

Summary and Review of the 1978 Assessment and Status of  
Sea Scallop (Placopecten magellanicus)  
Populations off the Northeast Coast of the United States

by

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Summary and Review of the 1978 Sea Scallop Assessment for  
Public Hearings on the Sea Scallop Management Plan

I. Background Life History Information

Brief summaries of sea scallop distribution, habitat, temperature range, reproduction, maximum age, food, growth, and behavior are presented in Table 1 (Sea Scallop - Life History Summary).

II. Fishing Areas

Sea scallop beds sufficiently dense and extensive enough to support commercial fishing exist from Port au Port Bay, Newfoundland, to the Virginia Capes, generally at depths between 40 and 100 meters (25-55 fathoms). Historically, the principal U.S. fishery grounds have been: off Penobscot Bay, Maine (in territorial waters), in the offshore areas of Georges Bank (Northern Edge and Northeast Peak; Southeast Section; and the South Channel), in the New York Bight Region, and off Delaware and Chesapeake Bays (Figure 1).

Recreational fishing is insignificant. It occurs in Maine where shallow water concentrations of sea scallops frequently exist.

III. Stock Differentiation and Spatfall Distribution

No biological evidence exists that would imply a separation of stocks within U.S. offshore sea scallop populations, except for minor growth rate differences occurring between northern (Georges Bank) and southern (Mid-Atlantic) populations resulting from differing temperature regimes.

Sea scallop larvae are pelagic and hence the distribution of spatfall is presumably related to the prevailing flow of water. The generalized sea surface circulation patterns (Figure 2) suggest that the Georges Bank scallop beds may be settled by progeny spawned from Georges Bank beds, while the prevailing southwesterly flow of water from Georges Bank probably results in Mid-Atlantic scallop beds being settled by progeny spawned from "upstream" beds. Sea scallop larvae, however, have never been positively identified in plankton collections and thus it has not been feasible to trace movements except from an inferential perspective.

IV. Review of Catch History

Landings records exist from as far back as 1887. The USA fishery remained at a low level until the 1930's, when the large scallop beds

on Georges Bank began to be more fully exploited (Figure 3). By 1939 annual landings had reached 4,500 metric tons due to the development of the New Bedford scallop industry. Landings dropped sharply during the war years, but increased rapidly afterward, reaching 9,000 tons in 1950. During the next decade, USA landings remained fairly stable from both Georges Bank and the Mid-Atlantic. From 1961 to 1973 total USA landings decreased from 12,500 tons to 2,400 tons, but have recently increased to the levels observed about 1960. USA landings in 1977 (11,000 tons) were the highest in 15 years.

Canada has been the only other nation conducting a fishery for scallops on Georges Bank or in the Mid-Atlantic (Figure 4). Canada entered the New England (Georges Bank) fishery in 1951 and by 1957 Canadian landings comprised 10% of the total Georges Bank scallop catch (Table 5). In late 1959, an exceptional year class (probably 1955) recruited to the Georges Bank fishery, and both USA and Canadian landings increased sharply. In 1962, total landings from New England reached 15,400 tons, about double that taken during 1958.

In 1965, a highly successful year-class recruited to the Mid-Atlantic grounds; both USA and Canadian vessels diverted their effort from New England to the south, causing a ten fold increase in Mid-Atlantic landings between 1964 and 1965. Many of the U.S. vessels did not return to Georges Bank to any extent until 1977.

During 1965-1973 on Georges Bank, and 1968-1974 in the Mid-Atlantic, total scallop landings stabilized at levels indicative of more normal recruitment patterns. Recruitment of the 1972 year-class was highly successful on both Georges Bank and in the Mid-Atlantic, resulting in a doubling of the landings, in each area, between 1975 and 1977. Total landings in 1977, about 24,000 tons, were the highest on record.

Geographic distribution of U.S. catches for Georges Bank and the Mid-Atlantic, during the last decade, are presented in Figures 6 and 7, respectively. Although the South Channel has been the major U.S. fishing grounds on Georges Bank in recent years, historically (1944-1977) the Northern Edge and Peak, fished primarily by Canada, has produced greater than 69% of the total Georges Bank sea scallop catch. In the Mid-Atlantic, the New York Bight - Hudson Canyon region has produced most of the scallop landings.

#### V. Growth and Yield

Estimates of age and growth from shell samples and tagging experiments for both Georges Bank and Mid-Atlantic populations reveal that between ages 3 and 5 (60-105 mm) scallops roughly quadruple their meat weight over the same interval that 18% of the population dies from natural causes

(Figures 8 and 9). Meats per pound are reduced from about 100 to 23 in this period. Between ages 8 and 9, annual growth falls to less than 10% per year, so that at age 8 (133 mm, 11 meats/lb) the increase in weight due to growth roughly balances the loss in weight due to natural mortality. Thus, if it were practical to wait until age 8 before landing scallops, the greatest yield for any given number of scallops entering the fishery would be achieved. This is indicated in the yield-per-recruit analyses performed on both the Georges Bank and Mid-Atlantic scallop populations (Figures 10 and 11). Although maximum yield per recruit is achieved by delaying mean age of first harvest to age 8, only slight gains are obtained by delaying harvest beyond age 6 (117 mm, 16 meats/lb). When size or age at first capture is held constant over a range of fishing mortality (Figures 12 and 13), two biological points become obvious: (1) for all values of size or age at first capture, the highest yields occur at rather low fishing mortality values; and (2) for all values of fishing mortality, yield increases as length at first capture increases.

Preliminary analyses of overall fishing mortality on scallop populations on Georges Bank and in the Mid-Atlantic indicate that between 1975 and 1977, fishing mortality rates (F) in both areas were in excess of  $F = 0.85$ . Maximum yield-per-recruit occurs at an F of 0.2-0.4 (depending on age at first capture). Hence, no gain in yield is realized by permitting F to exceed 0.2, and, in fact, potential yield actually decreases at higher fishing mortality rates.

## VI. Condition of the Stocks

Data on the condition of sea scallop populations in U.S. Atlantic waters are available from both research survey and commercial sources:

Sea scallop research-vessel surveys have been conducted by the National Marine Fisheries Service in two series: an older survey series conducted between 1960 and 1968 in which collection of basic life-history data was most often the major objective, although relative abundance and catch composition were also assessed, and a newer series of surveys conducted in 1975 and 1977 to specifically evaluate, on both Georges Bank and the Mid-Atlantic, relative abundance, population composition, and incoming recruiting year-class strength.

Commercial information on quantity of scallop meats landed, fishing areas, and size composition of the catch has been obtained from commercial landings statistics and NMFS dock-side commercial fishermen interviews.

Recent survey length-frequency data: The survey derived length-frequencies for 1975 and 1977 are summarized in Figures 14, 15, and 16. The 1975 results indicate that the 1972 year-class was a very strong one in almost all major fishing areas, both on Georges Bank and in the Mid-Atlantic. The 1977 results further corroborate the strength of the 1972 year-class.

Graphically, the relative differences in year-class strength are underestimated between pre-recruit (<69 mm) and recruited age-groups (>70 mm) since the data have not been adjusted for gear selectivity or efficiency between different size groups. Note the large difference in relative abundance (stratified mean number per tow) between Georges Bank and the Mid-Atlantic.

Survey length-frequency distribution of sea scallops from the three major fishing grounds (Northern Edge - Northeast Peak; South Channel; Southeast Part) on Georges Bank in 1975 and 1977 are depicted in Figure 15. Examination of the data reveals: (1) the striking difference in relative abundance of scallops between the Northern Edge - Northeast Peak and the other two areas of the Bank in both survey years; (2) the appearance of the strong 1972 year-class (40-60 mm) in the 1975 survey catches in the Northern Edge - Northeast Peak, and South Channel regions; and (3) the relative absence in 1977 of small scallops (<60 mm) in the South Channel and Southeast parts implying poor recruitment of the 1974 class in these regions.

Survey length-frequency distributions from the three major fishing areas in the Mid-Atlantic in 1975 and 1977 (Long Island - New Jersey; Delmarva; Virginia - North Carolina) (Figure 16) show the following: (1) the appearance of the strong 1972 year-class (40-65 mm) in the 1975 survey results in all areas; (2) the virtual absence of the 1974 year-class (40-65 mm) in the 1977 survey data in all regions; and (3) the drastic decline in the survey abundance of scallops in the Delmarva area between 1975 and 1977.

Recent commercial landings length-frequency data: The dependence of the US scallop fleet on the 1972 year-class is apparent in the USA commercial landings length-frequency distributions from the South Channel region of Georges Bank, 1975-1977 (Figure 17). The diminished importance of older age groups in the US catch in 1976 and 1977 is striking, since these were well represented in the 1975 landings and in earlier years.

The predominance of the 1972 year-class in the 1976 and 1977 Mid-Atlantic scallop fishery is evident in the US commercial landings length-frequency distributions of sea scallops from the New York Bight region of the Mid-Atlantic, 1975-1977 (Figure 18). A shift in the size range of scallops comprising the catch is also apparent between 1975-1977.

Relative abundance: Abundance indices of scallops on Georges Bank, using the older time series with the new surveys added (Figure 19), indicate that abundance was high through 1962, dropped by over half during 1963-65, and gradually declined until 1977, when it increased dramatically due to the successful 1972 year-class.

The 1977 research survey abundance indices (number-per-tow) indicate that the current relative abundance of the recruited (or commercially exploitable) segment of the scallop populations for almost all areas, other than the Northern Edge and Peak of Georges Bank is similar to that observed in 1975, but that the pre-recruit (less than about 70 mm) indices have drastically declined (Table 20). These results imply that recruitment of the 1973 and 1974 year-classes (first observed in the survey dredge at age 3) was fair and poor, respectively. Since catches between 1975 and 1977 doubled and tripled in most of the major fishing areas and recruitment prospects are poor, the present high catch levels cannot be sustained without greatly increasing fishing mortality. This is particularly true in the Mid-Atlantic and in the South Channel area of Georges Bank. Abundance can be expected to decline sharply in these regions as the 1972 and 1973 year-classes are fished out. Because of recent good recruitment on the Northern Edge, catches at the current level should keep fishing mortality relatively stable in the immediate future.

