International Council for
the Exploration of the Sea

ICES C.M. 1980/K:24
Shellfish Committee

SIZE SELECTION OF SEA SCALLOPS BY AN OFFSHORE SCALLOP SURVEY DREDGE

by

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ABSTRACT

Selectivity of a 2.44 meter research sea scallop dredge was evaluated during comparative alternate-haul experiments with a 2.44 m sea scallop dredge equipped with a 3.8 cm nylon mesh liner. Over the size range of scallops sampled (10-150 mm, shell height), the unlined survey dredge caught 73% as many scallops as the lined dredge. For scallops ≥ 70 mm, the unlined dredge was 33% more efficient resulting in an increased total catch of 24% by weight. The 50% retention shell height size was 55.1 mm with a 25-75% selection range of 23.7 mm; retention ratios significantly greater than 1.0 were regularly observed, particularly in the 75-100 mm size range. Selection ogives tended to exhibit a downward trend beyond the size where 100% retention was attained, a phenomenon previously observed in alternate-haul selection studies of both shellfish and finfish species. A 7.6-m Woods Hole scallop trawl was also employed at selected locations; yield and size composition of these catches are compared with the corresponding lined and unlined dredge results.

RÉSUMÉ

La selectivite d'une drague de peigne de mer de recherche de 2.44 mètres fut évalué pendant des expériments de remorque alternatif comparatives avec une drague de peigne de mer de 2.44 mètres équipé d'un revêtement de maille en nylon de 3.8 cm. Partout la portée de taille de peignes échantillonés (10-150 mm hauteur de coquille), la drague de levée sans revêtement à capturé 73% autant de peignes que la drague avec revêtement. Pour peignes de ≥ 70 mm, la drague sans revêtement était 33% plus éfficace ayant pour resultat un rendement total de poids augmenté par 24%. La grandeur a 50% de la taille de peigne retenue était 55.1 mm avec une portée de recueil de 25-75% de 23.7 mm; des rapports de conservation significativement au delà de 1.0 étaient observé régulièrement, particulièrement dans la portée de taille de 75-100 mm. Ogives de recueil avaient tendance de présenter une orientation inférieur au-delà de la taille oú une conservation de 10-% fut réalisé, un phénomène précédemment observé dans des études de recueil de remorque alternatif d'espèces de coguillage aussi bien que poisson. Une drague de peigne Woods Hole de 7.6-m a aussi été utilisé a des lieux choisis; la composition du rapport et de la taille de ces rendements son comparé aux resultats correspondants des dragues avec revêtement et sans revêtement.

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INTRODUCTION

Fundamental to improving research abilities in understanding the population dynamics of exploited shellfish resources is the need to develop and refine fishery independent methods of stock evaluation and abundance (Thomas, 1979). Too often fishery derived catch and effort data have been unreliable in assessing shellfish population conditions particularly when satisfactory standardization of fishing effort and gear performance is either rudimentary or lacking completely (Hancock, 1979). Cognizant of the problems associated with unknown but probably frequent changes in the fishing power in the Northwest Atlantic offshore fishery for sea scallops, Placopecten magellanicus, the Northeast Fisheries Center laboratory at Woods Hole has conducted sea scallop research vessel surveys since 1960 to obtain fishery independent data on resource conditions in the Georges Bank and Mid-Atlantic populatons (Merrill, 1962; MacKenzie et al., 1978; Posgay, 1979; Serchuk et al., 1979). These surveys can be classified into two series: an older survey series generally conducted semi-annually during 1960-1968 in the Georges Bank region in which quantification of basic life history parameters was most often the primary objective although relative abundance and population structure was also assessed (Brown et al., 1972; Merrill and Posgay, 1964; Haynes, 1966; Posgay, 1979), and a newer series conducted in 1975 and annually from 1977 onward to specifically evaluate relative abundance, size/age composition, and recruitment throughout the Georges Bank and Mid-Atlantic regions (Serchuk et al., 1979). Since 1977, a stratified random sampling design has been employed in the scallop surveys with the offshore areas being stratified into geographical zones on the basis of depth and latitude. Sampling stations are allotted to strata in proportion to the area of each stratum and assigned randomly within strata.

Between 1975 and 1978, the USA sea scallop surveys were conducted by the R/V ALBATROSS IV using a standard 3.05 m (10 ft) wide scallop dredge, equipped with a 5.1 cm (2 in) ring bag, towed for 15 minutes at 6.5 km/hr (3.5 knots) with a 3:1 wire scope. In subsequent annual surveys, a 2.44 m (8 ft) wide scallop dredge equipped with 5.1 cm rings and a 3.8 cm (1.5 in) polypropylene mesh liner has been the standard sampling gear. The rationale for use of this latter gear was that it was believed to be more efficient in retaining pre-recruit scallops (< 70 mm shell height) than the former unlined dredge. Preliminary comparisons of the 1977 USA Georges Bank catch per tow results with similar data derived from an independent Canadian sea scallop research vessel survey utilizing a 2.44 m dredge with a 3.8 cm mesh liner suggested that the lined dredge was about twice as efficient in capturing pre-recruit scallops as the unlined USA dredge (Serchuk et al., 1979).

Since the recent series of USA sea scallop surveys was designed to provide annual indices of scallop abundance for the offshore Northwest Atlantic populations, it was necessary to evaluate relative selectivity differences between the lined and unlined survey dredges to facilitate comparison between survey catch per tow results among years.

This paper presents the results of comparative fishing selection experiments conducted in offshore Mid-Atlantic waters using the alternate-haul method (Pope et al., 1975) with lined and unlined 2.44 m sea scallop dredges. A 7.6 m (25 ft) Woods Hole scallop trawl was also utilized in the selectivity trials at particular stations. All of the experiments were accomplished with the R/V ALBATROSS IV between 19 May and 12 June 1980.

MATERIALS AND METHODS

Gear

Both the lined and unlined scallop dredges were of similar construction (Figure 1). Each was constructed of 7.9 mm (5/16 in) rings, 51 mm (2 in) in diameter. Total weight of a dredge was 646 kg (1425 lb); the frame weighed 329 kg (725 lb). The bottom or "bag" of each dredge was double linked, 32 rings wide by 15 rings deep with 12 x 12 diamonds. The top or "apron" was 32 rings by 18 rings with a 76.2 mm (3 in) twine back. The sweep chain was 15.9 mm (5/8 in) case-hardened steel, 77 links long, hung to the bag with 7 link straps of 6.4 mm (¼ in) chain. The clubstick was 2.1 m (7 ft) long and possessed 15.2 cm (6 in) diameter rubber "cookies." The lined dredge was fitted with a 38 mm (1.5 in) polypropylene mesh liner throughout its entirety.

Construction specifications of the 7.6 m (25 ft) Woods Hole scallop trawl are provided in Figure 2.

