recruitment of the 1961 year class (Posgay 1968). The offshore Canadian scallop fishery, which had developed on Georges Bank in the mid-1950's (Table 2), also displaced its activity southward during this period (Figure 2). By 1969, however, total Mid-Atlantic landings had sharply declined from the record levels of the previous four years initiating a return of the Canadian fleet to the Georges Bank fishery and the departure of many USA vessels from the scallop fishery altogether. During 1970-1974, the remaining much-contracted USA scallop fleet landed an average of only 2600 tons per year. Annual USA landings during this period were the lowest since 1945 (Table 1) with the total 5-year USA catch being only 500 tons greater than that taken in 1961 (Table 3).

The rapid development and subsidence of the Mid-Atlantic fishery in the mid-1960's and early 1970's precipitated major alterations in both the structure and conduct of the entire Northwest Atlantic offshore scallop fishery. Beginning in 1965, withdrawal of USA effort from Georges Bank (Table 4) resulted in a marked increase in the percentage of total Georges Bank landings harvested by Canada (Table 2). During 1965-1977, Canada annually accounted for greater than 70% of the total Georges Bank scallop catch, a significant departure from the proportional harvests taken from this fishery prior to 1965 (Figure 2). In addition to the large reduction in USA Georges Bank effort during 1965 to 1977 (~77% less than during 1959-1965:Table 4), the residual USA effort shifted from the traditionally productive Northern Edge and Peak region (Statistical Areas 523 and 524:Figure 3) to the South Channel area (Statistical Areas 521, 522, and 526:Figure 3). Resultingly, USA landings from the Northern Edge and Peak sharply declined, averaging

172 tons between 1965 and 1976 (Table 5), 96% less than during 1957 to 1964 and only 3.6% of the Canadian average Northern Edge and Peak landings during the same 1965-1976 time period. The effect of this change from historical USA fishing practices was that virtually all (96.5%) of the total northeastern Georges Bank scallop landings between 1965 and 1976 were Canadian. In contrast, during 1957-1964, USA Northern Edge and Peak catches comprised 53.8% of the USA Georges Bank landings (Table 6) and 54.9% of the total Northern Edge and Peak harvests.

Perhaps the most striking alteration in USA fishing activities that commenced in 1965 was the increased importance of Mid-Atlantic landings to total USA scallop yields. From 1965-1979, USA Mid-Atlantic landings were nearly twice as great (1.93x) as those from Georges Bank (Table 3); during the 15-year period, Mid-Atlantic landings exceeded those from Georges Bank in all but three years (Figure 4) and comprised 62.7% of the total USA sea scallop landings (Table 7). By comparison, Mid-Atlantic scallop catches accounted for less than 23% of USA scallop landings during 1944-1964.

A more detailed review of the historical sea scallop fishery is presented in Serchuk et al. (1979).

Recent Fishery Trends

The period from 1975-1981 has been one of great change in the scallop fishery. Total Northwest Atlantic scallop landings doubled between 1975 and 1977 (11,808 to 24,148 tons: Table 1) and reached a all-time peak of 26,672 tons in 1978 (Figure 5). Record landings were attained in the Canadian Georges Bank fishery in 1977 (13,044 tons), the USA Mid-Atlantic fishery in 1978 (8,642 tons), and the entire USA sea scallop fishery in 1978 (14,483 tons). These increased yields primarily resulted from extremely successful recruitment of the 1972 year class in almost all areas on Georges Bank and the Mid-Atlantic, coupled with marked increases in fishing effort (see COMMERCIAL EFFORT).

Total scallop landings in 1980 and 1981 (estimated projection based on January-September 1981 data) were 17,805 and 19,475 tons, respectively (Table 1). USA landings continued to decline between these years (1980: 12,566 tons; 1981: 11,475 tons) while Canadian offshore landings increased 53% (1980: 5,239 tons; 1981: 8,000 tons).

The bulk of the USA landings in 1980 and 1981 were taken from Georges Bank (44.7% in 1980; 71.9% in 1981), a departure from annual patterns observed since 1974 (Table 7). The 1981 USA Georges Bank catch (8,200 tons) was the highest in 18 years. This increase was sustained exclusively by USA Northern Edge and Peak landings which more than doubled between 1980 and 1981 (1,941 to 4,306 tons) and were the highest since 1962 (Table 5). USA 1981 landings from both the South Channel and Southeast Part regions of Georges Bank declined from 1980 resulting in Northern Edge and Peak landings accounting for 62.0% of the 1981 USA Georges Bank harvest, approximately the same proportional share of the catch as occurred in 1961-1962 (Table 6). USA Georges Bank landings during 1980 and 1981 exceeded those of Canada (1980: 5,620 vs 5,239 tons; 1981: 8,200 vs 8,000 tons) and resulted in USA landings comprising greater than 50% of the total Georges Bank sea scallop harvest for the first successive years since 1963-1964 (Table 2).

The 1981 USA Mid-Atlantic catch was only 2,100 tons, a 59% decrease from 1980, and the lowest annual yield since 1975 (Table 7). USA Gulf of Maine landings, which had averaged 253 tons per year from 1961-1979, reached 1,637 tons in 1980 (a record high) but declined to 1,100 tons (second highest ever) in 1981. In both years, approximately 70% of the Gulf of Maine landings were derived from newly discovered offshore beds in the Fishery Conservation Zone (FCZ: >3 miles from shore)(Table 8). In 1980, the Gulf of Maine offshore fishery developed in the Jeffreys Basin-Cashes Ledge region (Statistical Areas 513 and 515: Figure 3) resulting in a tenfold

increase in landings in these areas from 1979 (Table 9). In 1981, the offshore fishery shifted to FCZ populations off of Grand Manan Island and Machias Bay (Statistical Areas 511 and 512: Figure 3), virtually abandoning the scallop beds fished in the previous year (Table 9). Reliance of the Gulf of Maine fishery on offshore populations is a recent phenomenon; prior to 1950, Gulf of Maine landings were wholly from inshore, territorial waters (Baird 1956). During 1970-1978, inshore landings comprised more than 87% of the total Gulf of Maine catch (Table 8).

Distribution of Commercial Landings by Gear

Both the USA and Canadian scallop fisheries are prosecuted primarily by dredging, the traditional method of harvesting sea scallops (Smith 1891; Royce 1946; Posgay 1957; Bourne 1964). All landings from the Canadian Georges Bank fishery have been obtained using scallop dredges (Jamieson et al. 1981), while greater than 95% of USA scallop landings (1964-1980) have been taken with dredges (Table 10). On Georges Bank and in the Gulf of Maine, dredges have accounted for 98 and 99%, respectively, of USA commercial scallop landings from these regions. In the Middle Atlantic, otter trawls have occasionally accounted for a significant proportion of the annual USA Mid-Atlantic catch (e.g., 32% in 1976). When this has occurred, it has generally been a reflection of increased resource abundance conditions and hence has normally been rather short-lived. Between 1964-1980, Mid-Atlantic trawl landings of scallops comprised 8.7% of the total USA Mid-Atlantic catch (Table 10).

Distribution of Commercial Landings by Vessel Class Category

Trends in USA and Canadian Northwest Atlantic sea scallop dredge landings between 1965-1980 for each of the principal fisheries indicate major differences in the relative importance of various fleet sectors. In the Canadian fishery on Georges Bank, Class 4 vessels (151-500 gross registered tons, GRT) have always

dominated, accounting for 84.8% of the Canadian Georges Bank landings during 1965-1979 (Table 11). In the USA Georges Bank fishery, Class 3 vessels (51-150 GRT) harvested the majority of the USA landings during 1965-1978 (62.3% of the USA Georges Bank catch), but during 1979 and 1980 Class 4 vessels accounted for the greatest share of the catch (58.5%) (Table 12, Figure 6). The increased importance of Class 4 vessels in the recent USA Georges Bank fishery has resulted from the addition of newly-built larger vessels into scalloping as well as the entry of Class 4 vessels which had previously operated in other fisheries (i.e., Gulf and South Atlantic shrimp fisheries).

In the USA Mid-Atlantic fishery, Class 3 vessel landings comprised the largest proportion of the USA sea scallop harvest between 1965 and 1969 (Figure 6), accounting for 81.6% of the USA Mid-Atlantic catch. Starting in 1970, however, and continuing through all years except 1979, vessel class 4 landings have dominated the fishery. Throughout this 11-year period, 57.8% of the total USA scallop landings from the Mid-Atlantic resource were taken by Class 4 vessels. In 1979 and 1980, Class 4 vessels accounted for 42.1 and 52.1%, respectively, of the USA Mid-Atlantic catch, the lowest Class 4 annual shares since 1969. Since Class 4 Mid-Atlantic landings sequentially declined during 1978-1980 (1,381 to 1,023 tons) while Georges Bank and Gulf of Maine Class 4 vessel landings generally increased (Table 12), a displacement of Class 4 vessel activities away from the Mid-Atlantic region appears to recently have transpired.

The USA Gulf of Maine scallop fishery has always been dominated by Class 2 vessels (5-50 GRT). During 1965-1979, this smaller vessel category accounted for 90.1% of the Gulf of Maine landings. Although Class 2 landings in 1980 again predominated, vessel classes 3 and 4 accounted for significant proportions of the landings (29.3 and 30.8%, respectively: Figure 6). The development of the Gulf

of Maine offshore fishery in 1980 resulted in a 12-fold increase in Class 3 landings from 1979 and an eightfold increase in Class 4 landings (Table 12). As a result, combined landings from vessel classes 3 and 4 exceeded Class 2 landings for the first time ever. Continuation of offshore Gulf of Maine exploitation patterns in 1981 suggests that the larger vessel classes may continue to be important in the Gulf of Maine fishery in the immediate future.

Commercial Effort

Effort statistics (days fished) from the commercial scallop fisheries on Georges Bank, in the Mid-Atlantic, and the Gulf of Maine were examined for trends in both USA and Canadian annual commercial fishing patterns. USA data were derived from NMFS interview and weighout records with individual trip records aggregated, where feasible, by year and vessel tonnage category, for vessels using scallop dredges and landing in New England (1965-1980) and New Jersey ports (1978-1980) (Table 13). Total annual USA effort for Georges Bank (Area 5Ze) during 1944-1964 was taken from Caddy (1975); for 1965-1980, overall USA annual effort was determined using a derived average obtained by weighting individual USA vessel class catch rates by the yearly percentages of USA Georges Bank landings accounted for by each vessel class (Table 14). For each year, the derived catch rate was subsequently divided into the total USA Georges Bank catch to obtain total USA effort (Table 4). Canadian Georges Bank effort data were taken from Caddy (1975), from statistics provided to NMFS by Canadian scientists (J. F. Caddy and R. Chandler, personal communication), and from effort summaries listed in ICNAF and NAFO Statistical Bulletins (Tables 4 and 11).

No adjustments to any of the reported effort data have been made for possible differences in fishing power within vessel classes over time, between vessel classes, or between USA and Canadian fleet sectors.

In the Georges Bank fishery, trends in both USA and Canadian effort have tended to parallel those of landings. During 1944-1956, USA effort gradually increased from 2,220 to 12,250 days fished (5.5-fold increase) while landings nearly quintupled (4.6-fold increase) (Table 4). USA effort declined during 1957 and 1958 but stabilized at about 8,100 days per year from 1959-1964. During this same period (1957-1964), the Canadian fishery underwent rapid development; effort increased almost sixfold while landings rose over sevenfold. Between 1964 and 1965, both USA and Canadian effort sharply declined (-69% USA; -15% Canadian) as both fleets displaced their exploitation to the Mid-Atlantic grounds (Table 4, Figure 2). During the subsequent 11 years (1966-1976), USA effort remained at relatively low levels, averaging only 1,860 days fished per year, while Canadian effort steadily increased from 5,500 days (1966) to 8,400 days (1975) fished per annum. Landings in these years followed similar patterns. Beginning in 1977, USA Georges Bank effort rapidly increased, rising 2.5-fold between 1977 and 1980 (4,514 vs 11,263 days fished). Canadian effort also increased from 1976 to 1979 (7,324 to 8,823 days fished) but declined to 6,838 days in 1980 (Table 4).

Class 4 vessels (151-500 GRT) accounted for 84.1% of the total Canadian nominal effort on Georges Bank during 1965-1979, almost identical to the landings percentage attributable to this vessel class (84.8%) (Table 11). As with catch, USA tonnage class 3 vessels dominated the USA Georges Bank fishery during 1965-1978, accounting for the majority of the reported effort in each of these years (Table 13). Since 1979, however, USA Class 4 effort has exceeded that of Class 3 vessels. In 1980, effort expended by USA vessel classes 3 and 4 reached record levels for the 1965-1980 Georges Bank time series (Class 3: 4,642 days; Class 4: 6,133 days). The 1980 values for these two vessel categories increased 14.4 and 39.2%, respectively, from 1979 effort levels (Table 13).

Trends in effort in the USA Mid-Atlantic fishery since 1965 reveal three distinct periods (Table 13). The first period, from 1965-1969, was characterized by historically high effort levels, primarily by Class 3 vessels, as the Mid-Atlantic fishery underwent increased exploitation. During the second period, 1970-1974, effort stabilized at very much lower levels with Class 4 vessels accounting for the majority of effort annually. In the most recent period, effort in all vessel categories has substantially increased to the high levels observed during the first period. Class 2 and Class 3 effort peaked in 1979; Class 4 effort attained a record high in 1980. Since 1979, Class 3 vessels have again accounted for the largest number of days fished annually in the Mid-Atlantic fishery.

In the USA Gulf of Maine sea scallop fishery, virtually all effort expended during 1965 to 1980 was by Class 2 vessels (Table 13). Class 2 effort doubled between 1965 and 1970, quadrupled between 1970 and 1973, and subsequently remained at relatively high levels through 1976. Effort sharply declined in 1977 (-39% from 1976), but successively annually increased afterward, doubling between 1977 and 1980. Class 2 effort in 1980 (2,827 days) was the highest in the recent 16-year time period. Increased participation of Class 3 and 4 vessels in the fishery occurred in 1980 when offshore scallop beds in the Gulf of Maine began to be more fully exploited.

Commercial Abundance Indices (Catch Per Effort)

Annual commercial indices of catch per unit of effort (CPUE: metric tons of scallop meats landed per day fished)[2], 1965-1980, for the Georges Bank, Mid-Atlantic

[2]Reported commercial effort was in actual hours of fishing time with the dredge on the bottom, recorded to the nearest tenth of a day. Hence, CPUE values presented herein represent relative fishing performance only for the time in which dredging occurred.

and Gulf of Maine fisheries were calculated to assess relative performance of the sea scallop fleets over time (Table 14). USA data were analyzed separately, by vessel tonnage class within fishery areas, and pertain to dredge vessels landing in New England (1965-1980) and New Jersey ports (1978-1980). As previously noted (Table 10), vessels using scallop dredges accounted for greater than 95% of all USA Northwest Atlantic sea scallop landings during 1964-1981. All trips in which any quantity of scallops was landed were used in deriving annual vessel class indices. Since the dredge fishery tends to be a highly "directed" one (i.e., harvesting scallops almost exclusively), catch per effort indices should generally reflect relative fishing success for scallops. To the extent, however, that fishing power has increased through time within vessel classes (i.e., technological, procedural, and/or gear modifications), more recent annual CPUE indices may overestimate relative vessel class efficiency compared with earlier values. Appropriate catchability coefficients accounting for these factors, unfortunately, are lacking for virtually all invertebrate dredge fisheries (Caddy 1977), including scallops.

Canadian CPUE indices were derived from Caddy (1975) and from subsequent aggregate landings and effort data provided by Canadian scallop biologists. These indices basically reflect the performance of Class 4 vessels (Table 4). Additionally, annual vessel class catch rates were derived from monthly tonnage class catch and effort data listed in ICNAF and NAFO Statistical Bulletins (Table 11).

On Georges Bank, similar historical trends in commercial CPUE are evident between USA and Canadian scallop fleets (Figure 7). From 1944 to 1958, prior to the full development of the Canadian fishery, annual composite USA indices were relatively stable, varying between 0.6-0.8 tons per day. Although USA landings significantly increased throughout this time, the CPUE indices imply that fishing mortality did not measurably alter scallop abundance, a major industry concern during

this period (Premetz and Snow 1953). In 1959, both USA and Canadian CPUE values sharply increased, peaking in 1960 (USA) and 1961 (Canada), and remaining above pre-1959 values through 1963-1964 (Table 4). The elevated catch rates and correspondingly high annual landings were sustained by a marked increase in scallop abundance due to exceptional recruitment of the 1955 year class to the fishery (Posgay 1968; Caddy and Lord 1971).

During 1965 to 1972, USA and Canadian annual commercial indices steadily declined to the lowest levels in the Georges Bank fishery. By 1972, CPUE for both fleets was about 35% less than in 1965, and about one-third of the peak 1960-1961 values. Total landings in 1972, 4,967 tons, were the lowest since 1948 with USA landings (821 tons) the lowest in the recorded Georges Bank time series (Table 4). The decline in CPUE indices and the lack of appreciable recruitment during this period (Caddy 1972a, b) indicate that the intensive fishing activities of the early 1960's resulted in substantial reduction in scallop abundance on Georges Bank. The rate of decline would assuredly have been greater had not both USA and Canadian fleets directed their fishing operations to the Mid-Atlantic grounds during the mid-1960's (Figure 2).

Beginning in 1973, yearly CPUE values sequentially increased, culminating in 1977 in a record CPUE for the Canadian fleet (1.52 tons/day fished) and a near-record CPUE for the USA fleet (1.06 tons/day fished) (Figure 7). Total annual landings tripled during this interval (5,288 to 17,849 tons: Table 4), primarily due to high levels of Canadian effort and the recruitment of the outstanding 1972 year class into the commercial fishery (MacKenzie et al. 1978; Serchuk et al. 1979). Subsequently, however, commercial CPUE on Georges Bank has dropped sharply; both USA and Canadian 1980 indices were half of the 1977 values, with the 1980 USA CPUE being the third lowest in the 37-year period since 1944. Although total landings

peaked in 1977, effort continued to increase resulting in record highs in 1979 (Canada) and 1980 (USA and Total) (Table 4). These trends imply that recent levels of fishing mortality on Georges Bank have been extremely high.

Estimated total Georges Bank landings in 1981 were 16,200 tons (USA: 8,200 tons; Canada: 8,000 tons),about a 50% increase from 1980 (Table 2). Preliminary USA CPUE data for the first seven months of 1981 show a marked increase in catch rates for all vessel classes fishing on the Northern Edge and Peak (about 62% of the 1981 USA Georges Bank landings was caught in this region); monthly CPUE values in late spring and early summer 1981 were extremely high ranging between 0.9 and 2.0 tons/day fished. Research survey and commercial size-frequency data indicate that the 1981 Northern Edge and Peak fishery relied heavily upon very successful recruitment of the 1977 year class in this area of Georges Bank (see COMMERCIAL CATCH COMPOSITION and RESEARCH SURVEY RELATIVE ABUNDANCE INDICES).

Yearly trends in both USA and Canadian individual vessel class CPUE indices during 1965-1980 are concordant with the patterns derived from the aggregated Georges Bank analyses (Tables 11 and 14, Figure 8).

In the Mid-Atlantic sea scallop fishery, USA commercial CPUE indices for vessel classes 3 and 4 during 1965-1980 exhibited similar chronological directionality as those for Georges Bank (Table 14, Figure 8). Annual values steadily declined from 1965-1971 (over a 60% reduction in both classes), stabilized briefly at low levels in 1972-1973, and then rapidly increased through 1977. The 1977 catch rates (Class 3: 1.14 tons/day fished; Class 4: 1.32 tons/day fished) were the highest ever in the fishery, eclipsing the previously high 1965 values by 14 and 20%, respectively, and were more than threefold greater than historically low indices observed in 1971. As on Georges Bank, these prominent 1977 CPUE levels resulted from recruitment of the extremely abundant 1972 year class throughout the Mid-

Atlantic fishery region (Serchuk et al 1979). Since 1977, annual USA CPUE indices have steeply declined. In 1980, both USA Class 3 and 4 catch rates were over 60% lower than in 1977, and among the lowest CPUE values in the 1965-1980 time period. Despite the decline in CPUE, total USA effort in the Mid-Atlantic fishery sharply increased during 1978-1980 resulting in a record high in 1980 (Table 13). Applying the 1980 USA annual mean catch rate (0.45 tons/day fished) for New England and New Jersey scallop dredge vessels landing scallops from the Mid-Atlantic resource (Table 14) to the 1980 total USA Mid-Atlantic catch (5,090 tons: Table 3) results in an estimated 1980 Mid-Atlantic effort of greater than 11,300 days fished.

The apparent decline in Mid-Atlantic scallop abundance implied by the recent reductions in commercial catch rates has been roughly compensated in terms of gross harvest revenue by substantial increases in ex-vessel prices (Table 15). The 1980 USA average landed price per pound of scallops ($3.84) was 2.4 times higher than in 1977 ($1.62) whereas the 1977 mean Mid-Atlantic CPUE (1.24 tons/day fished) was 2.8-fold greater than in 1980 (0.45 tons/day fished) (Table 14). Accordingly, through 1980, there remained an economic incentive to continue exploitation of the Mid-Atlantic sea scallop resource (as well as Georges Bank) despite the sizable decreases in population abundance.

Preliminary data for 1981 (January-June) indicate that USA Mid-Atlantic catch rates have declined further. Projected 1981 Mid-Atlantic landings (2,100 tons: Table 3) were the lowest since 1974 when CPUE was almost double the 1980 mean value. Average ex-vessel price of scallops in 1981 (based on preliminary New Bedford data) was only 3 cents higher than in 1980. These factors suggest that resource abundance further deteriorated in the Mid-Atlantic during 1981 and that the economic stimulus for concentration of fishing effort in this region has greatly diminished. The

appearance of many Mid-Atlantic based scallop vessels on Georges Bank during 1981, and the concomitant increased emphasis by the New England scallop fleet in 1981 in fishing the Georges Bank grounds tend to corroborate these inferences.

In the USA Gulf of Maine inshore scallop fishery, Class 2 vessel annual catch per effort indices (Table 14, Figure 8) best reflect trends in commercial fishing performance since greater than 90% of the 1965-1979 landings was taken by this class of vessels. Class 2 CPUE values gradually declined by over 60% between 1965 and 1974 (0.38 vs 0.14 tons/day, respectively). Class 2 landings almost quintupled between 1965 and 1972 while effort increased ninefold (Tables 12 and 13). Apart from 1975 when Class 2 CPUE rose sharply, recent annual catch rates have remained at relatively low levels.

Class 3 and 4 catch indices are most relevant in indicating the development of the offshore Gulf of Maine fishery which commenced during the winter of 1979-1980. The 1980 CPUE indices for these vessel classes (Class 3: 1.24 tons/day fished; Class 4: 1.82 tons/day fished) were the highest on record, and surpassed even the highest Class 3 and 4 annual catch rates recorded in both the USA Georges Bank and Mid-Atlantic fisheries during 1965-1980 (Table 14). The initial development of the fishery, principally in the Jeffreys Basin-Cashes Ledge area in 1979-1980, resulted in a tenfold increase in landings and about a fivefold increase in effort by Class 3 and 4 vessels between 1979 and 1980 (Tables 12 and 13). However, the abrupt withdrawal of fishing activity from this region in 1981 (Table 9: compare landings in 1980 and 1981 for Statistical Areas 513 and 515) to more northeasterly offshore areas in the Gulf of Maine (i.e., Grand Manan offshore waters) connotes that the 1980 catch rates were not sustainable; the rapid decline in Jeffreys Basin-Cashes Ledge landings in 1981 implies that fishing pressure, supported primarily by recruitment from the 1975 year class of scallops (see COMMERCIAL CATCH COMPOSITION), may have materially reduced resource abundance in this region.

Commercial Catch Composition

USA size frequency sampling of commercial sea scallop landings has been conducted since the 1950's (Posgay 1962). Since 1965, the sampling protocol has been to measure shell height (greatest distance between the umbo and ventral shell margin) from a random sample of shells (top valve only) obtained during the last tow of a vessel trip. Measurements are recorded by 5 mm intervals. Prior to 1972, scallops larger than 149 mm shell height measured in the USA commercial samples were grouped in the 145-149 mm size frequency interval, effectively truncating the upper end of the frequency distributions in these years. Since 1972, the actual size interval of these larger sized individuals has been recorded. In all years, the statistical area from which each sample was obtained and the gear used have been routinely chronicled. Additional data on depth fished, trip catch, vessel identification, and date of sample collection have also been collected.

Samples from vessels using scallop dredges account for virtually all of the USA size frequency data obtained during 1965-1981, reflecting the almost exclusive reliance in the USA fishery on dredging to capture scallops (Table 10). Accordingly, no evaluation of commercial catch composition in other than the dredge fishery has been performed.

For all years, annual shell height distributions were derived for each principal sea scallop fishing region on Georges Bank (South Channel, Southeast Part, and Northern Edge and Peak) and in the Middle Atlantic (New York Bight, Delmarva, and Virginia-North Carolina) (Figure 3). Gulf of Maine size frequencies were also derived for all years in which samples were available. Within each region, yearly size composition was determined by aggregating all samples collected within each year. From the resultant annual size frequency array, the percentage dis-

tribution of sampled scallops, at 5 mm shell height intervals, was calculated. Mean shell height, mean meat weight per scallop, and average meat count (i.e., number of scallop meats per pound) were subsequently derived from the annual frequency distributions. Mean meat weight per scallop was determined through application of area-specific (Georges Bank, Mid-Atlantic, and Gulf of Maine) shell height-meat weight equations to the shell height frequencies represented in the frequency distributions (see SHELL HEIGHT-MEAT WEIGHT RELATIONSHIPS); the average meat count was obtained by dividing the calculated mean meat weight per scallop into 453.6 grams (i.e., one pound).

To assess within-year size variability of the commercial samples from each fishing region, meat counts were individually determined for all samples and annual frequency distributions of the sample meat counts (in 5 unit intervals) were tabulated.

Composite annual size frequency distributions of scallop samples from both the Georges Bank and Mid-Atlantic fisheries were derived by weighting the yearly shell height distributions from each of the three principal scallop regions in both fisheries by the respective annual USA scallop landings from these regions. In effect, these composite distributions reflect the estimated size composition of the USA landings in each year.

Annual shell height frequencies for 1965-1980 from USA Georges Bank samples are depicted in Figures 9-12. Summary statistics on sample sizes, mean shell height, mean meat weight, and average meat count are presented, by principal scallop fishing region and year, in Tables 16 (1965-1974) and 17 (1975-1981).

The frequency distributions indicate that scallops on Georges Bank become recruited to the USA fishery after attaining a size of 70 mm shell height, the 50 percent selection point of commercial scallop dredges equipped with 3-inch

(76 mm) rings (Posgay 1962). Size selection of scallops by commercial dredges, however, is not sharp due to the accumulation of trash and scallops in the gear during towing (Bourne 1965, 1966). Equally, dredge efficiency progressively decreases with size for scallops below 100 mm shell height due to the ability of these smaller-sized individuals to elude capture by swimming away from the dredge path (Caddy 1968). Accordingly, the smallest sizes of scallops appearing in the landings generally reflect prevailing culling practices since commercial catches are normally sorted on deck before shucking, and undersized scallops returned overboard. Historically, the 50% cull size in the USA Georges Bank fishery has varied between 85-110 mm shell height (Posgay 1962, 1979; Brown et al. 1972), with reductions in cull size generally transpiring during years of good recruitment.

During 1965-1980, the average size of scallops in any of the USA Georges Bank annual frequency distributions ranged between 98.6 mm (South Channel, 1977) and 133.5 mm (Southeast Part, 1965) (Tables 16 and 17). Among principal fishery regions on the Bank, the mean size of scallops from the Southeast Part has consistently been larger than those from the South Channel or the Northern Edge and Peak. In none of the regions, however, did annual USA average meat counts exceed 28 per pound until 1981 when the mean size of South Channel and Northern Edge and Peak scallops were the smallest in the recent sampling time series (92.8 and 86.7 mm shell height, respectively).

Prior to 1981, only two USA samples of the 750 collected from Georges Bank between 1965 and 1980 had individual meat counts greater than 40 per pound (Tables 18 and 19). Most samples collected during 1965-1971 were less than 20 count (Table 18) while the majority of individual samples from 1972-1980 were less than 25 count (Table 19). These data, in conjunction with the growth rate of sea scallops on Georges Bank (Table 20), imply that the average age of landed scallops in the USA fishery has (until 1981) rarely ever been less than 4 years of age.

The composite USA Georges Bank shell height frequency distributions for 1966, 1970, and 1976 and 1977 display prominent modes at about 90 mm (Figure 9). Examination of the corresponding annual size distributions from each of the three fishery regions on the Bank (Figures 10-12) indicates that during 1966 and 1970 these modes were represented by South Channel landings almost exclusively, while during 1976 and 1977, these peaks were evident in all fishing areas. The increased proportion of smaller-sized scallops in the USA samples during these years suggests that incoming recruitment was relatively stronger than in adjacent periods. This is further reflected in the declines in average shell height and meat weight that occurred during these four years (Tables 16 and 17) and the increases in the percentage of samples containing elevated meat counts (Tables 18 and 19). The observed uptrends in USA Georges Bank CPUE in these years (particularly Class 3 indices) additionally imply that heightened year class recruitment transpired in the USA fishery during these times (Table 14). Finally, the subsequent progression and integrity of the height frequency modes in succeeding annual frequency distributions denotes that this recruitment was real and not a sampling artifact. Research vessel survey results from 1975 onward indicate that the commercial size frequency modes in 1976 and 1977 reflect the entry of the outstanding 1972 year class in the Georges Bank fishery (MacKenzie et al. 1978; Serchuk et al. 1979). The recruitment that occurred in 1966 and 1970 in the South Channel was probably more localized and of a lesser magnitude than either that of the 1972 year class or the exceptional 1955 year class. Nonetheless, this recruitment was sufficient to initiate reductions in the average age at harvest from 5 to 4 years for the USA fleet (Brown et al. 1972) and from 5 to 3 years of age for scallops landed in the Canadian Georges Bank fishery (Caddy 1971).

As noted previously, the mean size of scallops sampled from the 1981 USA Georges Bank landings was the smallest in the 1965-1981 period (Tables 16 and 17). Individual meat counts exceeded 60 count in 22% of the USA samples obtained from Northern Edge and Peak landings during January-September 1981 (Table 19). Elevated meat counts were equally characteristic of samples from South Channel landings. Provisional size frequency distributions from the 1981 sampling exhibit a prominent mode between 70-84 mm shell height indicating that scallops from the 1977 year class predominated the landings; a similar pattern prevailed in samples obtained from the 1981 Canadian Georges Bank fishery (G. Robert, personal communication). This dominance of the 1977 year class in the 1981 USA and Canadian commercial landings is concordant with 1980 and 1981 research vessel abundance indices which indicated that the 1977 year class was the principal year class in the Georges Bank resource and was stronger than the outstanding 1972 year class (see RESEARCH SURVEY RELATIVE ABUNDANCE INDICES), albeit more localized in distribution.

In the USA Mid-Atlantic fishery, annual shell height frequency distributions during 1965-1980 indicate a similar size at recruitment for scallops to the dredge fishery as on Georges Bank (Figures 13-16). Scallops less than 70 mm shell height have rarely occurred in Mid-Atlantic commercial samples implying virtually identical culling policies as for the Georges Bank fishery.

The average size of scallops in the Mid-Atlantic annual frequency distribution has varied between 95.4 mm (1965: Delmarva) and 122.5 mm shell height (1978: Delmarva) (Tables 21 and 22). Little consistent differences are evident in either the mean size or size range of scallops sampled from any of the Mid-Atlantic areas. During 1965-1971, sample meat counts seldom exceeded 40 count, with most samples less than 25-30 count (Table 23). Generally higher sample meat counts occurred during 1965-1967 when the Mid-Atlantic fishery was sustained by unprecedented recruitment from the 1961 year class (Posgay 1968).

The weighted aggregated Mid-Atlantic shell height frequency distributions for 1965, 1966, 1972, 1974, and 1976 all indicate reliance in the USA fishery on incoming recruitment (Figure 13). Recruitment of the extremely abundant 1961 year prevailed in each of the three Mid-Atlantic scallop regions during 1965-1966 (Figures 14-16). Recruitment during 1972 was much more localized, occurring principally in the Delmarva region (Figure 15). The slight increase in USA Mid-Atlantic CPUE during 1972 (Table 14) reflects this recruitment since most of the 1972 Mid-Atlantic landings were obtained from Delmarva (Table 3: Area 6B); greater than 50% of the 1972 Delmarva samples had meat counts higher than 30 per pound (Table 24). In 1974, localized recruitment again occurred but this time in the New York Bight area, where the size frequency distribution indicated a distinctive mode between 82-97 mm shell height (Figure 14). Mid-Atlantic scallop growth rate data (Table 20) imply that this mode corresponds to the size expected for age 4 scallops, i.e., the 1970 year class. Average shell height in New York Bight samples significantly declined in 1974 (98 mm vs 111 mm in 1973) and sample meat counts increased (Tables 21 and 24). The entry of the 1970 year class into the Mid-Atlantic fishery was accompanied by a substantial increase in USA commercial catch per effort in 1974 (Table 14) and an increased reliance on the New York Bight area in sustaining USA Mid-Atlantic scallop landings (Table 3). Recruitment in 1976 was widespread in the Mid-Atlantic; a prominent shell height mode between 87-97 mm appeared in both New York Bight and Delmarva annual frequency distributions (Figures 14 and 15) indicative of entry of the strong 1972 year class into the fishery. This year class, the strongest to appear since the 1961 cohort, dominated the fishery through 1980 as evidenced by the increase in landings throughout this period and the successive modal progression of the 1972 year class in the Mid-

Atlantic size frequency distributions from 1976 to 1980 (Figure 13). Size frequency distributions from the Delmarva and Virginia-North Carolina regions in 1979 and 1980 (Figures 15 and 16) indicate that some additional localized recruitment occurred from both the 1975 and 1976 year classes as well.

Provisional 1981 size frequency sample data from the Mid-Atlantic region indicate a continued dependence on larger-sized scallops (>110 mm shell height) in the USA commercial fishery. Average 1981 meat counts in all three fishery areas in the Mid-Atlantic were less than 15 count, among the lowest in the 1965-1981 sampling time sequence (Tables 21 and 22). Recruitment of the 1977 year class appears to be relatively minor in all Mid-Atlantic areas; only one of the 16 size frequency samples obtained from Mid-Atlantic landings during January-September 1981 had a meat count higher than 30 (New York Bight: Table 24).

Commercial sampling of USA Gulf of Maine scallop landings has been less encompassing than in either the Georges Bank or Mid-Atlantic fisheries (Table 25). Aside from 1980 when a special effort was made to obtain samples from the developing offshore fishery, the number of samples collected annually has been relatively low. To a large degree, this has been a reflection of the minor proportion of total USA scallop landings originating from the Gulf of Maine; only 3.5% of the total USA scallop catch during 1961-1979 was derived from the Gulf of Maine (Table 7).

The limited sampling data indicate that prior to 1972 most of the Gulf of Maine landings were comprised of scallops larger than 110 mm shell height (Figure 17), with individual sample meat counts never more than 25 count (Table 26). During 1972-1974, average annual meat counts increased to 27-30 count (Table 25), as incoming recruiting year classes dominated the size frequency distributions

(Figure 17). This situation abated in 1975 but reappeared during 1977-1980. In 1978 and 1980, virtually no scallops larger than 120 mm shell height were present in the size frequency samples, in striking contrast with previous years. Cull size in the 1980 offshore fishery was also lower than in preceding periods with sample meat counts as high as 80-85 count being observed (Table 26). In part, this resulted from increased shell stocking operations in 1980 and entry of Mid-Atlantic-based vessels into the Gulf of Maine fishery. In response to these circumstances, the States of Maine and Massachusetts prohibited the landing of sea scallops less than 3 inches (76 mm) in shell height at their ports.

The modal height of about 90 mm in the 1980 size frequency distributions (Figure 17) suggests that the offshore fishery was sustained primarily by recruitment from the 1975 year class (Table 20). This supposition is based on growth rate patterns of inshore Gulf of Maine scallops but, due to similarities between offshore and inshore height-weight equations (see SEA SCALLOP SHELL HEIGHT-MEAT WEIGHT RELATIONSHIPS) appears generally applicable to the offshore populations.

Provisional 1981 Gulf of Maine size frequency sampling data indicate a substantial decrease in sample meat counts from 1980 although this observation is derived from only three samples obtained during January-September 1981 (Tables 25 and 26).

Recreational Fishery

A limited recreational fishery for sea scallops exists in shallow, inshore waters north of Cape Cod in which scallops are retrieved by scuba diving. Most of this activity occurs in estuaries and embayments in the territorial waters of the State of Maine at depths less than 15 fathoms. Detailed landings data do not exist for the recreational fishery but it is probable that total annual recreational cathces are considerably less than a metric ton of meats. The State of Maine limits the recreational catch of sea scallops to one gallon of shucked meats per person per day during the sea scallop season, November 1 through April 15.

Research Vessel Surveys

USA research vessel sea scallop surveys have been conducted since 1960 to obtain fishery independent data on the ecology and abundance of the Georges Bank and Mid-Atlantic scallop populations (Serchuk et al. 1979). These surveys form two time series: an early series conducted during 1960-1968 primarily in the Georges Bank region in which collection of basic life history information was a principal survey objective although relative abundance and population structure were also derived (Merrill and Posgay 1964; Haynes 1966; Posgay 1979), and a newer series conducted in 1975 and annually from 1977 onward to specifically monitor population dynamics of the Georges Bank and Mid-Atlantic resources (Table 27).

Since 1979, USA surveys have been performed using the R/V Albatross IV equipped with a 2.44 m (8 ft) wide commercial sea scallop dredge possessing a 5.1 cm (2-inch) ring bag and a 3.8 cm (1.5 inch) polypropylene mesh liner. Detailed gear specifications are given in Serchuk and Smolowitz (1980). At each sampling station, the survey gear is towed for 15 minutes at 3.5 knots with a 3:1 wire scope. A stratified random sampling design is employed, with offshore areas between 27-110 m (15-60 fathoms) stratified into geographical zones based on depth and latitude (Figure 18). Sampling stations are allotted to strata in proportion to the area of each stratum and assigned randomly within strata. The current sampling strata encompass the main areal and bathymetric distribution of sea scallop populations on the Northwest Atlantic continental shelf.

USA scallop surveys accomplished between 1975 and 1978 used a 3.05 m (10 ft) wide, unlined scallop dredge as the standard sampling gear. Alternate haul comparative fishing selection experiments conducted in 1980 with lined and unlined 2.44 m (8 ft) sea scallop survey dredges (Serchuk and Smolowitz 1980) revealed significant differences in size selectivity between the lined and unlined gear;

for scallops <70 mm shell height, the lined dredge was much more efficient in capturing individuals than the unlined dredge while for scallops ≥70 mm the obverse was true (Figure 19). Equally, relative retention efficiency for the lined dredge progressively decreased with increases in scallop shell size between 25 and 70 mm. Accordingly, to standardize the 1975-1978 USA sea scallop survey results with subsequent survey data, individual tow catches were adjusted, by shell height size category, to reflect the size selectivity of the currently employed lined dredge. Also, a linear adjustment factor was applied to the earlier survey tow data to standardize the 3.05 m dredge results to 2.44 m dredge equivalents (0.8 = 2.44/3.05). Overall selectivity and gear adjustment factors used in the standardization process are presented, by shell height interval, in Table 28.

Although a stratified random sampling design was used in the 1977 and 1978 USA scallop surveys (the 1975 survey used a transect design), sampling strata differed from those used since 1979. To facilitate comparisons with more recent survey data, standardized tow data from the 1975-1978 surveys were post-stratified, before further analysis, into the current USA strata regimen.

Since 1977, Canada has conducted annual sea scallop research vessel surveys on Georges Bank, primarily in the Northern Edge and Peak region. These surveys are performed with the R/V E.E. Prince using a 2.44 m (8 ft.) offshore scallop dredge equipped with 7.62 cm rings (3-inch) and a 3.81 cm (1.5 inch) mesh nylon liner (Jamieson and Chandler, 1980). Sampling areas are selected on the basis of commercial effort expended by the combined USA and Canadian scallop fleets within 10-minute squares of latitude and longitude. Sampling stations are allocated to 10-minute square areas in proportion to the relative amount of commercial effort and CPUE in each square; within squares, stations are randomly located (Jamieson 1977). Sampling

intensity is facilitated by characterizing 10-minute square areas into low, medium, and high commercial catch per effort categories. A standard tow at each sampling station linearly covers 0.8 km (0.5 n mi) of ocean bottom as determined from LORAN navigational bearings (Jamieson and Chandler 1980).