Table 1. Sea scallop life history summary

SEA SCALLOP - LIFE HISTORY SUMMARY

DISTRIBUTION:	CONTINENTAL SHELF OF THE NORTHWEST ATLANTIC FROM THE STRAIT OF BELLE ISLE SOUTH TO CAPE HATTERAS.
HABITAT:	NORTH OF CAPE COD, IN SHALLOW WATER, LESS THAN 20 METERS (10 FATHOMS), FREQUENTLY JUST BELOW THE LOW TIDE MARK. IN SOUTHERN SECTIONS, IN DEEPER WATER, OVER 40 METERS (22 FATHOMS), TO DEPTHS EXCEEDING 200 METERS (110 FATHOMS). COMMERCIALY IMPORTANT BEDS USUALLY FOUND BETWEEN 40-100 METERS (22-55 FATHOMS). BOTTOM TYPE - FIRM SAND OR GRAVEL. ALSO ON MUD OR ROCK.
TEMPERATURE RANGE:	0-20°C (32-68°F). OPTIMUM TEMPERATURE ABOUT 10°C (50°F).
REPRODUCTION:	OPTIMUM SPawning TEMPERATURES: 8-11°C (46-52°F) (JULY - OCTOBER). MECHANISM WHICH TRIGGERS SPawning IS UNKNOWN; MAY BE CHANGE IN TEMPERATURE OR TIDAL ACTIONS. SEXES ARE SEPARATE, EXTERNAL FERTILIZATION. EGGS AND LARVAE ARE PELAGIC. LARVAE DEVELOP THROUGH THE TYPICAL PELECYPOD MOLLUSCAN DEVELOPMENTAL STAGES (TROCHOPHORE AND VELIGER STAGES)  LARVAL PERIOD: 4-6 WEEKS OR MORE  FECUNDITY: NOT PRECISELY KNOWN. A 100 MM FEMALE (4 OR 5 YEARS OLD) WILL PRODUCE ABOUT 2 MILLION EGGS.  AGE AT MATURITY: 3 YEARS OLD (60-75 MM)
MAXIMUM AGE:	ABOUT 20 YEARS
FOOD:	FILTER FEEDERS ON PLANKTON AND DETRITUS.
GROWTH:	STEADY INCREMENTS TO AGES IN EXCESS OF 10-12 YEARS. VARIABLE BETWEEN GEOGRAPHICAL REGIONS, AND ALSO WITHIN REGIONS.  RECORD SIZE: 230 MM SHELL LENGTH.
BEHAVIOR:	VIGOROUS SWIMMERS. INDIVIDUAL MOVEMENTS WITHIN BEDS BUT BEDS DO NOT SHIFT MARKEDLY. NO EVIDENCE OF SEASONAL MIGRATIONS OR DIRECTED MOVEMENTS OF ADULTS.

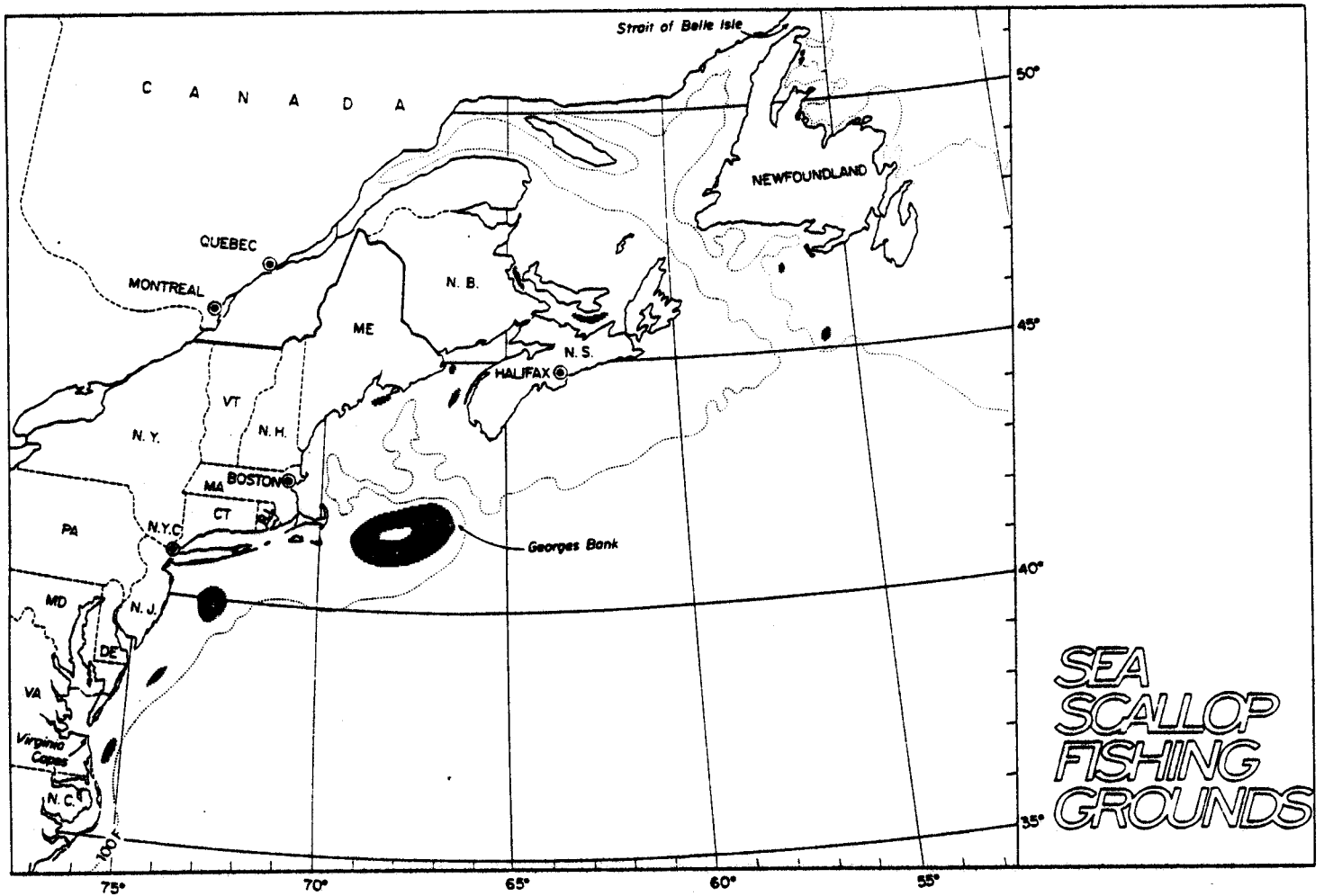


Figure 1. Major sea scallop fishing grounds in the Northwest Atlantic



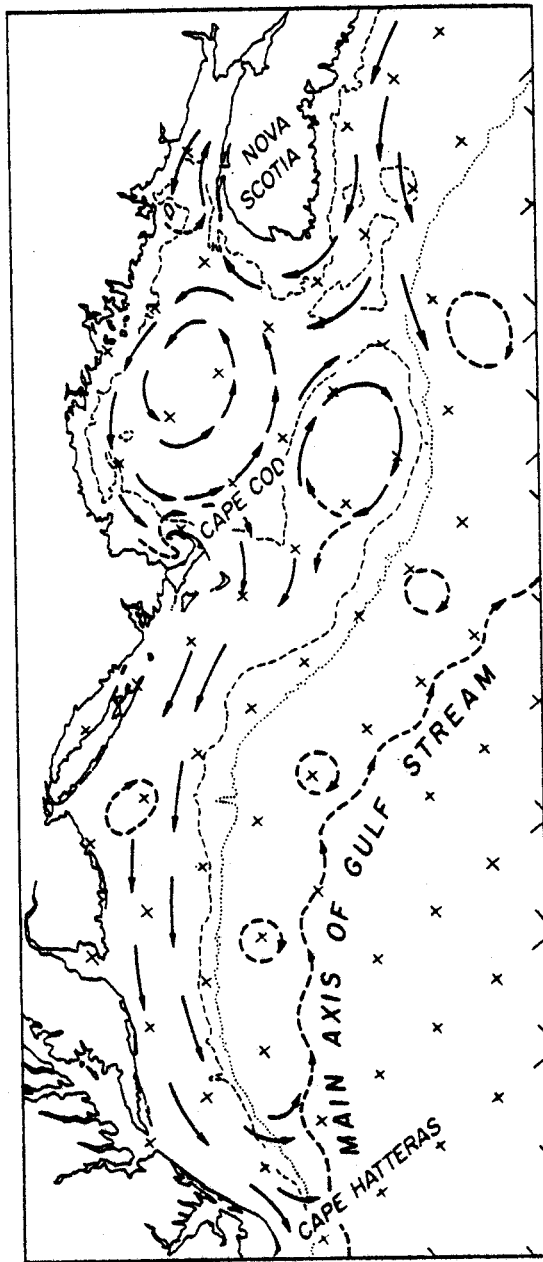


Figure 2. Generalized pattern of sea surface current circulation. Nova Scotia to Cape Hatteras.