Fishing Procedure

Gear selectivity trials were conducted in ten survey sampling strata (Figure 3) in conjunction with the 1980 USA research vessel sea scallop survey. The sampling strata were located in the Delmarva (Strata 10, 11, 14, 15, 18, and 19) and New York Bight (Strata 22, 23, 27, and 31) regions of the Mid-Atlantic Bight. Total area covered by these strata is approximately 13,466 km^2 (3926 nautical square miles); depths sampled ranged between 46 and 73 m (25-40 fm), and encompassed major portions of the Mid-Atlantic commercial sea scallop fishery grounds. Substrate types were somewhat variable between strata but were mostly sand and sand-gravel, often overlaid by shell fragments.

Standard USA sea scallop survey methods were used at each of the 88 randomly selected stations accomplished during the comparison experiments, viz. dredges were towed for 15 minutes at 6.3 km/hr with a 3:1 wire scope. The order in which the two dredges were towed alternated between successive stations. At three sampling locations (1 in stratum 19; 2 in stratum 23), the scallop trawl was also used and towed an equivalent distance over bottom as the dredges. For all gear, distance towed and speed over bottom was recorded with a Doppler speed log.

After each tow, the catch was sorted into biological and trash components. The entire scallop catch was weighed and shell height (distance from the umbone to the ventral margin of the shell) frequency measurements, by 5 mm intervals, recorded for all individuals. The composition of trash was evaluated and the total trash measured by volume, in bushel baskets. Relevant hydrographic data (depth and temperature) were also recorded.

Data Analysis

Shell height frequency data for each dredge were summarized by sampling strata, geographical region (Delmarva and New York Bight), and all strata combined. For each 5 mm shell height interval, the ratio of the number of scallops obtained in the unlined dredge to the number in the lined dredge was computed. These ratios were then smoothed by a moving geometric mean of threes and the upper asymptote of each curve was estimated by taking the geometric mean of the ratios over about 11-16 height intervals above the height interval at which the unlined dredge caught more scallops than the lined dredge (Hodder and May, 1965; Pope et al., 1975). The smoothed ratios were subsequently adjusted by dividing by the estimated upper asymptotic value. This latter treatment was performed since ratios appreciably greater than unity were obtained in each of the sampling strata. Similar adjustment techniques for alternate haul results are detailed in Dickie (1955), Beverton and Holt (1957), FAO (1960), Clark (1963), Templeman (1963), Hodder and May (1965), and Pope et al. (1975).

Adjusted retention percentages were plotted for all strata and geographical regions in which the total scallops obtained in each dredge exceeded 150 individuals. Insufficient samples were obtained in strata 10, 22, and 27 to permit selectivity analyses in these areas. The 25%, 50%, and 75% retention heights were derived in each of the remaining strata and combined geographical regions by linear regressions by deviates and logits (Pope et al., 1975). Visual inspection of the observed retention percentage in each of these areas suggested that the 25-75% selection range could be approximated by a straight line. For the aggregated Delmarva, New York Bight, and overall Mid-Atlantic selectivity results, selection curves were drawn through the retention points by eye.

Relative performance of each of the dredges was also assessed by mean catch per tow indices in each strata of total scallops, total weight of scallops, and volume of trash collected. Mean catch per tow values were also derived for pre-recruit (< 70 mm shell height) and recruit-size (≥ 70 mm shell height) scallops. To evaluate the effects of selectivity differences between the dredges in assessing recent trends in relative abundance of scallops in the Delmarva and New York Bight regions, stratified mean number per tow indices were calculated for each of these areas following the procedures given by Cochran (1977) and detailed in Pennington and Grosslein (1978).

RESULTS

A total of 10,351 sea scallops weighing 1.04 mt (live weight) were obtained in the 88 sets of comparative dredge hauls in the Mid-Atlantic experiments (Table 1). The 37 replicate tows in the Delmarva region (42% of total hauls) caught 5990 scallops weighing 535 kg; the 51 sets (58% of total hauls) of New York Bight tows yielded 4,361 individuals with a total weight of 508 kg. Allocation of sampling effort approximated the relative areal proportion of the total strata sampled within the two regions (i.e., 39% Delmarva, 61% New York Bight).

Individual stratum total scallop catch data and size frequency distributions, in number of scallops at height, are summarized in Table 1. Scallop were obtained in every lined dredge tow and in all but one of the unlined hauls. The size of scallops sampled ranged from 10-150 mm shell height; individuals between 30 and 140 mm comprised the bulk of the catches from each dredge in almost every stratum.

In six of the ten Mid-Atlantic strata, the lined dredge caught more total scallops per tow than the unlined dredge (Table 2). Unlined total scallop catches exceeded lined catches in strata 10, 18, 22, and 27. Apart from the stratum 18 data, however, these latter results may not be representative of comparative dredge performance because of the small sample sizes of scallops obtained in these strata and/or the limited number of replicate tows accomplished. For the composite Delmarva and New York Bight data sets, the unlined dredge was 69% and 80% as efficient, respectively, in capturing scallops as the lined dredge (Tables 3 and 4). Over the entire Mid-Atlantic region, the unlined dredge caught 73% as many scallops as the lined dredge (Table 5).

Percent size frequencies of scallops obtained by both dredges in each stratum (Figures 4-8) show a pronounced difference in size selectivity between gear. Small scallops (30-55 mm shell height) consistently comprised a larger proportion of the lined dredge catches than the unlined catches. Pre-recruit scallops (< 70 mm shell height) accounted for between 8.2 and 84.6% of the total scallops taken with the lined dredge in each stratum, while pre-recruit percentages of the total unlined catches per stratum ranged between 1.4 and 74.4 percent. In every stratum, the lined dredge caught a higher percentage of pre-recruits than the unlined dredge (Table 2, last column), irrespective of the density of scallops as evinced by the relative catch per tow indices (Table 2; Fig. 4-10).

In the Delmarva and New York Bight regions, the lined dredge pre-recruit catches were 2.1 and 2.9 times higher, respectively, than the corresponding total pre-recruit catches in the unlined dredge (Fourth column, Table 2; Tables 3 and 4). Over all areas combined, the lined dredge was 134% more efficient (3930/1683) in retaining pre-recruits than the unlined dredge (Table 5). Relative differences in pre-recruit retention efficiencies, however, progressively decreased with increases in scallop size between 25 and 65 mm; for 65 mm scallops, both dredge types exhibited about equal efficiency (Table 5).

Scallops ≥ 70 mm shell height appeared in greater numbers in the unlined dredge than in the lined catches (Tables 3-5). Except for strata 11 and 19, this pattern was consistent among sampling localities (Table 1). In these latter strata, the unlined dredge caught between 21 and 164% more commercial-size scallops than the lined gear (Fifth column, Table 2). Unlined dredge efficiency for recruit scallops was higher in the New York Bight than in Delmarva (146% vs 120%) even though relative densities of scallops (catch per tow indices) were greater in Delmarva (Table 2). Throughout the Mid-Atlantic, the unlined dredge was 33% more efficient in catching 70-150 mm scallops than the lined dredge (Table 2; Fig. 10).