Canadian survey data from the Northern Edge and Peak region were integrated with USA survey results by post-stratifying individual tow data into the USA sampling strata. The Canadian survey data were further adjusted to account for differences in the mean tow distance between USA and Canadian standard sampling tows. The mean tow distance per station on Georges Bank during the 1978-1981 USA surveys was 0.89 nautical miles in 1978, and 0.87 nautical miles in each of the succeeding three years. Hence, Canadian survey catch data were expanded by the ratio of the mean USA survey tow distance to the mean Canadian survey tow distance, i.e., 1.78 in 1978 and 1.75 for the 1979-1981 surveys. No selectivity adjustments were performed to the Canadian survey data since the Canadian survey dredge is almost identical to the USA 2.44 m lined survey dredge in configuration.

In both the USA and Canadian sea scallop surveys, similar catch processing procedures are employed. After each tow, the catch is sorted into biological and trash components. The entire scallop catch is weighed and shell height frequency measurements by 5 mm intervals, recorded for all individuals. On occasion, subsampling is necessary if extremely large quantities of scallops are obtained. Following enumeration of total number and weight of scallops caught, biological samples (shells, meat weights, ovary weights, etc.) are collected for aging, maturity, relative fecundity, and height-weight analyses. Frequently, samples are also obtained for special analyses (i.e., heavy metals, glycogen levels). Hydrographic and navigational data are routinely recorded at each sampling station including tow distance over bottom using a Doppler speed log.

A summary of USA and Canadian sea scallop survey cruises on Georges Bank and in the Mid-Atlantic from which data have been analyzed in this report is provided in Table 27. Data from USA surveys prior to 1975 were previously presented in Serchuk et al. (1979).

Survey monitoring of offshore Gulf of Maine sea scallop populations has been conducted as part of the USA annual spring and autumn bottom trawl surveys in this geographical region. Although the USA standard bottom trawl gear is not as efficient in sampling scallops as the sea scallop survey dredge (due to rollers on the trawl sweep), a preliminary comparison of relative abundance and size frequency data derived from USA trawl and dredge surveys on Georges Bank revealed similar historical trends. Accordingly, the use of bottom trawl surveys to obtain data on abundance and size structure of Gulf of Maine scallops appeared justified. Methodology and design of the stratified random bottom trawl surveys are detailed in Grosslein (1969, 1974), Pennington and Grosslein (1978) and Clark (1979, 1981).

Gulf of Maine bottom trawl sampling in strata 26-30 and 36-40 (Figure 20) during 1963-1981 resulted in the regular collection of scallops in strata 26-27 and 37-40. Tows performed in strata 28-30 and in stratum 36 yielded a total of only 26 scallops from all spring and autumn surveys. Hence, these strata were eliminated from subsequent analyses. The remaining Gulf of Maine strata were grouped, for analytical purposes, into two depth categories: 31-60 fm (strata 26, 39 and 40) and 61-100 fm (27, 37 and 38). Prefatory inspection of scallop data from these two depth zones revealed significant differences in population composition and abundance.

Due to uncertainty concerning the consistency of recording scallop catch data during Gulf of Maine bottom trawl surveys prior to 1974, only 1974-1981 survey data were analyzed for assessment evaluations. Cruise tracks and operational summaries of these surveys are provided in Patanjo (1979, 1981) and Azarovitz (1981).

Research Survey Relative Abundance Indices

Sea scallop research survey relative abundance indices were calculated in terms of standardized stratified mean catch per tow in numbers following the procedures of Cochran (1977: p. 91) and Pennington and Grosslein (1978). In all years, survey indices were tabulated for pre-recruit size scallops (<70 mm shell height, recruited scallops ($\geq$70 mm shell height), and total scallops (all sizes) per tow. Linear total catch per tow values were also transformed to logarithms (ℓn x+1) and retransformed estimates of total relative abundance calculated (Bliss 1967: p. 128) to normalize the distributional properties of the survey data and stabilize variances. Size-related parameters (mean shell height, mean meat weight per scallop sampled, and average meat count) were also derived from stratified survey height frequency distributions in all years for each area sampled (Figures 21-30).

On Georges Bank, trends in survey indices during 1975-1981 differed among the principal sea scallop regions(Table 29). In the South Channel region, the total linear number per tow index was relatively high in 1975, declined by about 50% by 1978, increased to a peak in 1980, and declined in 1981 to the lowest level in the recent South Channel time series. Pre-recruit indices in the South Channel were high in 1975 (30.2) and 1980 (51.2) implying above-average recruitment; size frequency modes in these years indicate that the 1972 and 1977 year classes were relatively successful ones (Figure 22). The 1981 pre-recruit value, however, suggests that recruitment of the 1978 year class into the commercial fishery during 1982 will be relatively minor.

Declines in the South Channel recruited scallop indices (1977-1978: 52.5 to 33.9; 1979-1981: 56.5 to 24.0) were associated with increased landings levels. Between 1975 and 1977, annual South Channel landings increased almost fourfold (Table 5); total landings in 1977 (4,382 tons) were the highest on record. Subsequent

annual South Channel catches have remained at historically high levels, averaging 3,300 tons during 1978-1981, greater than twice the 1957-1975 mean annual catch. The increased dependence of the fishery in recent years upon incoming recruitment (Table 19) and the concomitant rapid reductions in survey indices of commercial-sized scallops immediately after recruitment imply that recent South Channel exploitation rates have been extremely high. The exceptional 1955 year class sustained above average South Channel landings throughout 1959-1964; the two most recently successful year classes (1972 and 1977) together have sustained only 63% more yield during the 1976-1981 five year period than the 1955 year class did in a six year interval. Since commercial CPUE indices declined by about 50% during 1978-1980 (Table 14), the implication is that the recent annual landings reflect increased fishing mortality on year classes less abundant than the 1955 cohort.

Survey abundance indices in the Southeast Part of Georges Bank during 1975-1981 have fluctuated in nearly the same fashion as South Channel values except no survey evidence exists suggesting significant recruitment of the 1972 year class in this region (Table 29; Figure 23). Total number and recruit number per tow indices declined between 1975-1979, increased in 1980, and then fell to their lowest levels in 1981. Pre-recruit indices in 1979 and 1980 were higher than former values; Southeast Part survey size frequency distributions for these years (Figure 23) display modes at 40-50 mm and 80-90 mm indicative of good recruitment from the 1976 and 1977 year classes. The sharp reduction in all of the 1981 indices connotes, however, that neither these year classes nor the 1978 year class are presently highly abundant. Annual Southeast Part landings doubled between 1976 and 1977 and almost tripled between 1977 and 1979 (Table 5). Yearly landings since 1977 have been higher than any since 1965. As in the South Channel, these heightened landings levels have been accompanied by marked declines in the abundance of scallops in the Southeast Part area.

Survey catch per tow indices for the Northern Edge and Peak area have consistently been higher than those from any other region on Georges Bank or in the Mid-Atlantic (Table 29). Nonetheless, the recent series of survey values have exhibited the same general magnitude of fluctuation as in other regions. Total numbers per tow on the Northern Edge nearly tripled between 1975 and 1978, declined by 46% in 1979, and doubled in 1980. In 1981, total catch per tow was slightly less than in 1980 (681.9 vs 727.5). All of the 1981 Northern Edge and Peak catch indices, however, are believed to overestimate relative abundance compared with former years (perhaps by as much as 50%) since only half of the 10 strata comprising the standard Northern Edge and Peak strata set were sampled in the 1981 Canadian scallop survey. Because the five strata sampled in 1981 (Strata 63-66 and 71: Figure 18) have historically yielded the highest catch per tow indices of any in the Northern Edge strata set, stratified abundance estimates from the 1981 sampling over-represent regional scallop densities relative to previous surveys in which all of the Northern Edge and Peak strata were normally sampled. This can be substantiated by comparing the 1980 and 1981 stratified mean number per tow indices derived from the five strata sampled in 1981. A 54% decline in relative abundance (1492.5 vs 681.9) is evident between years.

Pre-recruit indices from the Northern Edge surveys in 1978, 1980, and 1981 suggest above average abundance of the 1975 and 1978 year classes and exceptional year class strength for the 1977 year class (Table 29). Prior to 1979, the 1972 year class dominated the Northern Edge and Peak scallop resource as evinced by annual modal progressions in the survey size-frequency distributions during 1975-1978 (Figure 24). The appearance of successful year classes on the Northern Edge and Peak is also reflected in reductions in mean shell height and meat weight, and increases in average meat count in the annual survey samples (Table 29).

The shell height frequency distributions from the Northern Edge and Peak region clearly indicate that the survey gear tends to effectively capture pre-recruit scallops after individuals have attained a size of 30 mm shell height, corresponding to scallops in their third year of life (i.e., older than age 2) (Figure 24; Table 20).

Occasionally, as in the South Channel in 1981, age 2 scallops (20-30 mm shell height) have appeared in survey catches (Figure 22). Hence, incoming recruitment to the commercial fishery can usually be assessed from survey data at least one to two years beforehand. This is corroborated, for above average year classes, by the appearance of prominent commercial size frequency modes between 70-90 mm and 90-110 mm one and two years after a cohort is identified in the survey frequency distributions by a mode between 30 and 60 mm. Equally, significant declines in the mean size of scallops sampled in the surveys are normally followed, a year later, by significant declines in the mean size of scallops in commercial samples (Tables 17 and 29). Both of these conditions prevailed in the 1981 Northern Edge and Peak commercial fishery which focused upon recruitment from the 1977 year class, detected as an outstanding cohort in the 1980 survey.

In response to recent improvements in recruitment, landings from the Northern Edge and Peak region have been at record and near-record levels. Total yearly landings during 1977-1981 averaged nearly 11,200 tons, 77% greater than the 1957-1976 mean, and 2,340 tons higher than the average annual landings that occurred during 1959-1964 when the exceptional 1955 year class sustained the fishery (Table 5). The relative dearth of scallops larger than 100 mm in the 1981 survey size frequency distribution (Figure 24) and the concomitant increase in commercial meat counts during 1981 (Table 19), however, suggests that incoming recruitment, upon fishery entry, has been rapidly harvested. It is likely that a similar situation will pertain in the 1982 fishery as the 1978 year class becomes recruited.

In the Mid-Atlantic area, survey relative abundance indices for all major regions were markedly lower in 1981 than in almost all previous survey years (Table 30). All regions exhibited relatively high catch per tow values in 1975 due to widespread success of the 1972 year class (Figures 25-28: 60 mm mode). Subsequent

recruitment, however, has generally been much poorer. In the New York Bight, pre-recruit indices were extremely low during 1977-1979 although the 1980 and 1981 values indicate moderate recruitment from the 1977 and 1978 year classes (Table 30; Figure 26). The latter two indices, however, are still less than half of the 1975 pre-recruit value. In Delmarva, localized recruitment was apparent from the 1979 and 1980 pre-recruit catch per tow indices (30.8 and 23.4, respectively) implying above average year class strength for the 1976 and 1977 cohorts. These year classes, however, subsequently appeared of minor significance in the 1980 and 1981 survey size frequency distributions (Figure 27). Total catch per tow in Delmarva in 1981 was the lowest in the survey time series and was 76% lower than in 1980.

Abundance indices in Virginia-North Carolina have sequentially declined since 1978. Apart from modest recruitment from the 1975 year class reflected in both the 1978 pre-recruit index and shell height frequency distribution (Figure 28), no significant recruitment has ensuingly occurred. As a result, recruit and total abundance have progressively diminished. All of the 1981 Virginia-North Carolina indices (pre-recruit, recruit, and total numbers per tow) were among the lowest obtained in the survey series.

Overall, total catch per tow values for the entire Mid-Atlantic area declined 61% between 1975 and 1981 with the 1981 index (18.6) the lowest on record (Table 30). Commercial landings during 1976-1980 exceeded the total Mid-Atlantic landings taken during 1964-1975 (Table 7); New York Bight landings peaked at 4,656 tons in 1979, while Delmarva landings peaked in 1978 (5,567 tons) (Table 3). Since 1978, however, total annual fishing yields from the Mid-Atlantic resources have successively declined. Between 1978 and 1981, annual landings declined 76% while survey recruit indices declined by 66%. Commercial Mid-Atlantic CPUE was 62% lower in 1980 than in 1978 (Table 14). Together these data imply that current resource abundance

throughout the Mid-Atlantic region is relatively low. The absence of strong recruitment in any of the Mid-Atlantic scallop regions suggests that the condition will continue to prevail during 1982.

USA spring and autumn bottom trawl survey indices of scallops in the Gulf of Maine indicate differential scallop abundance in waters between 30-60 fm and 61-100 fm (Table 31). In the 30-60 fm depth zone, total catch per tow indices since 1974 have been relatively stable (the 1977 autumn value appears to be anomalous). Survey size frequency distributions (Figure 29) imply that the 1974 and 1975 year classes were dominant in the population during 1978 and 1979, while the 1975 and 1976 cohorts dominated in 1980 and 1981. The 1981 survey shell height distribution also imply the existence of a 1978 year class (mode at 40 mm: see Table 20 for Gulf of Maine scallop size at age values). Most of the 1980-1981 offshore Gulf of Maine scallop exploitation is believed to have occurred in beds in the 30-60 fm depth range since the 1975 and 1976 year classes predominated in USA commercial samples obtained in these years (Figure 17).

Survey catch per tow indices in the Gulf of Maine 61-100 fm region were relatively low during 1974-1976 but markedly increased in 1977 (Table 31). Both spring and autumn size frequency distributions in 1977 and afterward (through 1980) imply that increases in abundance were due to a successful 1974 year class (Figure 30). Total catch indices peaked in the autumn 1980 survey at 35 scallops per tow, and at 98 scallops per tow in the spring 1981 survey. Although the autumn 1981 index declined 80% from the 1980 value (6.9 vs 34.9), this reduction probably reflects survey sampling variability since little, if any, commercial exploitation has occurred on these deep-water beds. Most scallop vessels fishing in the Gulf of Maine are not equipped with sufficient towing cable to effectively harvest scallops below 60 fathoms. Moreover, there is no indication of a decline in the average size of scallops in these deeper areas during 1980 and 1981, an effect normally observed

with intensified fishing activity. In fact, the mean shell height of the survey samples has progressively increased, in both survey series, since 1979 (Table 31).

The 1981 spring pre-recruit index was the highest recorded (5.3) during the 1974-1981 sampling, suggestive of recent recruitment success. Inspection of the 1981 size frequency distribution reveals two modes: one at 70 mm implying above average recruitment of the 1976 year class, and a broader mode between 90-110 mm corresponding to the 1974 and 1975 year classes (Figure 30).

Although the long-term productivity of the 61-100 fm scallop populations is not known, the extremely high 1980-1981 survey indices (higher than those from any other Northwest Atlantic area except the Northern Edge and Peak) suggest that current scallop densities in this deepwater zone may be sufficient to support a commercial fishery at least in the short term.

Survey Variability

Precision of sea scallop survey indices (total standardized stratified mean number per tow) for all Georges Bank and Mid-Atlantic regions was assessed from estimates of the standard deviation of the mean and the associated coefficient of variation (ratio of standard deviation to the mean), on both a linear and $\ell n\ (x+1)$ scale, calculated for each principal region in every survey year (Tables 32 and 33).

For the linear data, coefficients of variation range from 1.2 to 61.6% with most values higher on Georges Bank than in the Mid-Atlantic. The highest set of values occurred in the South Channel (29.4-61.6%), the consistently lowest in the New York Bight (8.7-19.5%). Annual values in almost all areas tended to fluctuate between 15 and 40%, with little apparent consistency between sample size (number of tows) and the resultant coefficient of variation (Table 27). No overt relationship between mean abundance and the coefficient of variation was detected, although in half of the regions the stratified mean and variance (standard deviation) were

linearly related (Southern Part, Northern Edge and Peak and Delmarva: $P < 0.05$). The mean coefficients of variation for the overall Georges Bank and Mid-Atlantic stratified abundance indices (1975-1981) are 14.9% and 13.7%, respectively, implying that proportional changes in abundance of less than about ±30% will normally not be detected with high probability (i.e., $P = 0.05$). For individual regions, annual differences in total mean catch per tow less than ±30-60% would usually not be detectable given the higher level of variation associated with the separate areas.

The transformed ($\ell n\ x+1$) data exhibit much less variability than the linear values. Coefficients of variation range from 1.9 to 16.8% of the mean in all regions except for Virginia -North Carolina where, due to small sample sizes and inconsistent sampling of all strata within the strata set through time, the values are much higher. Equally, apart from Virginia-North Carolina, the variances (standard deviations) have been stabilized; none of the correlation coefficients between $\ell n\ (x+1)$ mean catch per tow are significantly different from zero ($P>0.05$). Almost all of the transformed coefficients of variation are 1/3 to 1/2 as large as their respective linear values resulting in a significant improvement in relative precision using the ℓn scale. On an absolute basis, however, there is little improvement in detecting proportional changes in abundance since the retransformed confidence limits are about as large as the linear confidence bands (Tables 32 and 33).

Temporal trends in abundance as derived from the $\ell n(x+1)$ and retransformed survey values are similar to the corresponding time series of fluctuations in the linear number per tow indices both within and among survey regions.

Sea Scallop Shell Height-Meat Weight Relationships

Sea scallop samples for shell height-meat weight analysis were collected from Georges Bank and Mid-Atlantic USA sea scallop research vessel surveys during 1977-1981. Offshore Gulf of Maine specimens were obtained in 1980 from commercial

samples collected by the National Marine Fisheries Service, and the States of Maine and Massachusetts. Survey samples were randomly selected from the range of shell heights at a particular station; when catch permitted, a sample consisted of 30 adductor muscles (meats) with corresponding top valve shells per station. To insure broad geographical coverage, stations at which samples were to be collected were designated prior to the start of the survey. Gulf of Maine commercial samples were obtained from shell stock vessels fishing the Jeffreys Basin-Fippennies Ledge region, and represented random collections from the landed catch.

Shell height was recorded to the nearest millimeter, and the excised adductor muscle placed in an individual plastic bag and frozen. In the laboratory, the individual meat was weighed to the nearest 0.01 g.

Linear regression analyses were performed with height and weight data converted to natural logarithms with the form of the shell height-meat weight relationship assumed to be: $\ln W = a+b \ln H$. Meat weight-shell height equations were also computed; relationships were of the form: $\ln H = a+b \ln W$. Separate regression equations were derived for each principal scallop region sampled on Georges Bank and in the Mid-Atlantic, for aggregated Georges Bank and aggregated Mid-Atlantic samples, and for the Gulf of Maine. Regression and covariance analyses were conducted using procedures in Snedecor and Cochran (1967) and Neter and Wasserman (1974).

Statistical summaries of shell height and meat weight data are presented, by major area and sampling year, in Table 34. A total of 13,754 scallops were obtained from five survey cruises (3,036 from Georges Bank; 8,992 from the Mid-Atlantic) and eight commercial samples (1,726 from the Gulf of Maine). Survey samples were collected from 515 different sampling stations (136 stations on Georges Bank and 379 stations in the Mid-Atlantic); the 10-minute squares of

latitude and longitude in which survey samples were acquired are depicted in Figure 31. Survey sampling coverage extended from Virginia-North Carolina to the Southeast Part of Georges Bank in depths from 29-106 m (16-58 fm).

Shell heights ranged from 23 to 169 mm, with average sizes, modal heights, and minimum and maximum values almost identical between the Georges Bank and Mid-Atlantic samples (Table 34; Figures 32 and 33). The mean height of Gulf of Maine scallops was slightly less than in the other regions and the height frequency distribution, spanning 36-123 mm, was nearly unimodal unlike the other distributions (Figure 34). The virtual absence of scallops less than 70 mm from the Gulf of Maine samples is a reflection of commercial dredge selectivity and culling practices.

Meat weights ranged from 0.08 to 117.73 g with the largest individual meats taken from the Mid-Atlantic. Average overall meat weight was similar on Georges Bank and in the Mid-Atlantic but was about 56% less in the Gulf of Maine (20.0 vs 8.8). The largest meat from the Gulf of Maine (24.4 g) was only 4.4 g greater than the average meat size in the Georges Bank and Mid-Atlantic samples.

Regression parameters and related statistics for the shell height-meat weight and meat weight-shell height relations are summarized, by area and year, in Tables 35 and 36, respectively. Covariance analyses between regression equations paired both within and among areas were all statistically significant ($P<0.05$). However, differences in predicted values among equations within areas were relatively minor and not considered meaningful (i.e., lacking external validity: Campbell and Stanley 1963). Accordingly, single equations were calculated for Georges Bank and the Mid-Atlantic areas pooling data from all years (Tables 35 and 36). Pairwise comparison of the three areal regressions (Georges Bank, Mid-Atlantic, and offshore Gulf of Maine) indicated that each was statistically different ($P<0.05$) from one another, although no difference was detected between the slopes of the Georges Bank and Mid-Atlantic shell height-meat weight equations ($P>0.10$) (Figure 35).

Calculated meat weights at various shell heights, using individual area shell height-meat weight regressions, reveal little differences between Georges Bank and the Mid-Atlantic; most values differ by less than 10% percent (Table 37). Similarly, offshore and inshore Gulf of Maine equations [the latter reported by Haynes (1966) and based upon Penobscot Bay samples] predict almost identical weight at height values over the 40-120 mm sample shell height range used in fitting the regressions. This correspondence implies that inshore and offshore Gulf of Maine scallops exhibit comparable allometric growth patterns. Gulf of Maine scallops, however, contain less meat per unit shell height than either Georges Bank or Mid-Atlantic scallops.

For a given meat weight (or meat count), predicted shell heights of scallops among geographical areas differ only slightly (Table 38). Between 20 and 60 meat count (7.56-22.68 g meat weight), the most extreme differences between calculated mean shell heights for scallops in any of the USA Northwest Atlantic regions are less than 13 percent. As meat weight increases, these percentage differences progressively decline.

Analyses of seasonal differences in shell height-meat weight regressions could not be performed with the present data since almost all of the survey samples were collected during summer cruises. Seasonal differences, however, have been reported in height-weight relations of Georges Bank scallops collected during October, November-March, and April-September (Haynes 1966) and related to gonadal maturation state. Accordingly, the relationships derived in the present study for use in basic fisheries analyses (meat count estimation and yield per recruit) may not have similar precision when applied for different purposes.

Relative Fecundity Relationships

Relative fecundity (weight of ovary to shell height; weight of ovary to meat weight: Bagenal 1973, 1978) for sea scallops from Georges Bank and the Mid-Atlantic was evaluated from ovary weight, meat weight, and shell height measurements obtained during the 1981 USA sea scallop research vessel survey conducted during 9-19 June (Mid-Atlantic) and 23-2 July (Georges Bank). Ovaries were excised from 1,770 individuals (647 from Georges Bank; 1,123 from the Mid-Atlantic) collected from 225 survey sampling stations (71 stations on Georges Bank; 154 stations in the Mid-Atlantic). Ten-minute square areas in which ovary samples were obtained are presented in Figure 36. Sampling was restricted to female scallops, 45 mm shell height and larger, exhibiting visibly distinguishable roe (i.e., reddish-colored gonad). Gonad samples were randomly selected from individuals representative of the height distribution at each station. After excision, the crystalline style was removed and the ovary placed in an individual plastic bag containing the sample number and shell height, and frozen. In the laboratory, the ovary (and corresponding adductor muscle sample) was weighed to the nearest 0.01 g.

Linear regressions of the form, $\ln O = a+b \ln H$ and $\ln O = a+b \ln W$, were fitted to the individual ovary weight, shell height, and meat weight data for each principal scallop region sampled (i.e., South Channel, New York Bight, etc.). Pooled regressions were also calculated for both the Georges Bank and Mid-Atlantic regions.

Data used in the relative fecundity analyses are summarized, by region, in Table 39. Average ovary weights were higher on Georges Bank than in Mid-Atlantic regions, although the mean shell heights and meat weights of samples in all areas were similar. The range in ovary weights was wider on Georges Bank (0.13-68.63g) than in the Mid-Atlantic (0.08-52.94 g); coefficients of variation, however, were

of approximately the same magnitude. No consistent clinal trend in average ovary weight was observed among individual areas.

Regression statistics for the shell height-ovary weight and meat weight-ovary weight equations are presented in Tables 40 and 41, respectively. Correlation coefficients were relatively high and significantly greater than zero ($P<0.01$) except the Virginia-North Carolina values which were derived from only eight individuals. Analyses of covariance revealed no significant differences between any of the Mid-Atlantic regressions ($P>0.05$). South Channel and Southeast Part regressions were significantly different from each other and from any of the Mid-Atlantic regression lines ($P<0.05$). Pooled Georges Bank and Mid-Atlantic shell height-ovary weight equations (Table 40) differed in elevation (intercept values) but not in slope (Figure 37). The pooled meat weight-ovary weight relationships for these two areas, however, differed both in elevation and slope ($P <0.05$) (Figure 38).

Comparison of calculated mean ovary weights, among areas, over the shell height range used in the ovary weight-shell height analyses indicates that South Channel and Southeast Part scallops tend to have larger ovaries at a given shell size than scallops from the more southerly areas (Table 42). Assuming that the number of fully developed ova per gram of gonad is relatively constant, these data imply that Georges Bank scallops are more fecund per unit of shell height than those in the Mid-Atlantic. Over the 50-170 mm height range, calculated Georges Bank ovary weights are about 60% higher than Mid-Atlantic values, although much of this percentage difference results from the high relative fecundity of South Channel scallops.

At the size at which sea scallops become recruited to the commercial fishery (70 mm shell height), ovary weight is rather small ranging between 1-2 g in all areas. By the time scallops have attained 90 mm (approximately a year later: see Table 20), however, the ovary has doubled in size resulting in a significant increase in reproductive potential. In terms of meat size, ovary weight increases roughly 50% for both Georges Bank and Mid-Atlantic scallops during the half-year period of growth required for individuals to go from 60 to 40 meat count; between 40 and 30 count, ovary weight further increases by 35-40% (Table 43). Hence, substantial gains in potential egg deposition may be attained by increasing the size at which scallops are initially harvested in the commercial fishery. This will enhance reproductive potential by both elevating the number and fecundity of the spawning population, and increasing the number of eggs per recruit (Garrod and Knights 1979).

Yield Per Recruit

Yield per recruit analyses were performed for the Georges Bank, Mid-Atlantic, and offshore Gulf of Maine populations using the allometric model of Paulik and Gales (1964) since the slopes of the shell height-meat weight regressions for these areas (Table 35) were significantly greater than 3.0 ($P<0.001$). Calculations were conducted using the von Bertalanffy growth parameters presented in Table 20 with age at recruitment (t_p: age at first vulnerability to fishing gear) = 2.0 years and maximum age attained (t_λ) = 20 years. Natural mortality (M) was assumed to be 0.1 (Merrill and Posgay 1964). All analyses were accomplished by varying fishing mortality (F) between 0.01 and 1.50 and age at first capture (t_c) between 2.0 and 11.0 years (Tables 44-46). Transverse isopleths were also calculated for ages at first capture corresponding to 25, 30, 40, and 60 meat count scallops (Table 47; Figure 39).

Maximum yield per recruit occurs at ages 8.0, 8.5, and 10.5 for the Georges Bank, Mid-Atlantic, and Gulf of Maine populations, respectively, at F levels near 1.5 (Tables 44-46). Only slight gains (<9%), however, are achieved by delaying the mean age at first capture beyond age 6 for Georges Bank and Mid-Atlantic scallops and age 7.5 for Gulf of Maine scallops. Moreover, at these latter ages, maximum yield per recruit is obtained at relatively moderate fishing mortality rates (F_{max} = 0.4-0.5). Under these conditions, similar absolute yield per recruit values would be realized in all three areas.

Historically, the age at first capture in all USA sea scallop fishing regions has averaged about 4 years. For this average age at entry, maximum yield per recruit in all three major geographical areas occurs when F = 0.3. In recent years (particularly 1980 and 1981 on Georges Bank and in the Gulf of Maine), however, cull size has declined to between 3 and 4 years as a result of increased fishery dependence on incoming recruitment. Although F_{max} values at t_c = 3.0 to 3.5 are approximately the same as for t_c = 4.0 years, yield per recruit values are 6-12% less (when F = 0.2-0.3). However, recent fishing mortality levels have been well in excess of F_{max} as evinced by sharp reductions in both commercial CPUE and research survey indices. For F levels between 0.7 and 1.0, differences in yield per recruit between age 3 and 4 scallops range from 44-77% of the age 3 values. At these fishing mortality rates, significant potential yield is forfeited by harvesting smaller-sized scallops. This is illustrated in the transverse isopleths relating yield per recruit at four different meat counts to fishing mortality rate (Figure 39). In all areas, the highest values occur at relatively low F levels (F_{max} = 0.20-0.33: Table 47) and yield per recruit increases as meat decreases over the entire range of fishing mortality (> F = 0.1).

Marginal gains in yield per recruit at F levels above $F_{0.1}$ (Gulland 1977: p. 10) are relatively minor; greater than 92% of maximum yield per recruit is achieved at $F_{0.1}$ in any of the areas for any of the four meat counts (Figure 39). Moreover, fishing at $F_{0.1}$ provides a higher yield per recruit than is attained for most F values above 0.5. Accordingly, substantial reductions in current fishing mortality rates could ensue and be accompanied by increases rather than losses in yield per recruit without any change in meat count. The greatest gains, however, would be effectuated by concurrent reductions in both fishing mortality and meat count (Table 47).

Assessment Implications and Projected Outlook

The Northwest Atlantic sea scallop fishery is currently in a transitional state. Total annual USA and Canadian landings from Georges Bank, the Mid-Atlantic, and the Gulf of Maine during 1976-1981 were the highest on record; total landings, however, declined 33% between 1978 and 1980. Landings in 1981 were slightly higher than in 1980 (19,475 vs 17,805 tons) due to increased effort in the Georges Bank fishery where landings rose by nearly 50%. Mid-Atlantic and Gulf of Maine landings declined by 59% and 33%, respectively, between 1980 and 1981, with Mid-Atlantic landings being the lowest in seven years.

During 1976-1980, annual nominal effort in each of the principal sea scallop fisheries sequentially increased, with the 1980 values in all areas the highest ever recorded. Initially, effort increases were in response to significantly improved resource abundance on Georges Bank and in the Mid-Atlantic resulting from outstanding recruitment of the 1972 year class. In the Gulf of Maine, newly discovered offshore beds prompted increases in exploitation. Apart from the Northern Edge and Peak region of Georges Bank, subsequent scallop recruitment has

been much poorer and more localized. Resultingly, commercial catch per unit effort values have sharply declined; between 1978 and 1980, Georges Bank and Mid-Atlantic commercial CPUE indices decreased by about 50%. Equally pronounced reductions have been evident in research survey relative abundance indices. The 1981 research survey recruit (commercial size) catch per tow values in all areas except the Northern Edge and 61-100 fm depth zone in the Gulf of Maine were either the lowest or among the lowest ever obtained. Fishing effort, however, has remained high, stimulated in part, by a 2.4-fold increase in ex-vessel prices between 1977 and 1980.

In 1981, USA Georges Bank landings increased to their highest level in 18 years as a consequence of intense fishing activity on the Northern Edge and Peak sustained almost exclusively by recruitment from the 1977 year class. Approximately 62% of the USA Georges Bank catch was derived from the Northern Edge region, the highest proportion since 1962. For the first time since 1971, Georges Bank landings comprised more than half of the total USA sea scallop harvest. Although Canadian Georges Bank landings increased from 1980 to 1981 (again resulting from Northern Edge and Peak catches), the USA fishery accounted for greater than 50% of the total Georges Bank landings in 1981, only the second time (the first was in 1980) since 1964 that this has occurred. Average meat counts in both the USA and Canadian 1981 Georges Bank landings were well above historical levels, with the mean size of scallops in the USA landings the smallest in the 1965-1980 period. This reduction in cull size was precipitated by dependence on incoming recruitment from the 1977 year class, by a relative scarcity of larger-sized scallops on the Northern Edge (due presumably to heavy fishing mortality), and by the absence (USA) and liberalization (Canada) of meat size regulations. The available evidence suggests that, in spite of exceptional recruitment, fishing mortality on Georges Bank in 1981 was extremely high.

appearance of many Mid-Atlantic based vessels on Georges Bank in 1981 as the reduction in almost all Mid-Atlantic research survey indices imply source abundance in the southern regions has continued to subside. There o indication in either the survey or commercial size frequency distributions any significant recruitment of the magnitude that sustained the Mid-Atlantic shery during 1976-1980. The large reduction in Mid-Atlantic landings during 1981 is the most apparent manifestation of the diminished population levels.

As in 1980, the Gulf of Maine scallop fishery was dominated by offshore landings in 1981, a relatively recent phenomenon since traditionally territorial water landings have accounted for almost all of the Gulf of Maine commercial scallop catch. However, landings in 1981 were primarily derived from beds much further north then the ones exploited during 1980. This shift in the areal distribution of the 1981 landings suggests that fishing mortality in 1980 rapidly reduced standing stock biomass in the areas fished. Since the recent landings have been supported by single year classes, it is likely that current catch levels cannot be maintained unless additional high density beds are located. In this regard, relative abundance indices from USA spring and autumn bottom trawl surveys in the Gulf of Maine indicate that such beds exist in depths between 61-100 fm. The long-term productivity of these beds is not known although they are believed to be virtually unexploited at present. These deeper water populations should be accessible to Class 3 and 4 vessels which accounted for the majority of the Gulf of Maine landings during 1980 and 1981. Gear modifications will need to be made, however, in order to fish at these greater depths.

The current status and 1982 recruitment prospects for the New England and Mid-Atlantic sea scallop resources are summarized in Table 48. Apart from the Northern Edge and Peak and deepwater Gulf of Maine regions, incoming recruitment

in the immediate future will be poor or relatively low. Recruitment of the 1978 year class to the Northern Edge fishery in 1981 will be significant although this cohort appears to be less than half the size of the exceptional 1977 year class. Since the relative abundance of the 1978 year class on the Northern Edge and Peak is substantially higher than total relative abundance values in all other regions, it is likely that both the USA and Canadian fleets will continue (as in 1981) to concentrate their scallop efforts in this area of Georges Bank. In the absence of effective constraints on size at capture of scallops, meat counts in the 1982 fishery could be as high as those observed in 1981. Emergency implementation of the USA Fishery Management Plan for sea scallops in May 1982, however, is directed toward obviating this condition. Should landing levels remain at the 1981 level, further increases in fishing mortality are anticipated since the 1978 year class is no more than half as large as the 1977 year class which sustained the fishery in 1981. This situation will additionally be exacerbated if displacement of effort from other scallop regions to the Northern Edge continues to ensue. Lack of compliance in 1982 with the recently implemented measures of the USA Sea Scallop Management Plan may result in further losses in yield per recruit and resource reproductive potential, increasing the risks attendant with growth overfishing and elevating the likelihood of recruitment overfishing.

Depressed resource abundance levels in the Mid-Atlantic coupled with a lack of significant incoming recruitment suggest that recent landings levels (1976-1980) cannot be maintained in the near term. While there is a possibility of significant improvement in population biomass in the New York Bight region in 1983 should the initial indications of a better than average 1979 year class be realized, present abundant levels will continue to decline throughout the Mid-Atlantic unless effort is curtailed.

The prognosis for the offshore Gulf of Maine fishery is equivocal. Sustained high yields from the offshore beds fished during 1980-81 appear improbable. Exploitation on these populations has been accompanied by high fishing mortality rates, rapidly effecting abundance declines. A possibility exists, however, for a deep-water fishery in 61-100 fm where accumulated biomass appears relatively high. The potential long-term yield from these beds, however, is unknown.

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Table 1. United States and Canadian sea scallop landings (metric tons, meats) from the Northwest Atlantic (Northwest Atlantic Fisheries Organization Subarea 5 and Statistical Area 6), 1887-1981.

Year	USA[1]	Year	USA	Canada[2]	Total
1887	112	1943	2,508		2,508
*1888	91	1944	2,209		2,209
1889	141	1945	2,590		2,590
1892	53	1946	5,236		5,236
1897	435	1947	6,647		6,647
1898	156	1948	7,546		7,546
*1899	24	1949	8,299		8,299
*1900	79	1950	9,063		9,063
1901	286	1951	8,503	91	8,594
1902	61	1952	8,451	91	8,542
*1903	62	1953	10,713	136	10,849
1904	216	1954	7,997	91	8,088
1905	200	1955	10,036	136	10,172
*1906	255	1956	9,102	317	9,419
*1907	236	1957	9,523	771	10,294
1908	834	1958	8,608	1,470	10,078
*1909	843	1959	11,178	2,721	13,899
*1910	919	1960	12,065	3,390	15,455
*1911	663	1961	12,436	4,549	17,005
*1912	842	1962	11,174	5,694	16,868
*1913	353	1963	9,038	5,877	14,915
*1914	386	1964	7,704	5,901	13,605
*1916	266	1965	9,105	7,027	16,132
1919	89	1966	7,237	7,641	14,878
1921	38	1967	4,646	5,007	9,653
1924	154	1968	5,473	5,227	10,700
1926	506	1969	3,362	4,304	7,666
1928	216	1970	2,613	4,082	6,695
1929	1,130	1971	2,593	3,894	6,487
1930	1,111	1972	2,655	4,162	6,817
1931	1,058	1973	2,401	4,208	6,609
1932	1,517	1974	2,721	6,115	8,836
1933	2,009	1975	4,421	7,387	11,808
1934	54	1976	8,712	9,745	18,457
1935	1,955	1977	11,104	13,044	24,148
1937	3,989	1978	14,483	12,189	26,672
1938	4,041	1979	14,256	9,208	23,464
1939	4,440	1980[3]	12,566	5,239	17,805
1940	3,467	1981[4]	11,475	8,000	19,475
#1941	3,567				
1942	3,258				

[1]USA landings from 1887-1960 taken from Lyles (1969); USA landings from 1961-1975 taken from Fishery Statistics of the United States and from 1963-1978 from ICNAF Statistical Bulletins; 1979 landings from NAFO SCS Doc. 80/IX/27; 1980 landings from NAFO SCS Doc. 81/VI/15. For 1964-1980, USA landings statistics were validated against New England Detailed Weighout Data, Northeast Fisheries Center, Woods Hole, Mass.

[2]Canadian landings from 1951-1978 taken from ICNAF Statistical Bulletins and Hare (1977); 1979 landings from NAFO SCS Doc. 80/IX/27; 1980 landings from NAFO SCS Doc. 81/VI/15.

[3]Provisional

[4]Estimated yearly totals projected from January-September landings.

*Maine landings only - from Baird (1956).

#Total USA landings for 1941 taken from Premetz and Snow (1953).

Table 2. Historical trends in USA and Canadian sea scallop landings (metric tons, meats) from Georges Bank (NAFO Subdivision 5Ze), 1944-1981.

Year	USA	% of Total	Canada	% of Total	Total
1944	1,814	100	-	0	1,814
1945	1,769	100	-	0	1,769
1946	4,036	100	-	0	4,036
1947	4,853	100	-	0	4,853
1948	4,580	100	-	0	4,580
1949	5,306	100	-	0	5,306
1950	5,442	100	-	0	5,442
1951	5,714	98	91	2	5,805
1952	5,488	98	91	2	5,579
1953	7,392	98	136	2	7,528
1954	7,029	99	91	1	7,120
1955	8,299	98	136	2	8,435
1956	7,937	96	317	4	8,254
1957	7,846	91	771	9	8,617
1958	6,531	85	1,470	15	8,001
1959	8,481	76	2,721	24	11,202
1960	9,932	75	3,390	25	13,322
1961	10,660	70	4,549	30	15,209
1962	9,690	63	5,694	37	15,384
1963	7,910	57	5,877	43	13,787
1964	6,241	51	5,901	49	12,142
1965	1,483	25	4,418	75	5,901
1966	884	15	4,861	85	5,745
1967	1,221	20	5,001	80	6,222
1968	1,025	18	4,805	82	5,830
~~1969~~	~~1,325~~	~~24~~	4,302	~~76~~	~~5,627~~
1970	1,415	26	4,082	74	5,497
1971	1,329	25	3,894	75	5,223
1972	821	17	4,146	83	4,967
1973	1,080	20	4,208	80	5,288
1974	925	13	6,115	87	7,040
1975	857	10	7,387	90	8,244
1976	1,761	15	9,726	85	11,487
1977	4,805	27	13,044	73	17,849
1978	5,569	31	12,189	69	17,758
1979	6,573	42	9,208	58	15,781
1980	5,620	52	5,239	48	10,859
1981[3]	8,200	51	8,000	49	16,200

[1] Source of Data: 1944-1957, Caddy (1975); 1958-1978, ICNAF Statistical Bulletins; 1979, NAFO SCS Doc. 80/IX/27; 1980, NAFO SCS Doc. 81/VI/15.