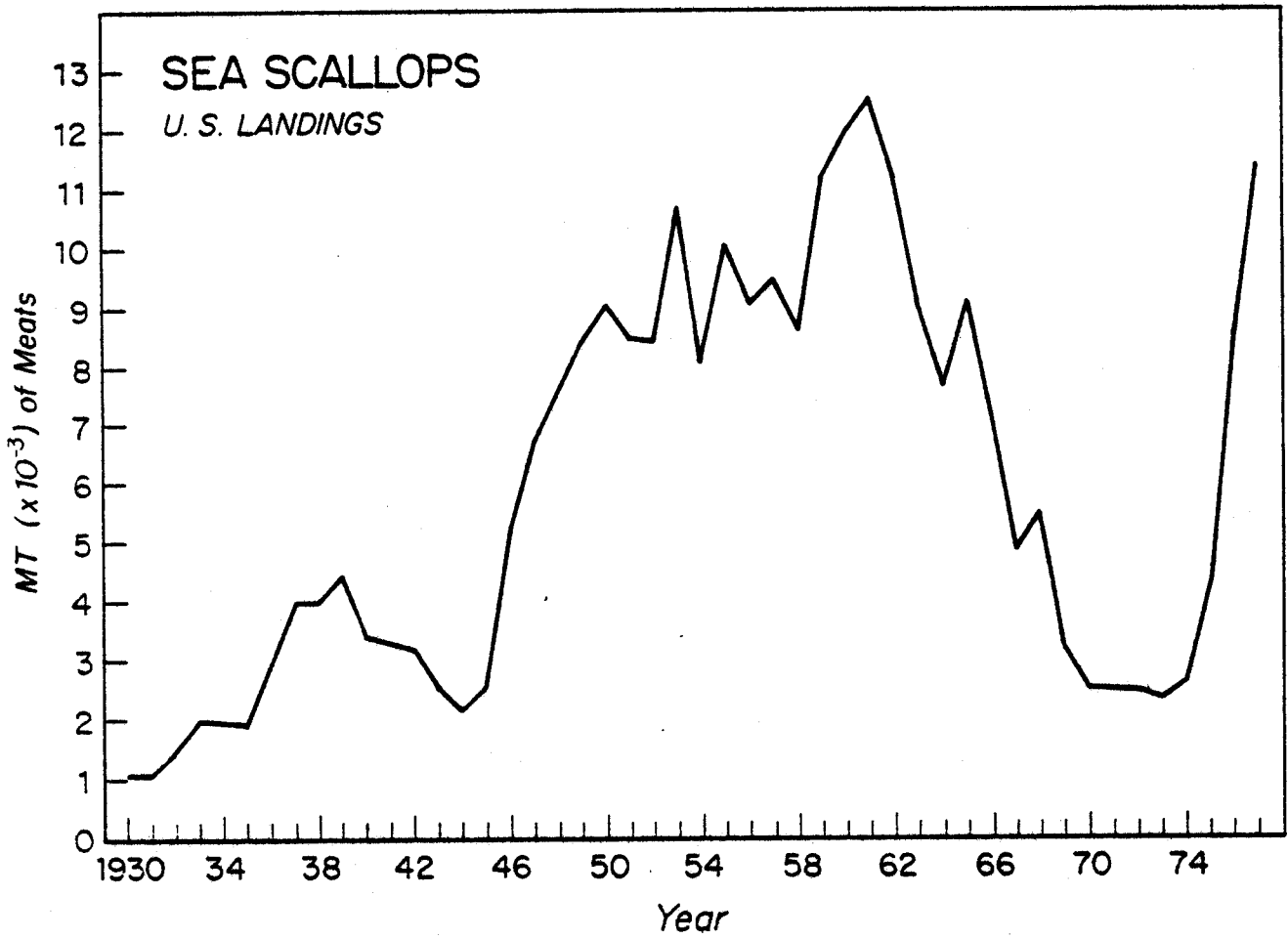


Figure 3. Total reported USA commercial sea scallop landings (metric tons, meats) from all Northwest Atlantic areas, 1930-1977.

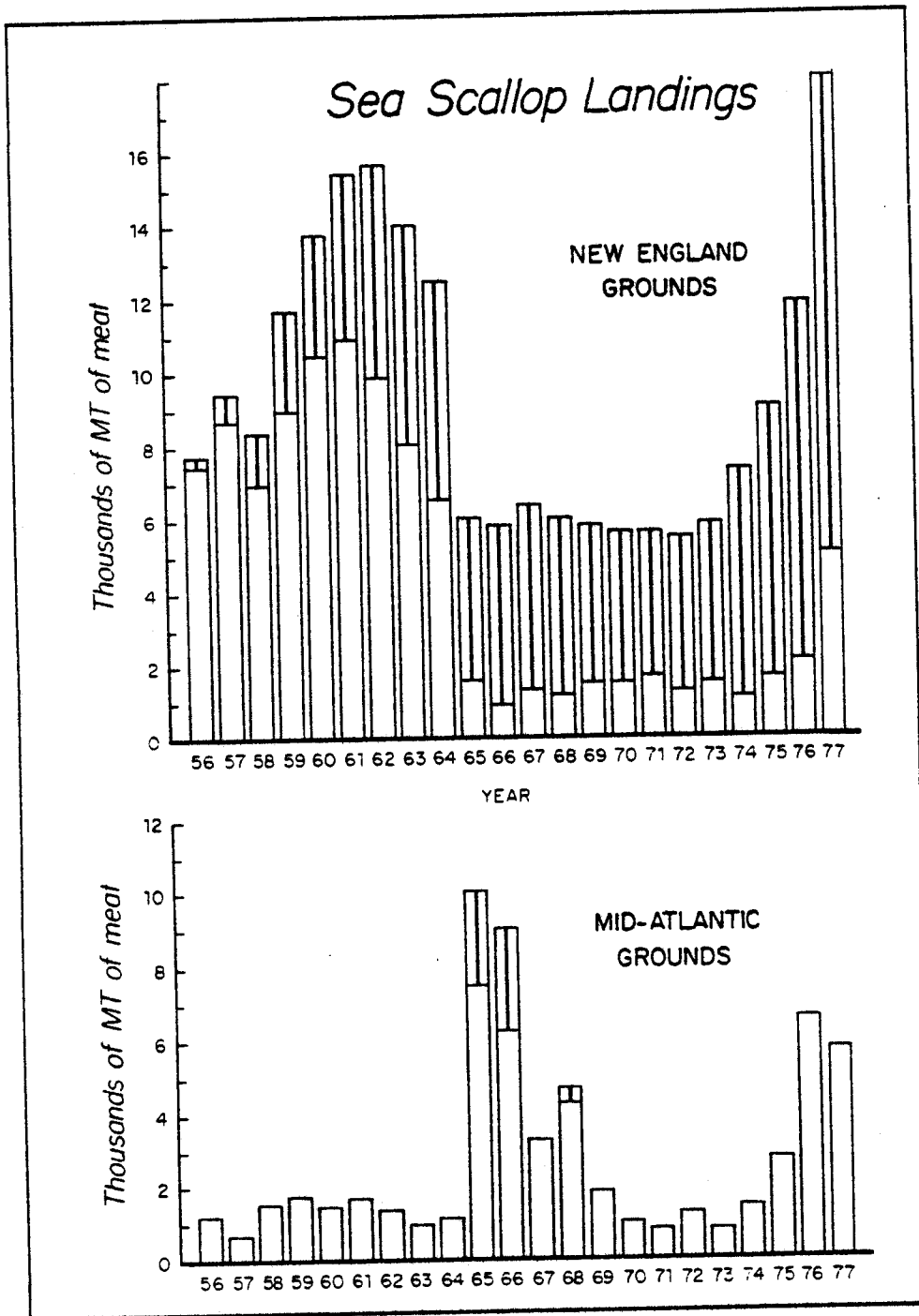


Figure 4. Total reported USA and Canadian commercial sea scallop landings (metric tons, meats) from Georges Bank (New England) and Mid-Atlantic grounds, 1956-1977. The upper lined portions of the bars represent Canadian landings.

TABLE 5. HISTORICAL TRENDS IN USA AND CANADIAN SEA SCALLOP LANDINGS (METRIC TONS, MEATS)  
FROM GEORGES BANK (ICNAF DIV. 52), 1944-1977<sup>1</sup>.

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	3,001
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	6,296	52	5,901	48	12,197
1965	1,509	25	4,418	75	5,927
1966	892	16	4,861	84	5,753
1967	1,229	20	5,001	80	6,230
1968	1,049	18	4,805	82	5,854
1969	1,343	24	4,302	76	5,645
1970	1,421	26	4,082	74	5,503
1971	1,336	26	3,894	74	5,230
1972	823	17	4,146	83	4,969
1973	1,083	20	4,208	80	5,291
1974	930	13	6,115	87	7,045
1975	907	11	7,387	89	8,294
1976	1,770	15	9,745	85	11,515
1977	4,816	27	13,036	73	17,850

<sup>1</sup> SOURCE: 1944-1957, CADDY (1975); 1958-1976, ICNAF STATISTICAL BULLETINS; 1977, ICNAF SUM. DOC. 78/VI/28 (REVISED 15 JUNE 1978).

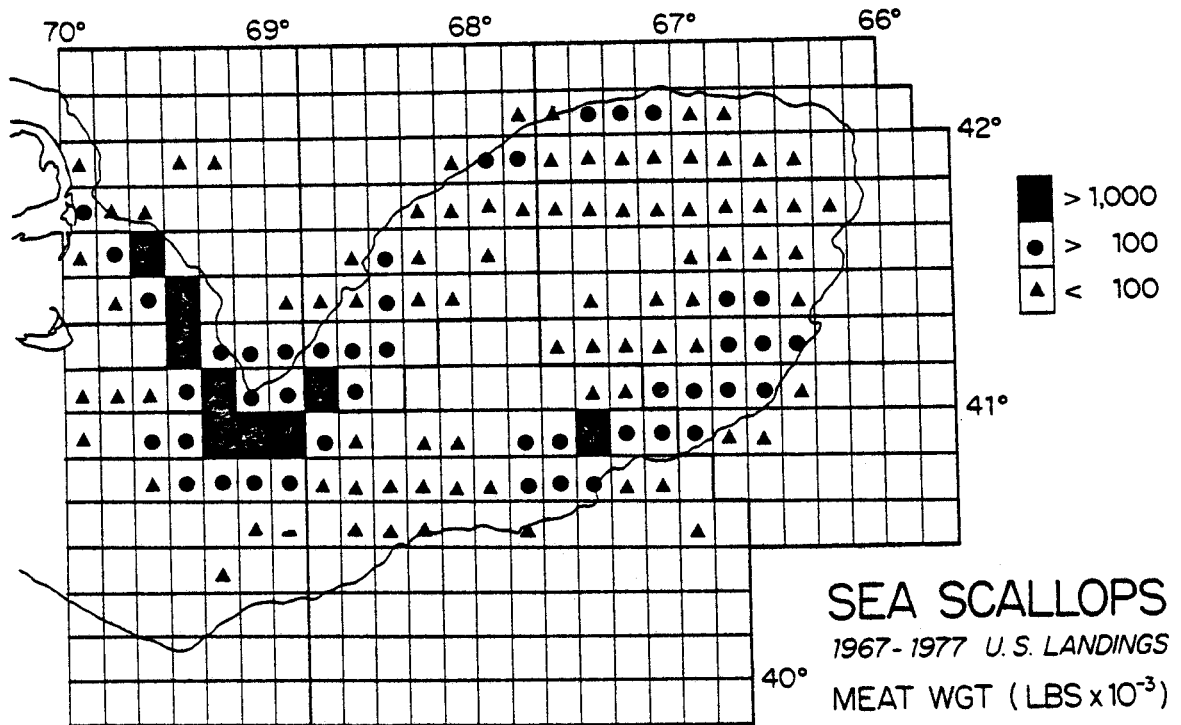


Figure 6. Geographic distribution of USA sea scallop landings (thousands of pounds, meats) from Georges Bank, 1967-1977.