Due to this increased efficiency in capturing recruit scallops, the total live weight of the unlined catches exceeded that of the lined catches. Again, apart from the seemingly anomalous results in strata 11 and 19, the unlined dredge caught between 5 and 280% more scallops, by weight, in each stratum than did the lined dredge (Tables 1 and 2). The differential in unlined efficiency for capturing scallops ≥ 70 mm noted between the New York Bight and Delmarva regions was also reflected in a similar catch weight differential between these areas; the ratio between unlined and lined weight per tow in the New York Bight was 17% higher than in Delmarva (1.42 vs 1.21, Table 2). For the entire 88 replicate tows, the unlined dredge caught 24% more scallops by weight than the lined dredge (577 kg vs 466 kg, Table 1).

There was little overall difference in the amount of trash landed per tow in the two dredges (Table 2). While a significant correlation ($r=0.79$; $p<0.05$) was found in the mean volume of trash landed in each strata by the two dredges, there was a lack of correlation, within each gear type, between the amount of trash landed and the size (weight) of scallop catch (lined gear: $r=0.08$, $p>0.10$; unlined gear: $r=0.06$; $p>0.10$). For all areas combined, the amount of trash caught per tow by each dredge differed by only 3% (4.86 bu, lined; 4.70 bu, unlined).

In Figures 11-14, adjusted retention percentages at shell height are presented, by strata, for the unlined dredge catches relative to the lined catches. In all areas, retention ratios significantly greater than 1.0 were evident, generally in the 75-100 mm range. Characteristic too in each stratum was a downward trend in percentage retention beyond the scallop size where 100% retention is attained. This phenomenon, most obvious in the Delmarva selection ogive (Fig. 15) but inherent also to the composite New York Bight and overall Mid-Atlantic selection data (Fig. 15 and 16), has previously been observed in alternate-haul selection studies of sea scallops (Dickie, 1955; Bourne, 1965; Jamieson and Lundy, 1979) as well as of fin-fish (Beverton and Holt, 1957; Templeman, 1963; Hodder and May, 1965; Jensen and Hennemuth, 1966; Lux 1968).

Estimates of the 50% selection retention size in each of the sampling strata and geographical regions range from 42.7 to 59.3 mm shell height (Table 6). For all data, the 50% selection point was 55.1 mm with a 25-75% selection range of 23.7 mm (Table 6; Fig. 16). No significant trend was detected between 50% retention height and the mean number of scallops caught per tow in the unlined dredge (r=0.16, p>0.10). Although individual stratum estimates of the 50% selection size and the concomitant selection span were variable, in part because of the modest scatter of retention ratios in strata 14, 18, and 31, the selection ogives for the Delmarva and New York Bight region are nearly parallel in the 25-75% selection range (Fig. 15 and 16). Retention of similar-sized scallops between 30 and 70 mm, however, was slightly greater in Delmarva than in the New York Bight. For scallops above 70 mm, selection was much sharper in Delmarva than in the Bight.

At the three sampling locations where the 7.6-m Woods Hole scallop trawl was fished and replicate dredge hauls were accomplished, the trawl caught more scallops and less trash than either of the dredges (Fig. 17). Catch comparisons between stations, however, are not fully reliable since trawl rigging changes were performed at each station; at station 19-3, legs were placed on the wings of the trawl, at station 23-1, a 6.1 m (20 ft) long 9.5 mm (3/8 in) chain was attached to the footrope, and at station 23-15, the tow rate was increased to 5.6 km/hr (3 knots) from the 4.6 km/hr (2.5 knots) velocity maintained at the two preceding trawl stations. Equally, quantitative comparisons between the trawl and dredge data are further constrained since the actual wingspread of the trawl has yet to be evaluated. Nonetheless, it is apparent that the trawl size-frequency distribution are quite similar to those derived from the unlined dredge, and that the trawl was equally or more efficient than both dredges in capturing small (25-60 mm) scallops. The reduced trawl efficiency for larger sized scallops probably reflects a tendency for the footrope to rise above the bottom as inferred from physical inspection of the footrope upon haulback and the relatively low amount of trash landed.

Stratified mean number per tow indices of scallops for the Delmarva and New York Bight regions derived from the lined and unlined dredge experiments are presented in Tables 7, together with relative abundance indices obtained from former scallop research surveys. The ratios of the lined to unlined 1980 indices are similar to those in Table 2, although the absolute value of the indices differ slightly because of the weighting procedures using in computing the stratified means.

The 1980 Delmarva pre-recruit indices indicate that the unlined dredge underestimated the relative abundance of scallops observed in the lined dredge by about half. This disparity conforms with the preliminary analyses made between the 1977 USA and Canadian Georges Bank sea scallop survey data in which lined dredge pre-recruit catches were about twice as high as unlined catches (Serchuk et al., 1979). In the New York Bight region, however, the 1980 pre-recruit indices differed by almost three-fold, implying a different pattern of relative selectivity between the dredges in this region. Hence, if comparisons are made between future lined survey abundance indices and previous annual unlined values, it may be necessary to apply different standardization coefficients in different geographical regions. Such differing selectivities may possibly arise from bottom type differences between areas.

The 1980 unlined abundance indices in Delmarva are similar to those derived from the 1975 survey which utilized an unlined 3.05 m (10 ft) dredge. Since the 1975 indices, particularly the pre-recruit index, were considered relatively high reflecting increased abundance as a result of recent successful recruitment (Serchuk et al., 1979), the 1980 values suggest that recruitment has recently been successful again. The pronounced size frequency modes observed in the 1980 data at about 45 mm shell height imply that this may be due to above average recruitment of the 1977 or 1978 year classes.

There is little indication from the 1980 New York Bight indices that recent recruitment has similarly been successful in this area. Even the 1980 lined relative abundance indices are several times less than the 1975 unlined values. The 1980 indices continue to support conclusions derived from the 1977 and 1978 survey data that fishery yield and commercial catch per effort from these scallop grounds will decline in the future in response to reduced scallop abundance and continued poor recruitment.

DISCUSSION

Validity of Alternate Haul Methodology

The merits and disadvantages of the alternate-haul approach in selectivity experiments have been summarized in FAO (1960) and Pope et al. (1975). The fundamental attraction of the procedure is that it is free from the biases and distortions that are frequently caused by the use of a cover (i.e., "masking effects" and re-entry of fish into the forward portion of the gear that had previously gone through into the cover). However, because the alternate-haul method does not directly measure escapement but compares catches from different mesh gears, haul-to-haul variation may be great thereby requiring a much larger number of hauls than would be needed to achieve equal precision in a covered experiment. Moreover, gear design, fishing strategy, bottom type, size and composition of catch, and species behavior will influence selectivity, apart from that due to mesh size (Caddy, 1978).

In the present experiments, a relatively large number of replicate dredge tows was performed in a standardized manner over a variety of geographical areas and bottom types. Both dredges were built to the same specifications and were fished in the same location at an identical velocity and distance as monitored by Loran-C navigational equipment and a Doppler speed log and plotter. Accordingly, experimental complications were minimized.

The populations of scallops sampled were not segregated into small discrete size groupings, nor did the observed selection ranges encompass a major portion of the total size range of scallops obtained in the selection experiments. These criteria, cited by Beverton and Holt (1957), need to be reasonably satisfied when dealing with any alternate-haul selection data.