[2] Landings during 1944-1963 represent landings from NAFO Division 5Z (Subdivisions 5Ze and 5Zw).

[3] Estimated yearly totals projected from January-September landings.

Table 3. USA commercial sea scallop landings (metric tons, meats) from the Northwest Atlantic (NAFO Subarea 5 and Statistical Area 6), by NAFO Statistical Region, 1961-1981.[1,2]

	NAFO Statistical Region											
Year	5Y	5Ze	5Zw	5Z	5NK[3]	Total 5	6A	6B	6C	6NK[3]	Total 6	Grand Total
1961	120			10,660		10,780					1,676	12,456
1962	103			9,690	3	9,796					1,378	11,174
1963	127			7,910		8,037					1,001	9,038
1964	192	6,241	55	6,296		6,488					1,216	7,704
1965	115	1,483	27	1,510		1,625					7,480	9,105
1966	93	884	8	892		985					6,252	7,237
1967	80	1,221	8	1,229		1,309					3,337	4,646
1968	113	1,025	24	1,049		1,162	1,951	486		1,874	4,311	5,473
1969	123	1,325	19	1,344		1,467	553	307		1,045	1,895	3,362
1970	132	1,415	6	1,421		1,553	431	42		587	1,060	2,613
1971	362	1,329	7	1,336		1,698	274			621	895	2,593
1972	525	821	2	823		1,348	265	388	6	648	1,307	2,655
1973	460	1,080	3	1,083		1,543	143	95	11	609	858	2,401
1974	223	925	5	930		1,153	869	628	71		1,568	2,721
1975	746	857	50	907		1,653	1,641	899	228		2,768	4,421
1976	366	1,761	9	1,770		2,136	4,494	1,725	357		6,576	8,712
1977	258	4,805	11	4,816	125	5,199	3,537	2,233	135		5,905	11,104
1978	243	5,569	29	5,598		5,841	2,603	5,567	472		8,642	14,483
1979	434	6,573	93	6,666		7,100	4,656	2,268	232		7,156	14,256
1980[4]	1,637	5,620	219	5,839		7,476	3,198	1,836	56		5,090	12,566
1981[5]	1,100	8,200	75	8,275		9,375					2,100	11,475

[1] See Figure 1 for geographical location of NAFO Statistical Regions.

[2] Source of Data: 1961-1975, Fishery Statistics of the United States; 1963-1978, ICNAF Statistical Bulletins; 1979, NAFO SCS Doc. 80/IX/27; 1980, NAFO SCS Doc. 81/VI/15, and NMFS Detailed Weighout Files.

[3] NK: Specific area of landings not known.

[4] Provisional.

[5] Estimated yearly totals projected from January-September landings.

Table 4. USA and Canadian landings (mt, meats), effort (days fished), and catch per unit of effort (CPUE) (mt landed of meats per day fished) from the Georges Bank sea scallop fishery, 1944-1980.

	Landings (mt, meats)			Effort (Days Fished, Unadjusted)			Nominal CPUE (mt/day fished)	
Year	USA	Canada	Total	USA[1]	Canada[2]	Total[3]	USA	Canada
1944	1814	--	1814	2223	--	2233	.816	--
1945	1769	--	1769	2391	--	2391	.740	--
1946	4036	--	4036	4934	--	4934	.818	--
1947	4853	--	4853	6434	--	6434	.754	--
1948	4580	--	4580	7613	--	7613	.602	--
1949	5306	--	5306	8428	--	8428	.630	--
1950	5442	--	5442	7349	--	7349	.741	--
1951	5714	91	5805	7626	123[4]	7749	.749	.740
1952	5488	91	5579	7742	128[4]	7870	.709	.711
1953	7392	136	7528	10031	185[4]	10216	.737	.735
1954	7029	91	7120	9343	121[4]	9464	.752	.752
1955	8299	136	8435	11619	190[4]	11809	.714	.716
1956	7937	317	8254	12246	490[4]	12736	.648	.647
1957	7346	771	8617	10500	1197	11697	.747	.644
1958	6531	1470	8001	8775	1598	10373	.744	.920
1959	8481	2721	11202	8556	2098	10654	.991	1.297
1960	9932	3390	13322	8039	2601	10640	1.235	1.303
1961	10660	4549	15209	8671	3147	11818	1.229	1.446
1962	9690	5694	15384	8959	4642	13601	1.082	1.227
1963	7910	5877	13787	7718	5905	13623	1.025	.995
1964	6241	5901	12142	6662	6723	13385	.937	.878
1965	1483	4418	5901	2095	5749	7844	.708	.768
1966	884	4861	5745	1056	5524	6580	.837	.880
1967	1221	5001	6222	1870	6785	8655	.653	.737
1968	1025	4805	5830	1854	6972	8826	.553	.689
1969	1325	4302	5627	2715	6684	9399	.488	.644
1970	1415	4082	5497	2563	7615	10178	.552	.536
1971	1329	3894	5223	2443	7688	10131	.544	.518
1972	821	4146	4967	1804	8264	10068	.455	.502
1973	1080	4208	5288	1872	8082	9954	.577	.521
1974	925	6115	7040	1404	8185	9589	.659	.747
1975	857	7387	8244	1110	8415	9525	.772	.878
1976	1761	9726	11487	1766	7324	9090	.997	1.328
1977	4805	13044	17849	4514	8601	13115	1.064	1.517
1978	5369	12189	17758	5862	8556	14418	.950	1.425
1979	6573	9208	15781	9245	8823	18068	.711	1.044
1980	5620	5239	10859	11263	6838	18101	.499	.766

[1]USA effort for 1944-1964 taken from Caddy (1975); USA effort for 1965-1980 derived from NMFS Detailed Weighout Files by calculating annual mean catch rates, weighted by the percentage of USA Georges Bank landings accounted for within each of three vessel classes (5-50 GRT; 51-150 GRT; 151-500 GRT) in relation to vessel class CPUE, and dividing the derived annual mean catch rate into the total USA Georges Bank sea scallop annual landings.

[2]Canadian effort for 1944-1974 taken from Caddy (1975); Canadian effort for 1975-1980 derived from effort data provided to NMFS by Canadian scientists.

[3]Not standardized for differences in fishing power between USA and Canadian sea scallop fleets.

[4]Estimated from USA catch per unit of effort.

Table 5. Distribution of USA and Canadian sea scallop landings (mt, meat) in the three principal sea scallop fishing regions on Georges Bank, 1957-1981.[1]

	USA				Canada				Total			
Year	South Channel	Southeast Part	No.Edge & Peak	Total	South Channel	Southeast Part	No.Edge& Peak	Total	South Channel	Southeast Part	No.Edge& Peak	Total
1957	1491	628	5727	7846	8	--	763	771	1499	628	6490	8617
1958	1241	457	4833	6531	--	--	1470	1470	1241	457	6303	8001
1959	1951	2799	3731	8481	--	--	2721	2721	1951	2799	6452	11202
1960	1788	4469	3675	9932	--	--	3390	3390	1788	4469	7065	13322
1961	2132	1812	6716	10660	--	--	4549	4549	2132	1812	11265	15209
1962	1744	1841	6105	9690	--	--	5694	5694	1744	1841	11799	15384
1963	2057	2215	3638	7910	--	470	5407	5877	2057	2685	9045	13787
1964	2569	1909	1763	6241	--	118	5783	5901	2569	2027	7546	12142
1965	677	390	416	1483	--	177	4241	4418	677	567	4657	5901
1966	716	24	144	884	--	--	4861	4861	716	24	5005	5745
1967	641	311	269	1221	--	--	5001	5001	641	311	5270	6222
1968	713	149	163	1025	--	--	4805	4805	713	149	4968	5830
1969	576	227	522	1325	--	--	4302	4302	576	227	4824	5627
1970	1069	159	187	1415	41	--	4041	4082	1110	159	4228	5497
1971	1091	214	24	1329	545	--	3349	3894	1636	214	3373	5223
1972	623	64	134	821	415	--	3731	4146	1038	64	3865	4967
1973	890	173	17	1080	1136	--	3072	4208	2026	173	3089	5288
1974	783	121	21	925	550	306	5259	6115	1333	427	5280	7040
1975	566	175	116	857	591	74	6722	7387	1157	249	6838	8244
1976	1575	141	45	1761	778	--	8948	9726	2353	141	8993	11487
1977	4121	277	407	4805	261	--	12783	13044	4382	277	13190	17849
1978	3918	366	1285	5569	--	--	12189	12189	3918	366	13474	17758
1979	3996	758	1819	6573	--	--	9208	9208	3996	758	11027	15781
1980	2994	685	1941	5620	--	--	5239	5239	2994	685	7180	10859
1981[2]	2292	346	4306	6944	--	--	6586	6586	2292	346	10892	13530

[1]South Channel: Statistical Areas 521, 522, and 526.
Southeast Part: Statistical Area 525.
Northern Edge and Peak: Statistical Areas 523 and 524.

[2]1981 landings statistics only include January-September landings and represent provisional values.

Table 6. Percentage distribution of USA and Canadian sea scallop landings (mt, meat) in three principal sea scallop fishing regions on Georges Bank, 1957-1981.[1]

	USA				Canada				Total			
Year	South Channel	Southeast Part	No. Edge & Peak	Total	South Channel	Southeast Part	No. Edge & Peak	Total	South Channel	Southeast Part	No. Edge & Peak	Total
1957	19.0	8.0	73.0	100.0	1.0	--	99.0	100.0	17.4	7.3	75.3	100.0
1958	19.0	7.0	74.0	100.0	--	--	100.0	100.0	15.5	5.7	78.8	100.0
1959	23.0	33.0	44.0	100.0	--	--	100.0	100.0	17.4	25.0	57.6	100.0
1960	18.0	45.0	37.0	100.0	--	--	100.0	100.0	13.4	33.5	53.0	99.9
1961	20.0	17.0	63.0	100.0	--	--	100.0	100.0	14.0	11.9	74.1	100.0
1962	18.0	19.0	63.0	100.0	--	--	100.0	100.0	11.3	12.0	76.7	100.0
1963	26.0	28.0	46.0	100.0	--	8.0	92.0	100.0	14.9	19.5	65.6	100.0
1964	41.2	30.6	28.2	100.0	--	2.0	98.0	100.0	21.2	16.7	62.1	100.0
1965	45.7	26.3	28.1	100.1	--	4.0	96.0	100.0	11.5	9.6	78.9	100.0
1966	81.0	2.7	16.3	100.0	--	--	100.0	100.0	12.5	0.4	87.1	100.0
1967	52.5	25.5	22.0	100.0	--	--	100.0	100.0	10.3	5.0	84.7	100.0
1968	69.6	14.5	15.9	100.0	--	--	100.0	100.0	12.2	2.6	85.2	100.0
1969	43.5	17.1	39.4	100.0	--	--	100.0	100.0	10.2	4.0	85.7	99.9
1970	75.5	11.2	13.2	99.9	1.0	--	99.0	100.0	20.2	2.9	76.9	100.0
1971	82.1	16.1	1.8	100.0	14.0	--	86.0	100.0	31.3	4.1	64.6	100.0
1972	75.9	7.8	16.3	100.0	10.0	--	90.0	100.0	20.9	1.3	77.8	100.0
1973	82.4	16.0	1.6	100.0	27.0	--	73.0	100.0	38.3	3.3	58.4	100.0
1974	84.6	13.1	2.3	100.0	9.0	5.0	86.0	100.0	18.9	6.1	75.0	100.0
1975	66.0	20.4	13.5	99.9	8.0	1.0	91.0	100.0	14.0	3.0	82.9	99.9
1976	89.4	8.0	2.6	100.0	8.0	--	92.0	100.0	20.5	1.2	78.3	100.0
1977	85.8	5.8	8.5	100.1	2.0	--	98.0	100.0	24.6	1.6	73.9	100.1
1978	70.4	6.6	23.1	100.1	--	--	100.0	100.0	22.1	2.1	75.9	100.1
1979	60.8	11.5	27.7	100.0	--	--	100.0	100.0	25.3	4.8	69.9	100.0
1980	53.3	12.2	34.5	100.0	--	--	100.0	100.0	27.6	6.3	66.1	100.0
1981[2]	33.0	5.0	62.0	100.0	--	--	100.0	100.0	16.9	2.6	80.5	100.0

[1] South Channel: Statistical Areas 521, 522, and 526.
Southeast Part: Statistical Area 525.
Northern Edge and Peak: Statistical Areas 523 and 524.

[2] 1981 landing statistics only include January-September landings and represent provisional values.

Table 7. Geographical distribution of USA commercial sea scallop landings (metric tons, meats) from the Northwest Atlantic (NAFO Subarea 5 and Statistical Area 6).

	USA Landings (mt, meats)					Percent of USA Annual Landings				
Year	Georges Bank	Mid Atlantic	Gulf of Maine	Other[1]	Total	Georges Bank	Mid Atlantic	Gulf of Maine	Other[1]	Total
1961	10,660	1,676	120	0	12,456	85.6	13.5	1.0	-	100.1
1962	9,690	1,378	103	3	11,174	86.7	12.3	0.9	<0.1	100.0
1963	7,910	1,001	127	0	9,038	87.5	11.1	1.4	-	100.0
1964	6,241	1,216	192	55	7,704	81.0	15.8	2.5	0.7	100.0
1965	1,483	7,480	115	27	9,105	16.3	82.2	1.3	0.3	100.1
1966	884	6,252	93	8	7,237	12.2	86.4	1.3	0.1	100.0
1967	1,221	3,337	80	8	4,646	26.3	71.8	1.7	0.2	100.0
1968	1,025	4,311	113	24	5,474	18.7	78.8	2.1	0.4	100.0
1969	1,325	1,896	123	19	3,362	39.4	56.4	3.7	0.6	100.1
1970	1,415	1,060	132	6	2,613	54.2	40.6	5.1	0.2	100.1
1971	1,329	895	362	7	2,593	51.3	34.5	14.0	0.3	100.1
1972	821	1,307	525	2	2,655	30.9	49.2	19.8	0.1	100.0
1973	1,080	857	460	4	2,401	45.0	35.7	19.2	0.2	100.1
1974	925	1,569	223	5	2,722	34.0	57.6	8.2	0.2	100.0
1975	857	2,769	746	50	4,422	19.4	62.6	16.9	1.1	100.0
1976	1,761	6,576	366	9	8,712	20.2	75.5	4.2	0.1	100.0
1977	4,805	5,904	258	136	11,102	43.3	53.2	2.3	1.2	100.0
1978	5,569	8,641	243	29	14,482	38.5	59.7	1.7	0.2	100.1
1979	6,573	7,156	434	93	14,256	46.1	50.2	3.0	0.7	100.0
1980	5,620	5,090	1,637	219	12,566	44.7	40.5	13.0	1.7	99.9
1981[2]	8,200	2,100	1,100	0	11,400	71.9	18.4	9.6	-	99.9

[1] Includes 5Zw (Southern New England) and 5NK (Area 5, specific subarea unknown) landings

[2] Estimated

Table 8. USA commercial sea scallop landings (metric tons, meats) from the Gulf of Maine (NAFO Division 5Y), 1899-1981[1].

Year	Inshore	Offshore	Total	Year	Inshore	Offshore[2]	Total
1899	24	-	24	1950	232	6	238
1900	79	-	79	1951	171	136	307
1901	99	-	99	1952	142	536	678
1902	57	-	57	1953	110	660	770
1903	62	-	62	1954	65	256	321
1904	64	-	64	1955	99	406	505
1905	285	-	285	1956	148	292	440
1906	255	-	255	1957	111	227	338
1907	236	-	236	1958	49	130	179
1908	432	-	432	1959	49	465	514
1909	843	-	843	1960	33	817	850
1910	919	-	919	1961	63	57	120
1911	663	-	663	1962	70	33	103
1912	842	-	842	1963	80	47	127
1913	353	-	353	1964	106	86	192
1914	386	-	386	1965	N/A	N/A	115
1916	266	-	266	1966	N/A	N/A	93
1919	33	-	33	1967	N/A	N/A	80
1924	134	-	134	1968	N/A	N/A	113
1928	148	-	148	1969	N/A	N/A	123
1929	163	-	163	1970	N/A	N/A	132
1930	198	-	198	1971	234	128	362
1931	266	-	266	1972	436	89	525
1932	276	-	276	1973	368	92	460
1933	487	-	487	1974	198	25	223
1935	337	-	237	1975	728	18	746
1938	360	-	360	1976	334	32	366
1939	179	-	179	1977	206	52	258
1940	207	-	207	1978	228	15	243
1941	144	-	144	1979	299	135	434
1942	59	-	59	1980	492	1145	1637
1943	103	-	103	1981[3]	N/A	N/A	1100
1944	46	-	46				
1945	48	-	48				
1946	62	-	62				
1947	230	-	230				
1948	206	-	206				
1949	231	-	231				

[1]Landings from 1899-1955 taken from Baird (1956); inshore landings from 1950-1964 taken from Dow (1969, 1977); total landings from 1956-1960 were taken from Lyles (1969) and represent landings in the State of Maine but not necessarily landings from the Gulf of Maine; total landings 1961-1980 taken from ICNAF and NAFO Statistical Bulletins; inshore landings 1971-1980 taken from NMFS Weighout Data; 1981 total landings are projections based on January-September 1981 landings.

[2]Offshore landings 1950-1970 include all landings outside of state territorial waters and may include offshore Georges Bank landings.

[3]Estimated yearly total from January-September landings.

N/A = Distribution of landings between inshore and offshore areas not available.

Table 9. USA commercial sea scallop landings (metric tons, meat weight) from the Gulf of Maine, by USA statistical area, 1964-1981.

	USA Statistical Area					
Year	511	512	513	514	515	Total
1964	14	60	3	102	13	192
1965	11	76	1	27	-	115
1966	13	79	-	1	-	93
1967	16	60	-	4	-	80
1968	21	77	1	14	-	113
1969	13	56	-	54	-	123
1970	8	74	-	50	-	132
1971	22	154	-	186	-	362
1972	127	296	16	86	-	525
1973	98	232	35	95	-	460
1974	44	149	9	21	-	223
1975	88	625	10	23	-	746
1976	46	234	5	81	-	366
1977	56	121	3	78	-	258
1978	49	172	3	19	-	243
1979	62	240	60	32	40	434
1980	155	402	547	75	458	1637
1981[1]	382	338	106	26	63	915

[1]January-September only.

Table 10. Percent distribution of USA commercial landings (metric tons, meats) of sea scallops, by gear type, within the principal sea scallop areas off the Northeast Coast of the United States (NAFO Subarea 5 and Statistical Area 6), 1964-1980. For 1964-1973, data only reflect landings in New England states (Maine, Massachusetts, and Rhode Island). For 1974-1980, data reflect landings in both New England and Mid-Atlantic states (Maine to North Carolina). Only landings identified by gear type were analyzed.

Year	Gulf of Maine		Georges Bank		So. New England		Mid-Atlantic		All Areas	
	Otter Trawl	Scallop Dredge	Otter Trawl	Scallop Dredge	Otter Trawl	Scallop Dredge	Otter Trawl	Scallop Dredge	Otter Trawl	Scallop Dredge
1964	<0.1	99.9	0.8	99.2	-	-	0.0	100.0	0.8	99.2
1965	0.0	100.0	0.3	99.7	-	-	0.0	100.0	0.1	99.9
1966	0.2	99.8	<0.1	99.9	-	-	0.0	100.0	<0.1	99.9
1967	0.4	99.6	0.3	99.7	-	-	0.0	100.0	0.1	99.9
1968	0.4	99.6	0.0	100.0	0.0	100.0	0.0	100.0	<0.1	99.9
1969	0.6	99.4	0.6	99.4	0.0	100.0	0.6	99.4	0.6	99.4
1970	0.2	99.8	0.4	99.6	<0.1	99.9	3.0	97.0	0.9	99.1
1971	1.1	98.9	1.3	98.7	3.0	97.0	<0.1	99.0	1.1	98.9
1972	0.1	99.9	0.6	99.4	4.3	95.7	0.8	99.2	0.6	99.4
1973	<0.1	99.9	1.4	98.6	3.3	96.7	1.4	98.6	1.1	98.9
1974	0.2	99.8	1.6	98.4	2.3	97.7	1.2	98.8	1.3	98.7
1975	0.8	99.2	1.6	98.4	15.9	84.1	20.9	79.1	13.7	86.3
1976	0.8	99.2	2.2	97.8	38.5	61.5	31.8	68.2	24.5	75.5
1977	1.5	98.5	0.6	99.4	7.5	92.5	12.8	87.2	7.1	92.9
1978	0.4	99.6	0.7	99.3	11.8	88.2	6.6	93.4	4.2	95.8
1979	1.1	98.9	0.4	99.6	5.6	94.4	7.2	92.8	3.8	96.2
1980	7.6	92.4	0.6	99.4	1.4	98.6	0.3	99.7	1.4	98.6
1964-1980:										
NE Landings[1]	2.4	97.6	0.7	99.3	5.0	95.0	1.6	98.4	1.2	98.8
MA Landings[2]	-	-	0.0	100.0	0.0	100.0	15.9	84.1	15.6	84.4
Total	2.4	97.6	0.7	99.3	4.8	95.2	8.7	91.3	4.9	95.1

[1]NE landings: landings of scallops in New England states (Maine, Massachusetts, and Rhode Island).

[2]MA landings: landings of scallops in Mid-Atlantic states (New York, New Jersey, Maryland, Virginia, and North Carolina).

Table 11. Canadian commercial sea scallop landings (metric tons, meats), effort (days fished), and catch per unit of effort (CPUE: landings of scallops per day fished) from Georges Bank (NAFO Area 5Ze), by vessel tonage class and year, 1965-1979.[1,2]

	Vessel Tonnage Class											
	Class 2			Class 3			Class 4			Class 5		
Year	Landings	Effort	CPUE	Landings	Effort	CPUE	Landings	Effort	CPUE	Landings	Effort	CPUE
1965	-	-	-	1581	2015	0.78	2853	3801	0.75	-	-	-
1966	-	-	-	1251	1429	0.88	3628	4234	0.86	-	-	-
1967	-	-	-	883	1242	0.71	4136	5597	0.74	-	-	-
1968	-	-	-	692	950	0.73	4118	5759	0.72	-	-	-
1969	-	-	-	650	1091	0.60	3659	6553	0.56	-	-	-
1970	-	-	-	661	1299	0.51	3400	6401	0.53	-	-	-
1971	-	-	-	590	1158	0.51	3255	6664	0.49	-	-	-
1972	-	-	-	570	1127	0.51	3590	7192	0.50	-	-	-
1973	-	-	-	557	997	0.56	3621	7054	0.51	50	93	0.54
1974	-	-	-	681	1010	0.67	5455	7268	0.75	-	-	-
1975	-	-	-	824	990	0.83	6591	7397	0.89	-	-	-
1976	-	-	-	1065	950	1.12	8696	6584	1.32	-	-	-
1977	225	204	1.10	1831	1306	1.40	10974	7249	1.51	-	-	-
1978	90	216	0.42	1608	1251	1.29	10491	7332	1.43	-	-	-
1979	3	3	1.00	1002	994	1.01	8203	7586	1.08	-	-	-
1965-1979	318	423	0.75	14446	17809	0.81	82670	96671	0.86	50	98	0.54
% of Totals	0.3	0.4		14.8	15.5		84.8	84.1		0.1	0.1	

[1]Vessel tonnage classes: Class 2 (25-50 GRT); Class 3 (51-150 GRT); Class 4 (151-500 GRT); Class 5 (501-900 GRT)

[2]Data derived from ICNAF and NAFO Statistical Bulletin for 1965-1979. Landings weight, listed in Statistical Bulletins as live weight, was converted to meat weight by dividing by 8.30.

Table 12. USA commercial sea scallop landings (metric tons, meats) from Georges Bank (Subdivision 5Ze), the Mid-Atlantic (Statistical Area 6), and the Gulf of Maine (Division 5Y), by vessel tonnage class (gross registered tons), 1965-1980. Data derived from vessels using scallop dredges and landing in New England and New Jersey ports.

Area / Tonnage Class	Year															
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Georges Bank (Subdivision 5Ze)																
5-50	16.9	2.2	5.6	1.5	-	-	-	9.4	-	0.1	2.0	261.2	891.9	370.3	188.8	73.0
51-150	1293.6	740.3	925.2	819.3	917.2	993.1	766.1	467.3	678.1	557.3	491.4	931.4	2545.3	2973.0	2612.7	1954.5
151-500	193.5	149.0	294.7	172.6	399.1	416.7	544.9	338.9	386.5	353.2	350.4	530.0	1271.4	2188.5	3458.2	3355.3
Total	1504.0	891.5	1225.5	993.4	1316.3	1409.8	1311.0	815.6	1064.6	910.6	843.8	1722.6	4708.6	5531.8	6259.7	5382.8
Mid-Atlantic (Area 6)																
5-50	20.5	0.7	0.8	7.8	1.5	-	-	-	-	-	0.9	18.5	34.2	39.4	101.9	10.0
51-150	3608.1	3530.3	1547.5	1601.3	481.7	189.9	72.2	289.2	42.5	397.1	659.7	1042.4	929.7	646.7	1552.6	932.6
151-500	345.5	530.5	324.2	827.9	362.5	268.9	201.7	363.5	202.7	540.3	845.2	1910.8	1600.3	1381.1	1202.5	1023.3
Total	3974.1	4061.5	1872.5	2437.0	845.7	458.8	273.9	652.7	245.2	937.4	1505.8	2971.7	2564.2	2067.2	2857.0	1965.9
Gulf of Maine (Division 5Y)																
5-50	99.5	92.6	77.5	108.5	107.8	114.6	222.8	487.0	393.8	210.6	734.1	349.0	249.0	238.3	313.2	587.4
51-150	15.1	-	2.1	4.3	14.1	17.0	108.3	32.3	47.2	12.1	6.5	14.4	4.6	3.3	34.5	430.5
151-500	-	-	-	-	-	-	26.6	4.9	18.6	-	-	-	-	-	53.5	453.6
Total	114.6	92.6	79.6	112.8	121.9	131.6	357.7	524.2	459.6	222.7	740.6	363.4	253.6	241.6	401.2	1471.5

Source: NEFC Detailed Weighout Records for vessels using scallop dredges. New Jersey weighout data are only included from 1978 onward.

Table 13. USA commercial sea scallop effort (days fished) on Georges Bank (Subdivision 5Ze), in the Mid-Atlantic (Statistical Area 6), and in the Gulf of Maine (Division 5Y), by vessel tonnage class (gross registered tons), 1965-1980. Data derived from vessels using scallop dredges and landing in New England and New Jersey ports.

Area / Tonnage Class	Year															
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Georges Bank (Subdivision 5Ze)																
5-50	11.2	11.4	17.3	5.5	-	-	-	20.4	-	0.2	10.5	308.1	1028.4	718.4	445.0	301.1
51-150	1921.3	893.9	1474.9	1500.0	1953.8	1755.3	1424.2	965.0	1102.7	811.8	594.4	914.2	2313.5	3196.9	4056.6	4641.8
151-500	216.4	168.9	401.9	304.2	759.5	822.9	988.7	805.9	739.6	576.3	494.9	516.8	1120.7	2088.6	4405.4	6132.8
Total	2148.9	1074.2	1894.1	1809.7	2713.3	2578.2	2412.9	1791.3	1842.3	1388.3	1099.8	1739.1	4462.6	6003.9	8907.0	11075.7
Mid-Atlantic (Area 6)																
5-50	48.1	3.0	5.0	38.9	3.5	-	-	-	-	-	3.3	59.8	70.7	82.5	144.0	28.0
51-150	3621.5	3784.4	2224.2	2561.4	1142.4	476.7	239.9	717.9	128.0	523.6	819.3	991.3	818.3	677.8	2566.1	2363.8
151-500	312.8	524.7	452.0	1196.2	700.4	516.0	479.5	688.5	428.0	700.9	923.8	1625.9	1216.1	1060.1	1564.3	1993.0
Total	3982.4	4312.1	2681.2	3796.5	1846.3	992.7	719.4	1406.4	556.0	1224.5	1746.4	2677.0	2105.1	1820.4	4274.4	4384.8
Gulf of Maine (Division 5Y)																
5-50	261.0	270.3	239.4	423.9	510.9	584.1	1062.7	1998.7	2364.5	1545.7	2392.8	2257.5	1371.4	1606.2	1853.6	2827.0
51-150	20.4	-	2.7	12.8	53.7	49.7	116.1	90.5	128.8	33.9	14.0	32.0	4.1	5.9	79.1	346.5
151-500	-	-	-	-	-	-	37.3	10.0	30.7	-	-	-	-	-	44.5	249.0
Total	281.4	270.3	242.1	436.7	564.6	633.8	1216.1	2099.2	2524.0	1579.6	2406.8	2289.5	1375.5	1612.1	1977.2	3422.5

Source: NEFC Detailed Weighout Records for vessels using scallop dredges. New Jersey weighout data are only included from 1978 onward.

Table 14. USA commercial sea scallop catch rates (metric tons of meats per day fished) from Georges Bank (Subdivision 5Ze), the Mid-Atlantic (Statistical Area 6), and the Gulf of Maine (Division 5Y), by vessel tonnage class (gross registered tons), 1965-1980. Data derived from vessels using scallop dredges and landing in New England and New Jersey ports.

Area / Tonnage Class	Year															
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Georges Bank (Subdivision 5Ze)																
5-50	1.51	0.20	0.32	0.27	-	-	-	0.46	-	0.15	0.19	0.85	0.87	0.52	0.42	0.24
51-150	0.67	0.83	0.63	0.55	0.47	0.57	0.54	0.48	0.61	0.69	0.83	1.02	1.10	0.93	0.64	0.42
151-500	0.89	0.88	0.73	0.57	0.53	0.51	0.55	0.42	0.52	0.61	0.71	1.03	1.13	1.05	0.78	0.55
Annual Mean[1]	0.71	0.84	0.65	0.55	0.49	0.55	0.54	0.46	0.58	0.66	0.78	1.00	1.06	0.95	0.71	0.50
Mid-Atlantic (Area 6)																
5-50	0.43	0.22	0.16	0.20	0.43	-	-	-	-	-	0.28	0.31	0.48	0.48	0.71	0.36
51-150	1.00	0.93	0.70	0.63	0.42	0.40	0.30	0.40	0.33	0.76	0.81	1.05	1.14	0.95	0.60	0.39
151-500	1.10	1.01	0.72	0.69	0.52	0.52	0.42	0.53	0.47	0.77	0.91	1.18	1.32	1.30	0.77	0.51
Annual Mean[1]	1.00	0.94	0.70	0.65	0.46	0.47	0.39	0.47	0.45	0.77	0.87	1.13	1.24	1.18	0.68	0.45
Gulf of Maine (Division 5Y)																
5-50	0.38	0.34	0.32	0.26	0.21	0.20	0.21	0.24	0.17	0.14	0.31	0.15	0.18	0.15	0.17	0.21
51-150	0.74	-	0.77	0.34	0.26	0.34	0.93	0.36	0.37	0.36	0.46	0.45	1.12	0.55	0.44	1.24
151-500	-	-	-	-	-	-	0.71	0.49	0.60	-	-	-	-	-	1.20	1.82
Annual Mean[1]	0.43	0.34	0.33	0.26	0.22	0.22	0.47	0.25	0.21	0.15	0.31	0.16	0.20	0.16	0.33	1.01

Source: NEFC Detailed Weighout Records for vessels using scallop dredges. New Jersey weighout data are only included from 1978 onward.

[1]Annual mean catch rates, for each area, were derived by weighting individual tonnage class annual catch rates by the percentage of total annual landings accounted for by each vessel class and summing the weighted catch rates over all three vessel class categories.

Table 15. USA ex-vessel prices (dollars per pound of meat, unadjusted for inflation) of sea scallops, 1947-1980.

Year	Ex-vessel Price	Annual Percent Change
1947	0.49	
1948	0.52	+6.1
1949	0.37	-28.8
1950	0.46	+24.3
1951	0.44	-4.3
1952	0.58	+31.8
1953	0.44	-24.1
1954	0.45	+2.3
1955	0.52	+15.6
1956	0.54	+3.8
1957	0.48	-11.1
1958	0.48	0.0
1959	0.48	0.0
1960	0.35	-27.1
1961	0.38	+8.6
1962	0.41	+7.9
1963	0.46	+12.2
1964	0.55	+19.6
1965	0.66	+20.0
1966	0.48	-27.3
1967	0.76	+58.3
1968	1.08	+42.1
1969	1.04	-3.7
1970	1.28	+23.1
1971	1.42	+10.9
1972	1.83	+28.9
1973	1.69	-7.7
1974	1.54	-8.9
1975	1.82	+18.2
1976	1.77	-2.7
1977	1.62	-8.5
1978	2.46	+51.9
1979	3.28	+33.3
1980	3.84	+17.1

Source: US Department of Commerce, Current Fisheries Statistics No. 6127, Basic Economic Indicators, Scallops 1930-1972 (issued June 1973); Fishery Statistics of the United States, 1970-1975 (issued annually); Fisheries of the United States, 1976-1980 (issued annually).

Table 16. Number of USA commercial size-frequency (shell height) sea scallop samples, total number of scallops measured, mean shell height (mm), mean meat weight (g), and average meat count (number of scallop meats per pound) for commercial sea scallop samples from the three principal scallop regions on Georges Bank, 1965-1974.

Area	Year	Number of Samples	Number of Scallops Measured	Mean Shell Height	Mean[1] Meat Weight	Average[2] Meat Count
South Channel (SA 521, 522, 526)	1965[4]	22	4,225	124.5	35.1	12.9
	1966	29	8,373	106.2	21.9	20.7
	1967	29	6,928	115.6	27.6	16.4
	1968	26	5,257	122.1	32.6	13.9
	1969	20	4,309	122.2	33.0	13.8
	1970	34	12,367	98.7	17.4	26.1
	1971	40	12,608	106.3	21.7	20.9
	1972	31	9,353	105.9	21.8	20.8
	1973	32	9,683	105.1	21.3	21.3
	1974	24	6,499	106.4	21.3	21.3
Southeast Part (SA 525)	1965[4]	13	2,415	133.5	41.5	10.9
	1966	1	171	120.5	31.5	14.5
	1967	12	2,628	129.8	38.5	11.9
	1968	6	1,290	131.6	39.8	11.4
	1969	16	3,404	127.2	36.1	12.6
	1970	8	1,532	128.4	37.7	12.0
	1971	16	3,711	122.2	32.4	14.0
	1972	6	1,157	124.9	34.4	13.2
	1973	8	3,079	107.8	22.8	19.9
	1974	8	2,893	103.8	20.4	22.3
Northern Edge and Peak (SA 523, 524)	1965[4]	8	1,242	124.3	34.7	13.1
	1966	4	1,269	107.3	22.1	20.5
	1967	10	2,085	125.0	34.2	13.2
	1968	11	2,441	127.2	36.6	12.4
	1969	24	6,463	116.8	28.6	15.8
	1970	3	875	116.9	28.1	16.1
	1971	0	0	-	-	-
	1972	11	2,459	123.3	34.3	13.2
	1973	0	0	-	-	-
	1974	0	0	-	-	-
Georges Bank[3] (Total)	1965[4]	43	7,882	126.8	36.7	12.4
	1966	34	10,313	106.8	22.2	20.5
	1967	51	11,641	121.3	31.8	14.3
	1968	43	8,988	124.3	34.3	13.2
	1969	60	14,176	120.9	31.8	14.3
	1970	45	14,774	104.4	21.1	21.5
	1971	56	16,319	109.0	23.5	19.3
	1972	48	12,969	110.2	24.9	18.2
	1973	40	12,762	105.5	21.5	21.1
	1974	32	9,392	106.0	21.2	21.4

[1]Mean meat weight derived by applying the 1978-1981 USA Georges Bank research survey sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 7.24854 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.1748} \quad (n = 3036,\ r = 0.97)$$

to each shell height in the yearly frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops represented in the yearly frequency distribution.

[2]Average meat count derived by dividing the calculated mean meat weight into 453.6 grams (1 pound).

[3]Mean shell height and mean meat weight derived from "weighting" the shell height frequency distributions from each of the three principal scallop regions by the reported annual USA sea scallop landings from each region.

[4]During 1965-1971, scallops larger than 149 mm shell height appearing in the USA commercial samples were grouped in the 145-149 mm size frequency interval. Hence, in these samples, mean shell height and mean meat weight will be higher and average meat count lower than values calculated and presented in this table.

Table 17. Number of USA commercial size-frequency (shell height) sea scallop samples, total number of scallops measured, mean shell height (mm), mean meat weight (g), and average meat count (number of scallop meats per pound) for commercial sea scallop samples from the three principal scallop regions on Georges Bank, 1975-1981.

Area	Year	Number of Samples	Number of Scallops Measured	Mean Shell Height	Mean[1] Meat Weight	Average[2] Meat Count
South Channel (SA 521, 522, 526)	1975	9	2,246	112.3	25.1	18.1
	1976	16	5,098	99.9	17.5	26.0
	1977	35	10,475	98.6	16.5	27.4
	1978	38	8,807	110.8	24.2	18.8
	1979	54	13,338	110.4	24.5	18.5
	1980	36	8,021	113.5	27.0	16.8
	1981[4]	19	5,589	92.8	15.5	29.2
Southeast Part (SA 525)	1975	4	1,599	105.9	20.1	22.6
	1976	0	0	--	--	--
	1977	1	287	116.7	27.8	16.3
	1978	8	1,487	126.0	35.3	12.9
	1979	8	1,369	129.6	38.8	11.7
	1980	12	3,009	110.3	25.4	17.9
	1981[4]	3	749	107.0	22.9	19.8
Northern Edge and Peak (SA 523, 524)	1975	1	199	123.7	32.4	14.0
	1976	0	0	--	--	--
	1977	7	1,533	111.0	24.4	18.6
	1978	14	3,440	117.0	28.8	15.7
	1979	29	6,375	119.2	29.9	15.2
	1980	26	5,796	110.3	24.5	18.5
	1981[4]	32	10,170	86.7	11.9	38.1
Georges Bank[3] (Total)	1975	14	4,044	112.6	25.1	18.1
	1976	16	5,098	99.9	17.5	26.0
	1977	43	12,295	100.7	17.9	25.4
	1978	60	13,734	113.2	25.9	17.5
	1979	91	21,082	115.0	27.6	16.4
	1980	74	16,826	112.0	25.9	17.5
	1981[4]	54	16,508	89.7	13.6	33.3

[1] Mean meat weight derived by applying the 1978-1981 USA Georges Bank research survey sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 7.24854 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.1748} \quad (n = 5036,\ r = 0.97)$$

to each shell height in the yearly frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops represented in the yearly frequency distribution.

[2] Average meat counts derived by dividing the calculated mean meat weight into 453.6 grams (1 pound).

[3] Mean shell height and mean meat weight derived from "weighting" the shell height frequency distributions from each of the three principal scallop regions by the reported annual USA sea scallop landings from each region.

[4] January-September only.

Table 18. Percent frequency distributions of sample meat counts (number of scallop meats per pound) derived from USA commercial size-frequency (shell height) sea scallop samples from the three principal scallop regions on Georges Bank, 1965-1971. For each year and region, the percent of samples within each 5-unit meat count interval is indicated[1]. The total Georges Bank frequency distributions were derived by "weighting" the sample meat count frequency distributions in each region by the reported annual USA sea scallop landings from that region, and hence represent annual meat count frequency distributions of USA Georges Bank sea scallop landings.