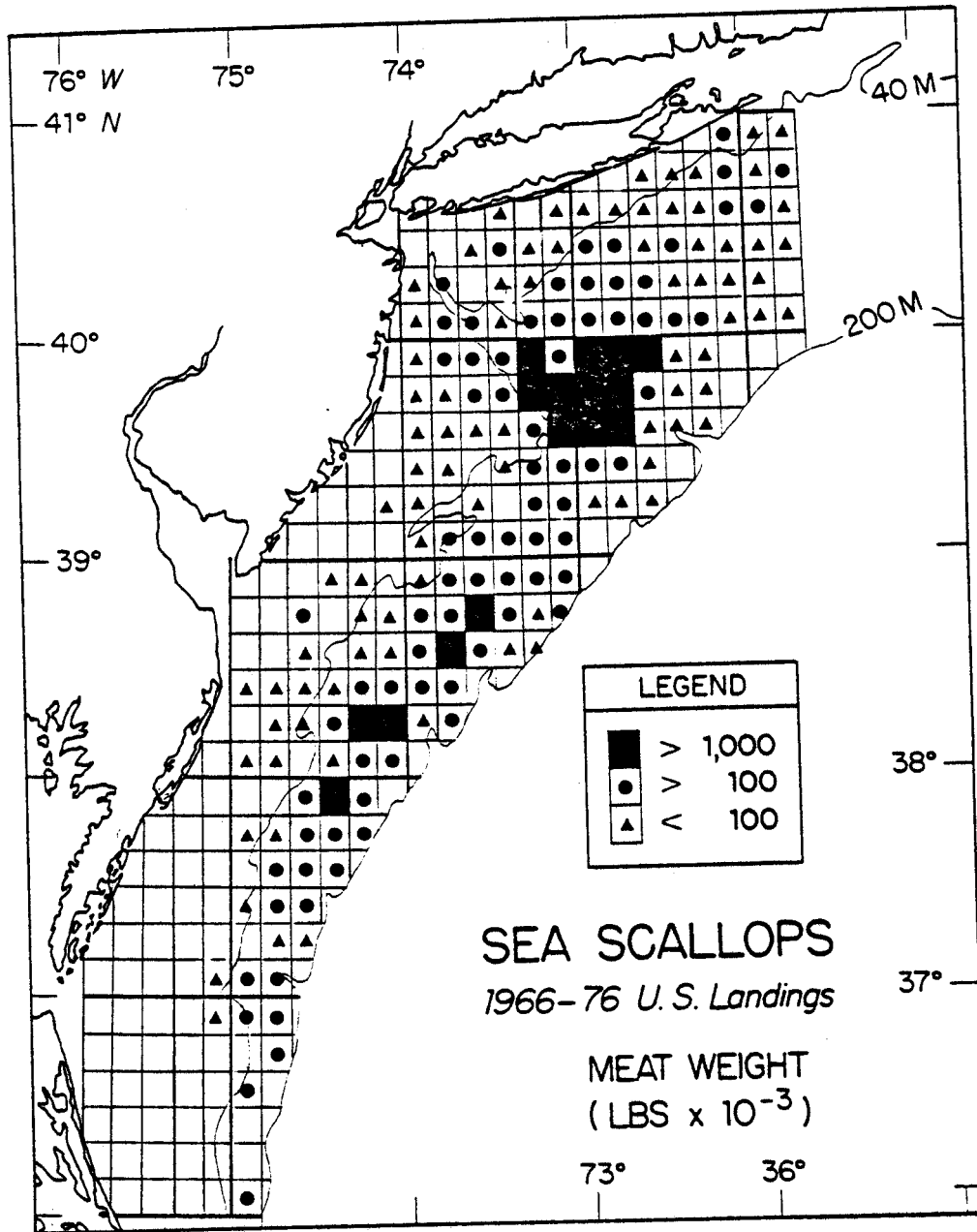


Figure 7. Geographic distribution of USA sea scallop landings (thousands of pounds, meats) from the Mid-Atlantic, 1966-1976.

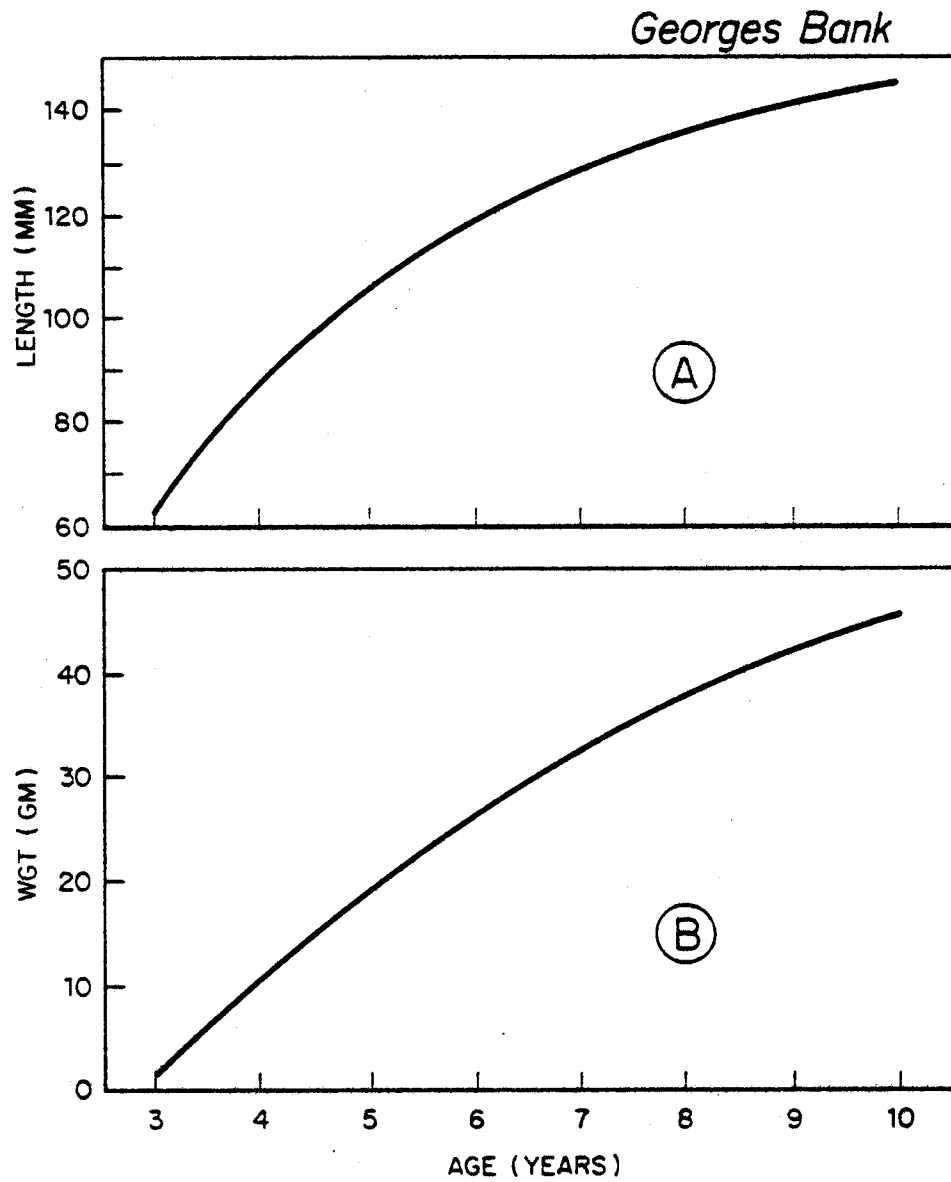


Figure 8. Mean size, at age, for Georges Bank sea scallops. Shell length (mm) is presented in (A); meat weight (gms) in (B).

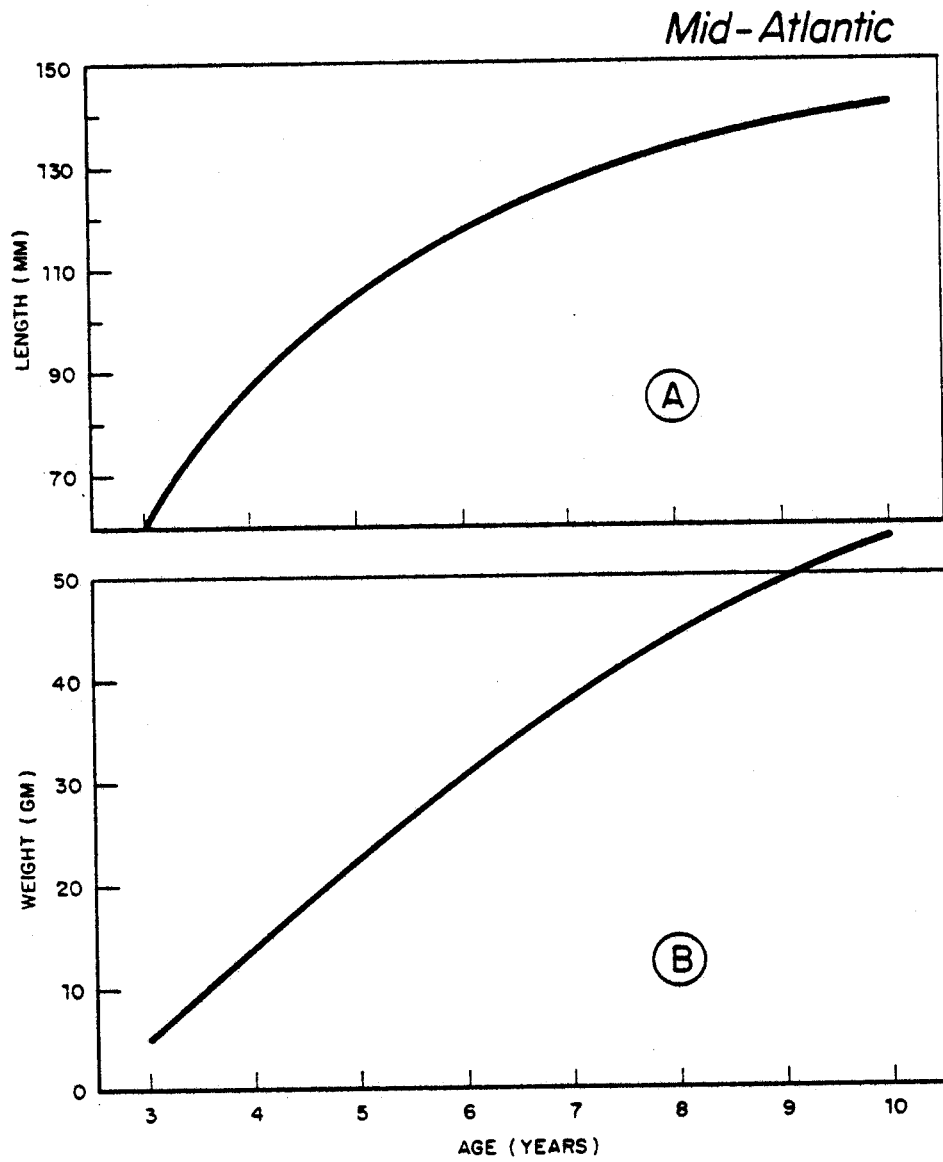


Figure 9. Mean size, at age, for Mid-Atlantic sea scallops. Shell length (mm) is presented in (A); meat weight (gms) in (B).