Size Selection

Although similar sea scallop size frequency modes were obtained in the dredge and trawl catches in almost all areas sampled, the magnitude of these modes differed substantially between gear type. The lined dredge and the trawl were much more efficient in capturing small and pre-recruit scallops than the unlined dredge. Contrariwise, for scallops ≥ 70 mm, the unlined dredge retained more individuals than either of the other gear. Compared to the lined catches of recruit scallops, the unlined dredge was 33% more efficient. Past scallop dredge experiments have discerned similar trends in selectivity between large and small mesh gear. Bourne (1965) found that catches of scallops ≥ 100 mm were 6% greater in an offshore scallop drag knit with 102 mm (4 in) rings than a comparable drag equipped with a 76 mm (3 in) ring bag. For scallops < 100 mm, however, the 102 mm ring drag was only 76% as efficient as the 76 mm ring drag. In Digby-style dredge selection trials, Jamieson and Lundy (1979) observed that lined drags retained more pre-recruit than unlined drags but that the unlined gear was significantly more efficient in catching larger, commercial-size scallops.

The available evidence from selection studies of all types of fishing gear (FAO, 1960; Beverton and Hodder 1962; ICNAF 1963) indicates that increases in mesh or ring size result in greater catches of larger animals at the upper end of the selection range and beyond. The presumption most often tendered for this efficiency increase is that it results from increased water flow through the larger spacings and/or decreased blockage of water flow by small fish and trash in the after parts of the gear. Mechanical sorting alone, however, is insufficient to explain the increased retention of scallops over 70 mm by the unlined dredge observed in the present study since the volume of trash obtained with both dredge types was virtually identical (Table 2). A more plausible explanation is that accumulated shell debris, trash, and bottom sediments may have been "bulldozed" in front of the lined dredge, but not the unlined dredge (Cameron, 1955; Caddy, 1968). Observations by divers, using underwater color video equipment, in previous gear performance trials conducted in June 1979 off of Cape Cod, Massachusetts (Smolowitz, unpublished data) indicated that a mound of sediment and trash was bulldozed just aft of the chain sweep of the lined dredge; this activity was rarely observed with an unlined dredge. The presence of the mound presumably causes much of the heavier trash and larger-sized scallops to slide forward and under the sweep chain, thereby escaping capture. Similar "heaping" observations have been recorded for Alberton scallop dredges in the Gulf of St. Lawrence (Caddy, 1973). Small scallops would not be affected as much by this process since they tend to rise above the bottom when disturbed (Bourne, 1966; Caddy, 1968; Jamieson and Lundy, 1979). Accordingly, once caught by the dredges, these smaller individuals would likely undergo the normal mechanical selection procedure associated with the dredge ring size or liner. The large trawl catches of scallops $\leq$ 60 mm tend to lend credence to this supposition.

The significant positive correlation between the amounts of trash in both the lined and unlined dredges, however, suggested that differential gear performance cannot be entirely responsible for the observed differences in size selectivity between the dredges. During the June 1979 scallop gear experiment, divers noticed many small scallops being washed out of the ring bag upon haulback, even at very slow haulback speeds. These observations indicate that selectivity can vary depending upon depth and haulback speed and time.

The 50% selection size of 55.1 mm, estimated from all of the dredge tows, is substantially lower than the 78.5 and 87.5 mm 50% retention sizes obtained by Caddy (1971, 1972) in 2.44 m sea scallop dredge experiments conducted on Georges Bank. In these latter studies, the covered codend method was employed, using 3.8 cm polypropylene mesh cover. This is the same size and type mesh used to construct the lined dredge in the present experiments. Since the Georges Bank dredge used by Caddy was knit from 76.5 mm (3 in) diameter rings rather than 50.8 mm (2 in) rings used in the current study, the appropriate comparison between experiments should not be the 50% selection point but rather the selection factor (i.e, the ratio of the 50% retention height to the size of ring involved). Selection factors calculated from Caddy's results are 1.03 and 1.14; the selection factor derived from the Mid-Atlantic experiments of 1.08 is nearly identical to these values. However, since a selection factor greater than unity is impossible for inflexible dredge rings (Caddy, 1971), the present results tend to confirm the conclusions of Posgay (1958), Caddy (1971, 1972), and Medcof (1952) that much of the selection occurs through the inter-ring spaces.

The downward trend in the Mid-Atlantic selection ogives beyond the point of maximum retention is difficult to explain, despite the fact that this pecularity has been previously found in alternate-haul experiments. In finfish selection experiments, two possible reasons for the descending retention ratios have been postulated: (1) if the greater efficiency of the large mesh gear (usually implied by retention ratios in excess of unity) results from increased water flow through the meshes, and if the ability of a fish to swim against this water flow increases with the size of fish, then the efficiency of the large mesh gear will become progressively less pronounced for larger fish (Beverton and Holt, 1957); and (2) if in small mesh trawls most of the water is strained through the wings, square and anterior part of the belly, and in large mesh trawls relatively more water is strained in the after parts, then fish in the small mesh trawl will tend to be selected by the large meshes of the forward parts of the trawl while fish in the large mesh trawl will usually be selected by the smaller mesh codend. When fish become large enough that they cannot pass through the anterior meshes of the net then the superiority of the large mesh net selection in the codend over small mesh net selection in the forward parts will progressively decrease (Templeman, 1963). For scallop selection, neither of these explanations are germane. It seems reasonable, however, to assume that both behavioral and physical factors are involved in producing the downward trend in the scallop selection curves.

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Table 1. Size frequency distributions of sea scallops by sampling stratum, obtained in alternate tow dredge selection experiments conducted with lined and unlined sea scallop dredges with the R/V ALBATROSS IV in the Delmarva and New York Bight region, May-June 1980.