			Meat Count Intervals[2]												
Area	Year	Number of Samples	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	45.0-49.9	50.0-54.9	55.0-59.9	60.0-64.9	Total
South Channel (SA 521, 522, 526)	1965	22	27.3	50.0	9.1	9.1	5.6								100.0
	1966	29	10.3	27.6	10.3	20.7	6.9	24.1							99.9
	1967	29	3.4	55.2	17.2	13.8	6.9	3.4							99.9
	1968	26	7.7	57.7	23.1	3.8	7.7								100.0
	1969	20	15.0	70.0	-	10.0	5.0								100.0
	1970	34		14.7	20.6	5.9	20.6	11.8	23.5	2.9					100.0
	1971	40		22.5	25.0	25.0	10.0	10.0	5.0	2.5					100.0
Southeast Part (SA 525)	1965	13	23.1	69.2	7.7										100.0
	1966	1		100.0											100.0
	1967	12	25.0	58.3	16.7										100.0
	1968	6		100.0											100.0
	1969	16	18.8	75.0	6.3										100.1
	1970	8		75.0	25.0										100.0
	1971	16		81.3	18.8										100.1
Northern Edge and Peak (SA 523, 524)	1965	8	25.0	25.0	50.0										100.0
	1966	4			50.0	25.0	25.0								100.0
	1967	10	10.0	70.0	20.0										100.0
	1968	11	18.2	54.5	27.3										100.0
	1969	24		58.3	16.7	25.0									100.0
	1970	3		33.3	66.7										100.0
	1971	0													-
Georges Bank (Total)	1965	43	25.6	48.0	20.2	4.2	2.1								100.1
	1966	34	8.4	25.1	16.5	20.8	9.7	19.5							100.0
	1967	51	10.4	59.3	17.7	7.2	3.6	1.8							100.0
	1968	43	8.2	63.4	20.4	2.6	5.4								100.0
	1969	60	9.7	66.2	7.7	14.2	2.2								100.0
	1970	45		23.9	27.2	4.5	15.6	8.9	17.7	2.2					100.0
	1971	56		32.2	24.7	20.5	8.2	8.2	4.1	2.1					100.0

[1] Meat count for each sample was derived by calculating the average meat weight per scallop in each sample and dividing this value into 453.6 grams (1 pound). The average meat weight per scallop was calculated by applying the 1978-1981 USA Georges Bank research survey sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 7.24854 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.1748} \quad (n = 3036,\ r = 0.97)$$

to each shell height in the sample frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops in the sample.

[2] During 1965-1971, individual scallops larger than 149 mm shell height that occurred in the USA commercial samples were grouped in the 145-149 mm size frequency interval. Hence, for these samples, the true meat counts are lower than those calculated and presented in this table.

Table 19. Percent frequency distributions of sample meat counts (number of scallop meats per pound) derived from USA commercial size-frequency (shell height) sea scallop samples from the three principal scallop regions on Georges Bank, 1972-1981. For each year and region, the percent of samples within each 5-unit meat count interval is indicated.[1] The total Georges Bank frequency distributions were derived by "weighting" the sample meat count frequency distributions in each region by the reported annual USA sea scallop landings from that region, and hence represent annual meat count frequency distributions of USA Georges Bank sea scallop landings.

Area	Year	Number of Samples	Meat Count Intervals												Total
			5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	45.0-49.9	50.0-54.9	55.0-59.0	60.0-64.9	
South Channel (SA 521, 522, 526)	1972	31		22.6	35.5	25.8	3.2	-	6.5	6.5					100.1
	1973	32		21.9	31.3	15.6	12.5	6.3	6.3	6.3					100.2
	1974	24		8.3	25.0	50.0	12.5	-	4.2						100.0
	1975	9		33.3	33.3	22.2	11.1								99.9
	1976	16		25.0	12.5	6.3	25.0	25.0	6.3						100.1
	1977	35		14.3	11.4	5.7	22.9	20.0	14.3	11.4					100.0
	1978	38	2.6	26.3	26.3	26.3	15.8	-	2.6						99.9
	1979	54	9.3	31.5	27.8	16.7	11.1	-	1.9	-	1.9				100.2
	1980	36	13.9	33.3	27.8	13.9	2.8	8.3							100.0
	1981[2]	19	15.8	10.5	10.5	10.5	5.3	10.5	15.8	-	10.5	-	10.5		99.9
Southeast Part (SA 525)	1972	6	16.7	66.7	16.7										100.1
	1973	8		12.5	25.0	37.5	25.0								100.0
	1974	8		12.5	-	37.5	12.5	25.0	-	-	12.5				100.0
	1975	4			50.0	50.0									100.0
	1976	0													-
	1977	1			100.0										100.0
	1978	8		87.5	-	12.5									100.0
	1979	8	12.5	75.0	12.5										100.0
	1980	12		33.3	41.7	16.7	-	8.3							100.0
	1981[2]	3		33.3	-	33.3	-	33.3							99.9
Northern Edge and Peak (SA 523, 524)	1972	11	9.1	54.5	36.4										100.0
	1973	0													-
	1974	0													-
	1975	1		50.0	-	50.0									100.0
	1976	0													-
	1977	7		28.6	42.9	-	14.3	14.3							100.1
	1978	14		57.1	21.4	7.1	7.1	7.1							99.8
	1979	29		51.7	37.9	6.9	3.4								99.9
	1980	26	3.8	34.6	15.4	23.1	19.2	3.8							99.9
	1981[2]	32		12.5	9.4	6.3	6.3	6.3	3.1	-	3.1	21.9	9.4	21.9	100.2
Georges Bank (Total)	1972	48	2.8	31.2	34.2	19.6	2.4	-	4.9	4.9					100.0
	1973	40		20.4	30.3	19.2	14.5	5.3	5.3	5.3					100.3
	1974	32		8.9	21.7	48.3	12.5	3.3	3.6	-	1.7				99.9
	1975	14		28.8	32.2	31.6	7.3								99.9
	1976	16		25.0	12.5	6.3	25.0	25.0	6.3						100.1
	1977	43		14.7	19.3	4.9	20.8	18.3	12.2	9.8					100.0
	1978	60	1.8	37.4	23.4	21.0	12.8	1.6	1.8						99.8
	1979	91	7.1	42.1	28.8	12.1	7.7	-	1.2	-	1.2				100.2
	1980	74	8.7	33.7	25.2	17.4	8.1	6.7							99.8
	1981[2]	54	5.2	12.9	9.3	9.0	5.7	9.0	7.1	-	5.4	13.6	9.3	13.6	100.1

[1] Meat count for each sample was derived by calculating the average meat weight per scallop in each sample and dividing this value into 453.6 grams (1 pound). The average meat weight per scallop was calculated by applying the 1978-1981 USA Georges Bank research survey sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 7.24854 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.1748} \quad (n = 3036,\ r = 0.97)$$

to each shell height in the sample frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops in the sample.

[2] January-September only.

Table 20. Mean size (height and meat weight) at age for sea scallops (*Placopecten magellanicus*) from the Gulf of Maine, Georges Bank, and Mid-Atlantic populations. Number of meats per pound for all three areas is also presented.*

	1	2	3	4	5	6	7	8	9	10	11	12
Gulf of Maine												
height (mm)[1]		26.92	56.05	79.43	98.18	113.23	125.30	134.99	142.76	149.00	154.00	158.02
meat weight (g)[2]		0.13	1.62	5.44	11.39	18.71	26.62	34.50	41.92	48.65	54.58	59.70
meat count/pound		3,489	280	83	40	24	17	13	11	9	8	8
Georges Bank												
height (mm)[3]		25.63	61.95	87.87	106.37	119.57	128.99	135.71	140.51	143.93	146.37	148.12
meat weight (g)[4]		0.22	3.55	10.75	19.72	28.59	36.38	42.74	47.73	51.52	54.34	56.43
meat count/pound		2,062	128	42	23	16	12	11	10	9	8	8
Mid-Atlantic												
height (mm)[5]		35.00	65.26	87.68	104.30	116.61	125.73	132.49	137.50	141.22	143.97	146.01
meat weight (g)[6]		0.58	4.37	11.36	19.91	28.56	36.44	43.16	48.67	53.05	56.46	59.09
meat count/pound		782	104	40	23	16	12	11	9	9	8	8

[1]Derived from von Bertalanffy growth equation: $l_t = 174.32(1-e^{-.2202(t-1.2383)})$.

[2]Derived from age-weight relationship: $w_t = 84.017(1-e^{-.2202(t-1.2383)})^{3.4813}$

[3]Derived from von Bertalanffy growth equation: $l_t = 152.46(1-e^{-.3374(t-1.4544)})$.

[4]Derived from age-weight relationship: $w_t = 61.850(1-e^{-.3374(t-1.4544)})^{3.1748}$

[5]Derived from von Bertalanffy growth equation: $l_t = 151.84(1-e^{-.2997(t-1.1256)})$.

[6]Derived from age-weight relationship: $w_t = 67.068(1-e^{-.2997(t-1.1256)})^{3.2335}$

*Sea scallops are spawned in the late summer-early autumn. An arbitrary birthdate of 1 October has been assigned to the date of spawning (Posgay and Norman, 1958). Hence, age in the above table refers to age as of 1 October.

Table 21. Number of USA commercial size-frequency (shell height) sea scallop samples, total number of scallops measured, mean shell height (mm), mean meat weight (g), and average meat count (number of scallop meats per pound) for commercial sea scallop samples from the three principal scallop regions in the Mid-Atlantic, 1965-1974.

Area	Year	Number of Samples	Number of Scallops Measured	Mean Shell Height	Mean[1] Meat Weight	Average[2] Meat Count
New York Bight (SA 6A)	1965[4]	52	19,258	106.9	23.4	19.4
	1966	41	14,578	102.4	20.3	22.3
	1967	27	7,239	114.8	28.9	15.7
	1968	64	21,134	107.5	24.1	18.9
	1969	32	11,056	107.7	23.7	19.1
	1970	15	4,842	111.5	25.7	17.7
	1971	16	3,699	120.5	33.3	13.6
	1972	21	5,471	114.4	28.4	15.9
	1973	11	3,465	110.8	26.8	16.9
	1974	17	7,300	98.4	17.8	25.5
Delmarva (SA 6B)	1965[4]	19	7,847	95.4	15.5	29.2
	1966	47	17,732	98.7	17.5	25.9
	1967	35	13,805	100.9	18.5	24.5
	1968	13	3,912	113.7	28.0	16.2
	1969	18	6,329	107.2	23.8	19.1
	1970	1	455	106.1	22.5	20.2
	1971	0	0	-	-	-
	1972	21	8,746	94.9	17.5	26.0
	1973	6	2,364	99.6	19.3	23.5
	1974	3	1,916	94.4	15.2	29.8
Virginia-North Carolina (SA 6C)	1965[4]	12	5,346	99.8	18.0	25.2
	1966	2	589	109.0	23.6	19.2
	1967	0	0	-	-	-
	1968	0	0	-	-	-
	1969	0	0	-	-	-
	1970	0	0	-	-	-
	1971	0	0	-	-	-
	1972	1	154	138.5	51.4	8.8
	1973	2	877	105.2	23.1	19.6
	1974	0	0	-	-	-
Mid-Atlantic[3] (Total)	1965[4]	83	32,451	101.5	19.5	23.2
	1966	90	32,899	100.7	19.0	23.9
	1967	62	21,044	107.4	23.4	19.4
	1968	77	25,046	108.7	24.8	18.3
	1969	50	17,385	107.5	23.8	19.1
	1970	16	5,297	111.0	25.4	17.9
	1971	16	3,699	120.5	33.3	13.6
	1972	43	14,351	103.1	22.2	20.5
	1973	19	6,706	106.3	23.7	19.1
	1974	20	9,216	96.7	16.7	27.2

[1]Mean meat weight derived by applying the 1977-1981 USA Mid-Atlantic research survey sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 5.92915 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.2335} \quad (n = 3992,\ r = 0.98)$$

to each shell height in the yearly frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops represented in the yearly frequency distribution.

[2]Average meat count derived by dividing the calculated mean meat weight into 453.6 grams (1 pound).

[3]Mean shell height and mean meat weight derived from "weighting" the shell height frequency distribution from each of the three principal scallop regions by the reported annual USA sea scallop landings from each region.

[4]During 1965-1971, scallops larger than 149 mm shell height appearing in the USA commercial samples were grouped in the 145-149 mm size frequency interval. Hence, in these samples, mean shell height and mean meat weight will be higher and average meat count lower than values calculated and presented in this table.

Table 22. Number of USA commercial size-frequency (shell height) sea scallop samples, total number of scallops measured, mean shell height (mm), mean meat weight (g), and average meat count (number of scallop meats per pound) for commercial sea scallop samples from the three principal scallop regions in the Mid-Atlantic, 1975-1981.

Area	Year	Number of Samples	Number of Scallops Measured	Mean Shell Height	Mean[1] Meat Weight	Average[2] Meat Count
New York Bight (SA 6A)	1975	30	11,048	104.8	21.4	21.2
	1976	42	18,597	96.6	16.9	26.9
	1977	29	11,058	103.1	20.0	22.7
	1978	18	6,110	107.5	22.9	19.8
	1979	8	1,860	117.7	31.2	14.5
	1980	24	5,546	113.4	28.5	15.9
	1981[4]	8	1,213	119.2	33.4	13.6
Delmarva (SA 6B)	1975	2	743	104.1	21.1	21.6
	1976	2	787	97.2	16.6	27.4
	1977	7	1,446	113.4	27.3	16.6
	1978	17	3,651	122.5	35.3	12.8
	1979	11	2,691	110.9	26.7	17.0
	1980	42	9,879	117.1	31.2	14.6
	1981[4]	8	1,330	116.5	30.8	14.7
Virginia-North Carolina (SA 6C)	1975	0	0	--	--	--
	1976	0	0	--	--	--
	1977	0	0	--	--	--
	1978	7	1,218	121.4	34.2	13.3
	1979	5	2,185	100.3	19.8	22.9
	1980	5	1,365	105.4	22.4	20.2
	1981[4]	2	554	116.7	31.0	14.6
Mid-Atlantic[3] (Total)	1975	32	11,791	104.6	21.3	21.3
	1976	44	19,384	96.8	16.8	27.0
	1977	36	12,504	107.1	22.8	19.9
	1978	42	10,979	117.9	31.5	14.4
	1979	24	6,736	114.9	29.4	15.4
	1980	71	16,790	114.6	29.4	15.5
	1981[4]	18	3,117			

[1]Mean meat weight derived by applying the 1977-1981 USA Mid-Atlantic research survey sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 5.92915 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.2335} \quad (n = 8992,\ r = 0.98)$$

to each shell height in the yearly frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops represented in the yearly frequency distribution.

[2]Average meat count derived by dividing the calculated mean meat weight into 453.6 grams (1 pound).

[3]Mean shell height and mean meat weight derived from "weighting" the shell height frequency distributions from each of the three principal scallop regions by the reported annual USA sea scallop landings from each region.

[4]January-September only.

Table 23. Percent frequency distribution of sample meat counts (number of scallop meats per pound) derived from USA commercial size-frequency (shell height) sea scallop samples from the three principal scallop regions in the Mid-Atlantic, 1965-1971. For each year and region, the percent of samples within each 5-unit meat count interval is indicated[1]. The total Mid-Atlantic frequency distributions were derived by "weighting" the sample meat count frequency distributions in each region by the reported annual USA sea scallop landings from that region, and hence represent annual meat count frequency distributions of USA Mid-Atlantic sea scallop landings.

Area	Year	Number of Samples	Meat Count Intervals[2]												Total
			5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	45.0-49.9	50.0-54.9	55.0-59.9	60.0-64.9	
New York Bight (SA 6A)	1965	52	1.9	32.7	25.0	15.4	19.2	3.8	-	1.9					99.9
	1966	41	2.4	17.1	19.5	14.6	31.7	14.6							99.9
	1967	27		51.9	25.9	14.8	7.4								100.0
	1968	64		25.0	34.4	29.7	9.4	-	1.6						100.1
	1969	32		31.3	31.3	28.1	6.3	-	3.1						100.1
	1970	15		20.0	46.7	33.3									100.0
	1971	16			68.8	31.3									100.1
Delmarva (SA 6B)	1965	19			5.3	15.8	21.1	47.4	10.5						100.1
	1966	47	4.3	6.4	4.3	17.0	29.8	36.2	2.1						100.1
	1967	35			14.3	37.1	37.1	8.6	2.9						100.0
	1968	13		38.5	46.2	15.4									100.1
	1969	18	11.1	11.1	38.9	16.7	22.2								100.0
	1970	1				100.0									100.0
	1971	0													-
Virginia-North Carolina (SA 6C)	1965	12			25.0	25.0	33.3	8.3	8.3						99.9
	1966	2			50.0	50.0									100.0
	1967	0													-
	1968	0													-
	1969	0													-
	1970	0													-
	1971	0													-
Mid-Atlantic (Total)	1965	83	0.8	13.5	19.4	18.4	24.0	17.5	5.5	0.8					99.9
	1966	90	3.3	11.8	12.5	16.1	30.5	24.9	1.0						100.1
	1967	62		24.2	19.7	26.7	23.3	4.6	1.5						100.0
	1968	77		27.7	36.8	26.8	7.5	-	1.3						100.1
	1969	50	4.0	24.1	34.0	24.0	12.0	-	2.0						100.1
	1970	16		18.2	42.6	39.2									100.0
	1971	16			68.8	31.3									100.1

[1]Meat count for each sample was derived by calculating the average meat weight per scallop in each sample and dividing this value into 453.6 grams (1 pound). The average meat weight per scallop was calculated by applying the 1977-1981 USA Mid-Atlantic research survey sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 5.92915 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.2335} \quad (n = 8992,\ r = 0.98)$$

to each shell height in the sample frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops in the sample.

[2]During 1965-1971, individual scallops larger than 149 mm shell height that occurred in the USA commercial samples were grouped in the 145-149 mm size frequency interval. Hence, for these samples, the true meat counts are lower than those calculated and presented in this table.

Table 24. Percent frequency distribution of sample meat counts (number of scallop meats per pound) derived from USA commercial size-frequency (shell height) sea scallop samples from the three principal scallop regions in the Mid-Atlantic, 1972-1981. For each year and region, the percent of samples within each 5-unit meat count interval is indicated.[1] The total Mid-Atlantic frequency distributions were derived by "weighting" the sample meat count frequency distributions in each region by the reported annual USA sea scallop landings from that region, and hence represent annual meat count frequency distributions of USA Mid-Atlantic sea scallop landings.

			Meat Count Intervals												
Area	Year	Number of Samples	5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	45.0-49.9	50.0-54.9	55.0-59.9	60.0 64.9	Total
New York Bight (SA 6A)	1972	21		42.9	47.6	9.5									100.0
	1973	11	9.1	18.2	45.5	9.1	9.1	9.1							100.1
	1974	17		5.9	17.6	23.5	11.8	23.5	11.8	-	5.9				100.0
	1975	30		3.3	46.7	26.7	13.3	10.0							100.0
	1976	42		2.4	16.7	28.6	9.5	35.7	4.8	2.4					100.1
	1977	29		3.4	20.7	51.7	20.7	3.4							99.9
	1978	18			55.6	38.9	5.6								100.1
	1979	8	12.5	37.5	37.5	12.5									100.0
	1980	24	8.3	45.8	25.0	16.7	-	4.2							100.0
	1981[2]	8	12.5	62.5	-	12.5	-	-	-	-	12.5				100.0
Delmarva (SA 6B)	1972	21	4.8	19.0	4.8	4.8	14.3	28.6	9.5	14.3					100.1
	1973	6		33.3	-	16.7	16.7	33.3							100.0
	1974	3					33.3	33.3	33.3						99.9
	1975	2			50.0	-	50.0								100.0
	1976	2				50.0	-	50.0							100.0
	1977	7		14.3	71.4	-	14.3								100.0
	1978	17	17.6	52.9	23.5	5.9									99.9
	1979	11	9.1	45.5	18.2	9.1	18.2								100.1
	1980	42	9.5	42.9	40.5	7.1									100.0
	1981[2]	8	12.5	62.5	12.5	-	12.5								100.0
Virginia-North Carolina (SA 6C)	1972	1	100.0												100.0
	1973	2			50.0	50.0									100.0
	1974	0													-
	1975	0													-
	1976	0													-
	1977	0													-
	1978	7		71.4	28.6										100.0
	1979	5			20.0	60.0	20.0								100.0
	1980	5		20.0	40.0	20.0	20.0								100.0
	1981[2]	2		50.0	50.0										100.0
Mid-Atlantic (Total)	1972	43	3.7	28.4	22.0	6.6	8.4	16.8	5.6	8.4					99.9
	1973	19	5.2	23.2	28.3	13.8	11.6	17.9							100.0
	1974	20		3.4	10.2	13.6	20.8	27.6	20.8	-	3.4				99.8
	1975	32		2.1	47.9	17.2	26.3	6.5							100.0
	1976	44		1.7	12.1	34.5	6.9	39.7	3.5	1.7					100.1
	1977	36		7.6	40.3	31.7	18.2	2.1							99.9
	1978	42	11.3	38.0	33.4	15.5	1.7								99.9
	1979	24	11.0	38.8	30.8	13.0	6.4								100.0
	1980	71	8.6	44.5	30.8	13.3	0.2	2.6							100.0
	1981														

[1] Meat count for each sample was derived by calculating the average meat weight per scallop in each sample and dividing this value into 453.6 grams (1 pound). The average meat weight per scallop was calculated by applying the 1977-1981 USA Mid-Atlantic research survey sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 5.92915 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.2335} \quad (n = 8992,\ r = 0.98)$$

to each shell height in the sample frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops in the sample.

[2] January-September only.

Table 25. Number of USA commercial size-frequency (shell height) sea scallop samples, total number of scallops measured, mean shell height (mm), mean meat weight (g) and average meat count (number of scallop meats per pound) for commercial sea scallop samples from the Gulf of Maine, 1965-1981.

Area	Year	Number of Samples	Number of Scallops Measured	Mean Shell Height	Mean[1] Meat Weight	Average[2] Meat Count
Gulf of Maine	1965[3]	1	131	143.7	43.5	10.4
	1966	0	0	-	-	-
	1967	0	0	-	-	-
	1968	0	0	-	-	-
	1969	2	504	123.2	26.7	17.0
	1970	1	281	128.2	30.4	14.9
	1971	3	706	128.0	30.1	15.1
	1972	5	2100	105.0	16.5	27.4
	1973	8	3453	103.1	16.1	28.2
	1974	4	1693	102.3	15.0	30.3
	1975	1	335	137.1	37.7	12.0
	1976	4	1323	109.7	19.3	23.5
	1977	5	1109	106.1	17.6	25.8
	1978	1	337	97.5	11.6	31.1
	1979	0	0	-	-	-
	1980	30	6058	90.0	9.3	48.6
	1981[4]	3	649	119.1	25.4	17.9

[1]Mean meat weight derived by applying the 1980 NMFS offshore Gulf of Maine commercial sample sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 1.32248 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.4813} \quad (n = 1726,\ r = 0.93)$$

to each shell height in the yearly frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops represented in the yearly frequency distribution.

[2]Average meat count derived by dividing the calculated mean meat weight into 453.6 grams (1 pound).

[3]During 1965-1971, scallops larger than 149 mm shell height appearing in the USA commercial samples were grouped in the 145-149 size frequency interval. Hence, in these samples, mean shell height and mean meat weight will be higher and average meat count lower than values calculated and presented in this table.

[4]January-September only.

Table 26. Percent frequency distribution of sample meat counts (number of scallop meats per pound) derived from USA commercial-size frequency (shell height) sea scallop samples from the Gulf of Maine, 1965-1981. For each year, the percent of samples within each 5-unit meat count interval is indicated.[1]

Area	Year	Number of Samples	Meat Count Intervals[3]																
			5.0-9.9	10.0-14.9	15.0-19.9	20.0-24.9	25.0-29.9	30.0-34.9	35.0-39.9	40.0-44.9	45.0-49.9	50.0-54.9	55.0-59.9	60.0-64.9	65.0-69.9	70.0-74.9	75.0-79.9	80.0-84.9	Total
Gulf of Maine (SA 5Y)	1965	1		100.0															100.0
	1966	0																	-
	1967	0																	-
	1968	0																	-
	1969	2		50.0	-	50.0													100.0
	1970	1		100.0															100.0
	1971	3		33.3	66.7														100.0
	1972	5		20.0	20.0			20.0	40.0										100.0
	1973	8	12.5	12.5	12.5		12.5	12.5	12.5		12.5	12.5							100.0
	1974	4			50.0				25.0		25.0								100.0
	1975	1		100.0															100.0
	1976	4			25.0	25.0	50.0												100.0
	1977	5		20.0		20.0			20.0		20.0	20.0							100.0
	1978	1							100.0										100.0
	1979	0																	-
	1980	30		3.3		-	3.3	3.3	3.3	6.7	20.0	16.7	13.3	10.0	6.7	3.3	6.7	3.3	99.9
	1981[2]	3		66.7			33.3												100.0

[1] Meat count for each sample was derived by calculating the average meat weight per scallop in each sample and dividing this value into 453.6 grams (1 pound). The average meat weight per scallop was calculated by applying the 1980 NMFS offshore Gulf of Maine commercial sample sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 1.32248 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.4813} \quad (n = 1726,\ r = 0.93)$$

to each shell height in the sample frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops in the sample.

Additionally, average meat weight per scallop was calculated by applying the inshore (Penobscot Bay) Gulf of Maine sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 5.88847 \times 10^{-7} \text{ Shell Height}_{(mm)}^{3.664} \quad (n = 1107, \text{ from Haynes, 1966})$$

to the data as described above. The distribution of sample meat counts derived from using the inshore equation closely agreed (85% agreement: 58 out of 68 samples) with that derived using the 1980 NMFS offshore equation. When differences occurred (i.e., ten samples) these were by only 1 meat count interval (≤5 units). In these cases, the calculated meat counts from using the inshore equation were lower than those derived using the offshore equation. Because of the overall similarity of results, only the meat count distributions calculated from the 1980 NMFS offshore equation are presented in the table.

[2] Only includes samples collected during January through September.

[3] During 1965-1971, individual scallops larger than 149 mm shell height that occurred in the USA commercial samples were grouped in the 145-149 size frequency interval. Hence, for these samples, the true meat counts are lower than those calculated and presented in this table.

Table 27. Sea scallop research vessel survey cruises on Georges Bank, in Southern New England, and in the Mid-Atlantic, 1975-1981. Only cruises for which sea scallop relative abundance data (catch per tow) are presented in this report are listed. For each survey, gear and tow durations are provided as well as the number of tows accomplished in NEFC sea scallop sampling strata (Strata 1-66; 71-74).

					Number of Tows Accomplished									
					Georges Bank					Mid-Atlantic				
Year	Country	Research Vessel	Dredge Size	Tow Duration	South Channel	Southeast Part	No. Edge and Peak	Total	So. New England	New York Bight	Delmarva	Virginia-No. Carolina	Total	Grand Total
1975	USA	ALBATROSS IV	10' - unlined	15 min	64	21	53	138	6	38	28	13	79	223
1977	USA	ALBATROSS IV	10' - unlined	15 min	37	24	71	132	24	130	27	11	168	324
1978	USA	ALBATROSS IV	10' - unlined	15 min	51	22	-	73	34	127	66	23	216	323
1978	CAN	E.E. PRINCE	8' - lined	0.5 mi	(18)[1]		76	94	-	-	-	-	-	137
1979	USA	ALBATROSS IV	8' - lined	15 min	54	21	-	75	24	130	64	8	202	301
1979	CAN	E.E. PRINCE	8' - lined	0.5 mi	-	(5)[1]	155	160	-	-	-	-	-	160
1980	USA	ALBATROSS IV	8' - lined	15 min	45	21	-	66	6	131	65	13	209	281
1980	CAN	E.E. PRINCE	8' - lined	0.5 mi	-	(25)[1]	320	345	-	-	-	-	-	345
1981	USA	ALBATROSS IV	8' - lined	15 min	63	20	-	83	22	132	64	14	210	315
1981	CAN	E.E. PRINCE	8' - lined	0.5 mi	-	-	101		-	-	-	-	-	101

[1] Catch data from these tows were not used in deriving relative abundance indices since USA data were available

Table 28. Derivation of sea scallop adjustment factors (standardization coefficients), by shell height category, used to standardize the 1975, 1977, and 1978 NEFC research survey sea scallop catch per tow data (obtained with a 10-foot, unlined sea scallop dredge) to those obtained in the 1979-1981 NEFC sea scallop research surveys (obtained with an 8-foot, lined sea scallop dredge).

Shell Height (mm)	(A) Unlined Dredge/Lined Dredge Smoothed Retention Ratio (ICES C.M. 1980/K24, p. 19)	(B) Selectivity Adjustment Factor (1/A)	(C) Linear Gear Width Adjustment Factor (8 ft dredge/10 ft dredge)	(D) Overall Selectivity and Gear Adjustment Factor (B X C)
2	0.119	8.40	0.80	6.72
7	0.119	8.40	0.80	6.72
12	0.119	8.40	0.80	6.72
17	0.119	8.40	0.80	6.72
22	0.119	8.40	0.80	6.72
27	0.119	8.40	0.80	6.72
32	0.189	5.29	0.80	4.23
37	0.259	3.86	0.80	3.09
42	0.320	3.13	0.80	2.50
47	0.411	2.43	0.80	1.94
52	0.552	1.81	0.80	1.45
57	0.727	1.38	0.80	1.10
62	0.875	1.14	0.80	0.91
67	0.992	1.01	0.80	0.81
72	1.156	0.87	0.80	0.70
77	1.180	0.85	0.80	0.68
82	1.332	0.75	0.80	0.60
87	1.332	0.75	0.80	0.60
92	1.332	0.75	0.80	0.60
97	1.332	0.75	0.80	0.60
102	1.332	0.75	0.80	0.60
107	1.332	0.75	0.80	0.60
112	1.332	0.75	0.80	0.60
117	1.332	0.75	0.80	0.60
122	1.332	0.75	0.80	0.60
127	1.332	0.75	0.80	0.60
132	1.332	0.75	0.80	0.60
137	1.332	0.75	0.80	0.60
142	1.332	0.75	0.80	0.60
147	1.332	0.75	0.80	0.60
152	1.332	0.75	0.80	0.60

Table 29. USA sea scallop research survey relative abundance indices (standardized stratified mean number per tow), mean shell height (mm) of scallops sampled, mean meat weight (g) per scallop sampled, and average meat count (number of scallop meats per pound) of scallops sampled from sea scallop research surveys on Georges Bank, 1975, 1977-1981. Data are presented by principal scallop regions on Georges Bank. Survey indices are presented for pre-recruit (<70 mm shell height), recruit (≥70 mm shell height), and total scallops per tow.[1]

		Standardized Stratified Mean Number Per Tow					
Area	Year	Number <70 mm Per Tow	Number ≥70 mm Per Tow	Total Number Per Tow	Mean Shell Height	Mean[2] Meat Weight	Average[3] Meat Count
South Channel	1975	30.2	25.9	56.1	81.6	14.1	32.2
	1977	4.0	52.5	56.5	100.9	19.5	23.3
	1978	5.1	32.9	38.0	101.1	19.5	23.3
	1979	4.5	56.5	61.0	93.1	15.5	29.2
	1980	51.2	19.3	70.5	58.2	5.8	78.0
	1981	9.9	24.0	33.9	81.2	12.8	35.6
Southeast Part	1975	1.8	38.2	40.0	110.5	24.5	18.5
	1977	2.8	24.3	27.1	104.1	22.0	20.6
	1978	2.1	23.9	26.0	117.2	30.7	14.8
	1979	6.9	19.2	26.1	99.4	23.8	19.0
	1980	19.4	37.4	56.8	78.2	11.2	40.5
	1981	1.3	17.4	18.7	102.5	21.2	21.4
Northern Edge and Peak	1975	86.9	120.2	207.1	76.9	9.4	48.4
	1977	66.2	384.7	450.9	85.2	11.2	40.4
	1978	177.5	372.6	550.1	85.1	13.8	33.8
	1979	63.9	232.9	296.8	87.1	13.4	33.8
	1980	599.3	128.2	727.5	52.3	3.5	131.0
	1981	277.0	404.9	681.9	68.8	6.2	73.6
Georges Bank (all areas)	1975	46.3	62.4	108.7	80.1	11.4	39.7
	1977	27.9	176.1	204.0	87.6	12.5	36.4
	1978	66.0	152.4	218.4	87.1	14.6	31.1
	1979	28.7	120.9	149.6	88.5	14.1	32.2
	1980	305.6	74.2	379.8	53.4	3.8	118.8
	1981	76.3	119.9	196.2	70.6	7.1	64.1

[1]Relative abundance indices from the Northern Edge and Peak, 1978-81, derived from Canadian research vessel survey data standardized to USA tow distance.

[2]Mean meat weight derived by applying the 1978-1981 USA Georges Bank research survey sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 7.24854 \times 10^{-6} \text{ Shell Height (mm)}^{3.1748} \quad (n = 3036,\ r = 0.97)$$

to each shell height in the survey frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops represented in the survey frequency distribution.

[3]Average meat count derived by dividing the calculated mean meat weight into 453.6 grams (1 pound).

Table 30. USA sea scallop research survey relative abundance indices (standardized stratified mean number per tow), mean shell height (mm) of scallops sampled, mean meat weight (g) per scallop sampled, and average meat count (number of scallop meats per pound) of scallops sampled from sea scallop research surveys in the Mid-Atlantic, 1975, 1977-1981. Data are presented by principal scallop regions in the Mid-Atlantic. Survey indices are presented for pre-recruit (<70 mm shell height), recruit (≥70 mm shell height), and total scallops per tow.

		Standardized Stratified Mean Number Per Tow					
Area	Year	Number <70 mm Per Tow	Number ≥70 mm Per Tow	Total Number Per Tow	Mean Shell Height	Mean[1] Meat Weight	Average[2] Meat Count
New York Bight	1975	27.3	23.5	50.8	75.0	9.8	46.1
	1977	1.1	39.4	40.5	98.4	18.2	25.0
	1978	2.5	36.1	38.6	102.5	21.2	21.4
	1979	3.9	13.7	17.6	95.3	20.9	21.8
	1980	10.7	10.8	21.5	75.6	12.8	35.5
	1981	13.1	13.5	26.6	68.2	8.9	50.8
Delmarva	1975	25.2	15.6	40.8	71.8	8.0	56.7
	1977	3.3	24.0	27.3	103.0	23.0	19.7
	1978	8.3	26.0	34.3	95.7	19.4	23.3
	1979	30.8	39.3	70.1	73.7	9.6	47.3
	1980	23.4	13.3	36.7	66.8	8.6	52.5
	1981	2.8	5.9	8.7	90.1	18.6	24.4
Virginia - No. Carolina	1975	47.7	10.9	58.6	66.0	5.5	83.1
	1977	0.2	0.2	0.4	84.7	13.2	34.4
	1978	15.4	7.1	22.5	68.6	6.5	69.7
	1979	4.6	6.5	11.1	75.3	10.2	44.4
	1980	0.8	4.6	5.4	87.9	13.9	32.6
	1981	0.4	0.8	1.2	95.2	19.1	23.8
Mid-Atlantic (all areas)	1975	28.9	19.4	48.3	72.8	8.7	52.2
	1977	1.7	30.1	31.8	99.7	19.5	23.2
	1978	6.0	29.2	35.2	97.7	19.5	23.3
	1979	13.9	22.9	36.8	79.9	12.8	35.4
	1980	14.8	11.3	26.1	71.3	10.7	42.5
	1981	8.6	10.0	18.6	72.0	10.6	42.7

[1]Mean meat weight derived by applying the 1977-1981 USA Mid-Atlantic research survey sea scallop shell height-meat weight equation.

$$\text{Meat Weight (g)} = 5.92915 \times 10^{-6} \text{ Shell Height (mm)}^{3.2335} \quad (n = 8992,\ r = 0.98)$$

to each shell height in the survey frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops represented in the survey frequency distribution.

[2]Average meat count derived by dividing the calculated mean meat weight into 453.6 grams (1 pound).

Table 31. Gulf of Maine sea scallop relative abundance indices (stratified mean number per tow), mean shell height (mm) of scallops sampled, mean meat weight (g) per scallop sampled, and average meat count (number of meats per pound) of scallops sampled, by depth zone (31-60 fathoms and 61-100 fathoms), from USA spring and autumn bottom trawl surveys, 1974-1981.

		Spring						Autumn					
		Stratified Mean Number Per Tow						Stratified Mean Number Per Tow					
Depth Zone (fm)	Year	Number <70 mm Per Tow	Number ≥70 mm Per Tow	Total Number Per Tow	Mean Shell Height	Mean[1] Meat Weight	Average[2] Meat Count	Number <70 mm Per Tow	Number ≥70 mm Per Tow	Total Number Per Tow	Mean Shell Height	Mean[1] Meat Weight	Average[2] Meat Count
31-60	1974	0.4	3.7	4.1	84.0	7.5	60.5	0.2	1.4	1.6	84.7	7.7	59.1
	1975	1.2	1.4	2.6	72.6	5.2	88.0	0.2	0.8	1.0	75.9	5.3	86.0
	1976	0.4	1.4	1.8	77.5	5.7	79.0	0.0	1.3	1.3	90.6	9.2	49.2
	1977	0.4	1.5	1.9	82.5	7.2	63.4	0.7	15.6	16.3	84.8	7.6	59.8
	1978	2.2	1.7	3.9	65.6	3.3	136.1	0.2	1.0	1.2	77.4	5.5	82.9
	1979	0.7	3.0	3.7	73.9	4.6	99.2	0.1	0.3	0.4	74.7	5.4	84.7
	1980	0.0	2.1	2.1	102.8	17.4	26.1	0.2	0.2	0.4	75.0	7.7	59.2
	1981	0.5	1.2	1.7	78.0	7.2	62.9	0.1	0.3	0.4	81.4	6.9	65.3
61-100	1974	0.1	0.0	0.1	50.0	1.1	417.5	0.0	0.0	0.0	-	-	-
	1975	0.0	0.1	0.1	70.0	3.5	129.4	0.0	0.0	0.0	-	-	-
	1976	<0.1	<0.1	0.1	65.0	2.8	163.3	0.1	0.1	0.2	66.8	3.5	128.6
	1977	1.1	0.6	1.7	60.7	2.6	173.0	12.0	3.4	15.4	56.4	2.3	198.4
	1978	4.1	0.7	4.8	56.7	2.0	225.6	4.0	11.2	15.2	70.9	4.0	113.5
	1979	2.1	6.2	8.3	71.3	4.1	110.4	1.7	9.4	11.1	72.6	4.2	107.6
	1980	0.1	33.0	33.1	86.2	7.5	60.1	1.7	33.2	34.9	81.3	6.3	72.0
	1981	5.3	92.2	97.5	92.9	10.4	43.8	0.3	6.6	6.9	87.4	8.2	55.0

[1] Mean meat weight derived by applying the 1980 NMFS offshore Gulf of Maine commercial sample sea scallop shell height-meat weight equation,

$$\text{Meat Weight (g)} = 1.32248 \times 10^{-6}\ \text{Shell Height}_{(mm)}^{3.4813}\ (n = 1726,\ r = 0.93)$$

to each shell height in the survey frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops in the survey frequency distribution.

[2] Average meat count derived by dividing the calculated mean meat weight into 453.6 grams (1 pound).

Table 32. Standardized stratified mean catch (number) per tow of sea scallops from USA sea scallop research vessel surveys on Georges Bank, 1975 1977-1981[1]. Standard deviation of the mean (S.D.), coefficient of variation (C.V.: 100 S.D./Mean), and 95% confidence limits are provided as indices of variability. Data are summarized by the three principal sea scallop regions on Georges Bank and for the entire Georges Bank area.