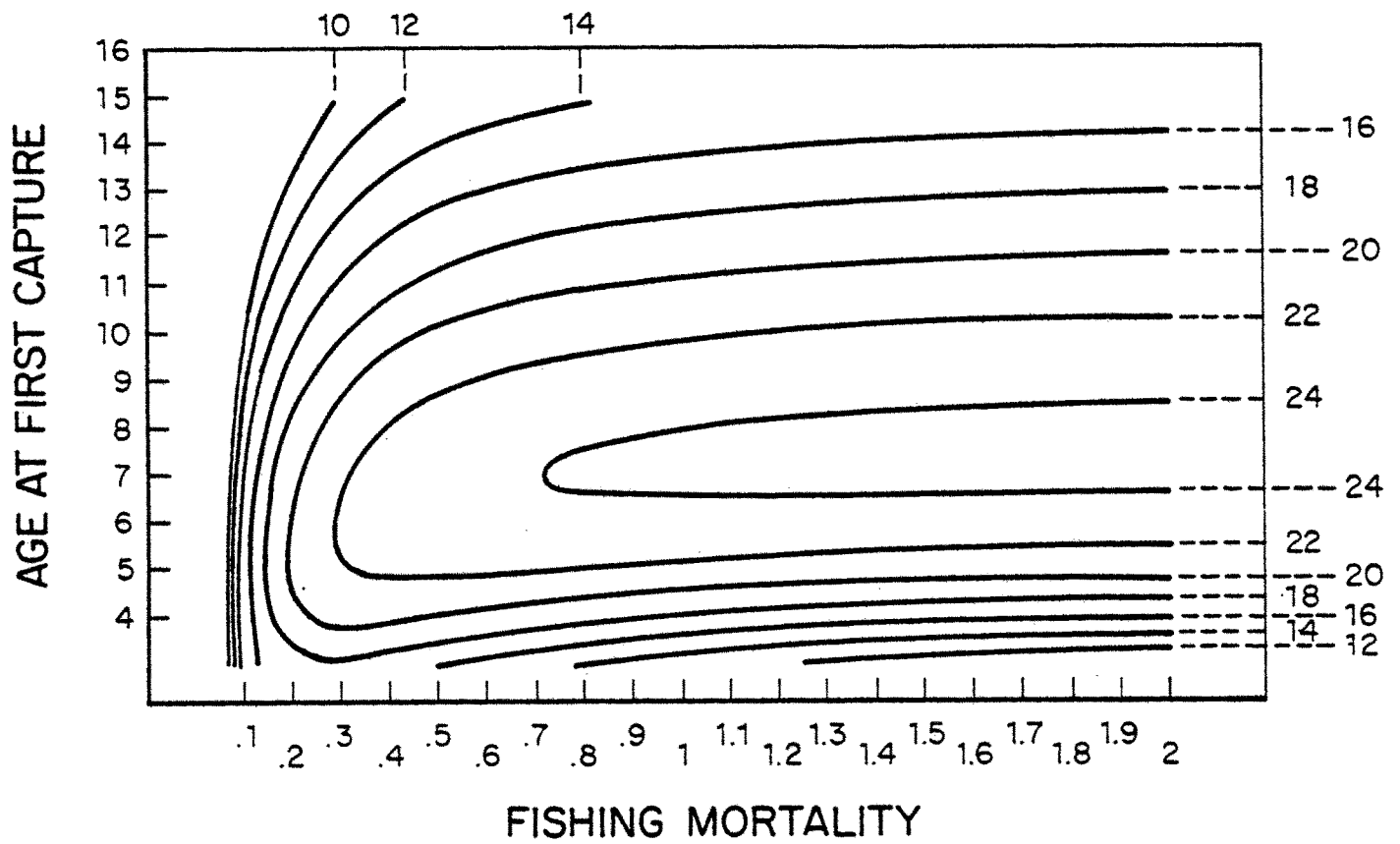


Figure 10. Yield per recruit isopleth for Georges Bank sea scallops. Yield is expressed as grams (meat weight) per recruit.

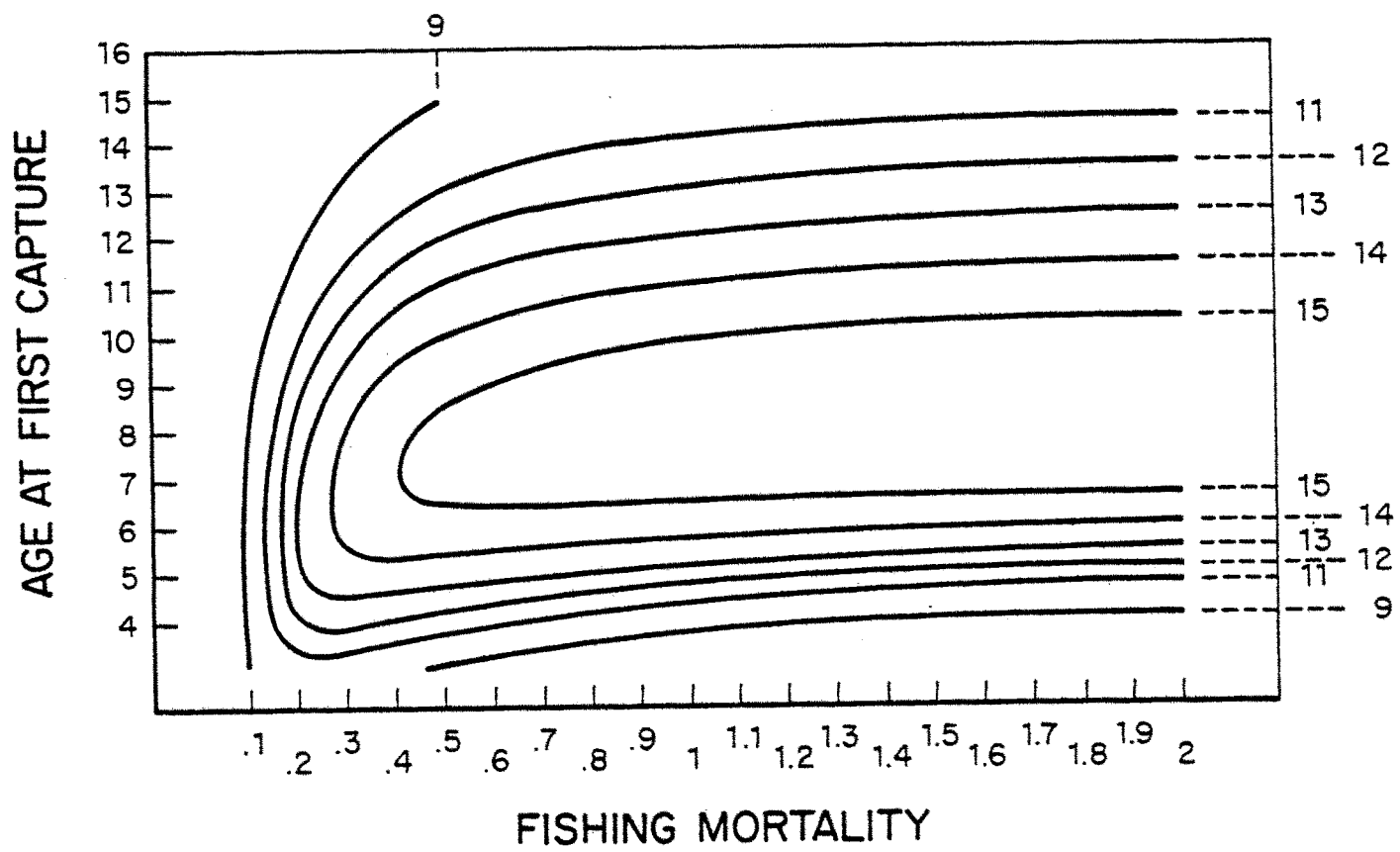
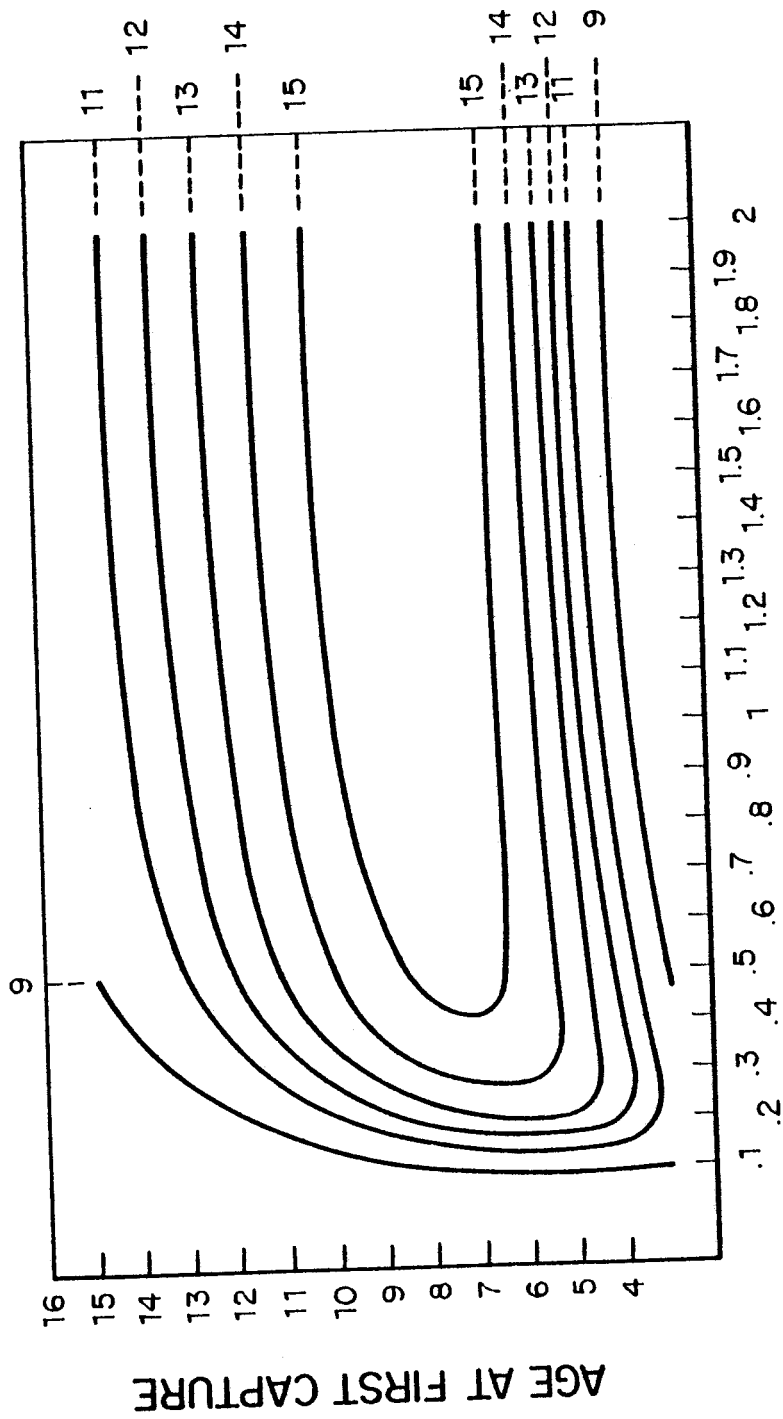


Figure 11. Yield per recruit isopleth for Mid-Atlantic sea scallops. Yield is expressed as grams (meat weight) per recruit.