Shell Height[1] (mm)	Delmarva[2]												New York Bight[2]								All Areas		
	10		11		14		15		18		19		22		23		27		31		(10-31)		Grand Total
	L	UNL	L	UNL	L	UNL	L	UNL	L	UNL	L	UNL	L	UNL	L	UNL	L	UNL	L	UNL	L	UNL	
10											1				2				1		4		4
15															1				1		2		2
20					1						2								2	3	5	3	8
25							1				7	1			18	1			33	5	59	7	66
30			2	1	8	3	21	5	4		24	10	1	3	52	7			67	9	179	38	217
35			8	3	23	20	78	12	27	8	95	29	8	12	147	27			73	11	459	122	581
40			18	7	87	42	205	53	58	25	198	75	18	18	267	53			49	3	900	276	1176
45	3		26	13	109	53	302	85	54	40	352	163	13	10	345	126	1		29	4	1234	494	1728
50	1		10	7	20	30	163	79	27	22	243	140	2		156	77		1	13	4	635	360	995
55			4	2	6	6	32	22	3	9	114	81			57	32			8	14	224	166	390
60			3		1	5	6	4	3	7	75	63			20	22			19	15	127	116	243
65		1	2	2		4	10	6	4	5	43	40		2	27	24			16	17	102	101	203
70	1	1	3	5	5	12	11	14	7	3	12	15	2		45	46			25	24	111	120	231
75	2	3	3	8	4	9	22	34	4	6	14	28	1	3	40	45		1	25	29	115	166	281
80	2	2	6	6	9	11	21	32	2	3	23	22	6	4	25	30			39	30	133	140	273
85		7	6	1	5	10	19	31	4	5	16	23	2	7	30	58	2		60	69	144	211	355
90		3	13	14	6	16	24	32	3	13	4	10	4	1	32	50	2		32	40	120	179	299
95	6	5	22	19	12	19	27	55	5	28	8	17	1	3	27	34		1	19	26	127	207	334
100	3	4	27	18	21	29	52	77	15	28	26	26		4	31	35		9	15	44	190	274	464
105	7	15	31	18	21	17	53	54	11	28	29	16	1		31	38	2	1	38	77	224	264	488
110	13	10	22	17	18	23	44	41	13	16	18	13	1	3	26	55			66	115	221	293	514
115	5	7	17	4	18	15	26	27	13	19	23	9	5	8	39	52	2	1	62	89	210	231	441
120	1	5	7	4	15	15	21	15	9	16	11	10	3	8	45	81	1	1	58	76	171	231	402
125	1	3	2	1	16	11	16	15	6	20	10	8	6	9	34	66	1	4	24	43	116	180	296
130			2	1	10	7	15	9	5	12	8	4		9	23	43	1	4	12	14	76	103	179
135	2	2	1	2	8	9	4	7	4	5	4	2		4	19	14		2	3	5	45	52	97
140	2	1	1	1	4	8	1	2	4	4	4	2	1	4	6	10		2	2	1	25	35	60
145		2			4	3	1	2		1		1			2			3			7	12	19
150					1	1		1				1			1						2	3	5
Total No.	49	71	236	154	432	378	1175	714	285	323	1364	809	75	112	1548	1026	12	30	791	767	5967	4384	10351
No. of Tows	2	2	4	4	7	7	12	12	7	7	5	5	6	6	20	20	1	1	24	24	88	88	176
Total Weight (kg)	10.0	23.5	33.3	21.4	48.2	53.2	79.5	83.9	28.3	49.8	56.8	47.0	8.1	18.2	107.0	136.1	2.3	8.8	92.3	135.4	465.8	577.3	1043.1

[1]Lower limit of 5 mm category (i.e, 10 mm represents 10-14 mm interval)

[2]L = lined dredge.
UNL = unlined dredge.

Table 2. Mean catch per tow results, by strata and area, of sea scallops obtained in alternate tow dredge selection experiments conducted with lined and unlined 8-foot sea scallop dredges with the R/V ALBATROSS IV, May-June 1980.

STRATUM / AREA	Total Scallops per Tow	Total Weight of Scallops per Tow	Volume of Trash per Tow	No. of Scallops < 70 mm per Tow	No. of Scallops ≥ 70 mm per Tow	Ratio of < 70 mm to Total
STRATUM 10						
lined dredge	24.50	5.0	6.63	2.00	22.50	.082
unlined dredge	35.50	11.75	4.88	0.50	35.00	.014
Unlined ÷ lined	1.45	2.35	0.74	0.25	1.56	
STRATUM 11						
lined dredge	59.00	8.33	2.50	18.25	40.75	.309
unlined dredge	38.50	5.35	1.50	8.75	29.75	.227
Unlined ÷ lined	0.65	0.64	0.60	0.48	0.73	
STRATUM 14						
lined dredge	61.71	6.89	7.43	36.43	25.29	.590
unlined dredge	54.00	7.60	9.71	23.29	30.71	.431
Unlined ÷ lined	0.88	1.10	1.31	0.64	1.21	
STRATUM 15						
lined dredge	97.92	6.63	3.56	68.17	29.75	.696
unlined dredge	59.50	6.99	2.75	22.17	37.33	.373
Unlined ÷ lined	0.61	1.05	0.77	0.33	1.25	
STRATUM 18						
lined dredge	40.71	4.04	8.29	25.71	15.00	.632
unlined dredge	46.14	7.11	7.96	16.57	29.57	.359
Unlined ÷ lined	1.13	1.76	0.96	0.64	1.97	

Table 2. (continued)

STRATUM / AREA	Total Scallops per Tow	Total Weight of Scallops per Tow	Volume of Trash per Tow	No. of Scallops < 70 mm per Tow	No. of Scallops ≥ 70 mm per Tow	Ratio of < 70 mm to Total
STRATUM 19						
lined dredge	272.80	11.36	5.05	230.80	42.00	.846
unlined dredge	161.80	9.40	3.90	120.40	41.40	.744
Unlined ÷ lined	0.59	0.83	0.77	0.52	0.99	
STRATUM 22						
lined dredge	12.50	1.35	5.50	7.00	5.50	.560
unlined dredge	18.67	3.03	4.00	7.50	11.17	.402
Unlined ÷ lined	1.49	2.24	0.73	1.07	2.03	
STRATUM 23						
lined dredge	77.40	5.35	4.61	54.60	22.80	.705
unlined dredge	51.30	6.80	4.43	18.45	32.85	.360
Unlined dredges	0.66	1.27	0.96	0.34	1.44	
STRATUM 27						
lined dredge	12.00	2.30	?	1.00	11.00	.083
unlined dredge	30.00	8.75	6.00	1.00	29.00	.033
Unlined ÷ lined	2.50	3.80		1.00	2.64	
STRATUM 31						
lined dredge	32.96	3.85	4.02	12.96	20.00	0.393
unlined dredge	31.96	5.64	4.28	3.54	28.42	0.111
Unlined ÷ lined	0.97	1.46	1.06	0.27	1.42	

Table 2. (continued)

STRATUM / AREA	Total Scallops per Tow	Total Weight of Scallops per Tow	Volume of Trash per Tow	No. of Scallops < 70 mm per Tow	No. of Scallops ≥ 70 mm per Tow	Ratio of < 70 mm to Total
DELMARVA						
lined dredge	95.70	6.25	5.44	67.14	28.56	.702
unlined dredge	66.19	7.54	5.19	31.97	34.22	.483
Unlined ÷ lined	0.69	1.21	0.95	0.48	1.20	
NEW YORK BIGHT						
lined dredge	47.57	4.11	4.43	28.35	19.22	.596
unlined dredge	37.94	5.85	4.34	9.80	28.14	.258
Unlined ÷ lined	0.80	1.42	0.98	0.35	1.46	
ALL AREAS						
lined dredge	67.81	5.29	4.86	44.66	23.15	.659
unlined dredge	49.82	6.56	4.70	19.13	30.69	.384
Unlined ÷ lined	0.73	1.24	0.97	0.43	1.33	

Table 3. Size frequency distribution and retention percentages for sea scallops obtained in alternate tow dredge selection experiments in the Delmarva region (Strata 10, 11, 14, 15, 18 and 19) conducted with lined and unlined sea scallop dredges with the R/V ALBATROSS IV, 1980.