		Linear				Ln (x + 1)				Re-Transformed	
Region	Year	Mean	S.D.	C.V.	Confidence Limits	Mean	S.D.	C.V.	Confidence Limits	Mean	Confidence Limits
South Channel	1975	56.1	17.0	30.1	23.2- 89.9	2.5674	0.2183	8.5	2.1398-2.9950	52.9	34.1- 81.6
	1977	56.5	21.2	38.5	13.6- 96.6	1.4682	0.2473	16.8	0.9837-1.9527	30.4	18.3- 49.9
	1978	38.0	7.8	20.4	23.0- 53.8	1.4171	0.1689	11.9	1.0862-1.7480	25.4	18.0- 35.8
	1979	61.0	37.6	61.6	-12.7-134.8	1.5418	0.1857	12.0	1.1777-1.9059	21.5	14.6- 31.3
	1980	70.5	29.9	42.4	12.0-129.0	1.5692	0.2096	13.4	1.1571-1.9813	25.7	16.7- 39.3
	1981	33.9	10.0	29.4	14.3- 53.5	1.6711	0.2366	14.2	1.2073-2.1349	26.5	16.3- 42.8
Southeast Part	1975	40.0	9.4	23.4	21.7- 58.6	2.9255	0.3011	10.3	2.3352-3.5158	53.2	29.0- 96.8
	1977	27.1	8.7	31.5	10.5- 44.6	1.9997	0.3155	15.8	1.3811-3.6183	35.4	18.6- 66.6
	1978	26.0	4.5	16.9	18.0- 35.8	2.7908	0.1762	6.3	2.4452-3.1364	29.1	20.3- 41.5
	1979	26.1	6.7	25.6	13.0- 39.2	2.4192	0.3009	12.4	1.8292-3.0092	34.3	18.6- 62.7
	1980	56.8	21.8	38.3	14.2- 99.5	2.2990	0.4307	18.7	1.4548-3.1432	84.4	35.7- 197.7
	1981	18.7	4.1	22.0	10.6- 26.8	2.2330	0.2278	10.2	1.7865-2.6795	23.6	14.8- 37.5
Northern Edge and Peak	1975	207.1	70.7	33.9	69.8-346.7	3.5373	0.3785	10.7	2.7956-4.2790	446.2	212.0- 937.8
	1977[1]	450.9	91.2	20.2	272.2-629.7	3.8416	0.2272	5.9	3.3964-4.2868	1269.5	813.0-1982.1
	1978[1]	550.1	64.5	11.7	424.0-677.2	5.7736	0.1112	1.9	5.5553-5.9919	559.5	450.0- 696.2
	1979[1]	296.8	27.6	9.2	245.0-353.4	4.8503	0.1853	3.8	4.4873-5.2133	418.8	291.0- 602.5
	1980[1]	727.5	119.2	16.4	494.2-961.6	4.0011	0.1184	3.0	3.7692-4.2330	2201.5	1745.6-2776.4
	1981[1]	681.9	116.5	17.1	454.7-911.5	4.7078	0.2198	4.7	4.2770-5.1386	1906.7	1239.0-2933.8
Georges Bank (all areas)	1975	108.7	27.1	24.9	56.0-162.3	2.9822	0.1796	6.0	2.6299-3.3345	124.3	87.1- 177.3
	1977	204.0	36.6	17.9	132.5-276.1	2.5088	0.1518	6.1	2.2116-2.8060	243.5	180.6- 328.1
	1978	218.4	23.3	10.7	173.2-264.7	3.2682	0.1113	3.4	3.0499-3.4865	626.9	503.8- 780.0
	1979	149.6	19.7	13.1	111.9-189.1	3.0133	0.1211	4.0	2.7757-3.2509	248.3	195.6- 315.2
	1980	379.8	57.7	15.2	267.0-493.0	2.8509	0.1194	4.2	2.6173-3.0845	487.0	385.4- 615.4
	1981	196.2	15.4	7.8	166.0-226.7	2.5633	0.1467	5.7	2.2759-2.8507	175.0	131.0- 233.6

[1]Stratified mean catch (number) per tow indices for the Northern Edge and Peak, 1978-1981, were derived from Canadian sea scallop research survey data post-stratified into USA sampling strata and standardized for differences in tow distance between USA and Canadian standard survey tows.

Table 33. Standardized stratified mean catch (number) per tow of sea scallops from USA sea scallop research vessel surveys in the Mid-Atlantic, 1975, 1977-1981. Standard deviation of the mean (S.D.), coefficient of variation (C.V.: 100 S.D./Mean), and 95% confidence limits are provided as indices of variability. Data are summarized by the three principal sea scallop regions in the Mid-Atlantic and for the entire Mid-Atlantic area.

		Linear				ln (x + 1)				Re-Transformed	
Region	Year	Mean	S.D.	C.V.	Confidence Limits	Mean	S.D.	C.V.	Confidence Limits	Mean	Confidence Limits
New York Bight	1975	50.8	10.0	19.5	31.6- 70.7	2.1907	0.2197	10.0	1.7599-2.6215	62.4	40.2- 96.6
	1977	40.5	3.5	8.7	33.8- 47.7	2.1368	0.1485	6.9	1.8461-2.4275	71.3	53.0- 95.6
	1978	38.6	3.6	8.8	32.4- 46.0	2.2003	0.1251	5.7	1.9547-2.4459	61.6	48.0- 79.1
	1979	17.6	2.1	11.8	13.5- 21.7	2.0713	0.1153	5.6	1.8453-2.2973	19.5	15.4- 24.7
	1980	21.5	2.6	11.9	16.4- 26.5	1.9366	0.1175	6.1	1.7064-2.1668	24.4	19.2- 31.0
	1981	26.6	4.9	18.5	17.0- 36.3	1.8141	0.1197	6.6	1.5797-2.0485	22.5	17.6- 28.7
Delmarva	1975	40.8	11.0	26.7	19.7- 62.9	2.7166	0.3022	11.1	2.1244-3.3088	50.2	27.3- 91.6
	1977	27.3	3.6	13.4	20.0- 34.2	2.6288	0.2540	9.7	2.1310-3.1266	39.9	23.8- 66.2
	1978	34.3	3.4	9.9	27.8- 41.2	2.0714	0.2233	10.9	1.6336-2.5092	50.1	32.0- 78.2
	1979	70.1	26.1	37.2	19.0-121.2	2.2576	0.2585	15.9	1.5547-2.9605	110.5	54.2-224.1
	1980	36.7	7.0	19.0	23.1- 50.4	2.0951	0.2377	11.3	1.6292-2.5610	38.9	24.0- 62.6
	1981	8.7	2.4	27.3	4.1- 13.4	1.3413	0.2161	16.1	0.9177-1.7649	8.5	5.2- 13.5
Virginia-No. Carolina	1975	58.6	0.7	1.2	57.5- 60.3	0.5630	0.1004	17.8	0.3660-0.7600	6.8	5.4- 8.4
	1977	0.4	0.2	36.1	0.1- 0.8	0.1935	0.0981	50.7	0.0015-0.3855	0.4	0.1- 0.7
	1978	22.5	14.0	60.8	-4.4- 50.3	1.4280	0.5539	38.8	0.3424-2.5136	24.4	7.6- 74.3
	1979	11.1	2.3	20.9	6.5- 15.6	1.2907	0.3482	27.0	0.6081-1.9733	11.0	5.1- 22.7
	1980	5.4	0.4	7.5	4.6- 6.2	0.5469	0.0810	14.8	0.3877-0.7061	2.6	2.0- 3.2
	1981	1.2	0.4	36.4	0.4- 2.1	0.3542	0.1167	32.9	0.1256-0.5828	0.9	0.5- 1.4
Mid-Atlantic (all areas)	1975	48.3	6.6	13.5	35.8- 61.5	2.1812	0.1580	7.2	1.8713-2.4911	54.5	39.7- 74.6
	1977	31.8	2.3	7.3	27.3- 36.4	2.0851	0.1184	5.7	1.8532-2.3170	48.1	38.0- 60.9
	1978	35.2	2.8	7.7	30.3- 41.1	2.0661	0.1210	5.9	1.8293-2.3029	52.0	40.8- 66.1
	1979	36.8	9.7	26.4	17.7- 55.8	2.1101	0.1496	7.1	1.8168-2.4034	36.5	27.0- 49.3
	1980	26.1	2.9	11.3	20.4- 31.9	1.9168	0.1101	5.7	1.7012-2.1324	27.2	21.7- 34.0
	1981	18.6	3.0	16.0	12.8- 24.4	1.5529	0.1044	6.7	1.3483-1.7575	14.5	11.6- 18.0

Table 34. Summary statistics of sea scallop shell height-meat weight data, by area caught and year.

			Shell Height (mm)						Meat Weight (g)					
Area	Year	n	$\bar{X}$	S.D.	S.E.	C.V.	Min	Max	$\bar{X}$	S.D.	S.E.	C.V.	Min	Max
Georges Bank	1978	316	109.29	14.29	0.80	13.07	80	145	21.51	9.60	0.54	44.62	5.61	52.53
	1979	543	112.20	27.30	1.17	24.33	23	169	27.13	16.78	0.72	61.84	0.21	76.12
	1980	868	77.90	28.67	0.97	36.81	32	163	11.87	13.67	0.46	115.22	0.29	75.13
	1981	1309	102.97	25.92	0.72	25.18	44	168	22.12	16.66	0.46	75.32	0.66	89.53
	All	3036	98.11	29.23	0.53	29.79	23	169	20.02	16.19	0.29	80.86	0.21	89.53
Mid-Atlantic	1977	784	99.71	18.15	0.65	18.20	40	152	15.75	8.96	0.32	56.90	0.62	69.08
	1978	1196	110.26	12.41	0.36	11.25	67	149	22.99	8.99	0.26	39.10	3.31	67.73
	1979	1546	102.21	21.92	0.56	21.44	29	156	21.61	13.80	0.35	63.86	0.08	77.06
	1980	2980	85.72	31.98	0.59	37.30	25	156	17.77	17.10	0.31	96.26	0.14	91.92
	1981	2486	97.28	26.03	0.52	26.75	46	162	21.43	17.85	0.36	83.29	1.07	117.73
	All	8992	96.23	26.98	0.28	28.04	25	162	19.96	15.52	0.16	77.75	0.08	117.73
Gulf of Maine (offshore)	1980	1726	89.15	11.39	0.27	12.78	36	123	8.84	3.98	0.10	44.97	0.40	24.40

Table 35. Regression parameters and statistics for shell height (mm) - meat weight (g) regressions for Northwest Atlantic sea scallops, by area and year. Regressions are of the form: ln meat weight (g) = ln a + b (ln shell height $_{(mm)}$).

		Regression Statistics								
Area	Year	N	Intercept (a)	Slope (b)	ln $\bar{x}$	ln $\bar{y}$	ln s_x	ln s_y	Correlation Coefficient (r)	Residual Mean Square Error
Georges Bank	1978	316	-11.4122	3.0700	4.6855	2.9723	0.13047	0.44139	0.907	0.03449
	1979	543	-11.5638	3.1100	4.6823	2.9982	0.29751	0.94710	0.977	0.04099
	1980	868	-12.6358	3.3640	4.2903	1.7968	0.35857	1.23480	0.977	0.06993
	1981	1309	-11.2338	3.0491	4.6016	2.7969	0.25829	0.82285	0.957	0.05690
All Years	1978-1981	3036	-11.8347	3.1748	4.5356	2.5651	0.32933	1.07275	0.974	0.05827
Mid-Atlantic	1977	784	-12.9111	3.3764	4.5840	2.5663	0.19626	0.68125	0.973	0.02501
	1978	1196	-11.1600	3.0284	4.6962	3.0620	0.11420	0.38758	0.892	0.03064
	1979	1546	-12.2628	3.2788	4.6007	2.8221	0.23829	0.80429	0.971	0.03646
	1980	2980	-12.3302	3.3166	4.3703	2.1640	0.41690	1.40150	0.987	0.05248
	1981	2486	-12.3379	3.3078	4.5398	2.6787	0.27674	0.93357	0.981	0.03363
All Years	1977-1981	8992	-12.0356	3.2335	4.5179	2.5732	0.32703	1.07915	0.980	0.04634
Gulf of Maine (offshore)	1980	1726	-13.5356	3.4813	4.4810	2.0642	0.13791	0.51368	0.935	0.03338

Table 36. Regression parameters and statistics for meat weight (g) - shell height (mm) regressions for Northwest Atlantic sea scallops, by area and year. Regressions are of the form: $\ln \text{shell height}_{(mm)} = \ln a + b\,(\ln \text{meat weight}_{(g)})$.

Area	Year	N	Intercept (a)	Slope (b)	$\ln \bar{x}$	$\ln \bar{y}$	$\ln s_x$	$\ln s_y$	Correlation Coefficient (r)	Residual Mean Square Error
		Regression Statistics								
Georges Bank	1978	316	3.8882	0.26825	2.9723	4.6855	0.44139	0.13047	0.907	0.00301
	1979	543	3.7622	0.30688	2.9982	4.6823	0.94710	0.29751	0.977	0.00404
	1980	868	3.7807	0.28365	1.7968	4.2903	1.23480	0.35857	0.977	0.00590
	1981	1309	3.7613	0.30043	2.7969	4.6016	0.82285	0.25829	0.957	0.00561
All Years	1978-1981	3036	3.7686	0.29904	2.5651	4.5356	1.07275	0.32923	0.974	0.00549
Mid-Atlantic	1977	784	3.8648	0.28023	2.5663	4.5840	0.68125	0.19626	0.973	0.00208
	1978	1196	3.8912	0.26291	3.0620	4.6962	0.38758	0.11420	0.892	0.00266
	1979	1546	3.7884	0.28781	2.8221	4.6007	0.80429	0.23829	0.971	0.00320
	1980	2980	3.7352	0.29346	2.1640	4.3703	1.40150	0.41690	0.987	0.00464
	1981	2486	3.7612	0.29066	2.6787	4.5398	0.93357	0.27674	0.981	0.00296
All Years	1977-1981	8992	3.7538	0.29696	2.5732	4.5179	1.07915	0.32703	0.980	0.00426
Gulf of Maine (offshore)	1980	1726	3.9630	0.25093	2.0642	4.4810	0.51368	0.13791	0.935	0.00241

Table 37. Calculated meats weights (g) at shell height (mm) for sea scallops from Georges Bank, the Mid-Atlantic area, offshore Gulf of Maine, and inshore Gulf of Maine.

	Calculated Meat Weight (g)			
Shell Height (mm)	Georges Bank[1]	Mid Atlantic[2]	Offshore Gulf of Maine[3]	Inshore Gulf of Maine[4]
40	0.88	0.90	0.50	0.44
50	1.80	1.85	1.09	0.99
60	3.20	3.33	2.05	1.93
70	5.22	5.48	3.51	3.39
80	7.98	8.45	5.58	5.53
90	11.60	12.36	8.41	8.52
100	16.21	17.38	12.13	12.53
110	21.94	23.65	16.91	17.77
120	28.92	31.33	22.89	24.44
130	37.29	40.59	30.25	32.77
140	47.18	51.58	39.15	42.99
150	58.74	64.47	49.78	55.36
160	72.09	79.44	62.32	70.13
170	87.39	96.64	76.96	87.57
180	104.78	116.26	93.90	107.97

[1] Calculated from NMFS 1978-1981 Georges Bank research survey shell height-meat weight equation,

$$\text{Meat Weight (g)} = 7.24854 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.1748} \quad (N = 3036,\ r = 0.97)$$

[2] Calculated from NMFS 1977-1981 Mid-Atlantic research survey shell height-meat weight equation,

$$\text{Meat Weight (g)} = 5.92915 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.2335} \quad (N = 8992,\ r = 0.98)$$

[3] Calculated from NMFS 1980 offshore Gulf of Maine commercial sample shell height-meat weight equation,

$$\text{Meat Weight (g)} = 1.32248 \times 10^{-6} \text{ Shell Height}_{(mm)}^{3.4813} \quad (N = 1726,\ r = 0.93)$$

[4] Calculated from inshore Gulf of Maine (Penobscot Bay) commercial sample shell height-meat weight equation,

$$\text{Meat Weight (g)} = 5.88847 \times 10^{-7} \text{ Shell Height}_{(mm)}^{3.6664} \quad (N = 1107, \text{ from Haynes, 1966}).$$

Table 38. Calculated shell heights (mm) at meat weight (g) for sea scallops from Georges Bank, the Mid-Atlantic area, offshore Gulf of Maine, and inshore Gulf of Maine.

Meat Weight (g)	Meat Count	Calculated Shell Height (mm)				Largest % Difference in Shell Height Between Two Most Extreme Values
		Georges[1] Bank	Mid[2] Atlantic	Offshore[3] Gulf of Maine	Inshore[4] Gulf of Maine	
7.56	60	79.3	77.8	87.4	87.1	12.0%
8.25	55	81.4	79.9	89.3	89.2	11.8
9.07	50	83.8	82.2	91.5	91.6	11.4
10.08	45	86.4	84.8	94.0	94.2	11.1
11.34	40	89.5	87.8	96.8	97.3	10.8
12.96	35	93.2	91.3	100.1	100.9	10.5
15.12	30	97.6	95.6	104.0	105.3	10.1
18.14	25	103.1	100.9	108.9	110.6	9.6
22.68	20	110.2	107.9	115.2	117.6	9.0

[1] Calculated from NMFS 1978-1981 Georges Bank research survey sea scallop meat weight-shell height equation,

$$\text{Shell Height (mm)} = 43.3194 \text{ Meat Weight (g)}^{0.29904} \quad (N = 3036,\ r = 0.97).$$

[2] Calculated from NMFS 1977-1981 Mid-Atlantic research survey sea scallop meat weight-shell height equation,

$$\text{Shell Height (mm)} = 42.6830 \text{ Meat Weight (g)}^{0.29696} \quad (N = 8992,\ r = 0.98)$$

[3] Calculated from NMFS 1980 offshore Gulf of Maine commercial sample sea scallop meat weight - shell height equation,

$$\text{Shell Height (mm)} = 52.6149 \text{ Meat Weight (g)}^{0.25093} \quad (N = 1726,\ r = 0.93).$$

[4] Calculated by inverse prediction from inshore Gulf of Maine (Penobscot Bay) commercial sample sea scallop meat weight - shell height equation,

$$\text{Shell Height (mm)} = (169.8234 \times 10^4 \text{ Meat Weight (g)})^{0.27293} \quad (N = 1107, \text{ from Haynes, 1966}).$$

Table 39. Summary statistics of sea scallop shell height, meat weight, and ovary weight data used in deriving shell height-ovary weight and meat weight-ovary weight relationships. All data collected from the 1981 USA sea scallop research vessel survey.

		Shell Height (mm)						Meat Weight (g)						Ovary Weight (g)					
Area	N	$\bar{x}$	S.D.	S.E.	C.V.	Min	Max	$\bar{x}$	S.D.	S.E.	C.V.	Min	Max	$\bar{x}$	S.D.	S.E.	C.V.	Min	Max
Georges Bank	647	106.38	24.45	0.96	22.98	46	168	24.38	17.02	0.67	69.79	1.27	89.53	11.15	9.64	0.38	86.45	0.13	68.63
South Channel	475	104.77	24.80	1.14	23.67	46	166	23.85	17.58	0.81	73.74	1.27	89.53	12.08	10.46	0.48	86.62	0.13	68.63
Southeast Part	172	110.81	22.92	1.75	20.68	74	168	25.86	15.29	1.17	59.14	4.45	74.60	8.60	6.24	0.48	72.52	1.01	34.43
Mid-Atlantic	1123	103.98	24.53	0.73	23.59	50	162	25.41	18.53	0.55	72.92	1.69	117.73	6.51	5.76	0.17	88.51	0.08	52.94
New York Bight	749	101.41	24.76	0.90	24.41	50	162	23.57	17.93	0.66	76.08	1.69	111.75	5.80	4.87	0.18	84.07	0.08	49.40
Delmarva	366	108.98	23.45	1.23	21.52	52	154	29.00	19.29	1.01	66.51	2.05	117.73	7.87	6.94	0.36	88.19	0.28	52.94
Virginia-No. Carolina	8	116.00	9.87	3.49	8.51	105	137	32.96	12.07	4.27	36.61	18.92	60.30	11.56	9.80	3.47	84.77	3.22	29.71
All Areas	1770	104.85	24.52	0.58	23.38	46	168	25.03	17.99	0.43	71.87	1.27	117.73	8.21	7.75	0.18	94.38	0.08	68.63

Table 40. Statistics describing regression equation between shell height (mm) and ovary weight (g) for Northwest Atlantic sea scallops, by area. Regressions are of the form: ln ovary weight (g) = ln a + b (ln shell height).

	Regression Statistics								
Area	N	Intercept (a)	Slope (b)	ln $\bar{x}$	ln $\bar{y}$	ln s_x	ln s_y	Correlation Coefficient (r)	Residual Mean Square Error
Georges Bank	647	-14.7635	3.6171	4.6404	2.0213	0.23091	0.95486	0.875	0.21449
South Channel	475	-16.1495	3.9402	4.6237	2.0688	0.23788	1.01660	0.922	0.15534
Southeast Part	172	-11.4974	2.8564	4.6869	1.8903	0.20400	0.74569	0.781	0.21780
Mid-Atlantic	1123	-15.1163	3.5895	4.6147	1.4482	0.24521	1.02600	0.858	0.27827
New York Bight	749	-14.9297	3.5438	4.5880	1.3293	0.25185	1.05230	0.848	0.31126
Delmarva	366	-15.2204	3.6207	4.6668	1.6767	0.22401	0.92838	0.874	0.20462
Virginia-No. Carolina	8	-25.2334	5.7627	4.7506	2.1429	0.08196	0.82802	0.570	0.53962
All Areas	1770	-15.2127	3.6484	4.6240	1.6575	0.24034	1.0378	0.845	0.30824

Table 41. Statistics describing regression equations between meat weight (g) and ovary weight (g) for Northwest Atlantic sea scallops, by area. Regressions are of the form: ln ovary weight (g) = ln a + b (ln meat weight).

Area	N	Regression Statistics							
		Intercept (a)	Slope (b)	$\overline{\ln x}$	$\overline{\ln y}$	$\ln s_x$	$\ln s_y$	Correlation Coefficient (r)	Residual Mean Square Error
Georges Bank	647	-1.3743	1.1532	2.9446	2.0213	0.73509	0.95486	0.888	0.19348
South Channel	475	-1.4255	1.2061	2.8971	2.0688	0.77120	1.01660	0.915	0.16873
Southeast Part	172	-1.3526	1.0543	3.0759	1.8903	0.60768	0.74569	0.859	0.14646
Mid-Atlantic	1123	-1.6646	1.0618	2.9316	1.4482	0.82691	1.02600	0.856	0.28210
New York Bight	749	-1.6305	1.0447	2.8333	1.3293	0.85296	1.05230	0.847	0.31387
Delmarva	366	-1.7288	1.0909	3.1218	1.6767	0.73975	0.92838	0.869	0.21129
Virginia-No. Carolina	8	-1.6150	1.0904	3.4463	2.1429	0.32333	0.82802	0.426	0.65486
All Areas	1770	-1.5521	1.0931	2.9361	1.6575	0.79437	1.03780	0.837	0.32310

Table 42. Calculated ovary weight (g) at shell height (mm), by area, for sea scallops from Georges Bank and the Mid-Atlantic.

Shell Height (mm)	Area							
	South Channel	Southeast Part	New York Bight	Delmarva	Virginia-No. Carolina	Georges Bank	Mid Atlantic	All Areas
50	0.48	0.72	0.34	0.35	0.07	0.54	0.34	0.39
60	0.98	1.22	0.66	0.67	0.19	1.05	0.66	0.76
70	1.80	1.89	1.13	1.18	0.47	1.83	1.14	1.33
80	3.05	2.77	1.82	1.91	1.02	2.96	1.85	2.17
90	4.86	3.88	2.76	2.92	2.01	4.54	2.82	3.33
100	7.36	5.24	4.02	4.28	3.69	6.64	4.11	4.90
110	10.71	6.88	5.63	6.04	6.39	9.38	5.79	6.93
120	15.09	8.83	7.66	8.28	10.54	12.85	7.91	9.53
130	20.69	11.09	10.17	11.06	16.72	17.16	10.55	12.76
140	27.70	13.71	13.23	14.47	25.63	22.44	13.76	16.72
150	36.36	16.79	16.89	18.57	38.14	28.80	17.63	21.50
160	46.89	20.07	21.24	23.46	55.33	36.38	22.22	27.21
170	59.54	23.87	26.33	29.22	78.47	45.29	27.62	33.95

Table 43. Calculated ovary weight (g) at selected meat weight sizes (g), by area, for sea scallops from Georges Bank and the Mid-Atlantic.

Meat Weight (g)	Area								
	Meat Count	South Channel	Southeast Part	New York Bight	Delmarva	Virginia-No. Carolina	Georges Bank	Mid Atlantic	All Areas
7.56	60	2.76	2.18	1.62	1.61	1.81	2.61	1.62	1.93
8.25	55	3.06	2.39	1.78	1.77	1.99	2.88	1.78	2.13
9.07	50	3.43	2.64	1.96	1.97	2.20	3.22	1.97	2.36
10.08	45	3.90	2.95	2.19	2.21	2.47	3.63	2.20	2.65
11.34	40	4.50	3.35	2.48	2.51	2.81	4.16	2.49	3.01
12.96	35	5.28	3.85	2.85	2.90	3.25	4.86	2.87	3.48
15.12	30	6.36	4.53	3.34	3.44	3.84	5.80	3.38	4.12
18.14	25	7.92	5.49	4.04	4.19	4.69	7.15	4.11	5.03
22.68	20	10.37	6.95	5.11	5.35	5.98	9.26	5.21	6.42

Table 44. Yield (grams, meat weight) per recruit for Georges Bank sea scallops as a function of fishing mortality rate (F) and age at first capture (t_c). Natural mortality (M) = 0.1, and age at recruitment (t_p) = 2.0 years.

Fishing Mortality Rate (F)	Age at first capture (t_c, years) and corresponding shell height (mm) and meat weight (g)[1]																		
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0
	(25.6)	(45.3)	(62.0)	(76.0)	(87.9)	(97.9)	(106.4)	(113.5)	(119.6)	(124.7)	(129.0)	(132.6)	(135.7)	(138.3)	(140.5)	(142.4)	(143.9)	(145.3)	(146.4)
	(0.2)	(1.3)	(3.6)	(6.8)	(10.8)	(15.2)	(19.7)	(24.2)	(28.6)	(32.7)	(36.4)	(39.7)	(42.7)	(45.4)	(47.7)	(49.8)	(51.5)	(53.1)	(54.4)
0.1	12.7	13.4	13.9	14.4	14.8	15.0	15.1	15.1	14.9	14.6	14.3	13.9	13.4	12.9	12.3	11.7	11.1	10.5	9.9
0.2	13.0	14.3	15.6	16.8	17.8	18.6	19.1	19.5	19.6	19.6	19.4	19.0	18.6	18.1	17.5	16.8	16.1	15.4	14.7
0.3	11.3	13.0	14.7	16.4	17.9	19.1	20.1	20.7	21.2	21.4	21.3	21.1	20.8	20.4	19.8	19.2	18.5	17.8	17.1
0.4	9.5	11.4	13.5	15.5	17.3	18.8	20.1	21.0	21.7	22.1	22.2	22.1	21.9	21.5	21.0	20.5	19.8	19.1	18.4
0.5	8.0	10.0	12.3	14.5	16.6	18.4	19.9	21.0	21.8	22.4	22.6	22.6	22.5	22.2	21.7	21.2	20.6	19.9	19.2
0.6	6.8	8.9	11.3	13.7	15.9	17.9	19.6	20.9	21.8	22.5	22.8	22.9	22.8	22.6	22.2	21.7	21.1	20.4	19.7
0.7	5.8	8.0	10.4	12.9	15.3	17.4	19.2	20.7	21.7	22.5	22.9	23.1	23.1	22.8	22.5	22.0	21.4	20.8	20.1
0.8	5.0	7.2	9.7	12.3	14.8	17.0	18.9	20.5	21.6	22.5	23.0	23.2	23.2	23.0	22.7	22.2	21.7	21.0	20.3
0.9	4.4	6.5	9.1	11.7	14.3	16.7	18.7	20.3	21.5	22.4	23.0	23.3	23.3	23.2	22.8	22.4	21.8	21.2	20.6
1.0	3.9	6.0	8.6	11.3	13.9	16.3	18.4	20.1	21.4	22.4	23.0	23.3	23.4	23.3	23.0	22.5	22.0	21.4	20.7
1.1	3.5	5.6	8.1	10.9	13.6	16.0	18.2	19.9	21.3	22.3	23.0	23.3	23.4	23.3	23.1	22.6	22.1	21.5	20.9
1.2	3.1	5.2	7.7	10.5	13.2	15.8	18.0	19.8	21.2	22.3	23.0	23.4	23.5	23.4	23.1	22.7	22.2	21.6	21.0
1.3	2.8	4.8	7.4	10.2	13.0	15.5	17.8	19.7	21.1	22.2	22.9	23.4	23.5	23.4	23.2	22.8	22.3	21.7	21.1
1.4	2.6	4.6	7.1	9.9	12.7	15.3	17.6	19.5	21.0	22.2	22.9	23.4	23.5	23.5	23.3	22.9	22.4	21.8	21.1
1.5	2.3	4.3	6.8	9.7	12.5	15.1	17.5	19.4	21.0	22.1	22.9	23.4	23.6	23.5	23.3	22.9	22.4	21.8	21.2

[1] Shell height derived from Von Bertalanffy growth equation: $l_t = 152.46\ (1-e^{-.3374(t-1.4544)})$.

Meat weight derived from shell height-meat weight equation: $\text{Meat Weight}_{(g)} = 7.24854 \times 10^{-6}\ \text{Shell Height}_{(mm)}^{3.1748}$.

Table 45. Yield (grams, meat weight) per recruit for Mid-Atlantic sea scallops as a function of fishing mortality rate (F) and age at first capture (t_c). Natural mortality (M) = 0.1, and age at recruitment (t_p) = 2.0 years.

Fishing Mortality Rate (F)	Age at first capture (t_c, years) and corresponding shell height (mm) and meat weight (g)[1]																		
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0
	(35.0)	(51.3)	(65.3)	(77.3)	(87.7)	(96.6)	(104.3)	(110.9)	(116.6)	(121.5)	(125.7)	(129.4)	(132.5)	(135.2)	(137.5)	(139.5)	(141.2)	(142.7)	(144.0)
	(0.6)	(2.0)	(4.4)	(7.6)	(11.4)	(15.5)	(19.9)	(24.3)	(28.6)	(32.6)	(36.4)	(40.0)	(43.2)	(46.1)	(48.7)	(51.0)	(53.0)	(54.9)	(56.5)
0.1	13.2	13.8	14.4	14.9	15.2	15.4	15.5	15.5	15.4	15.1	14.8	14.4	14.0	13.5	12.9	12.3	11.7	11.1	10.5
0.2	13.5	14.9	16.0	17.2	18.2	18.9	19.5	19.9	20.1	20.1	19.9	19.7	19.3	18.8	18.2	17.6	16.9	16.2	15.5
0.3	11.7	13.4	15.1	16.7	18.2	19.4	20.4	21.1	21.6	21.8	21.9	21.8	21.5	21.1	20.6	20.1	19.4	18.7	18.0
0.4	9.9	11.9	13.9	15.8	17.5	19.1	20.3	21.3	22.0	22.5	22.7	22.7	22.5	22.2	21.8	21.3	20.7	20.1	19.4
0.5	8.4	10.5	12.7	14.8	16.8	18.6	20.0	21.2	22.1	22.7	23.0	23.2	23.1	22.9	22.5	22.0	21.5	20.9	20.2
0.6	7.3	9.4	11.7	14.0	16.1	18.0	19.7	21.0	22.0	22.7	23.2	23.4	23.4	23.2	22.9	22.5	22.0	21.4	20.7
0.7	6.3	8.5	10.8	13.2	15.5	17.6	19.3	20.8	21.9	22.7	23.2	23.5	23.6	23.5	23.2	22.8	22.3	21.7	21.1
0.8	5.6	7.7	10.2	12.6	15.0	17.2	19.0	20.6	21.8	22.7	23.3	23.6	23.7	23.6	23.4	23.0	22.5	21.9	21.3
0.9	4.9	7.1	9.6	12.1	14.5	16.8	18.7	20.3	21.6	22.6	23.2	23.6	23.8	23.7	23.5	23.2	22.7	22.1	21.5
1.0	4.4	6.6	9.1	11.6	14.1	16.4	18.5	20.2	21.5	22.5	23.2	23.7	23.8	23.8	23.6	23.3	22.8	22.3	21.7
1.1	4.0	6.2	8.6	11.2	13.8	16.2	18.2	20.0	21.4	22.4	23.2	23.7	23.9	23.9	23.7	23.4	22.9	22.4	21.8
1.2	3.7	5.8	8.3	10.9	13.5	15.9	18.0	19.8	21.3	22.4	23.2	23.7	23.9	23.9	23.8	23.5	23.0	22.5	21.9
1.3	3.4	5.5	8.0	10.6	13.2	15.7	17.8	19.7	21.2	22.3	23.1	23.7	23.9	24.0	23.8	23.5	23.1	22.6	22.0
1.4	3.1	5.2	7.7	10.3	13.0	15.5	17.7	19.5	21.1	22.2	23.1	23.6	23.9	24.0	23.9	23.6	23.2	22.7	22.1
1.5	2.9	5.0	7.4	10.1	12.8	15.3	17.5	19.4	21.0	22.2	23.1	23.6	23.9	24.0	23.9	23.6	23.2	22.7	22.1

[1] Shell height derived from von Bertalanffy growth equation: $l_t = 151.84\ (1-e^{-.2997(t-1.1256)})$.

Meat weight derived from shell height-meat weight equation: $\text{Meat Weight}_{(g)} = 5.92915 \times 10^{-6}\ \text{Shell Height}_{(mm)}^{3.2335}$.

Table 46. Yield (grams, meat weight) per recruit for Gulf of Maine sea scallops as a function of fishing mortality rate (F) and age at first capture (t_c). Natural mortality (M) = 0.1, and age at recruitment (t_p) = 2.0 years.

Fishing Mortality Rate (F)	Age at first capture (t_c, years) and corresponding shell height (mm) and meat weight (g)[1]																		
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0
	(26.9)	(42.3)	(56.1)	(68.4)	(79.4)	(89.3)	(98.2)	(106.1)	(113.2)	(119.6)	(125.3)	(130.4)	(135.0)	(139.1)	(142.8)	(146.1)	(149.0)	(151.6)	(154.0)
	(0.1)	(0.6)	(1.6)	(3.2)	(5.4)	(8.2)	(11.4)	(14.9)	(18.7)	(22.6)	(26.6)	(30.6)	(34.5)	(38.3)	(41.9)	(45.4)	(48.7)	(51.7)	(54.6)
0.1	11.1	11.6	12.2	12.7	13.2	13.6	13.9	14.1	14.2	14.3	14.2	14.1	13.8	13.6	13.2	12.8	12.4	11.9	11.3
0.2	10.2	11.3	12.4	13.5	14.5	15.5	16.3	17.0	17.6	18.0	18.3	18.5	18.5	18.4	18.2	17.9	17.5	17.0	16.5
0.3	8.1	9.4	10.8	12.2	13.6	14.9	16.1	17.2	18.1	18.8	19.4	19.8	20.1	20.2	20.2	20.0	19.7	19.4	18.9
0.4	6.4	7.7	9.2	10.8	12.4	13.9	15.4	16.7	17.8	18.8	19.6	20.2	20.6	20.9	21.0	20.9	20.8	20.5	20.2
0.5	5.0	6.4	7.9	9.6	11.3	13.0	14.6	16.1	17.4	18.5	19.5	20.2	20.8	21.1	21.3	21.4	21.3	21.1	20.8
0.6	4.1	5.4	7.0	8.7	10.5	12.3	14.0	15.6	17.0	18.2	19.3	20.1	20.7	21.2	21.5	21.6	21.6	21.4	21.2
0.7	3.4	4.6	6.2	7.9	9.8	11.6	13.4	15.1	16.6	17.9	19.1	20.0	20.7	21.2	21.5	21.7	21.7	21.6	21.4
0.8	2.8	4.1	5.6	7.3	9.2	11.1	12.9	14.7	16.3	17.7	18.9	19.8	20.6	21.2	21.6	21.8	21.8	21.8	21.6
0.9	2.4	3.6	5.1	6.8	8.7	10.7	12.6	14.3	16.0	17.4	18.7	19.7	20.5	21.1	21.6	21.8	21.9	21.9	21.7
1.0	2.1	3.2	4.7	6.4	8.3	10.3	12.2	14.0	15.7	17.2	18.5	19.6	20.4	21.1	21.6	21.8	22.0	21.9	21.8
1.1	1.8	2.9	4.4	6.1	8.0	10.0	11.9	13.8	15.5	17.0	18.4	19.5	20.4	21.0	21.5	21.8	22.0	22.0	21.8
1.2	1.6	2.7	4.1	5.8	7.7	9.7	11.7	13.6	15.3	16.9	18.2	19.4	20.3	21.0	21.5	21.8	22.0	22.0	21.9
1.3	1.4	2.5	3.9	5.6	7.5	9.5	11.5	13.4	15.1	16.7	18.1	19.3	20.2	20.9	21.5	21.8	22.0	22.0	21.9
1.4	1.3	2.3	3.7	5.4	7.3	9.3	11.3	13.2	15.0	16.6	18.0	19.2	20.1	20.9	21.5	21.8	22.0	22.1	22.0
1.5	1.2	2.1	3.5	5.2	7.1	9.1	11.1	13.0	14.8	16.5	17.9	19.1	20.1	20.9	21.4	21.8	22.0	22.1	22.0

[1] Shell height derived from Von Bertalanffy growth equation: $l_t = 174.32\ (1-e^{-.2202(t-1.2383)})$.

Meat Weight derived from shell height-meat weight equation: $\text{Meat Weight}_{(g)} = 1.32248 \times 10^{-6}\ \text{Shell Height}_{(mm)}^{3.4813}$

Table 47. Yield (grams, meat weight) per recruit for sea scallops from Georges Bank, the Mid-Atlantic, and the Gulf of Maine as a function of fishing mortality rate (F) for age at first capture (t_c) corresponding to 25, 30, 40, and 60 meat counts (number of meats per pound). Shell heights (mm) for each meat count and t_c values are also provided. F_{max} and $F_{0.1}$ values for each yield per recruit curve are also presented. All analyses performed with natural mortality rate (M) = 0.1 and age at recruitment (t_p) = 2.0 years.

				Fishing Mortality Rate (F)																
Region	Meat Count	Shell Height[1]	t_c	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	F_{max}	$F_{0.1}$
Georges Bank	25	103.1	4.797	15.1	18.9	19.7	19.6	19.3	18.9	18.5	18.2	17.9	17.6	17.4	17.1	16.9	16.7	16.6	0.33	0.17
	30	97.6	4.484	15.0	18.5	19.1	18.8	18.3	17.8	17.4	17.0	16.6	16.3	16.0	15.7	15.5	15.3	15.1	0.29	0.16
	40	89.5	4.076	14.8	17.9	18.1	17.6	16.9	16.2	15.7	15.1	14.7	14.3	13.9	13.6	13.4	13.1	12.9	0.26	0.15
	60	79.3	3.631	14.5	17.1	16.8	16.0	15.1	14.3	13.6	13.0	12.4	12.0	11.6	11.2	10.9	10.7	10.4	0.23	0.14
Mid-Atlantic	25	100.9	4.770	15.5	19.3	20.0	19.8	19.4	19.0	18.6	18.2	17.9	17.6	17.3	17.1	16.9	16.7	16.5	0.31	0.16
	30	95.6	4.440	15.4	18.9	19.3	18.9	18.4	17.8	17.3	16.9	16.5	16.2	15.9	15.6	15.4	15.2	15.0	0.28	0.15
	40	87.8	4.006	15.2	18.2	18.2	17.6	16.8	16.2	15.5	15.0	14.6	14.2	13.8	13.5	13.3	13.0	12.8	0.25	0.14
	60	77.8	3.522	14.9	17.2	16.8	15.9	14.9	14.1	13.4	12.7	12.2	11.8	11.4	11.0	10.7	10.5	10.2	0.22	0.13
Gulf of Maine	25	108.9	5.689	14.2	17.3	17.6	17.2	16.6	16.1	15.7	15.3	15.0	14.7	14.5	14.2	14.1	13.9	13.7	0.27	0.15
	30	104.0	5.361	14.0	16.9	16.9	16.3	15.7	15.1	14.6	14.2	13.9	13.6	13.3	13.1	12.8	12.7	12.5	0.25	0.15
	40	96.8	4.918	13.8	16.2	15.9	15.2	14.4	13.7	13.1	12.7	12.2	11.9	11.6	11.4	11.1	10.9	10.8	0.22	0.14
	60	87.4	4.399	13.5	15.3	14.6	13.6	12.7	11.9	11.3	10.7	10.3	9.9	9.6	9.3	9.1	8.9	8.7	0.20	0.13

[1] Shell height corresponding to the average meat weight per scallop for each meat count (60 count: 7.56 g; 30 count: 11.34 g; 30 count: 15.12 g; 25 count: 18.14 g) was derived from the following meat weight-shell height equations:

Georges Bank: $\text{Shell Height}_{(mm)} = 43.3194\ \text{Meat Weight}_{(g)}^{0.29904}$

Mid-Atlantic: $\text{Shell Height}_{(mm)} = 42.6830\ \text{Meat Weight}_{(g)}^{0.29696}$

Gulf of Maine: $\text{Shell Height}_{(mm)} = 52.6149\ \text{Meat Weight}_{(g)}^{0.25093}$

Table 48. Current status and recruitment prospects for sea scallop resources off New England and in the Mid-Atlantic.