FISHING MORTALITY

Figure 11. Yield per recruit isopleth for Mid-Atlantic sea scallops. Yield is expressed as grams (meat weight) per recruit.

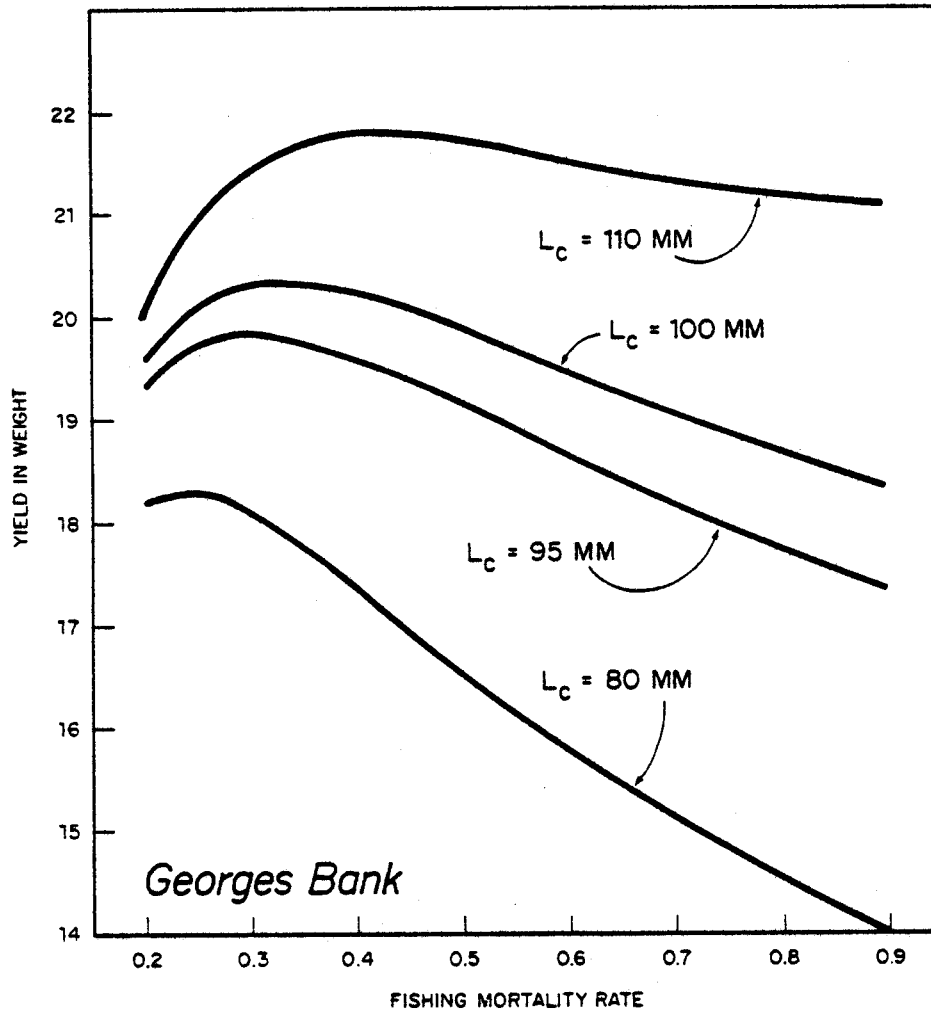


Figure 12. Yield per recruit for Georges Bank sea scallops as a function of fishing mortality for various sizes (shell length) at first capture ( $L_c$ ). Yield is expressed as grams per recruit.

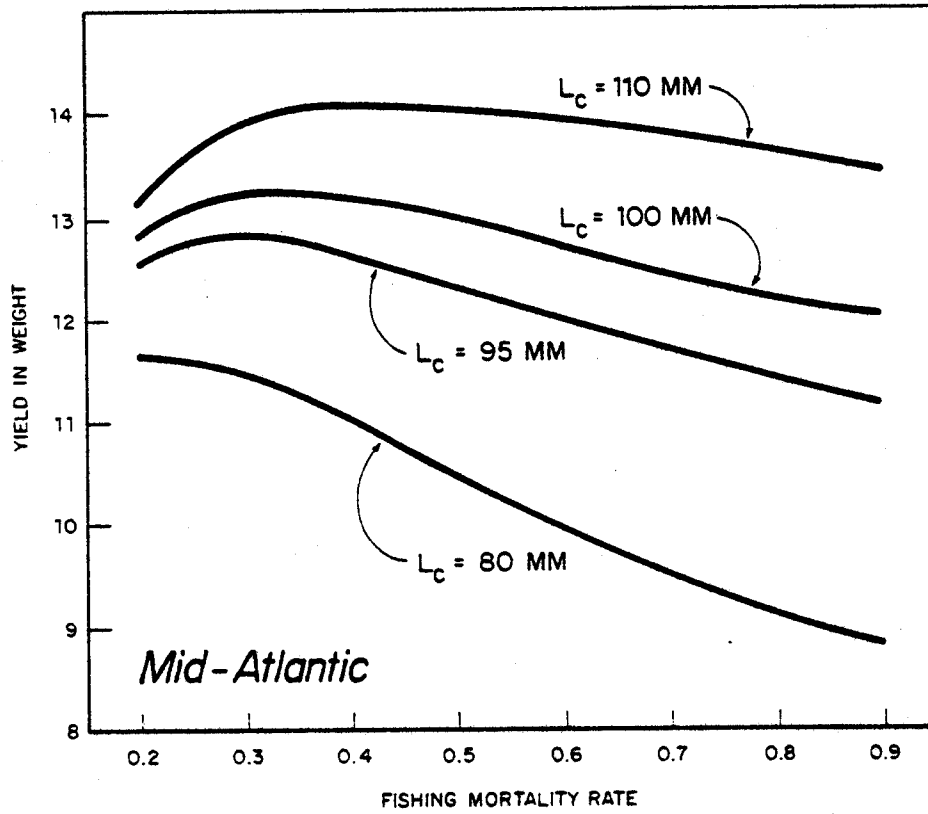


Figure 13. Yield per recruit for Mid-Atlantic sea scallops as a function of fishing mortality for various sizes (shell length) at first capture ( $L_c$ ). Yield is expressed as grams per recruit.

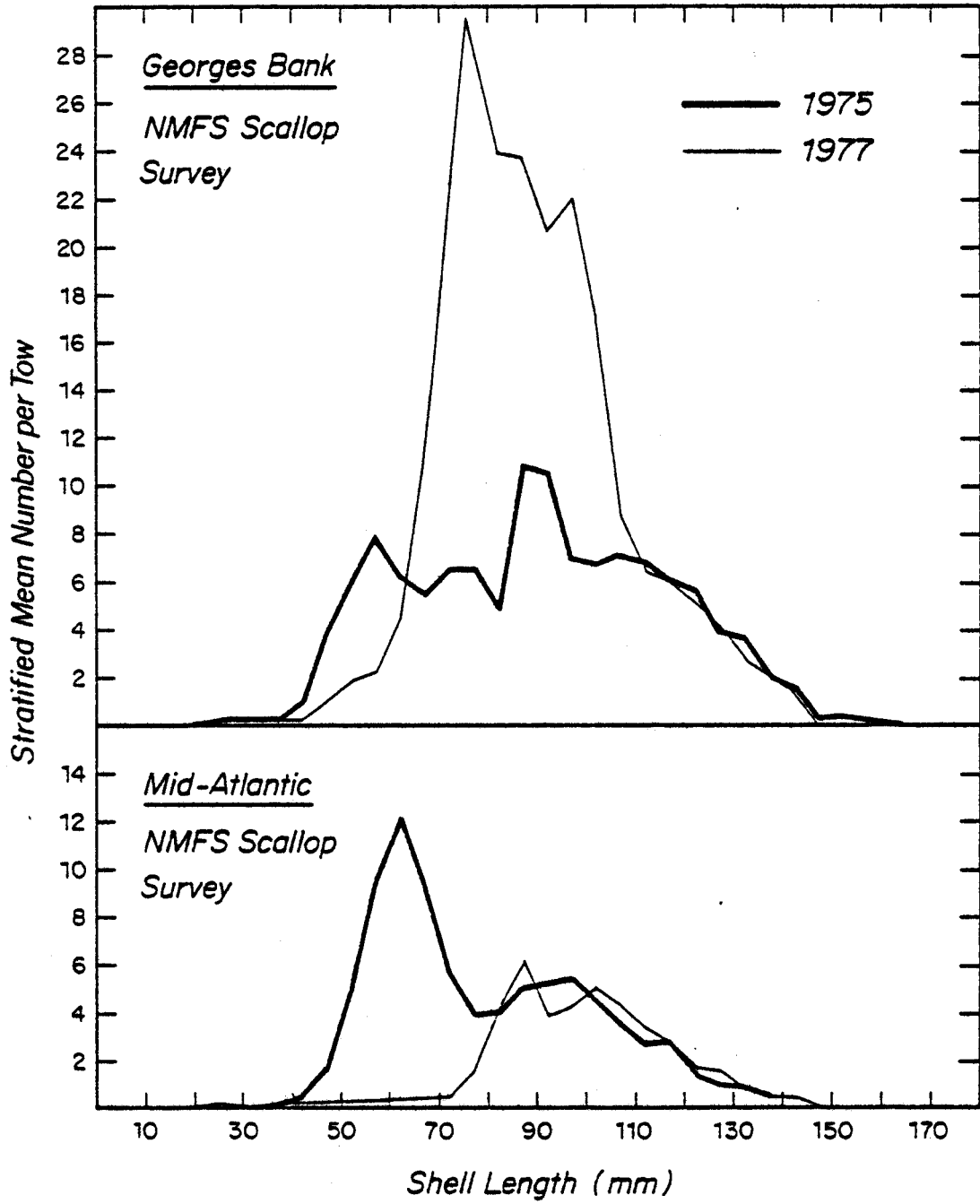


Figure 14. NMFS research vessel survey length-frequency distributions of sea scallops from Georges Bank and the Mid-Atlantic, 1975 and 1977.