	Lined Dredge		Unlined Dredge		Retention			
Shell Height (mm)	No. of Scallops	Percent of Total	No. of Scallops	Percent of Total	Unlined ÷ Lined	Smoothed[1] Retention		Adjusted[2] % Retention
10	1	0.1<			.000			
15								
20	3	0.1			.000	.005		0.4
25	8	0.2	1	0.1<	.125	.034		2.8
30	59	1.7	19	0.8	.322	.232		19.4
35	231	6.5	72	2.9	.312	.330		27.6
40	566	16.0	202	8.2	.357	.360		30.1
45	846	23.9	354	14.5	.418	.447		37.4
50	464	13.1	278	11.4	.599	.574		48.0
55	159	4.5	120	4.9	.755	.741		62.0
60	88	2.5	79	3.2	.898	.873		73.1
65	59	1.7	58	2.4	.983	1.042		87.2
70	39	1.1	50	2.0	1.282	1.313		109.9
75	49	1.4	88	3.6	1.796	1.406		117.7
80	63	1.8	76	3.1	1.206	1.494		125.0
85	50	1.4	77	3.1	1.540	1.484		124.2
90	50	1.4	88	3.6	1.760	1.692		141.6
95	80	2.3	143	5.8	1.788	1.584	x= 1.195[3]	132.6
100	144	4.1	182	7.4	1.264	1.301		108.9
105	152	4.3	148	6.0	.974	1.049		87.8
110	128	3.6	120	4.9	.938	.899		75.2
115	102	2.9	81	3.3	.794	.911		76.2
120	64	1.8	65	2.7	1.016	.972		81.3
125	51	1.4	58	2.4	1.137	.984		82.3
130	40	1.1	33	1.3	.825	1.033		86.4
135	23	0.6	27	1.1	1.174	1.029		86.1
140	16	0.5	18	0.7	1.125	1.335		111.7
145	5	0.1	9	0.4	1.800	1.825		152.7
150	1	0.1<	3	0.1	3.000			
Total	3541	100.0	2449	99.8				
No. of Tows	37	37	37	37				

[1] Smoothed by moving geometric averages of threes.

[2] 100 (Smoothed retention /1.195)

[3] Geometric mean.

Table 4. Size frequency distributions and retention percentages for sea scallops obtained in alternate tow dredge selection experiments in the New York Bight (Strata 22, 23, 27 and 31) conducted with lined and unlined sea scallop dredges with the R/V ALBATROSS IV, 1980.

	Lined Dredge		Unlined Dredge		Retention		
Shell Height (mm)	No. of Scallops	Percent of Total	No. of Scallops	Percent of Total	Unlined ÷ Lined	Smoothed[1] Retention	Adjusted[2] % Retention
10	3	0.1			.000		
15	2	0.1			.000	.011	0.8
20	2	0.1	3	0.2	1.500	.056	3.9
25	51	2.1	6	0.3	.118	.304	21.1
30	120	4.9	19	1.0	.158	.160	11.1
35	228	9.4	50	2.6	.219	.197	13.7
40	334	13.8	74	3.8	.222	.260	18.0
45	388	16.0	140	7.2	.361	.338	23.4
50	171	7.0	82	4.2	.480	.497	34.4
55	65	2.7	46	2.4	.708	.686	47.5
60	39	1.6	37	1.9	.949	.876	60.7
65	43	1.8	43	2.2	1.000	.973	67.4
70	72	3.0	70	3.6	.972	1.047	72.6
75	66	2.7	78	4.0	1.182	1.016	70.4
80	70	2.9	64	3.3	.914	1.155	80.0
85	94	3.9	134	6.9	1.426	1.192	82.6
90	70	2.9	91	4.7	1.300	1.362	94.4
95	47	1.9	64	3.3	1.362	1.524 x=1.443[3]	105.6
100	46	1.9	92	4.8	2.000	1.637	113.4
105	72	3.0	116	6.0	1.611	1.816	125.8
110	93	3.8	173	8.9	1.860	1.609	111.5
115	108	4.5	150	7.8	1.389	1.588	110.0
120	107	4.4	166	8.6	1.551	1.593	110.4
125	65	2.7	122	6.3	1.877	1.782	123.5
130	36	1.5	70	3.6	1.944	1.606	111.3
135	22	0.9	25	1.3	1.136	1.610	111.6
140	9	0.4	17	0.9	1.889	1.477	102.4
145	2	0.1	3	0.2	1.500		
150	1	0.1<					
Total	2426	100.1	1935	100.0			
No. of Tows	51	51	51	51			

[1]Smoothed by moving geometric averages of threes.

[2]100 (Smoothed retention/1.443)

[3]Geometric mean.

Table 5. Size frequency distribution and retention percentages for sea scallops obtained in alternate tow dredge selection experiments in the Delmarva and New York Bight regions (strata 10-31) conducted with lined and unlined sea scallop dredges with the R/V ALBATROSS IV, 1980.

	Lined Dredge		Unlined Dredge		Retention		
Shell Height (mm)	No. of Scallops	Percent of Total	No. of Scallops	Percent of Total	Unlined ÷ Lined	Smoothed[1] Retention	Adjusted[2] % Retention
10	4	0.1			.000		
15	2	0.1<			.000	.008	0.6
20	5	0.1	3	0.1	.600	.041	3.1
25	59	1.0	7	0.2	.119	.247	18.6
30	179	3.0	38	0.9	.212	.189	14.2
35	459	7.7	122	2.8	.266	.259	19.5
40	900	15.1	276	6.3	.307	.320	24.1
45	1234	20.7	494	11.3	.400	.411	31.0
50	635	10.6	360	8.2	.567	.552	41.6
55	224	3.8	166	3.8	.741	.727	54.8
60	127	2.1	116	2.6	.913	.875	65.9
65	102	1.7	101	2.3	.990	.992	74.8
70	111	1.9	120	2.7	1.081	1.156	87.1
75	115	1.9	166	3.8	1.443	1.180	88.9
80	133	2.2	140	3.2	1.053	1.306	98.4
85	144	2.4	211	4.8	1.465	1.320	99.5
90	120	2.0	179	4.1	1.492	1.527	115.1
95	127	2.1	207	4.7	1.630	1.519	114.5
100	190	3.2	274	6.3	1.442	1.405 x= 1.327[3]	105.9
105	224	3.8	264	6.0	1.179	1.311	98.8
110	221	3.7	293	6.7	1.326	1.198	90.3
115	210	3.5	231	5.3	1.100	1.254	94.5
120	171	2.9	231	5.3	1.351	1.321	99.5
125	116	1.9	180	4.1	1.552	1.416	106.7
130	76	1.3	103	2.3	1.355	1.345	101.4
135	45	0.8	52	1.2	1.156	1.299	97.9
140	25	0.4	35	0.8	1.400	1.405	105.9
145	7	0.1	12	0.3	1.714	1.533	115.5
150	2	0.1<	3	0.1	1.500		
Total	5967	100.0	4384	100.2			
No. of Tows	88	88	88	88			

[1] Smoothed by moving geometric average of threes.

[2] 100 (Smoothed retention/1.327)

[3] Geometric mean.

Table 6. Retention sizes[1] (shell height mm) of sea scallops, by sampling strata and area, for the 8-foot, unlined sea scallop dredge obtained in alternate tow dredge selection experiments conducted with lined and unlined 8-foot sea scallop dredges with the R/V ALBATROSS IV, 1980.