Resource Area	USA Commercial Age Class Frequency[3]	Survey Year	Relative Abundance Indices[1,2] Pre-Recruit <70 mm	Recruit ≥70 mm	Total	Recruitment Prospects
Gulf of Maine						
Offshore: 30-60 fms	1980: '75 and '74 year classes dominant 1981: Mixed year classes, '76 year class and older	1975	1.2	1.4	2.6	Poor recruitment from the 1977 year class. Low level recruitment from the 1978 year class.
		1976	0.4	1.4	1.8	
		1977	0.4	1.5	1.9	
		1978	2.2	1.7	3.9	
		1979	0.7	3.0	3.7	
		1980	0.0	2.1	2.1	
		1981	0.5	1.2	1.7	
Offshore: 61-100 fms	1980-1981: Little, if any, commercial exploitation	1975	0.0	0.1	0.1	Very good recruitment from the 1976 year class.
		1976	<0.1	<0.1	0.1	
		1977	1.1	0.6	1.7	
		1978	4.1	0.7	4.8	
		1979	2.1	6.2	8.3	
		1980	0.1	33.0	33.1	
		1981	5.3	92.2	97.5	
Georges Bank						
South Channel	1980: Mixed year classes, '76 year class and older 1981: '77 year class predominant	1975	30.2	25.9	56.1	Very good recruitment from the 1977 year class. Low level recruitment from the 1978 year class.
		1977	4.0	52.5	56.5	
		1978	5.1	32.9	38.0	
		1979	4.5	56.5	61.0	
		1980	51.2	19.3	70.5	
		1981	9.9	24.0	33.9	
Southeast Part	1980: Mixed year classes, '76 year class and older 1981: Mixed year classes '76 and older	1975	1.8	38.2	40.0	Good recruitment from the 1977 year class. ~~Low level recruitment~~ from the 1978 year class.
		1977	2.8	24.3	27.1	
		1978	2.1	23.9	26.0	
		1979	6.9	19.2	26.1	
		1980	19.4	37.4	56.8	
		1981	1.3	17.4	18.7	
Northern Edge and Peak	1980: Mixed year classes, '75 year class and '72 year class predominant 1981: '77 year class predominant	1975	86.9	120.2	207.1	Exceptional recruitment from the 1977 year class. Very good recruitment from the 1978 year class.
		1977	66.2	384.7	450.9	
		1978	177.5	372.6	550.1	
		1979	63.9	232.9	296.8	
		1980	599.3	128.2	727.5	
		1981	277.0	404.9	681.9	
Mid-Atlantic						
New York Bight	1980: Mixed year classes none predominant 1981: Mixed year classes '76 and '74 year classes most predominant	1975	27.3	23.5	50.8	Low level recruitment from the 1977 and 1978 year classes.
		1977	1.1	39.4	40.5	
		1978	2.5	36.1	38.6	
		1979	3.9	13.7	17.6	
		1980	10.7	10.8	21.5	
		1981	13.1	13.5	26.6	
Delmarva	1980: Mixed year classes, '75 and '74 year classes most predominant 1981: Mixed year classes, '77 year class and older	1975	25.2	15.6	40.8	Low level recruitment from the 1977 and 1978 year classes.
		1977	3.3	24.0	27.3	
		1978	8.3	26.0	34.3	
		1979	30.8	39.3	70.1	
		1980	23.4	13.3	36.7	
		1981	2.8	5.9	8.7	
Virginia-No. Carolina	1980: '76 and '75 year classes predominant 1981: Mixed year classes, '76 year class and older	1975	47.7	10.9	58.6	Poor recruitment from the 1977 and 1978 year classes.
		1977	0.2	0.2	0.4	
		1978	15.4	7.1	22.5	
		1979	4.6	6.5	11.1	
		1980	0.8	4.6	5.4	
		1981	0.4	0.8	1.2	

[1] Relative abundance indices for Georges Bank and the Mid-Atlantic areas represent standardized stratified mean number per tow from sea scallop research vessel surveys. For all areas on Georges Bank, except the Northern Edge and Peak during 1978-1981, and for all areas in the Mid-Atlantic, the indices are derived from NMFS research vessel sea scallop surveys. The 1978-1981 Northern Edge and Peak indices are derived from Canadian research vessel sea scallop survey data standardized for dredge size and type, and for distance towed.

[2] Relative abundance indices for offshore Gulf of Maine represent stratified mean number per tow from NMFS spring offshore research vessel bottom trawl surveys.

[3] 1981 data derived from January-September commercial size-frequency samples only.

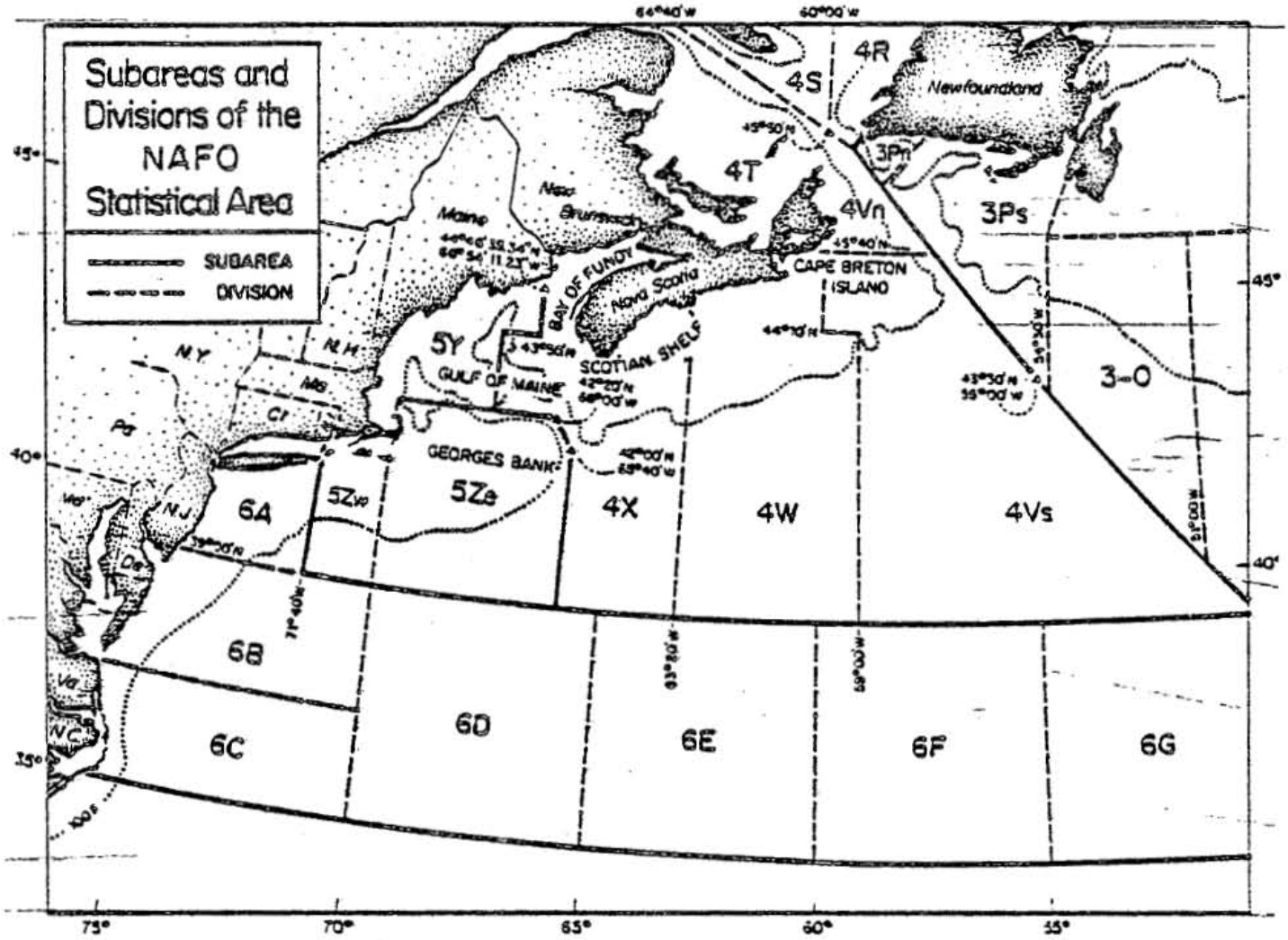


Figure 1. Northwest Atlantic from Newfoundland to North Carolina showing Northwest Atlantic Fishery Organization (NAFO) subareas and divisions. Principal USA sea scallop resources are located on Georges Bank (Subdivision 5Ze), in the Middle Atlantic (Statistical Area 6 encompassing Subareas 6A, 6B, and 6C), and in the Gulf of Maine (Division 5Y).

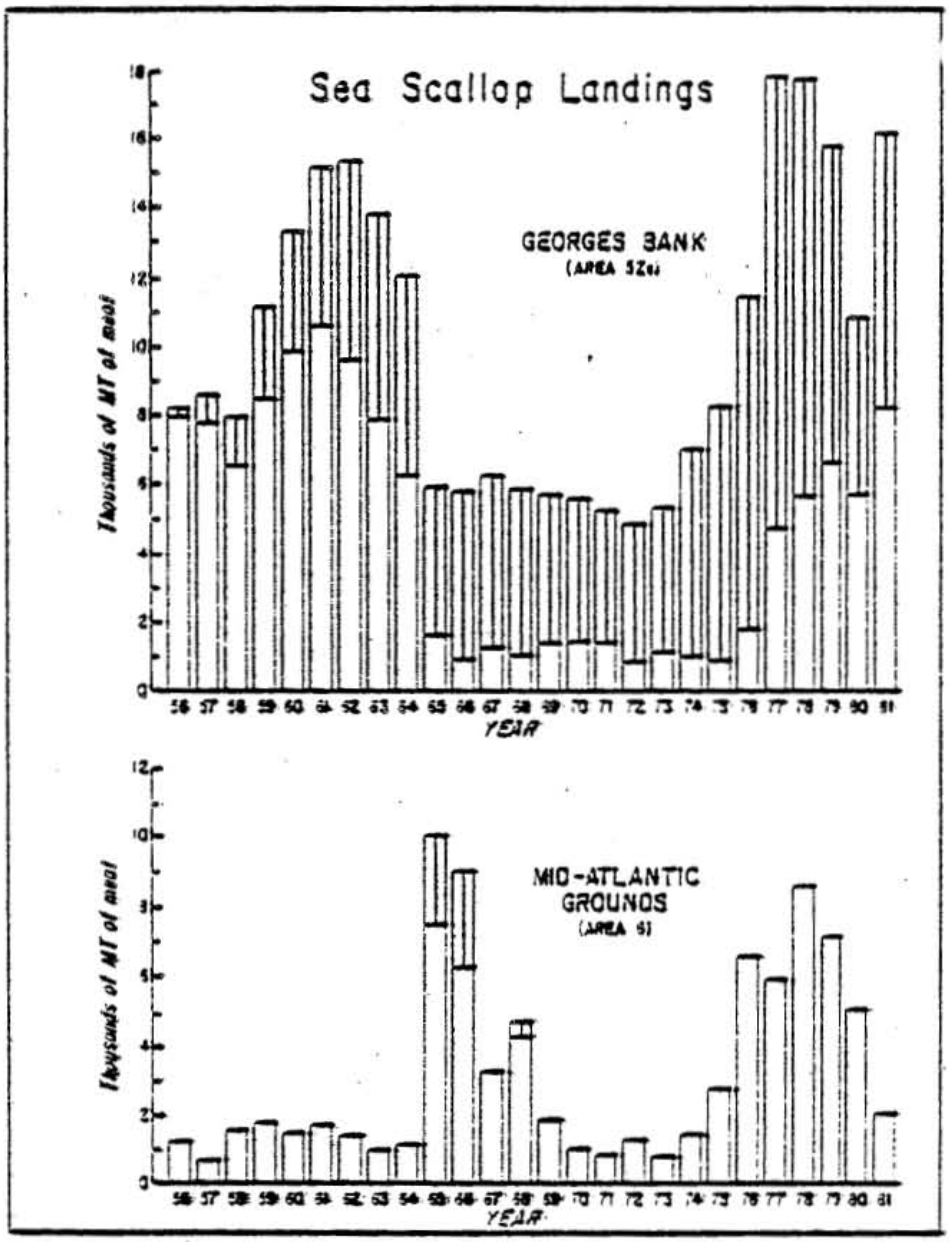


Figure 2. Total United States and Canadian commercial sea scallop landings (metric tons, meats) from Georges Bank (Area 5Ze) and the Middle Atlantic (Area 6), 1956-1981. The upper lined portions of the bars represent Canadian landings.

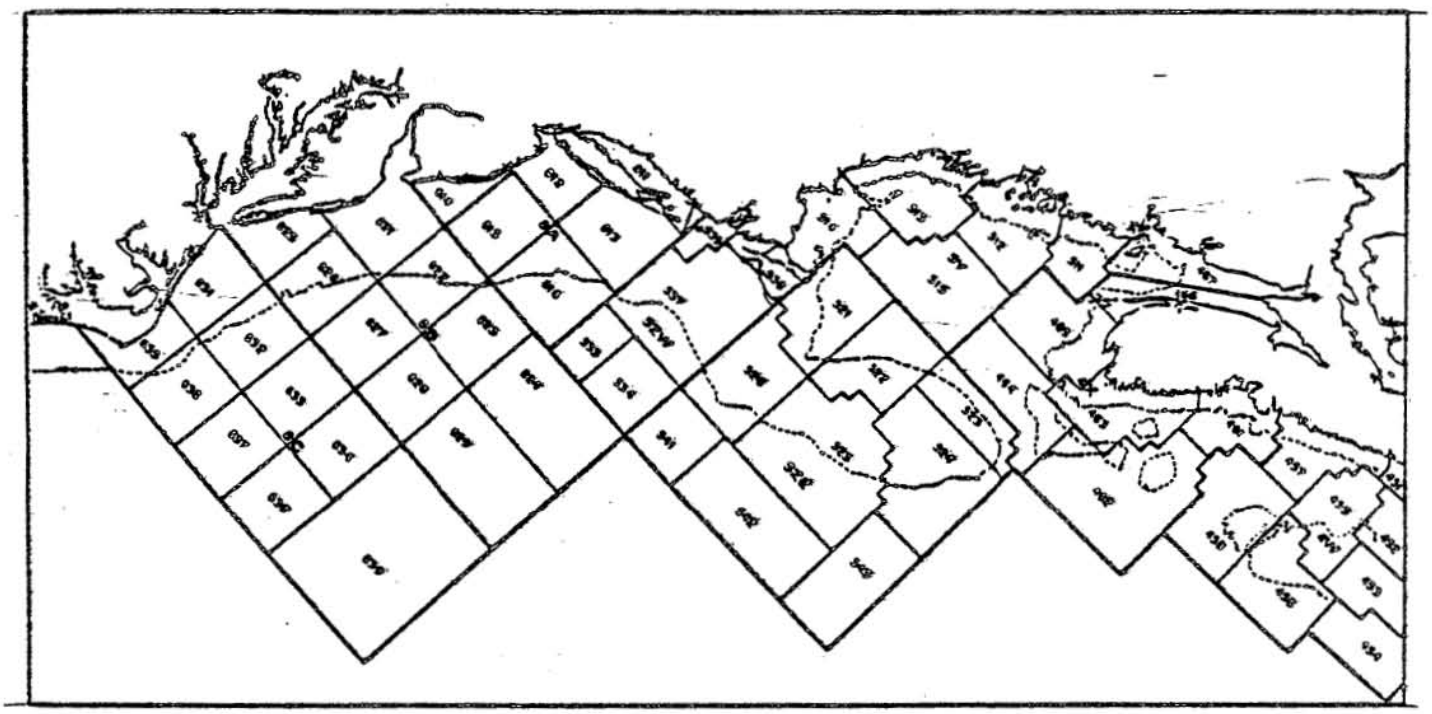


Figure 3. Commercial statistical reporting areas in the Northwest Atlantic from Nova Scotia to Cape Hatteras, North Carolina. Principal statistical areas from which sea scallops have been landed include: Georges Bank (Areas 521-526), the Middle Atlantic (Areas 611-616, 621-622, 623-626, 631-632), and the Gulf of Maine (Areas 511-515). Sea scallop landings on Georges Bank and the Middle Atlantic are often aggregated by three major fishing regions within each geographical unit: Georges Bank (South Channel: Areas 521, 522, and 526; Southeast Part: Area 525: and Northern Edge and Peak: Areas 523 and 524); Middle Atlantic (New York Bight: Areas 611-616; Delmarva: Areas 621-626; and Virginia-North Carolina: Areas 631-632).

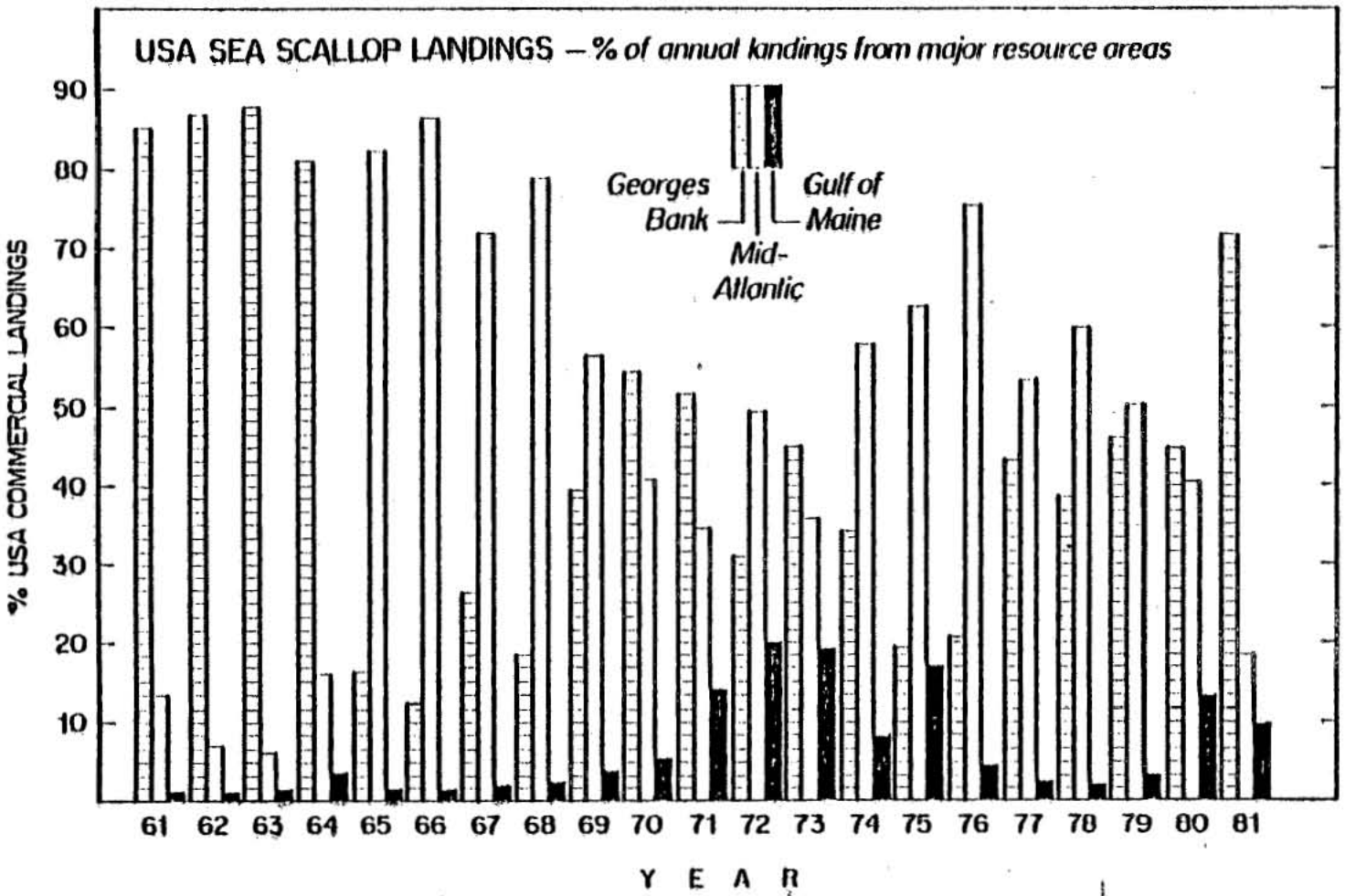


Figure 4. Percentage distribution of total annual USA commercial sea scallop landings (metric tons, meats) from Georges Bank (Area 5Ze), the Mid-Atlantic (Area 6) and the Gulf of Maine (Area 5Y), 1961-1981.

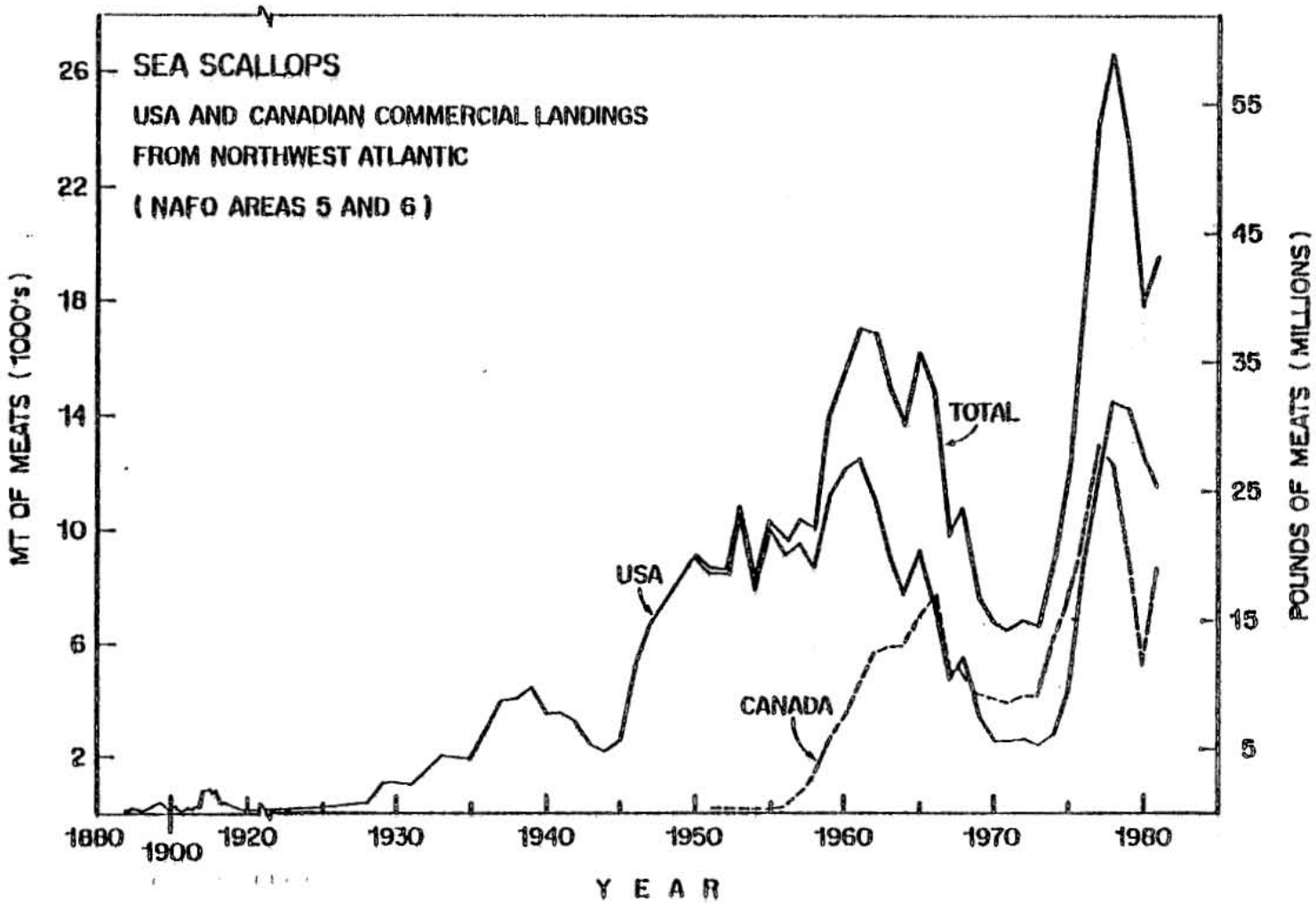


Figure 5. USA and Canadian commercial sea scallop landings from the Northwest Atlantic (NAFO Areas 5 and 6), 1887-1981.

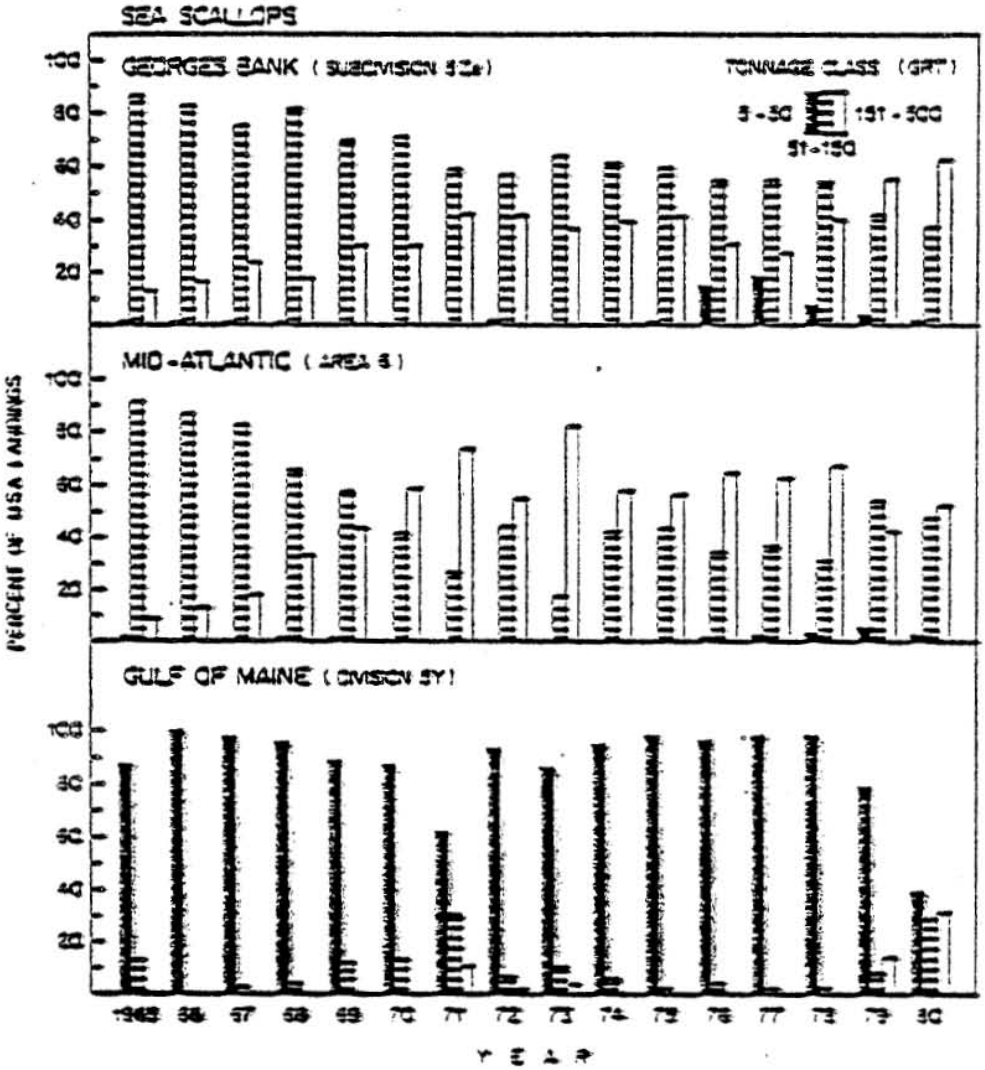


Figure 6. Percent distribution of USA commercial sea scallop landings (metric tons, meats), by vessel tonnage class, from Georges Bank (Subdivision 5Ze), the Middle Atlantic (Area 6) and the Gulf of Maine (Division 5Y), 1965-1980. The distributions reflect the percent of USA sea scallop landings within each geographical area accounted for by the three vessel classes annually. Data derived from vessels using scallop dredges and landing in New England (1965-1980) and New Jersey (1978-1980) ports.

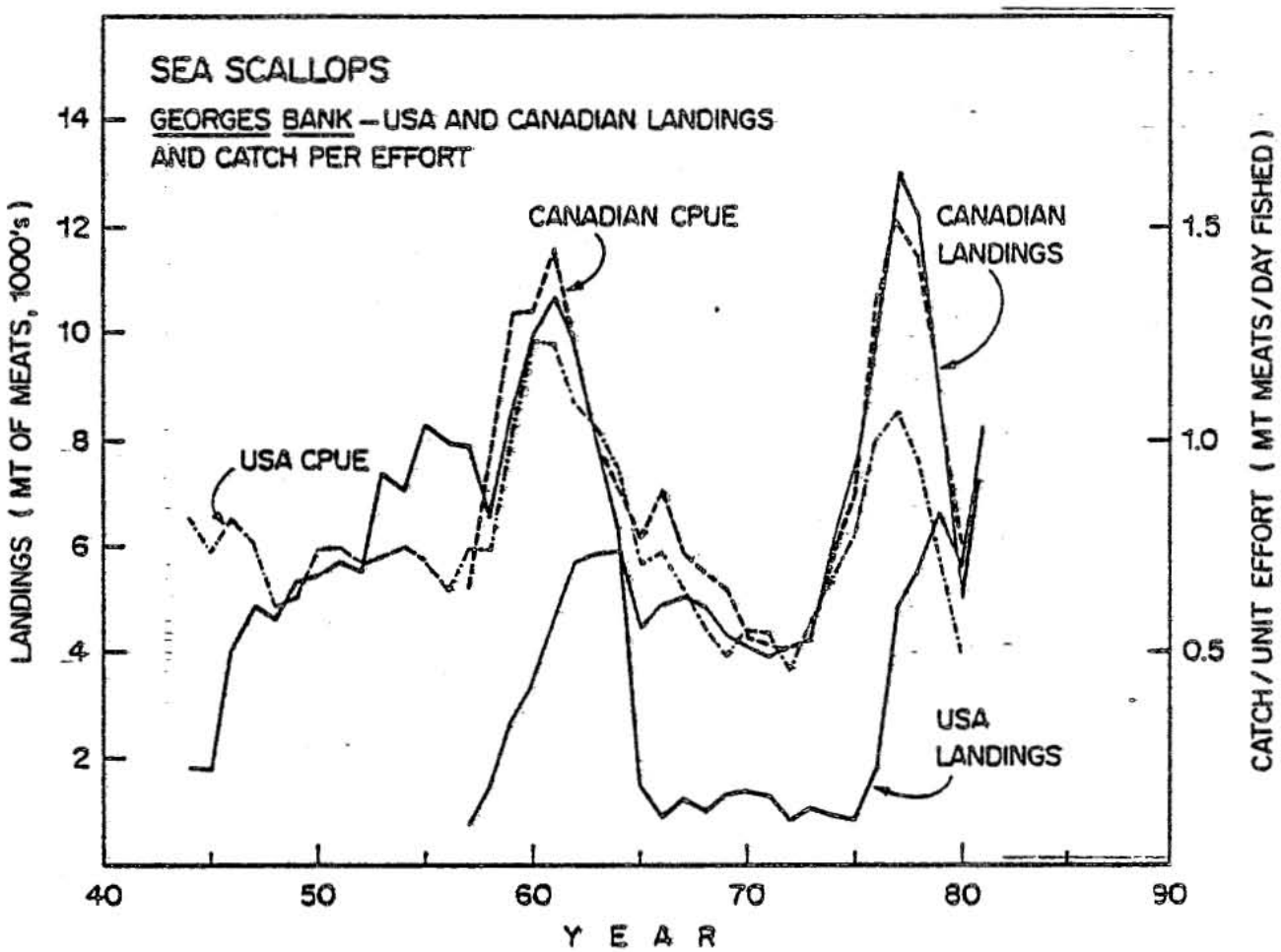


Figure 7. USA and Canadian commercial sea scallop landings (metric tons, meats) and commercial catch per unit of effort (CPUE: metric tons of meats landed per day fished) from Georges Bank (Area 5Ze), 1944-1981.

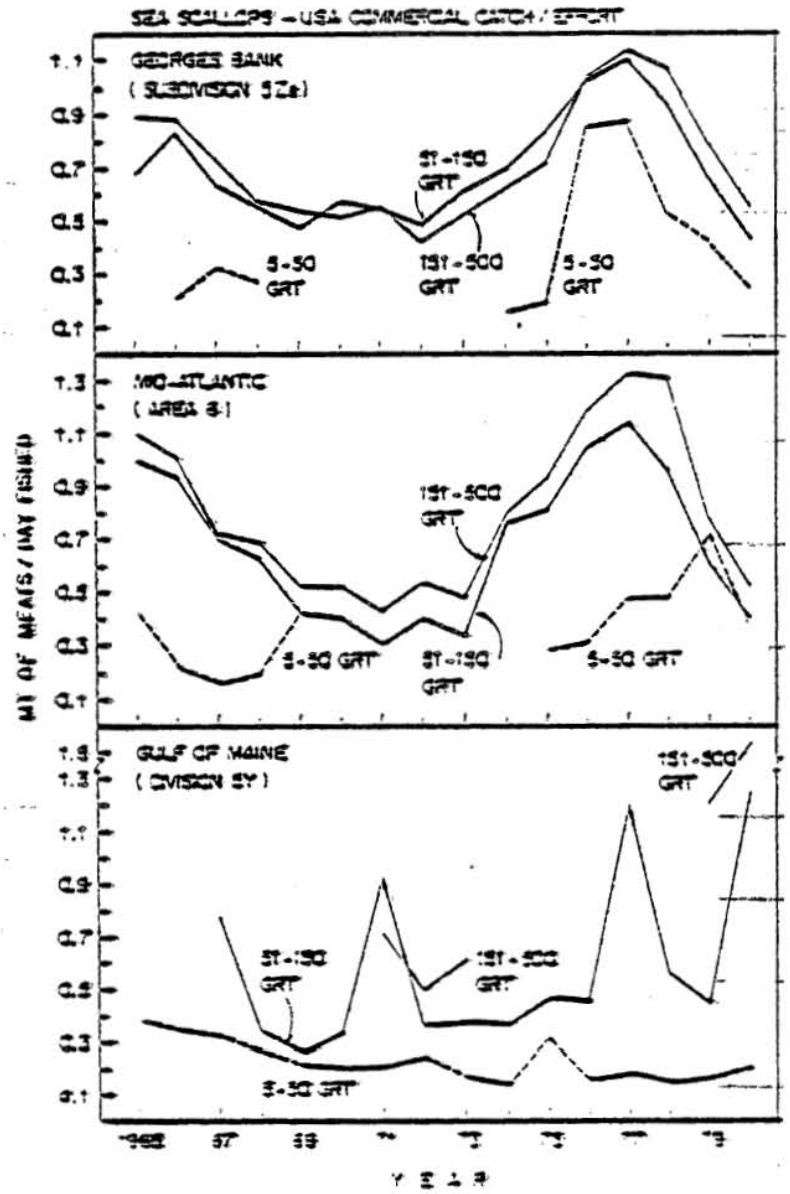


Figure 8. USA commercial sea scallop catch rates (metric tons of meats landed per day fished) from Georges Bank (Subdivision 5Ze), the Middle Atlantic (Area 6) and the Gulf of Maine (Division 5Y), by vessel tonnage class, 1965-1980. Data derived from vessels using scallop dredges and landing in New England (1965-1980) and New Jersey (1978-1980) ports.

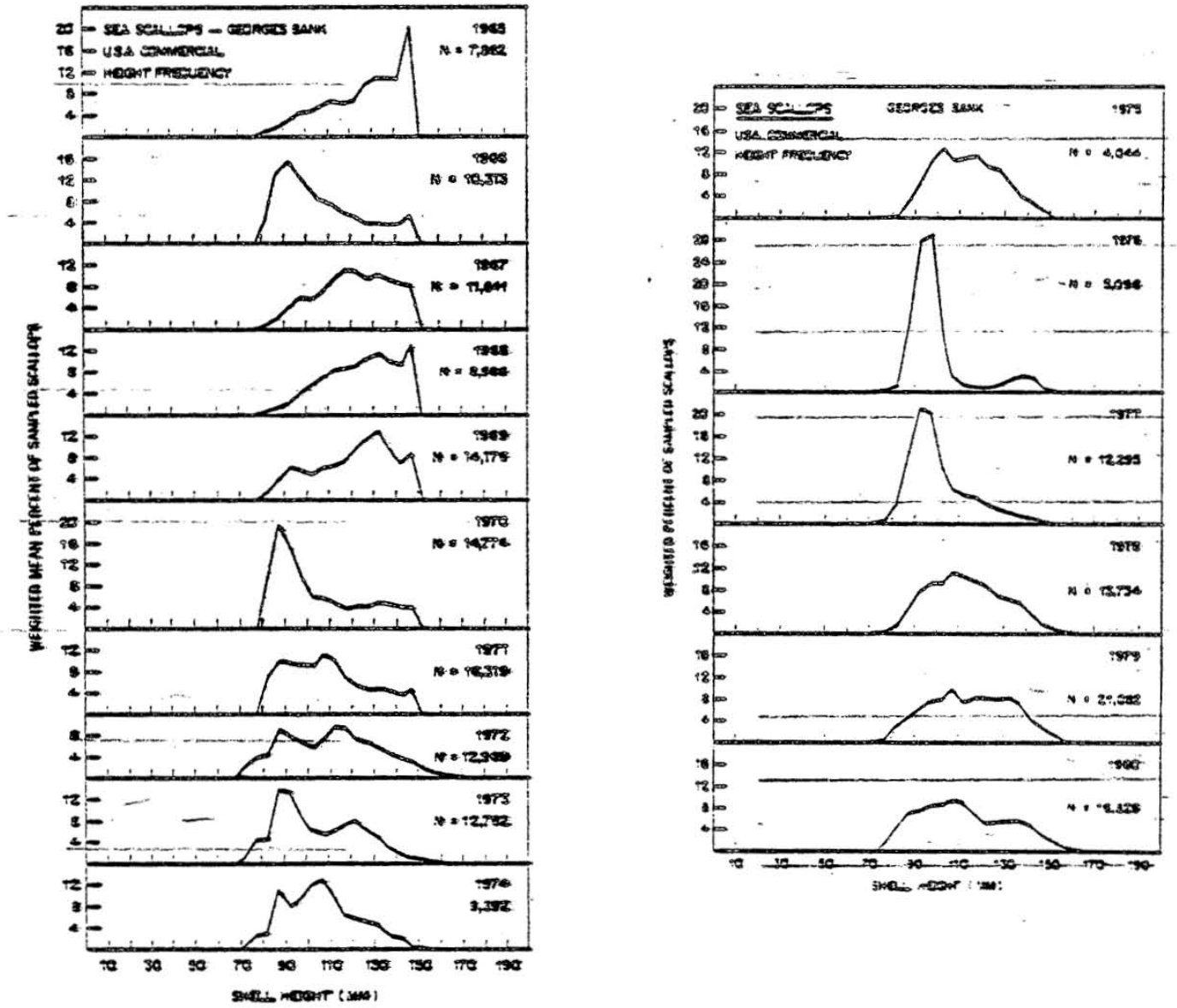


Figure 9. Shell height frequency distributions of USA commercial sea scallop samples from Georges Bank (area 5Ze), 1965-1980. Each yearly distribution was derived by weighting USA commercial shell height frequency distributions from the South Channel, Southeast Part, and Northern Edge and Peak regions in each year by the respective annual USA commercial sea scallop landings from these regions.