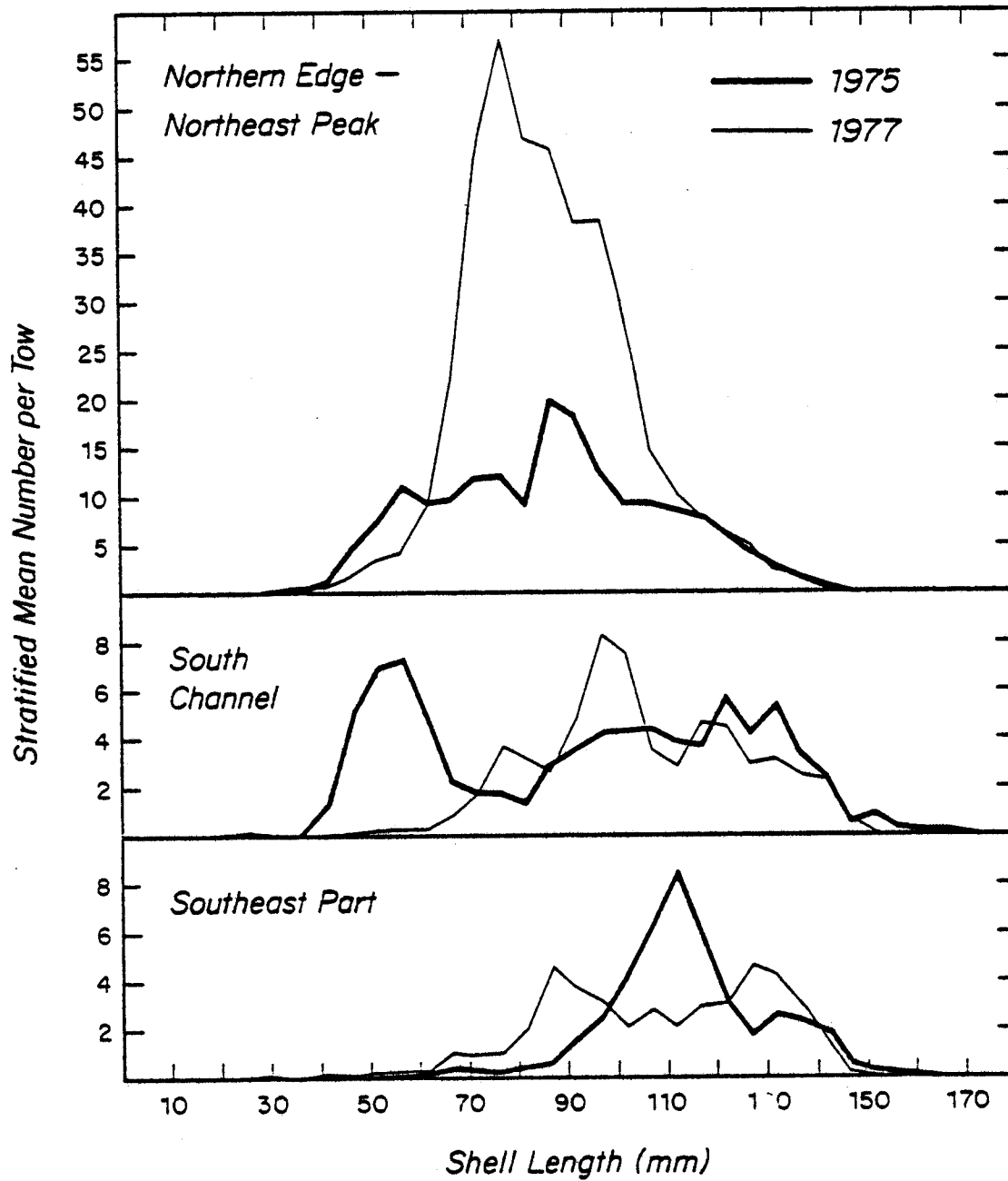
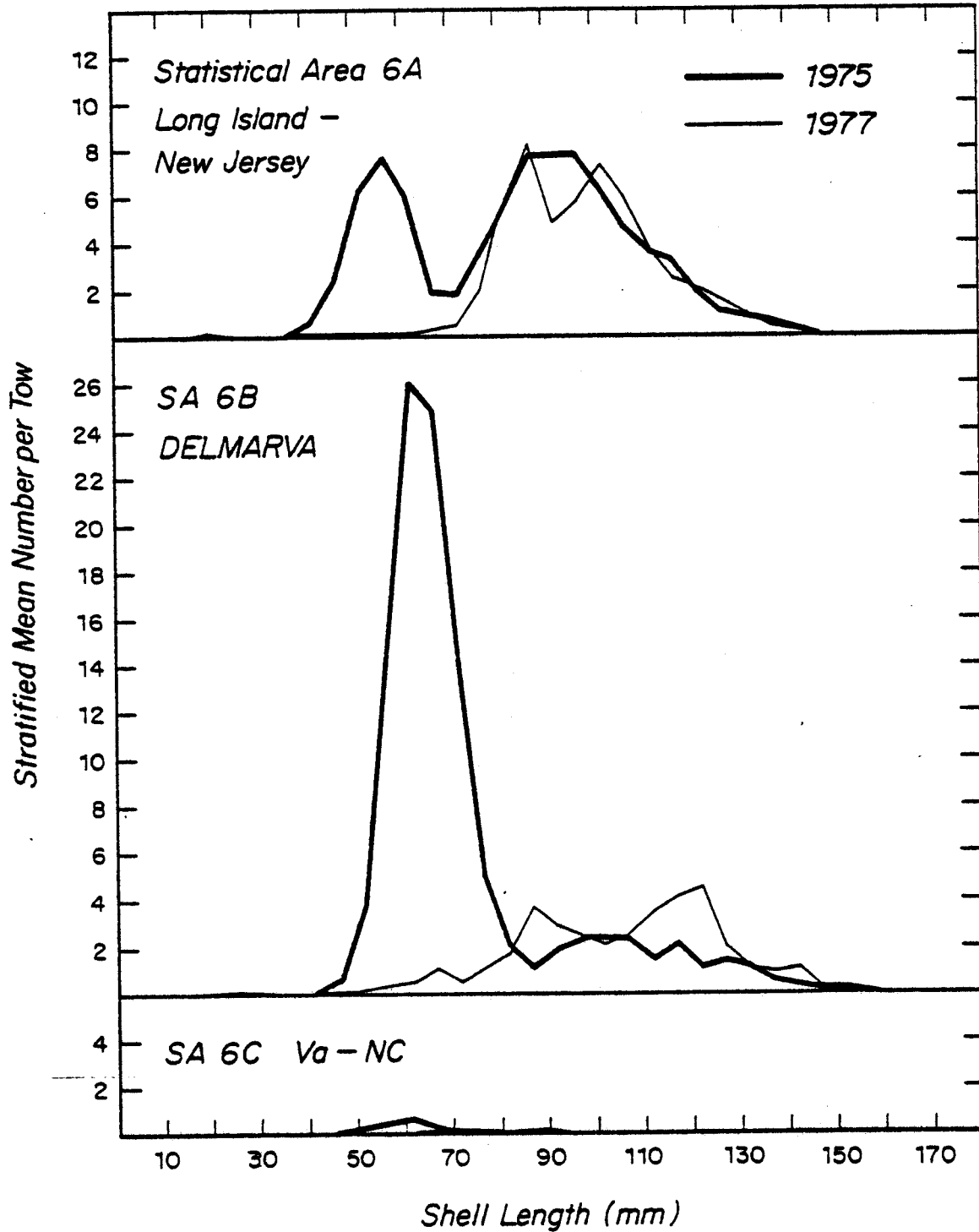


Figure 15. NMFS research vessel survey length-frequency distributions of sea scallops from the three major fishing grounds on Georges Bank (Northern Edge - Northeast Peak, South Channel, and Southeast Part), 1975 and 1977.

Figure 16. NMFS research survey length-frequency distributions of sea scallops from the three major fishing grounds in the Mid-Atlantic (Long Island-New Jersey, Delmarva, and Virginia - North Carolina), 1975 and 1977.