	50% Retention Height	25% Retention Height	75% Retention Height	25-75% Selection Range
STRATUM 11	59.3	39.3	79.4	40.1
STRATUM 14	42.7	28.8	56.6	27.8
STRATUM 15	58.1	44.2	72.0	27.8
STRATUM 18	48.6	42.7	54.6	11.9
STRATUM 19	57.4	42.2	72.6	30.4
STRATUM 23	58.5	48.0	69.0	21.0
STRATUM 31	55.9	51.3	60.6	9.3
DELMARVA	51.9	40.4	63.4	23.0
NEW YORK BIGHT	58.5	47.5	69.6	22.1
ALL AREAS	55.1	43.3	67.0	23.7

[1]Derived by linear regression of deviates and linear regression of logits against shell height (see Pope et al. 1975: p.23-24).

Table 7. USA sea scallop research survey relative abundance indices (stratified mean number per tow), 1975-1980, for strata in which alternate tow dredge selection experiments using lined and unlined sea scallop dredges were conducted with the R/V ALBATROSS IV during May-June 1980. Survey indices are presented for pre-recruit (< 70 mm shell height) recruit (≥ 70 mm shell height) and total scallops per tow.

		Stratum 10			Stratum 11			Stratum 14			Stratum 15			Stratum 18		
Year	Dredge[1] Type	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow
1975	U-10	69.5	18.0	87.5	25.7	12.3	38.0	31.0	66.0	97.0	66.2	77.2	143.4	12.5	14.5	27.0
1977	U-10	-	-	-	4.0	83.0	87.0	7.0	70.0	77.0	17.5	69.5	87.0	-	-	-
1978	U-10	44.0	152.4	196.4	55.4	96.2	151.6	8.3	98.6	106.9	25.8	160.3	186.1	22.2	139.7	161.9
1979	L-8	79.6	85.4	165.0	4.8	60.1	64.9	12.7	41.0	53.7	28.4	85.0	113.4	5.6	43.1	48.7
1980	L-8	2.0	22.5	24.5	18.3	40.7	59.0	36.4	25.3	61.7	68.2	29.7	97.9	25.7	15.0	40.7
1980	U-8	0.5	35.0	35.5	8.8	29.0	38.5	23.3	30.7	54.0	22.2	37.3	59.5	16.6	29.5	46.1

		Stratum 19			Stratum 22			Stratum 23			Stratum 27			Stratum 31		
Year	Dredge[1] Type	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow
1975	U-10	1.5	20.0	21.5	8.0	2.0	10.0	52.8	56.9	109.7	7.0	21.0	28.0	86.4	181.9	268.3
1977	U-10	5.8	97.0	102.8	0.4	120.6	121.0	3.2	158.4	161.6	2.9	266.4	269.3	1.2	112.3	113.5
1978	U-10	13.5	85.0	98.5	1.4	32.3	33.7	4.7	165.2	169.9	1.4	148.8	150.2	1.9	154.3	156.2
1979	L-8	36.8	65.4	102.2	9.8	7.0	16.8	17.9	48.3	66.2	5.7	26.6	32.3	4.4	15.6	20.0
1980	L-8	230.8	42.0	272.8	7.0	5.5	12.5	54.6	22.8	77.4	1.0	11.0	12.0	13.0	20.0	33.0
1980	U-8	120.4	41.4	161.8	7.5	11.2	18.7	18.4	32.9	51.3	1.0	29.0	30.0	3.6	28.4	32.0

		Delmarva (Strata 10, 11, 14, 15, 18, 19)			New York Bight (Strata 22, 23, 27, 31)		
Year	Dredge[1] Type	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow	No. < 70 mm per Tow	No. ≥ 70 mm per Tow	Total No. per Tow
1975	U-10	34.8	39.2	74.0	51.4	91.4	142.8
1977	U-10	9.8	79.1	88.9	2.0	155.9	157.9
1978	U-10	26.8	123.9	150.7	2.6	140.7	143.3
1979	L-8	25.5	64.5	90.0	9.3	26.2	35.5
1980	L-8	71.8	29.8	101.6	22.3	17.3	39.6
1980	U-8	35.0	34.3	69.4	8.0	27.6	35.6

[1]Dredge Type: U-10 is unlined 10-foot dredge.
L-8 is lined 8-foot dredge.
U-8 is unlined 8-foot dredge.