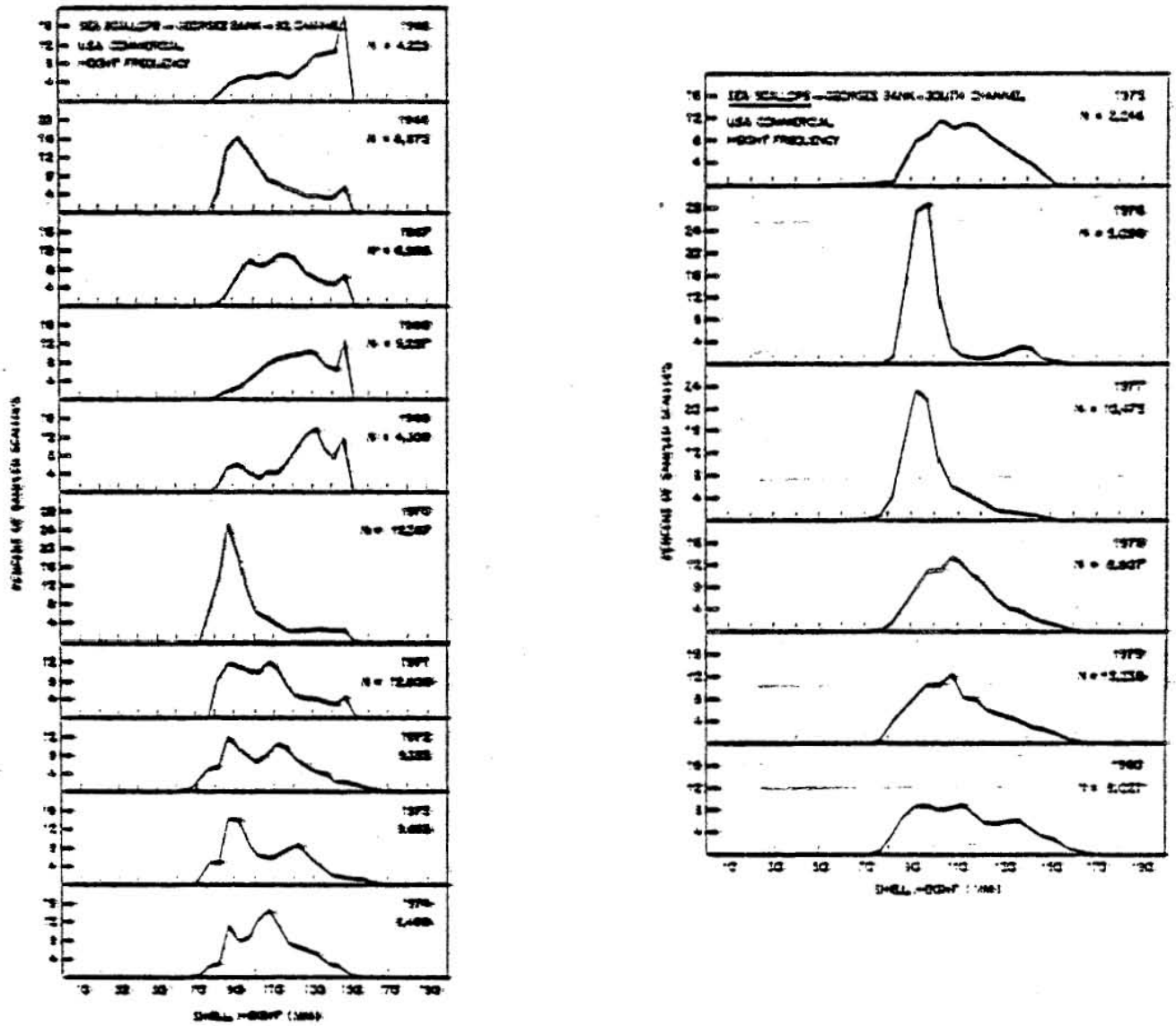


Figure 10. Shell height frequency distribuitons of USA commercial sea scallop samples from the South Channel region (Statistical Areas 521, 522, and 526) of Georges Bank, 1965-1980.

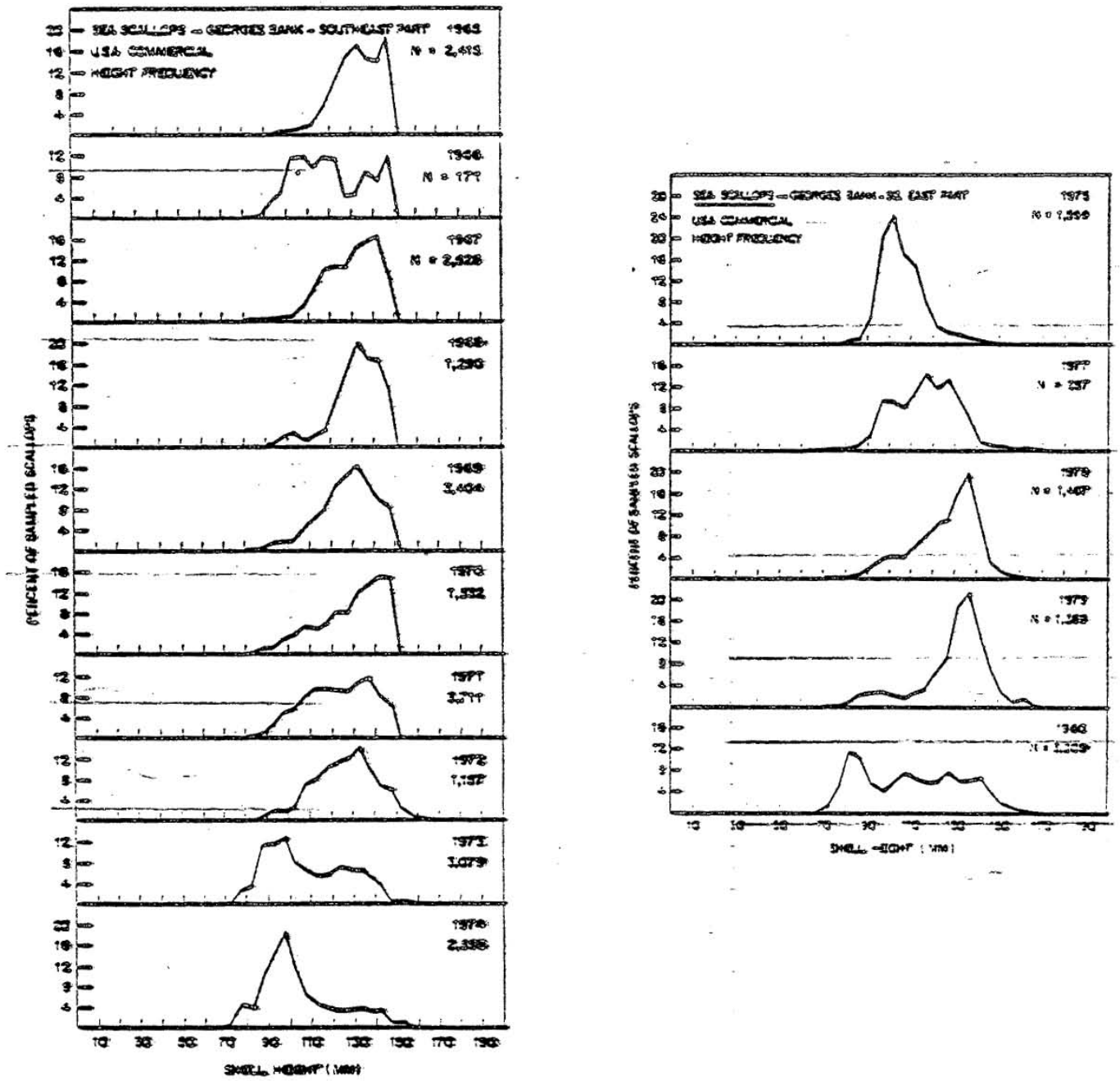


Figure 11. Shell height frequency distributions of USA commercial sea scallop samples from the Southeast Part region (Statistical Area 525) of Georges Bank, 1965-1980. No samples were obtained in 1976.

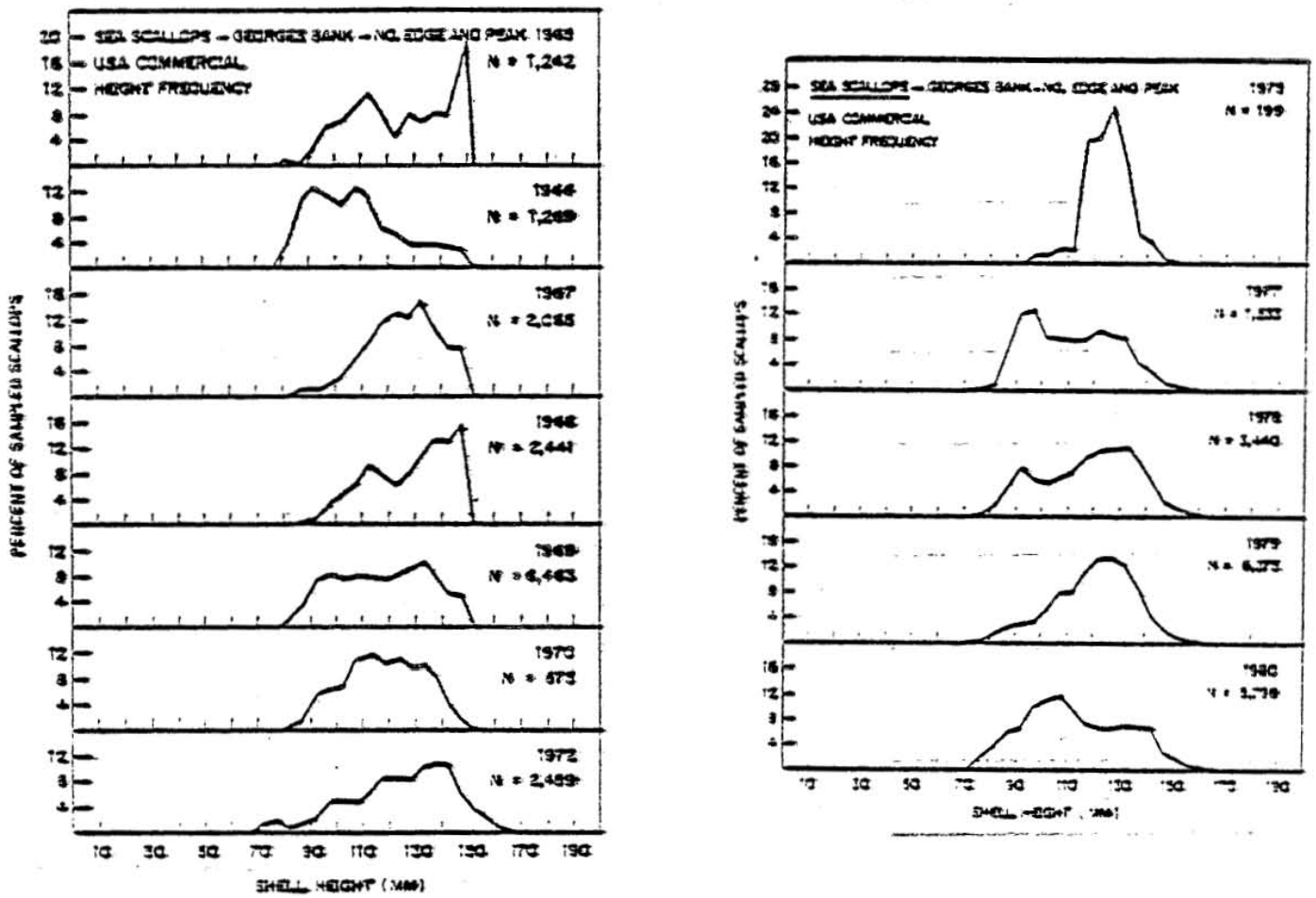


Figure 12. Shell height frequency distributions of USA commercial sea scallop samples from the Northern Edge and Peak region (Statistical Areas 523 and 524) of Georges Bank, 1965-1980. No samples were obtained in 1971, 1973, 1974, and 1976.

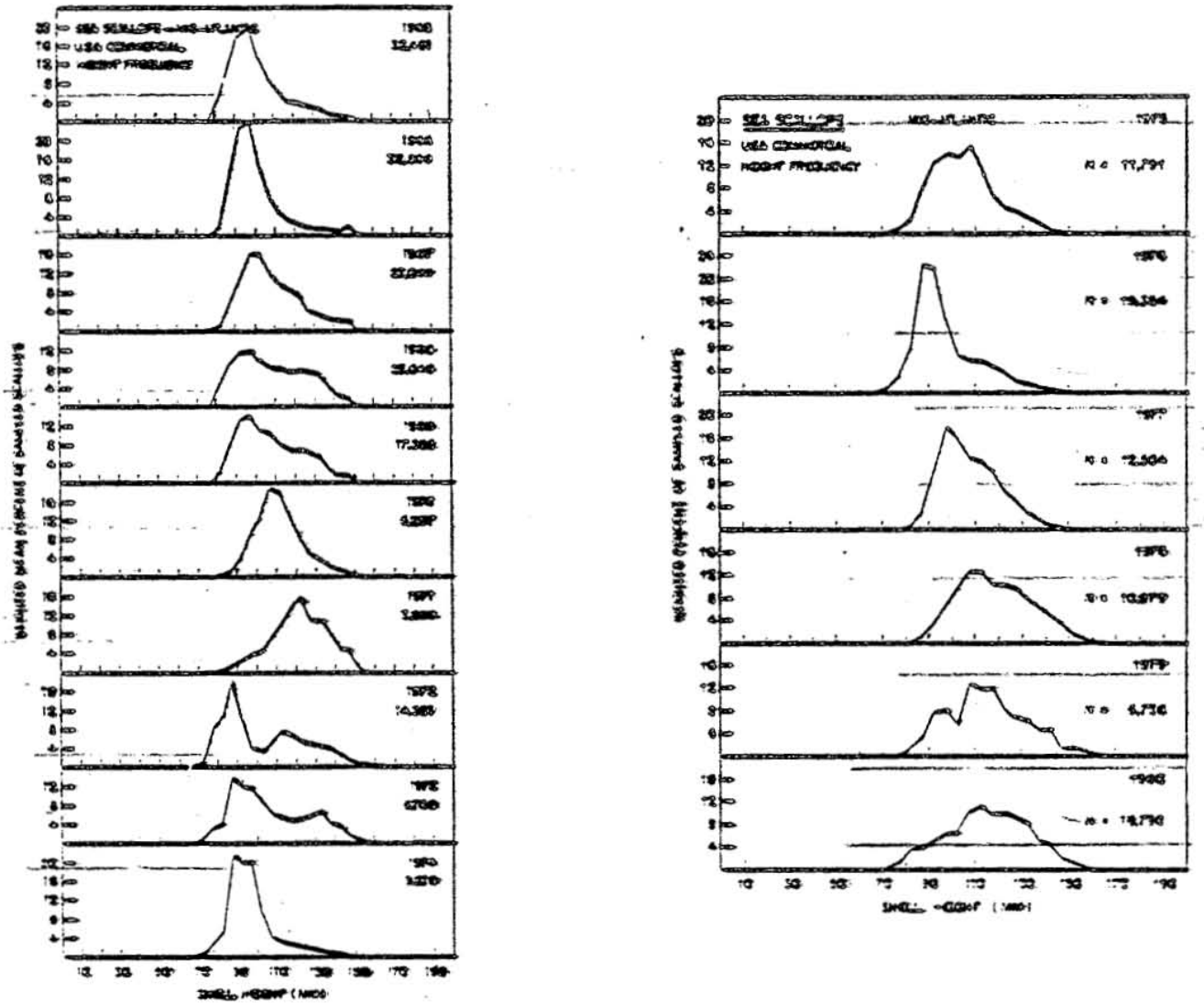


Figure 13. Shell height frequency distributions of USA commercial sea scallop samples from the Middle Atlantic (Area 6), 1965-1980. Each yearly distribution was derived by weighting USA commercial shell height frequency distributions from the New York Bight, Delmarva, and Virginia-North Carolina regions in each year by the respective annual USA commercial sea scallop landings from these regions.

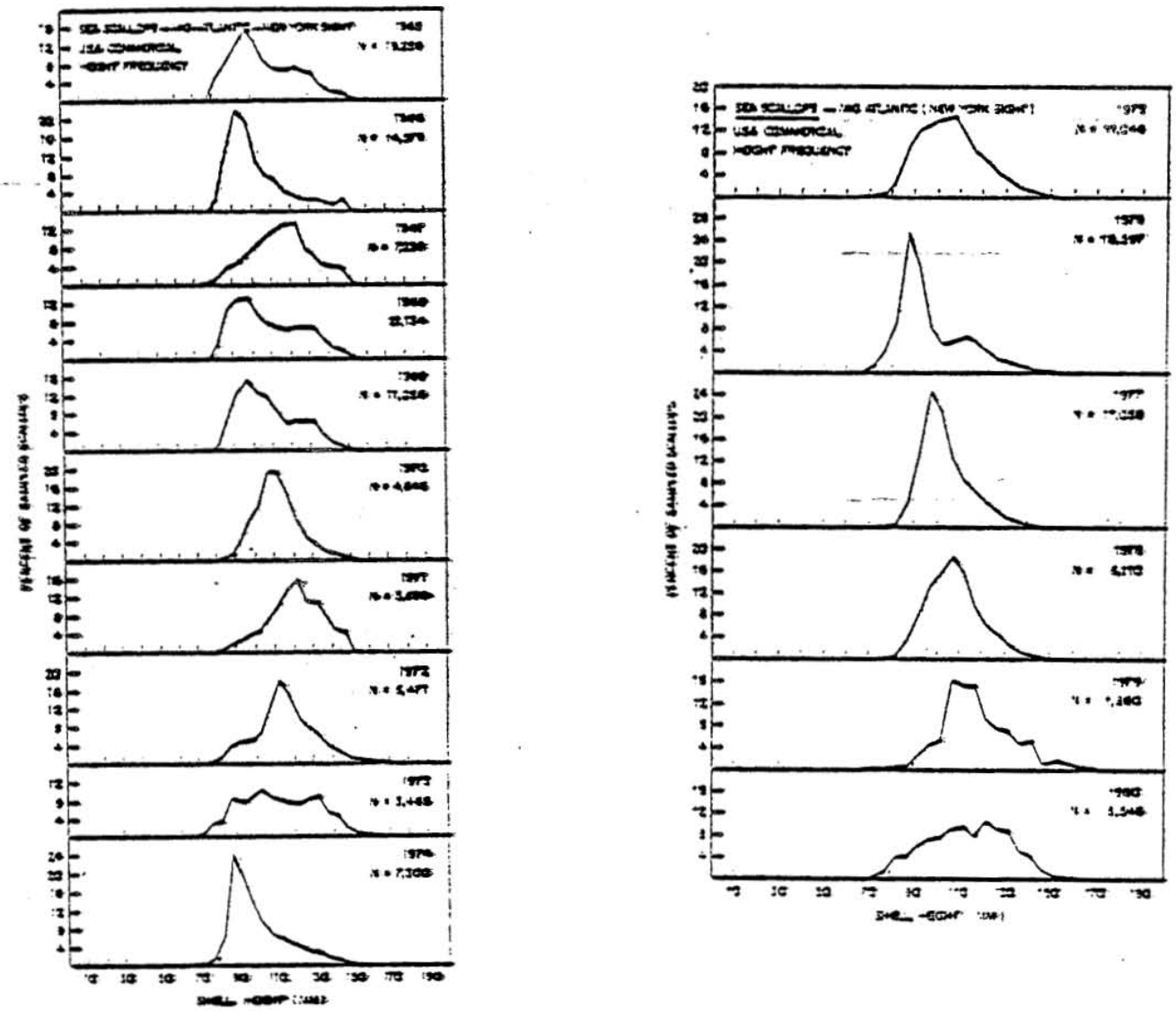


Figure 14. Shell height frequency distributions of USA commercial sea scallop samples from the New York Bight region (Statistical Areas 611-616) of the Middle Atlantic, 1965-1980.

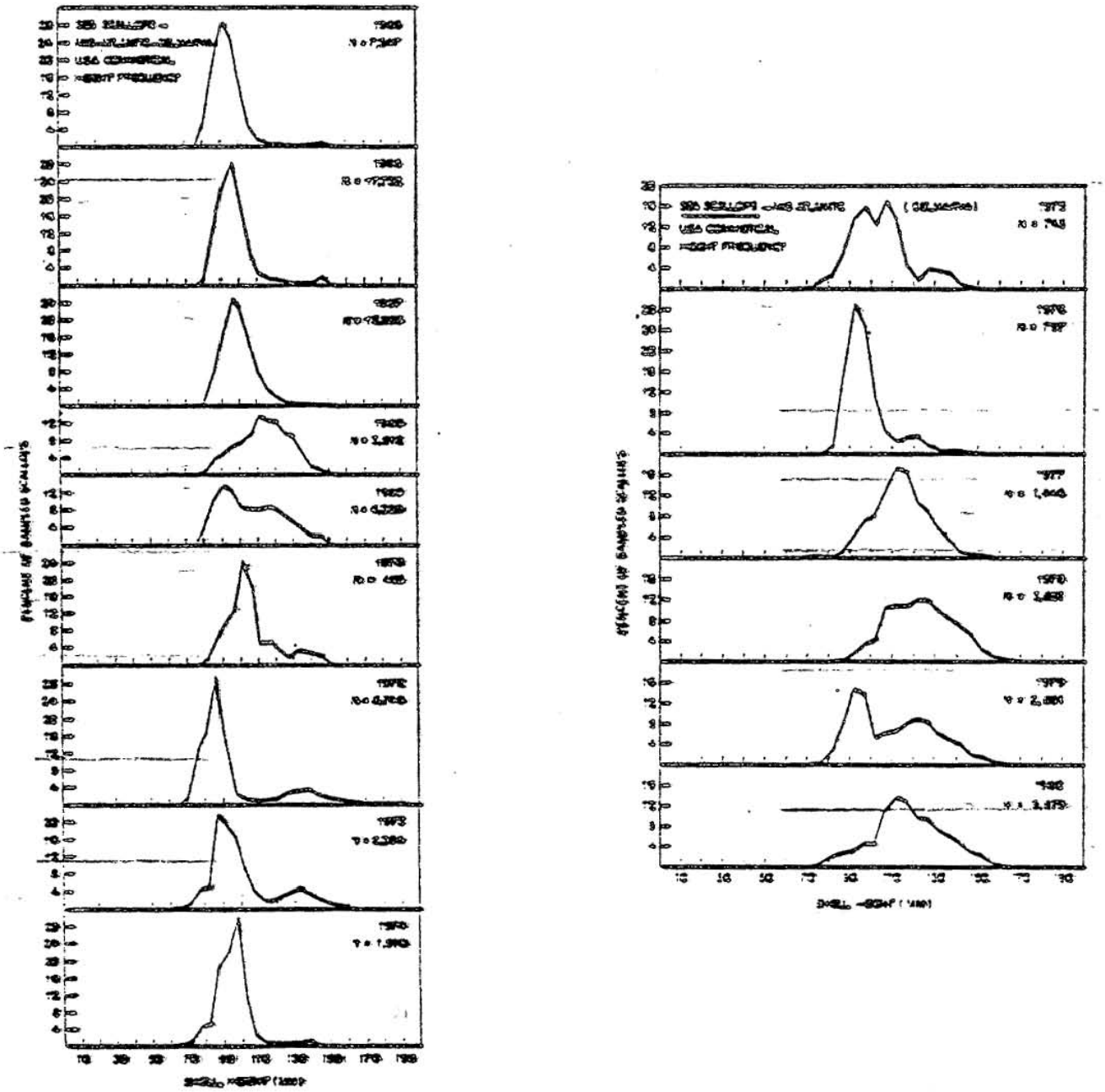


Figure 15. Shell height frequency distributions of USA commercial sea scallop samples from the Delmarva region (Statistical Areas 621-626) of the Middle Atlantic, 1965-1980. No samples were obtained in 1971.

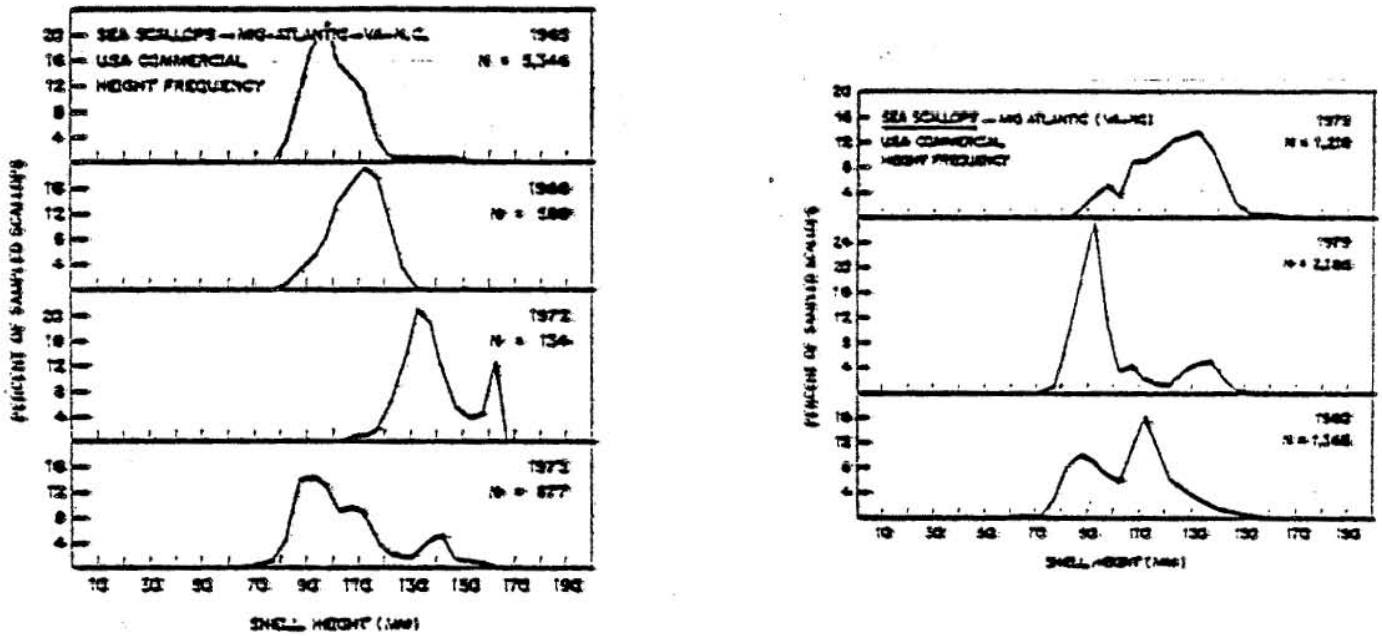


Figure 16. Shell height frequency distributions of USA commercial sea scallop samples from the Virginia-North Carolina region (Statistical Areas 631-632) of the Middle Atlantic, 1965-1980. No samples were obtained during 1967-1971 and 1974-1977.

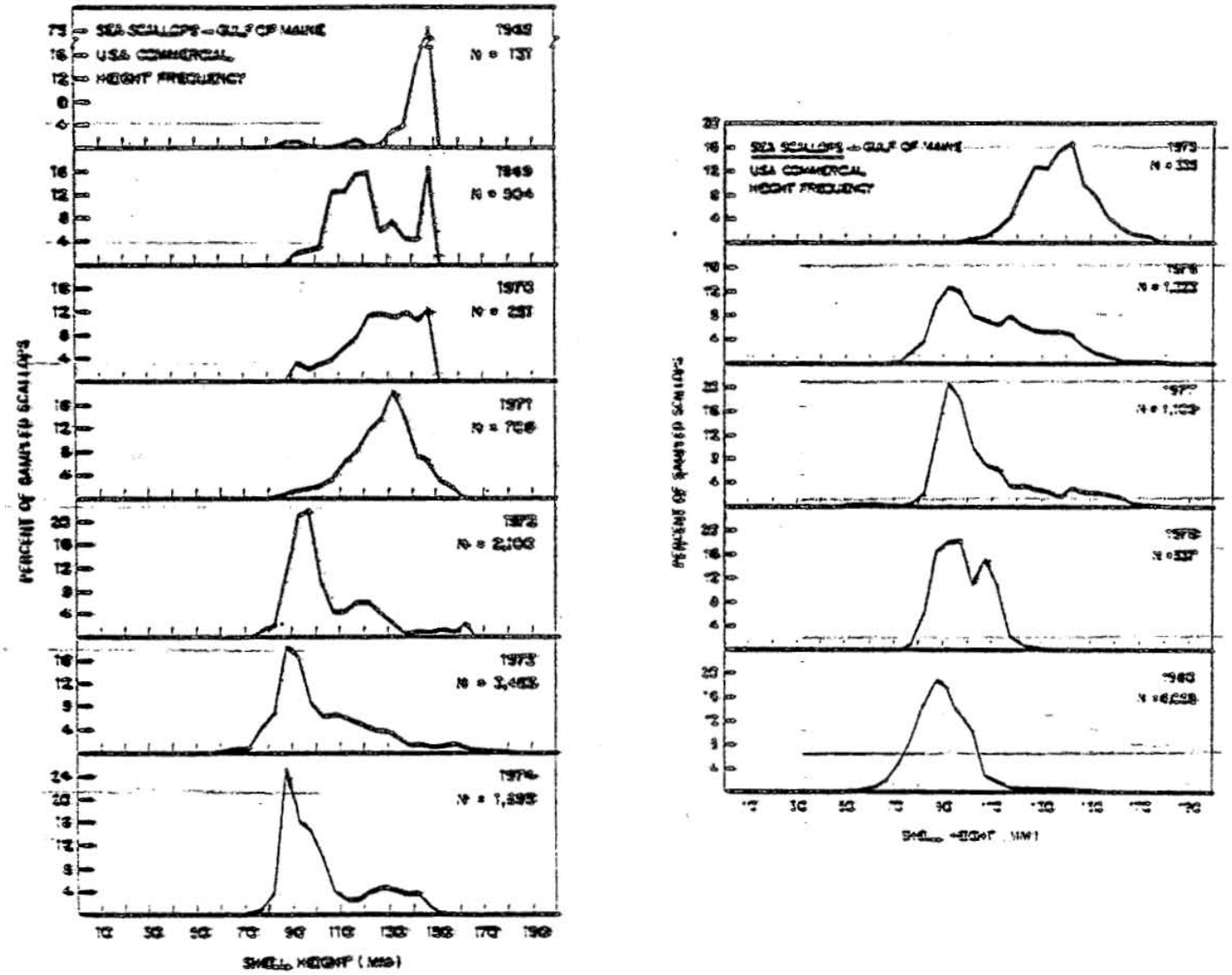


Figure 17. Shell height frequency distributions of USA commercial sea scallop samples from the Gulf of Maine (Statistical Areas 511-515), 1965-1980. No samples were obtained during 1966-1968 and in 1979.

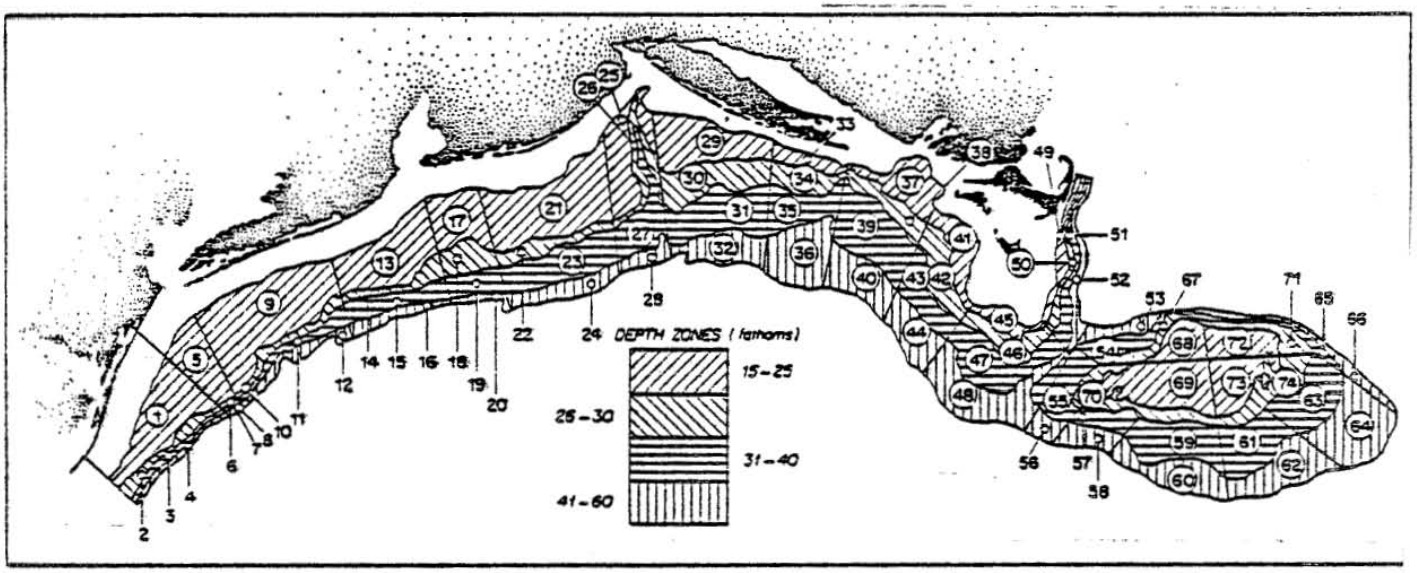


Figure 18. USA (Northeast Fisheries Center) sea scallop research vessel survey sampling strata in the Northwest Atlantic, Georges Bank to Cape Hatteras, used in annual surveys since 1979. For analytical purposes, survey strata are grouped by major fishing regions: Virginia-North Carolina (Strata 1-8); Delmarva (Strata 9-20); New York Bight (Strata 21-36); Southern New England (Strata 37-44); South Channel (Strata 45-56); Southeast Part (Strata 57-60); and Northern Edge and Peak (Strata 61-66, 71-74).

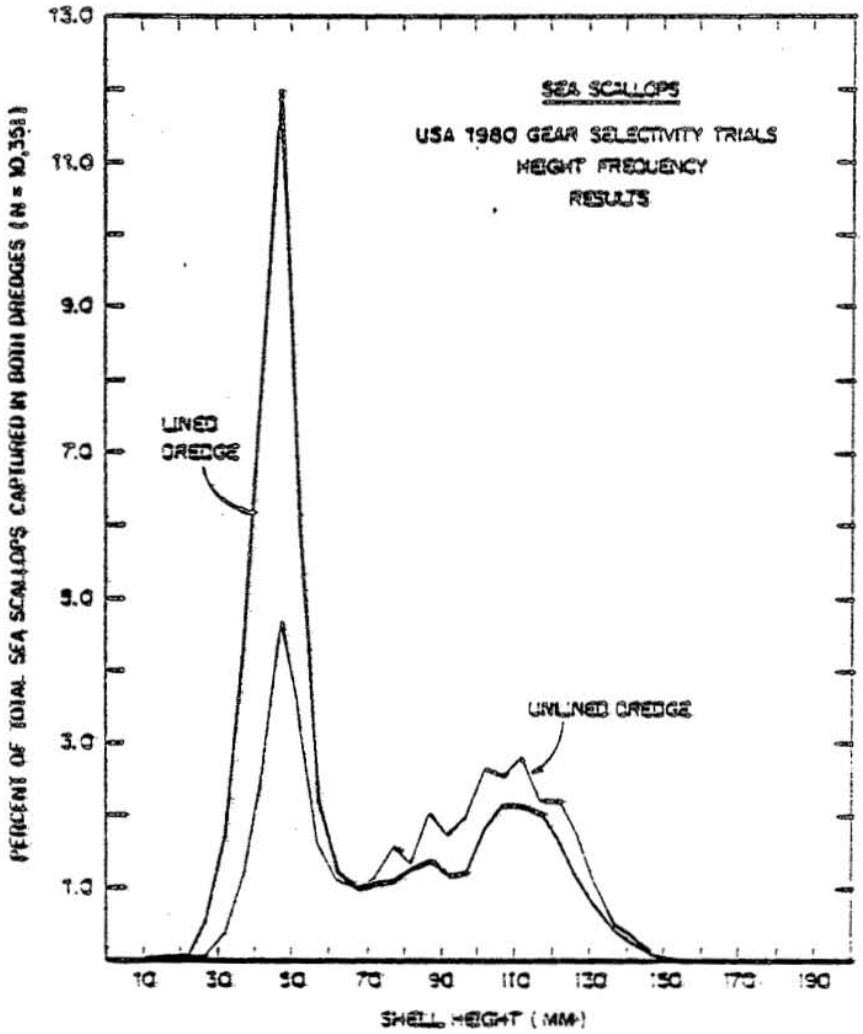


Figure 19. Shell height frequency distributions of sea scallops obtained in USA alternate-tow, research survey dredge size-selectivity experiments conducted with lined and unlined 2.44 meter (8 foot) sea scallop dredges in the Middle Atlantic during 1980 (from Serchuk and Smolowitz 1980: p. 19).

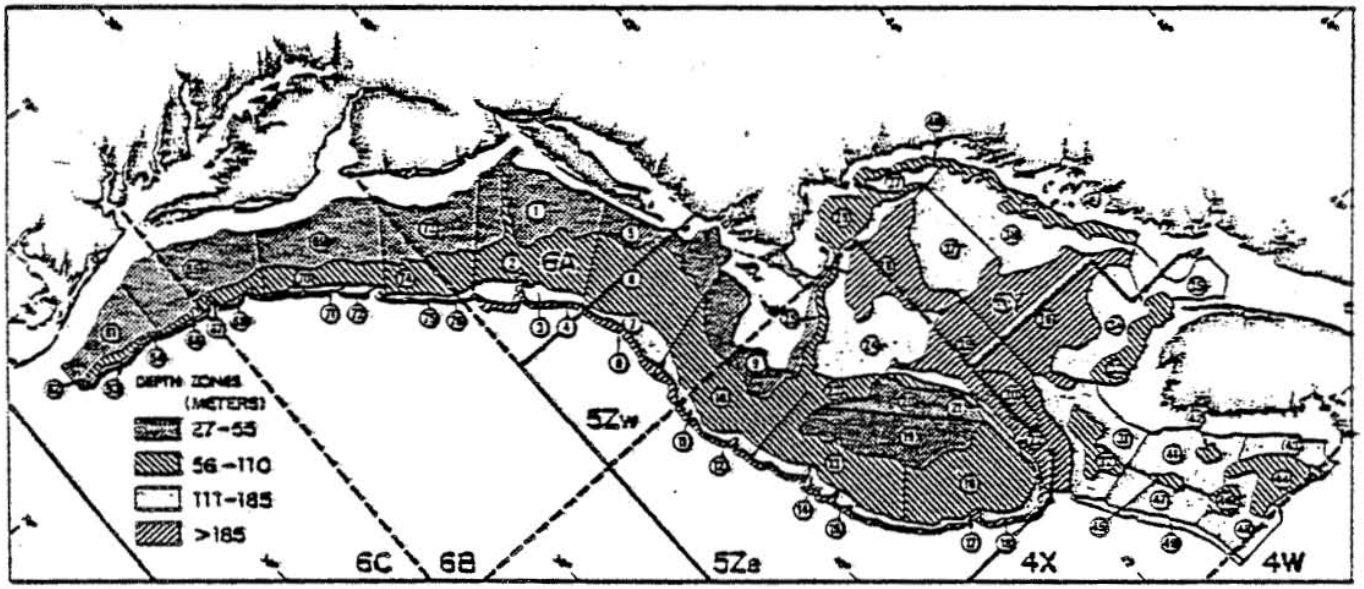
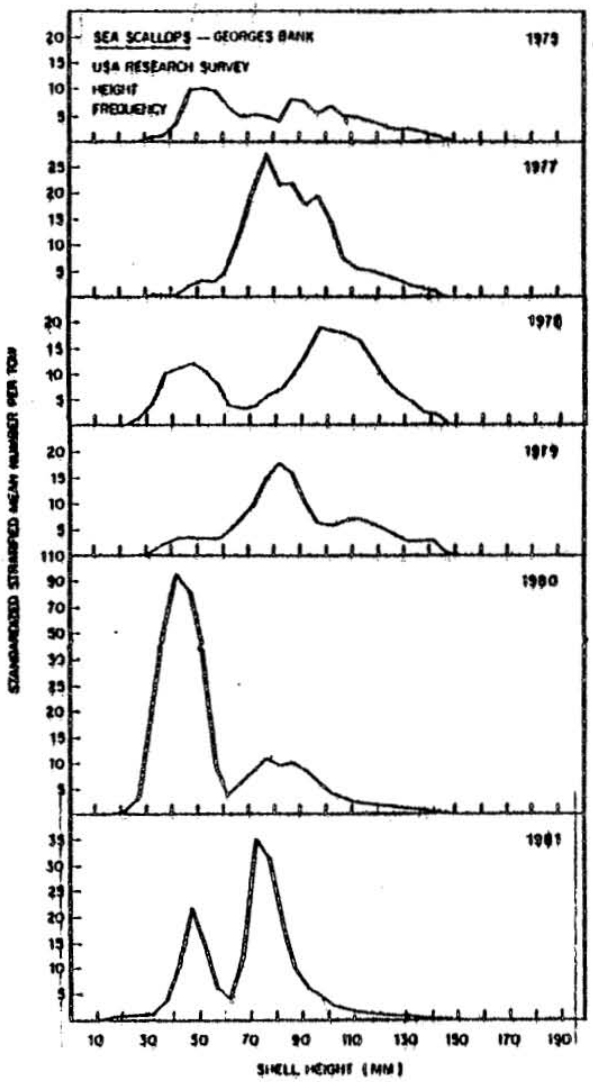


Figure 20. USA (Northeast Fisheries Center) offshore (>27 m) bottom trawl survey sampling strata in the Northwest Atlantic, Nova Scotia to Cape Hatteras. Gulf of Maine strata in which sea scallop catches were analyzed include 26, 39, and 40 (31-60 fm) and 27, 37, and 38 (61-100 fm).



gure 21. Sea scallop research vessel survey shell height frequency distributions of sea scallops from Georges Bank (Strata 45-66, 71-74), 1975, 1977-1981. Frequency distributions for 1975 and 1977 were derived from USA research vessel surveys. Frequency distributions for 1978-1981 were derived from both USA and Canadian research vessel surveys.