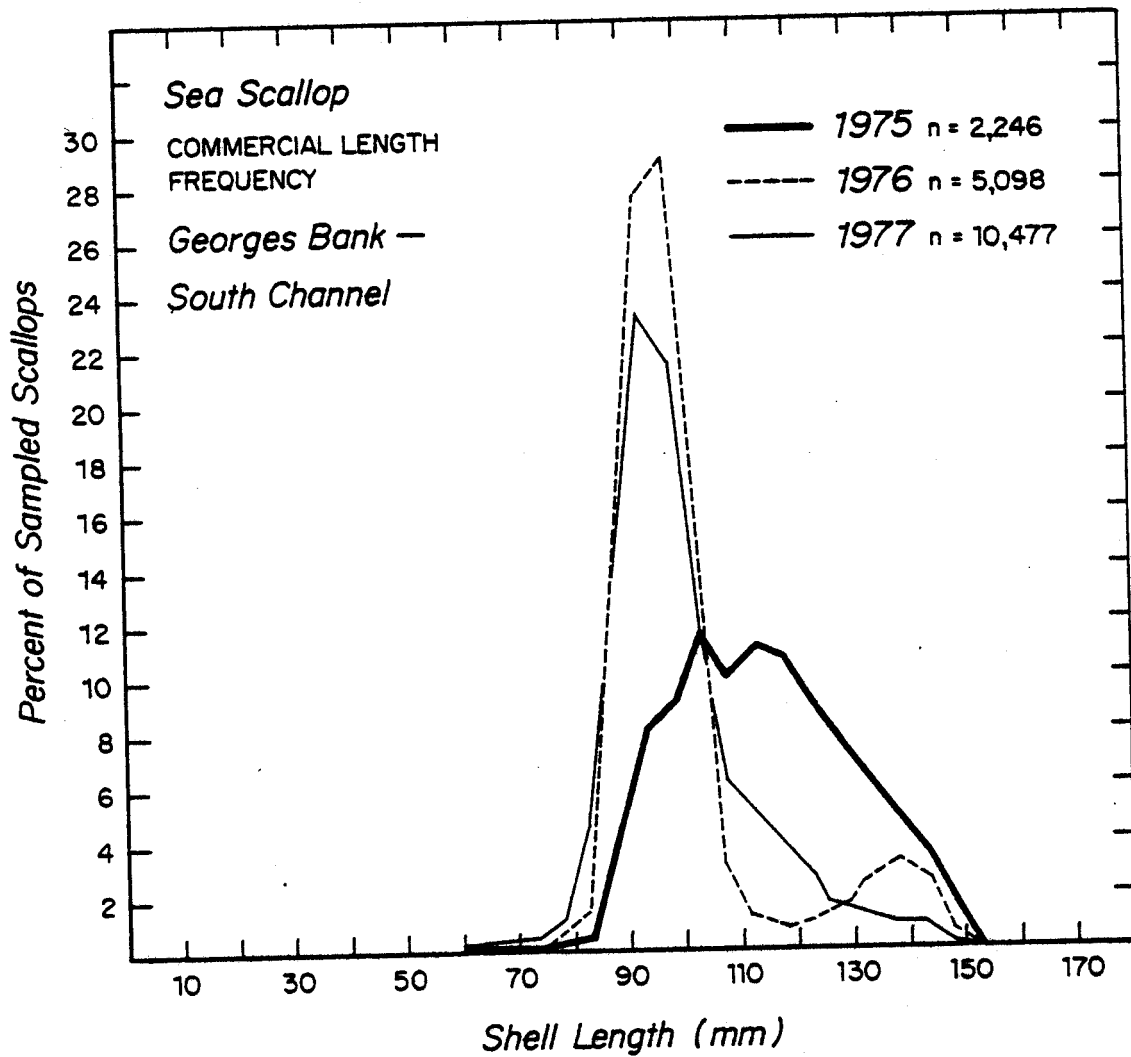


Figure 17. USA commercial landings length-frequency distributions of sea scallops from the South Channel region of Georges Bank, 1975-1977.

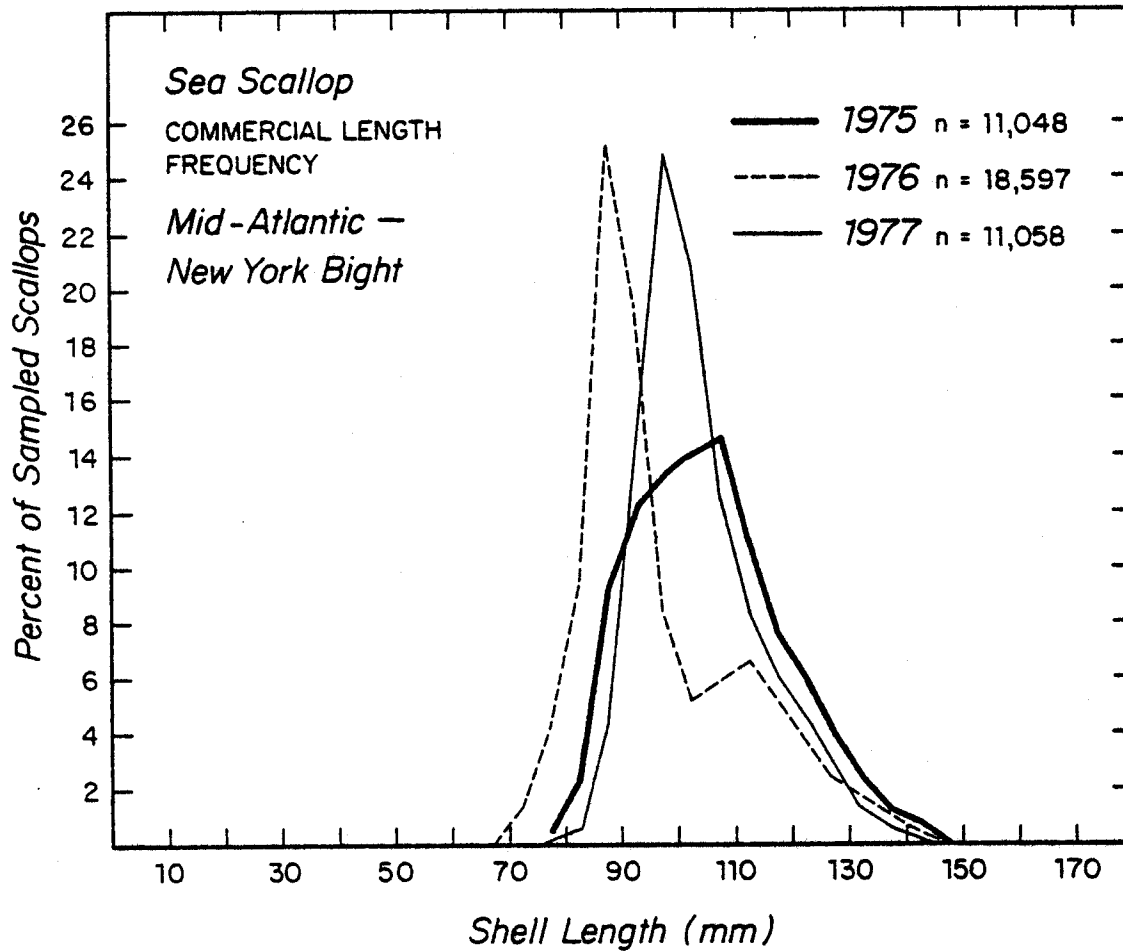


Figure 18. USA commercial landings length-frequency distributions of sea scallops from the New York Bight region of the Mid-Atlantic, 1975-1977.

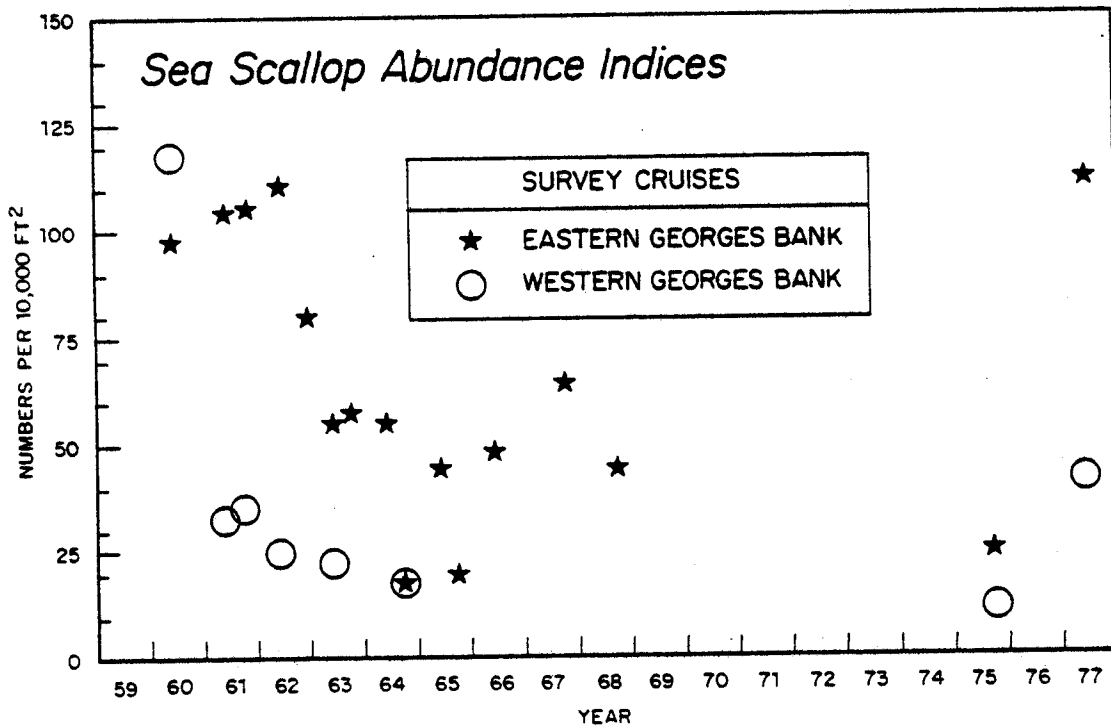


Figure 19. Relative abundance indices of Georges Bank sea scallops derived from NMFS research vessel surveys, 1960-1977. Abundance is expressed as numbers of scallops larger than 70 mm (shell length) caught per 10,000 square feet dredged.

TABLE 20. USA SEA SCALLOP RESEARCH SURVEY RELATIVE ABUNDANCE INDICES (STRATIFIED MEAN NUMBER PER TON), 1975 AND 1977, AND TOTAL REPORTED COMMERCIAL LANDINGS (METRIC TONS, MEATS) (USA AND CANADA), 1975-1977, FOR GEORGES BANK AND THE MID-ATLANTIC. SURVEY INDICES ARE PRESENTED FOR PRE-RECRUIT (<69 MM SHELL LENGTH), RECRUIT (>70 MM SHELL LENGTH), AND TOTAL SCALLOPS PER TON.

AREA	1975				1977		LANDINGS (METRIC TONS, MEATS)			
	NUMBER <69 MM PER TON	NUMBER >70 MM PER TON	TOTAL NUMBER PER TON	NUMBER <69 MM PER TON	NUMBER >70 MM PER TON	TOTAL NUMBER PER TON	1975	1976	1977	TOTAL
<u>GEORGES BANK</u>										
SOUTH CHANNEL	27.9	55.4	83.3	1.9	59.8	61.7	1166	2235	4423	7824
SOUTHEAST PART	0.9	44.1	45.0	2.4	42.8	45.2	231	166	341	738
NORTHERN EDGE-	43.6	134.6	178.2	42.7	349.4	392.1	7141	9027	12989	29157
NORTHEAST PEAK										
TOTAL	31.4	92.0	123.4	21.6	196.5	218.1	8538	11428	17753	37719
<u>MID-ATLANTIC</u>										
NEW YORK BIGHT	25.0	57.2	82.2	0.7	52.3	53.0	1641	4494	3494	9629
DELMARVA	70.2	39.3	109.5	2.4	34.4	36.8	899	1725	2197	4821
VIRGINIA-NO CAROLINA	1.7	0.1	1.8	0.1	0.1	0.2	228	357	134	719
TOTAL	38.0	47.1	85.1	1.2	42.7	43.9	2768	6576	5825	15169