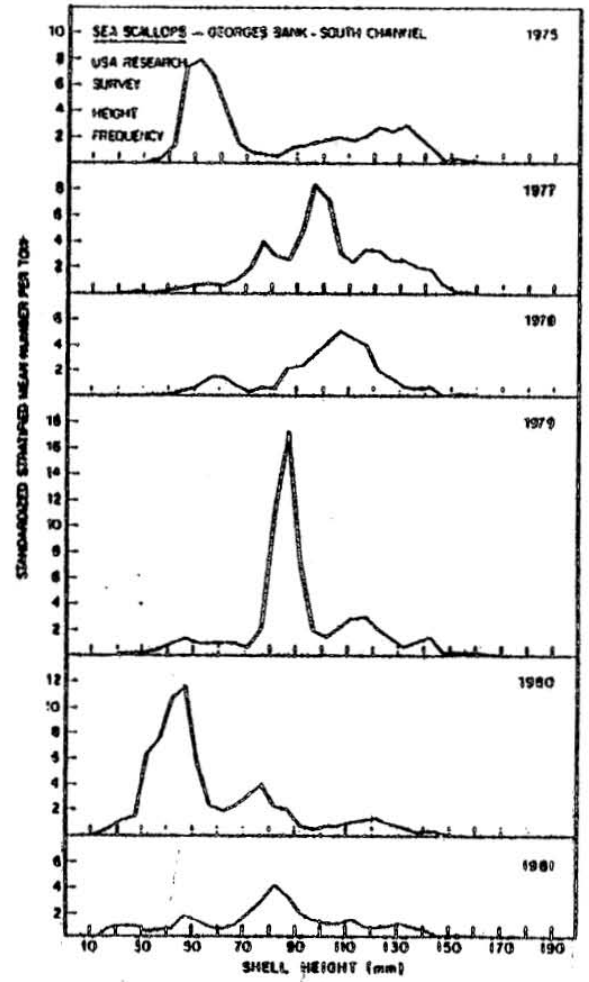


Figure 22. USA sea scallop research vessel survey shell height frequency distributions of sea scallops from the South Channel region (Strata 45-56) of Georges Bank, 1975, 1977-1981.

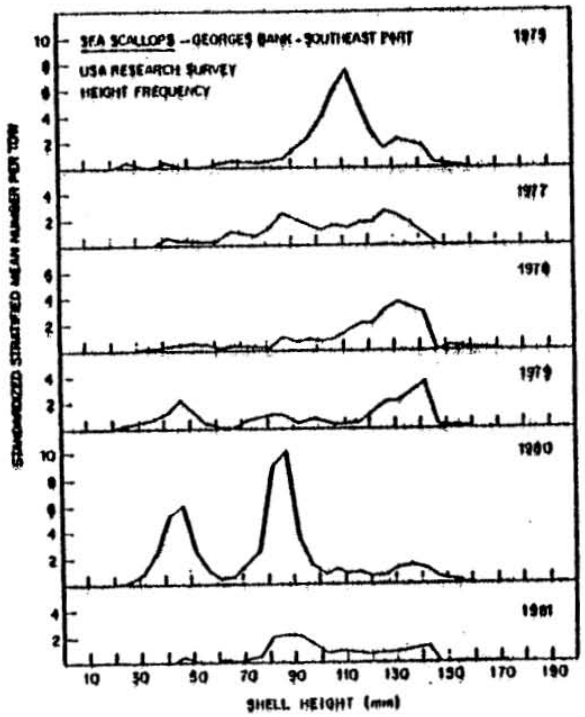


Figure 23. USA sea scallop research vessel survey shell height frequency distributions of sea scallops from the Southeast Part region (Strata 57-60) of Georges Bank, 1975, 1977-1981.

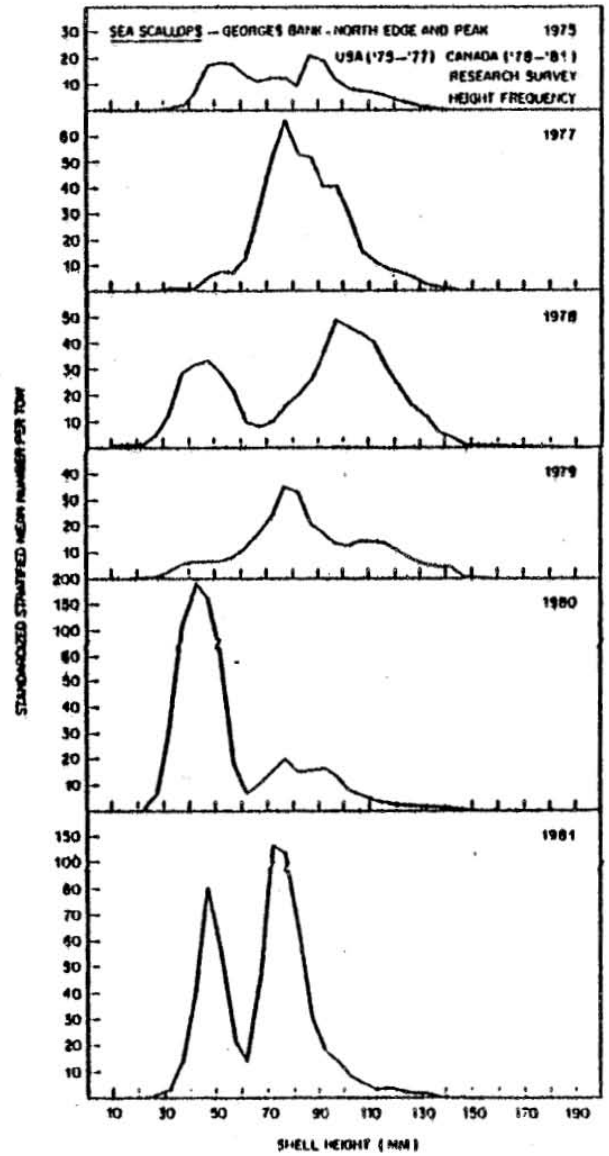
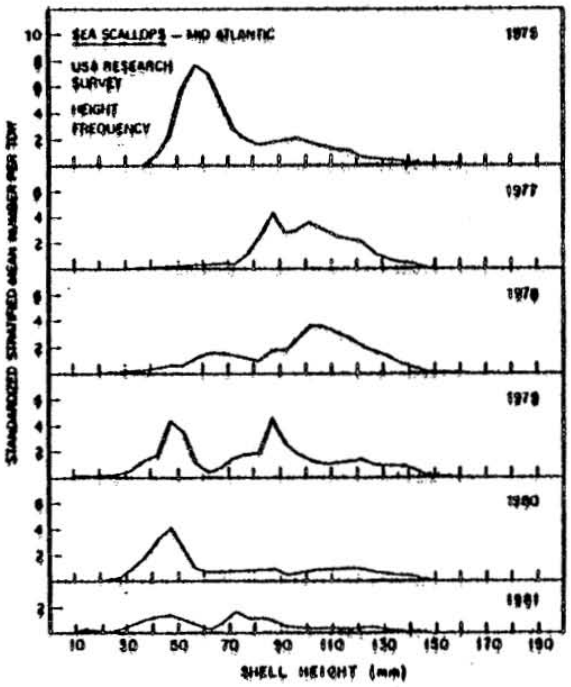


Figure 24. Sea scallop research vessel survey shell height frequency distributions of sea scallops from the Northern Edge and Peak region (Strata 61-66, 71-74) of Georges Bank, 1975, 1977-1981. Frequency distributions for 1975 and 1977 were derived from USA research vessel surveys. Frequency distributions for 1978-1981 were derived from Canadian research vessel surveys.



ure 25. USA sea scallop research vessel survey shell height frequency distributions of sea scallops from the Middle Atlantic (Strata 1-36), 1975, 1977-1981.

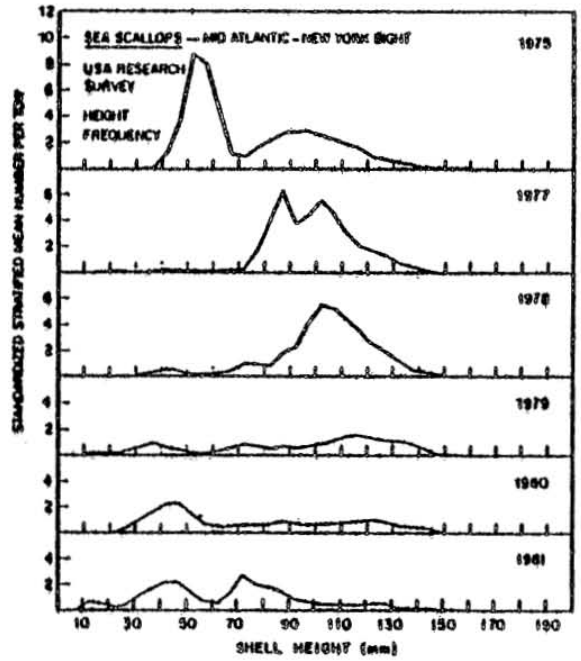


Figure 26. USA sea scallop research vessel survey shell height frequency distributions of sea scallops from the New York Bight region (Strata 21-36) of the Middle Atlantic, 1975, 1977-1981.

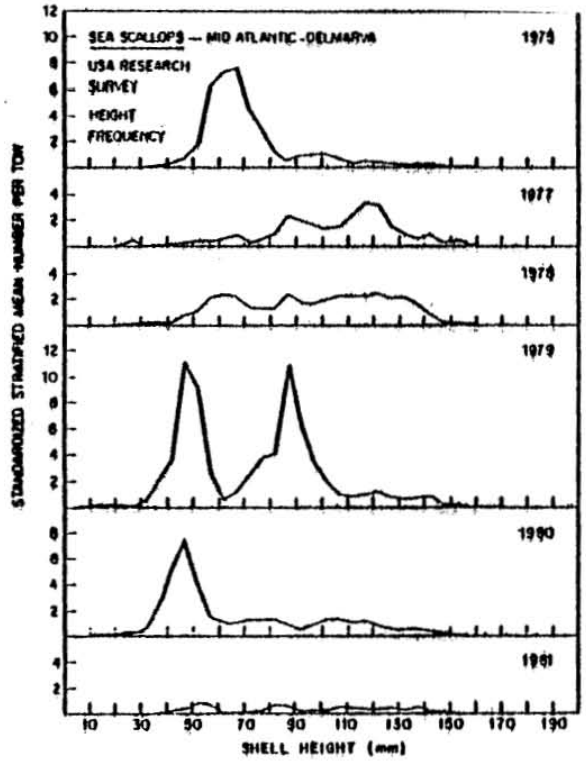


Figure 27. USA sea scallop research vessel survey shell height frequency distributions of sea scallops from the Delmarva region (Strata 9-20) of the Middle Atlantic, 1975, 1977-1981.

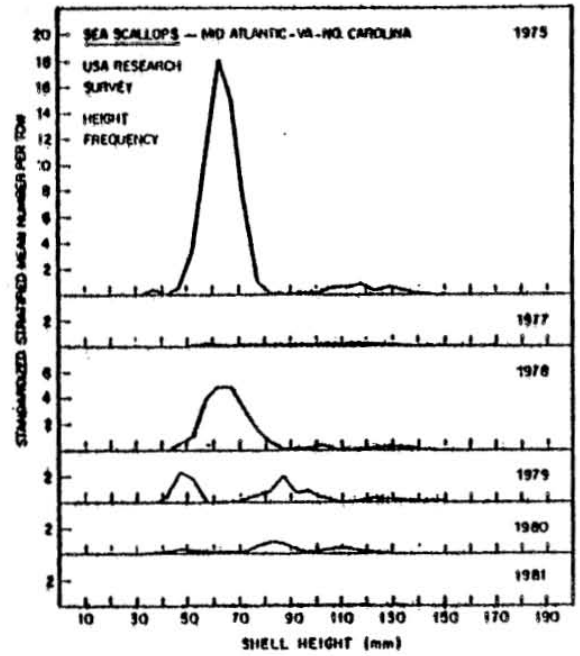
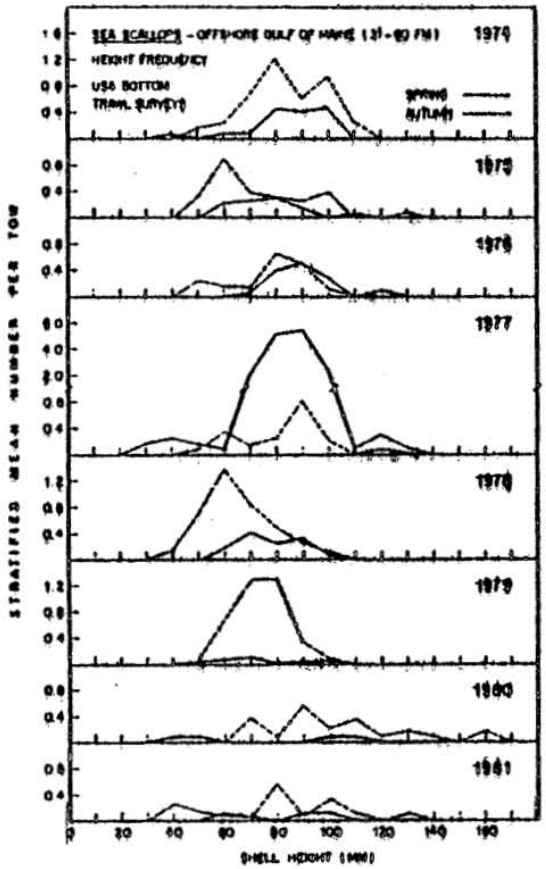


Figure 28. USA sea scallop research vessel survey shell height frequency distributions of sea scallops from the Virginia-North Carolina region (Strata 1-
of the Middle Atlantic, 1975, 1977-1981.



gure 29. USA offshore spring and autumn research vessel bottom trawl survey shell height frequency distributions of sea scallops from the 31-60 fathom depth zone (Bottom trawl strata 26, 39, and 40) in the Gulf of Maine, 1974-1981.

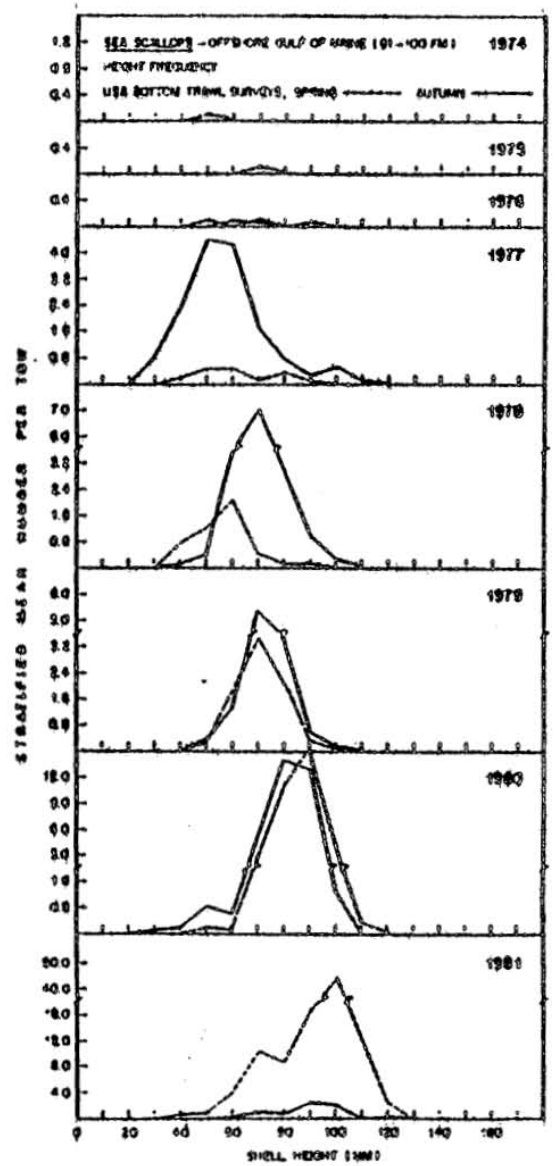


Figure 30. USA offshore spring and autumn research vessel bottom trawl survey shell height frequency distributions of sea scallops from the 61-100 fathom depth zone (Bottom trawl strata 27, 37, and 38) in the Gulf of Maine, 1974-1981.

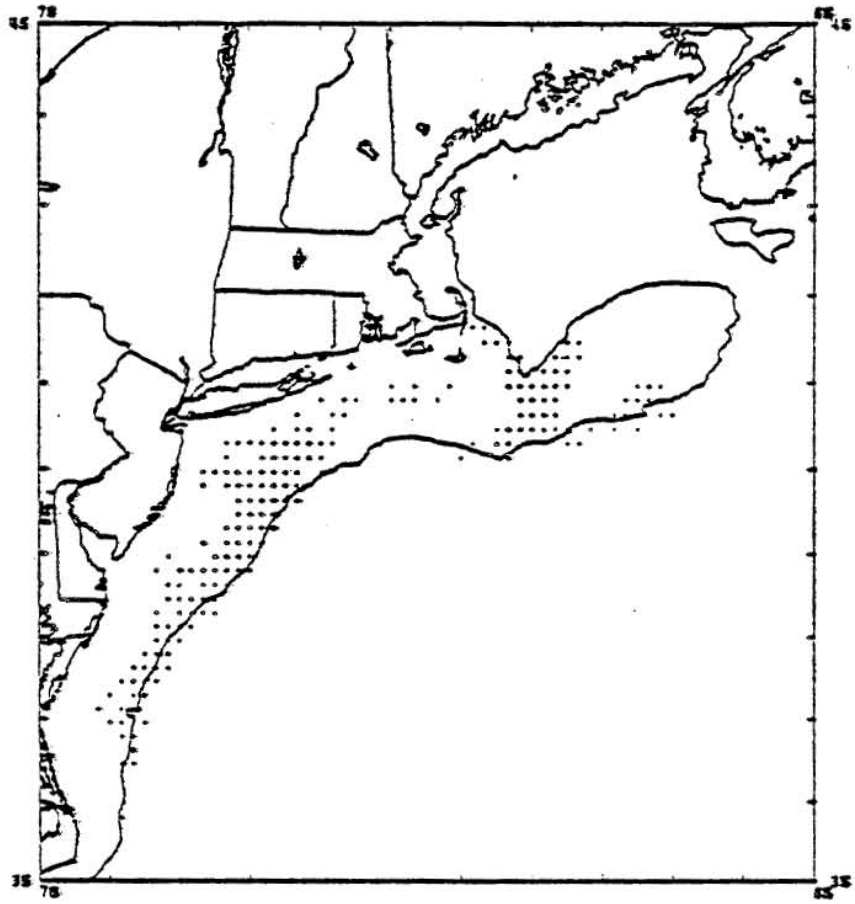


Figure 31. Locations of ten-minute squares of latitude and longitude on Georges Bank and in the Middle Atlantic where sea scallops were collected for shell height-meat weight analyses during USA sea scallop research vessel surveys, 1977-1981. Each point represents the center of a ten-minute square in which samples were obtained and may represent more than one survey station within the ten-minute square at which samples were collected.

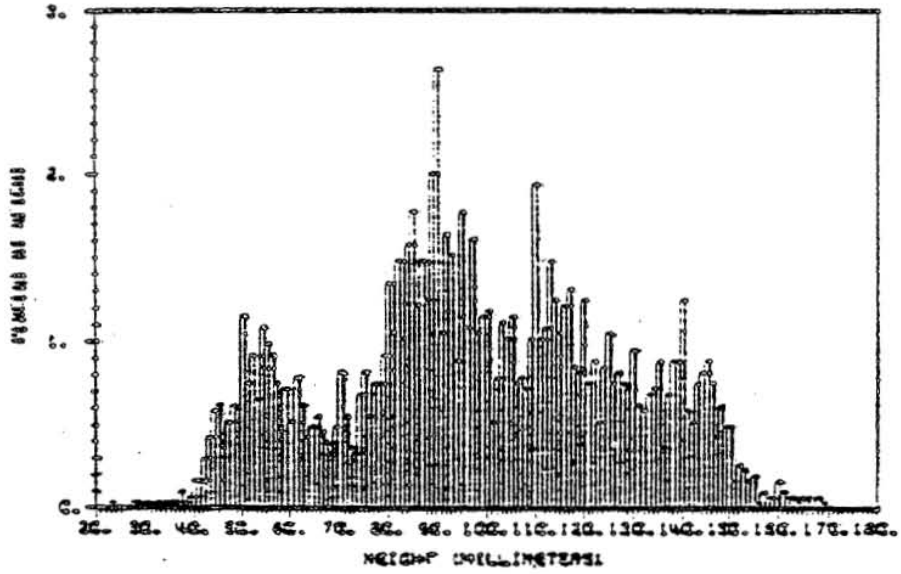


Figure 32. Shell height frequency distribution of Georges Bank sea scallops collected for shell height-meat weight analyses during USA sea scallop research vessel surveys, 1978-1981.

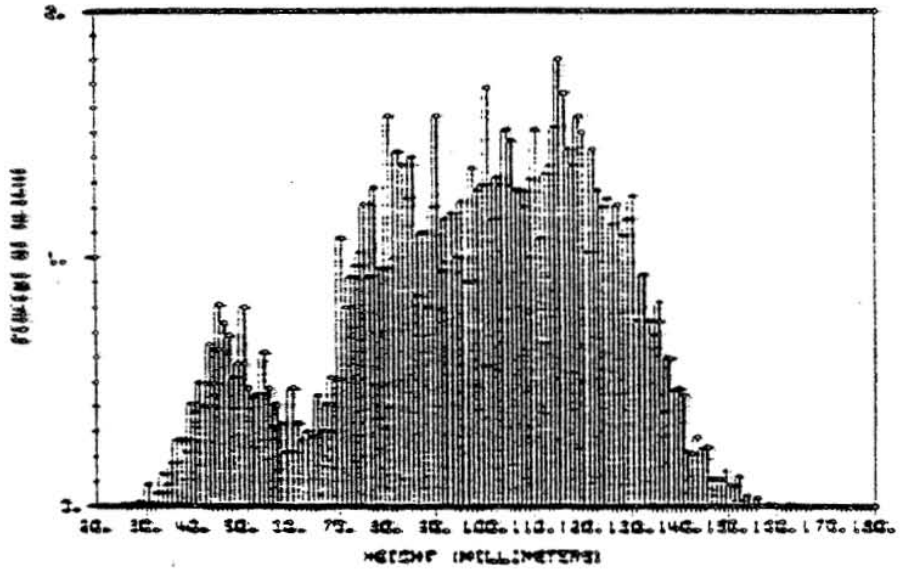


Figure 33. Shell height frequency distribution of Middle Atlantic sea scallops collected for shell height-meat weight analyses during USA sea scallop research vessel surveys, 1977-1981.

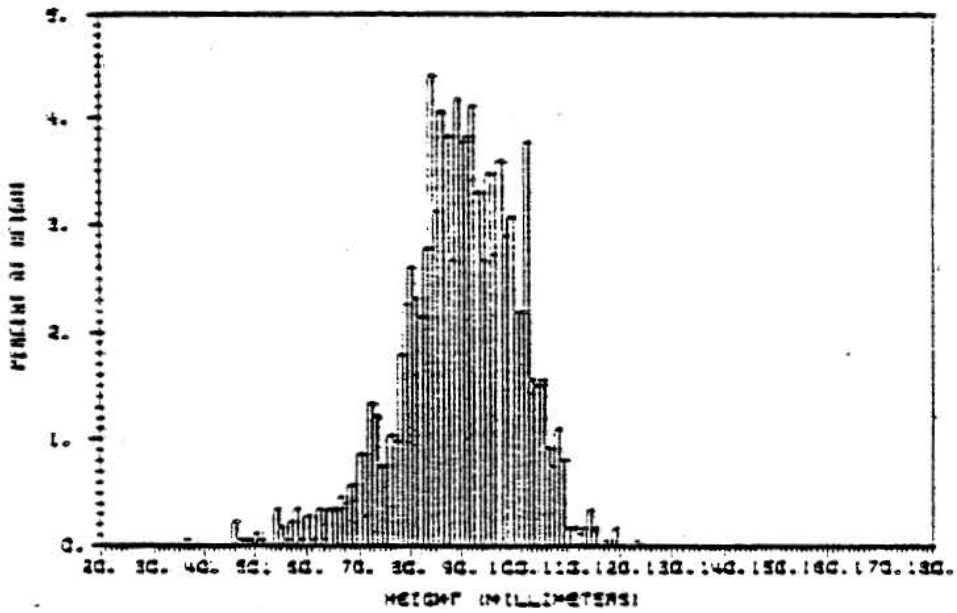


Figure 34. Shell height frequency distribution of offshore Gulf of Maine sea scallops collected for shell height-meat weight analyses from 1980 NMFS and States of Maine and Massachusetts commercial sea scallop samples.

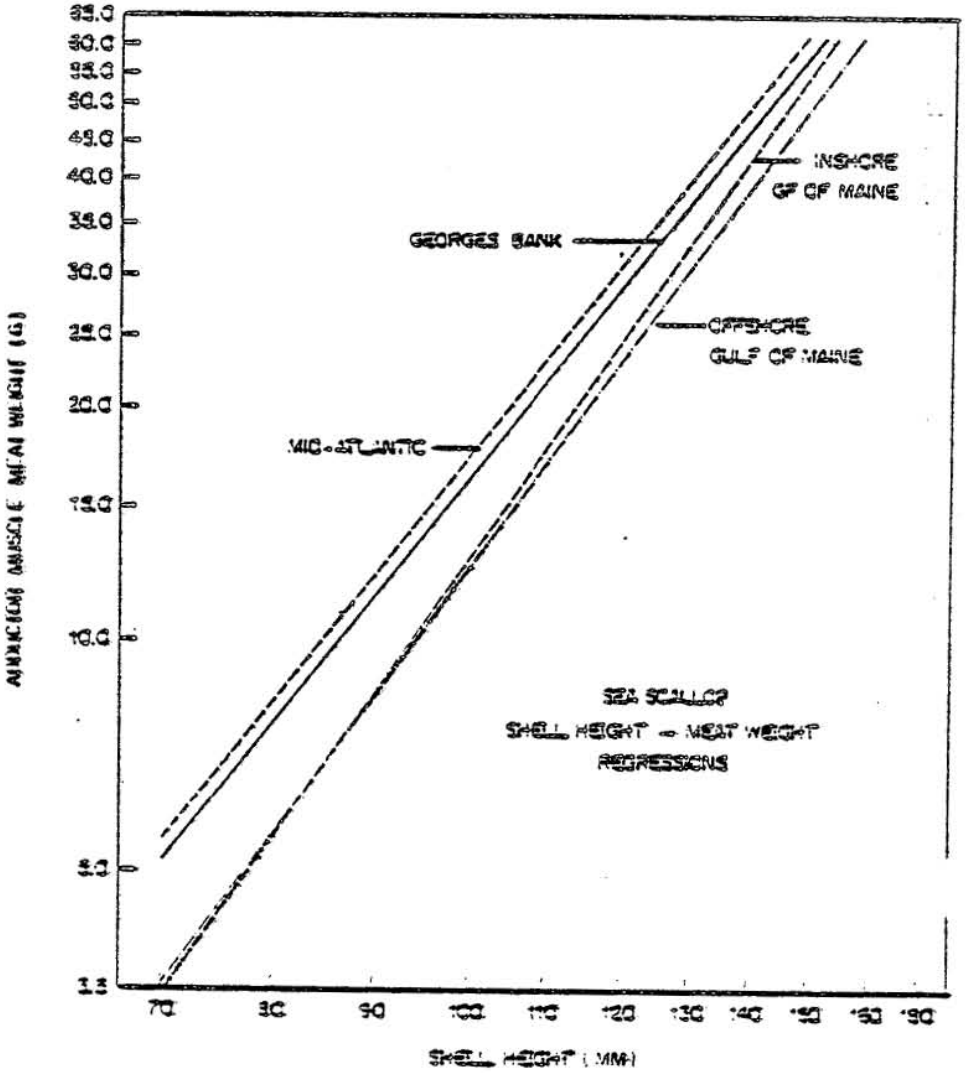


Figure 35. Shell height-meat weight regression relationships for sea scallops taken from Georges Bank (1978-1981 USA scallop surveys), the Middle Atlantic (1977-1981 USA scallop surveys), offshore Gulf of Maine (1980 NMFS and States of Maine and Massachusetts commercial sea scallop samples), and inshore (Penobscot Bay) Gulf of Maine (from Haynes 1966).

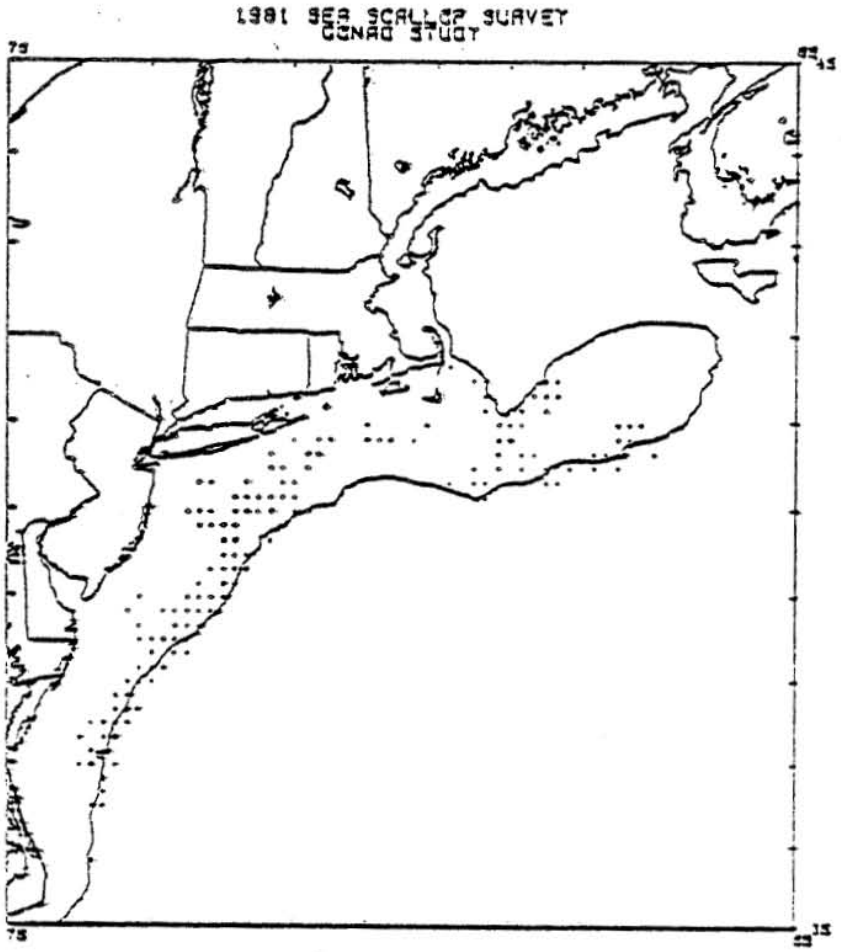


Figure 36. Locations of ten-minute squares of latitude and longitude on Georges Bank and in the Middle Atlantic where sea scallops were collected for shell height-ovary weight and meat weight-ovary weight analyses during the 1981 USA sea scallop research vessel survey. Each point represents the center of a ten-minute square in which ovary samples were obtained and may represent more than one survey station within the ten-minute square at which ovary samples were collected.

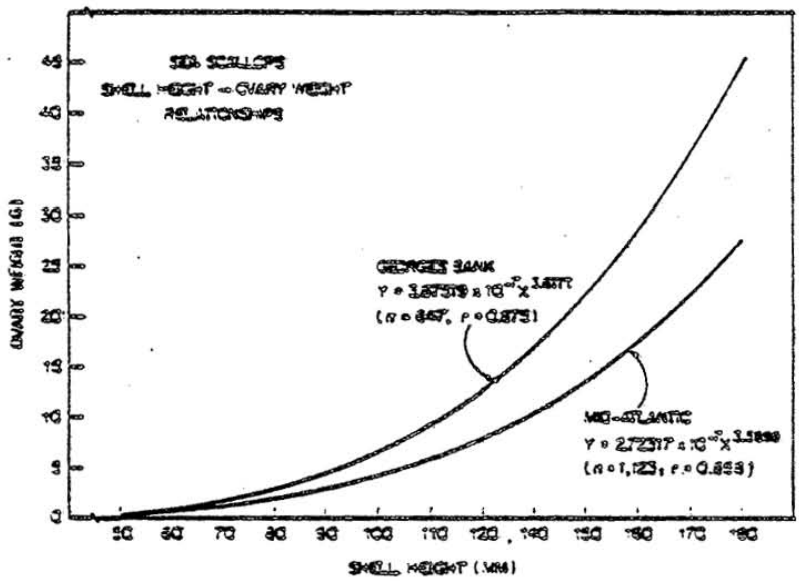


Figure 37. Shell height-ovary weight relationships for sea scallops sampled from Georges Bank and the Middle Atlantic during the 1981 USA sea scallop research vessel survey.

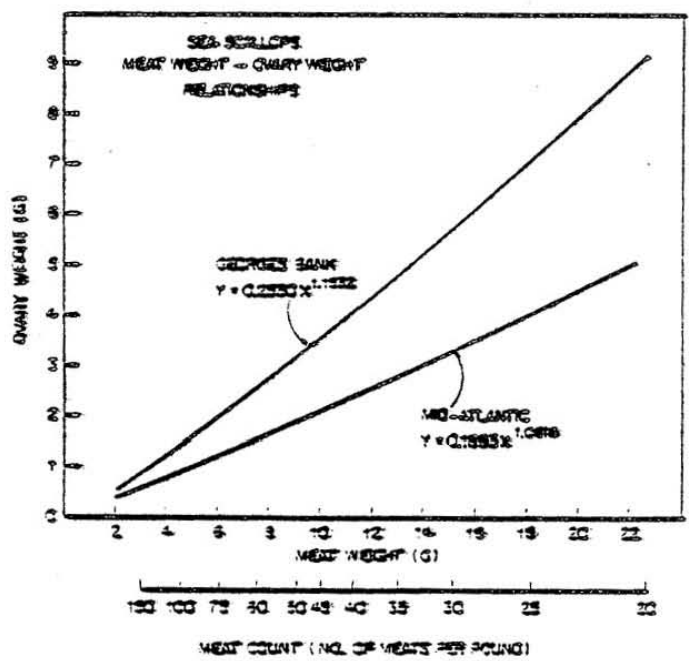


Figure 38. Meat weight-ovary weight relationships for sea scallops sampled from Georges Bank and the Middle Atlantic during the 1981 USA sea scallop research vessel survey.

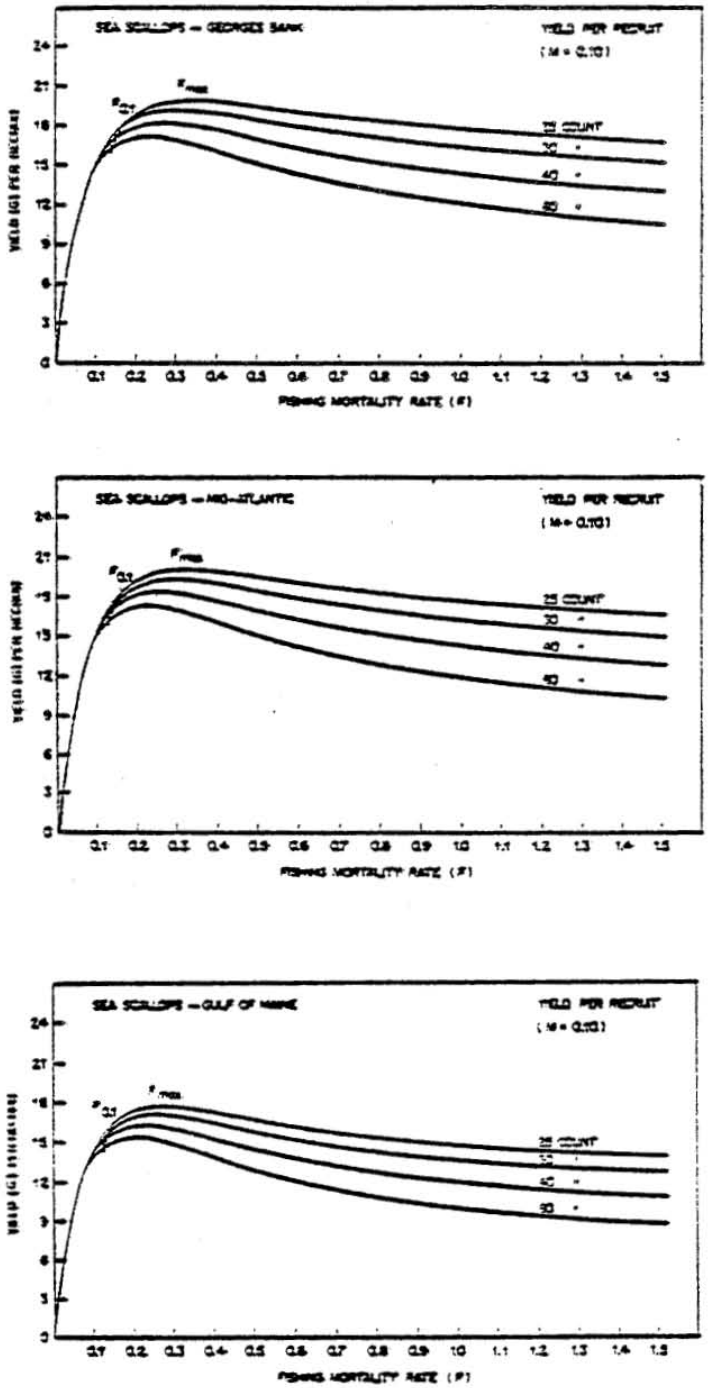


Figure 39. Yield (grams, meat weight) per recruit for Georges Bank, Middle Atlantic, and Gulf of Maine sea scallops as a function of fishing mortality rate (F) and age at entry to the fishery corresponding to 25, 30, 40, and 60 meat count scallops. F_{max} and $F_{0.1}$ values are indicated for each yield per recruit curve. All analyses were performed using the Paulik and Gales (1964) allometric yield per recruit model with natural mortality rate (M) = 0.1 and age at recruitment (t_p) = 2.0 years. Meat counts refer to the number of scallop meats in a pound.