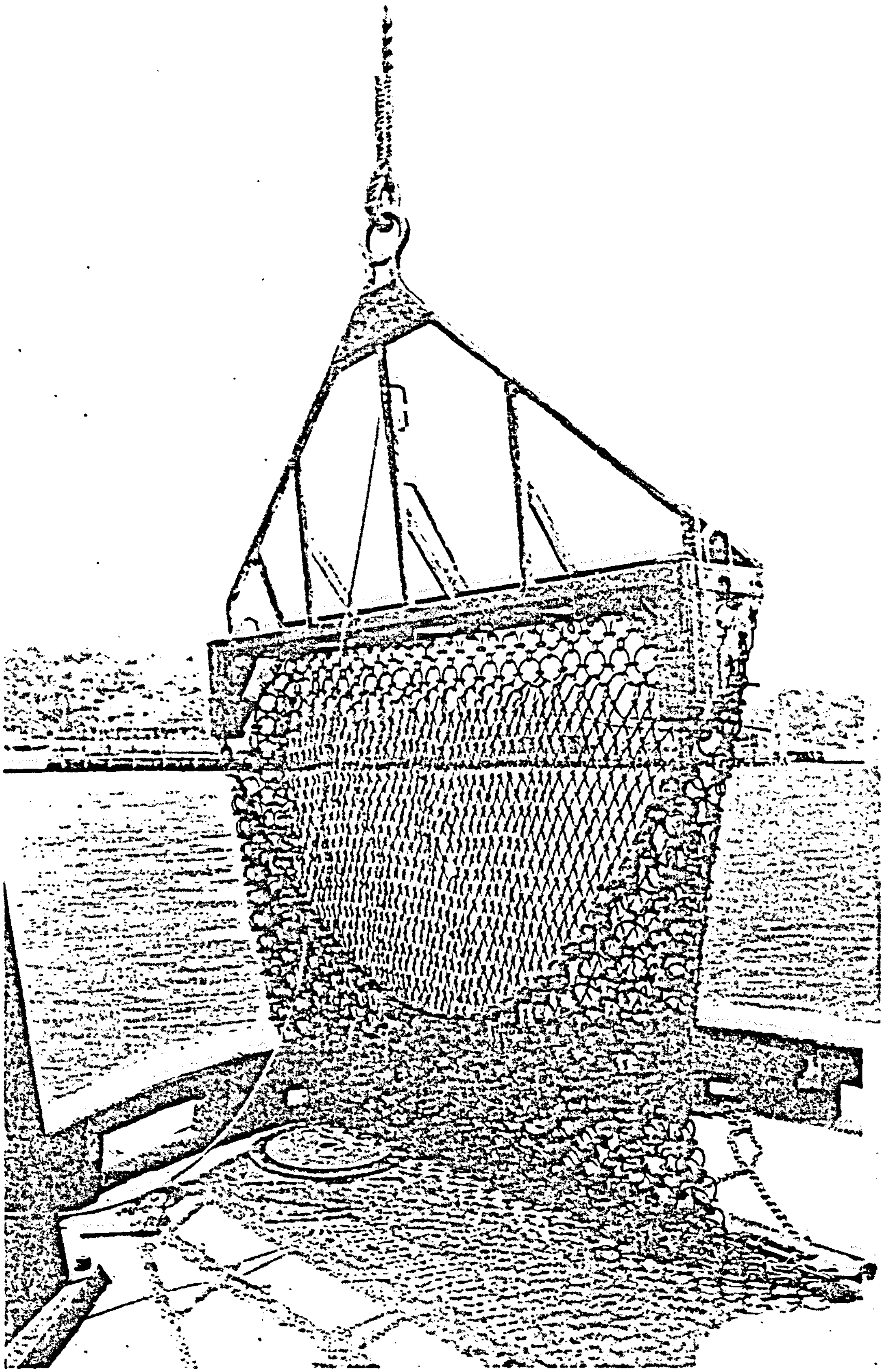
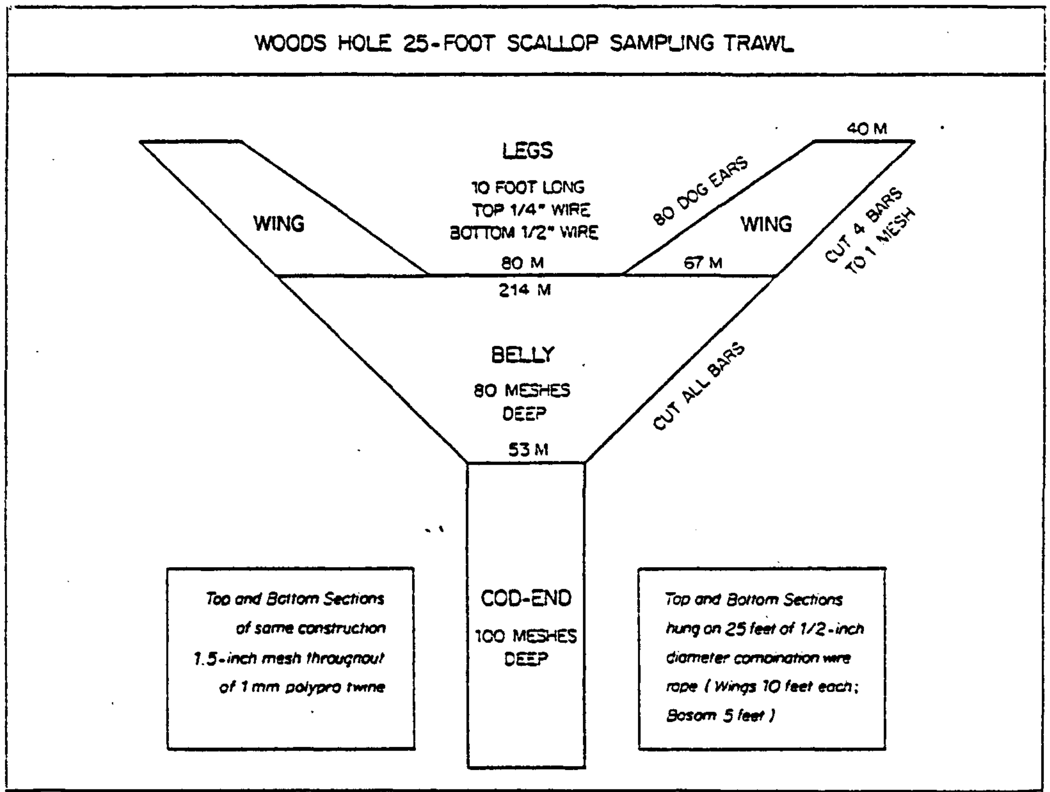


Figure 1. Photograph of the standard 2.44 m wide sea scallop dredge used in alternate-haul gear selection experiments in the Mid-Atlantic during May - June 1980.



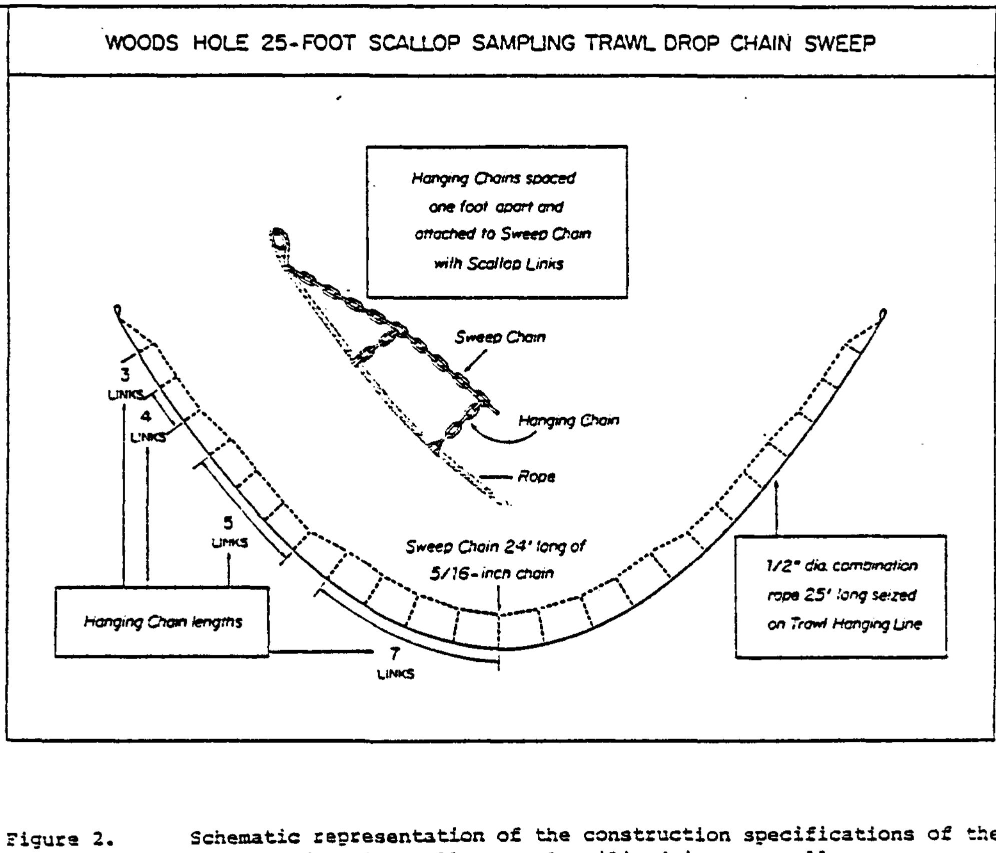


Figure 2. Schematic representation of the construction specifications of the 7.6 m Woods Hole scallop trawl utilized in sea scallop gear selectivity experiments during May - June 1980.

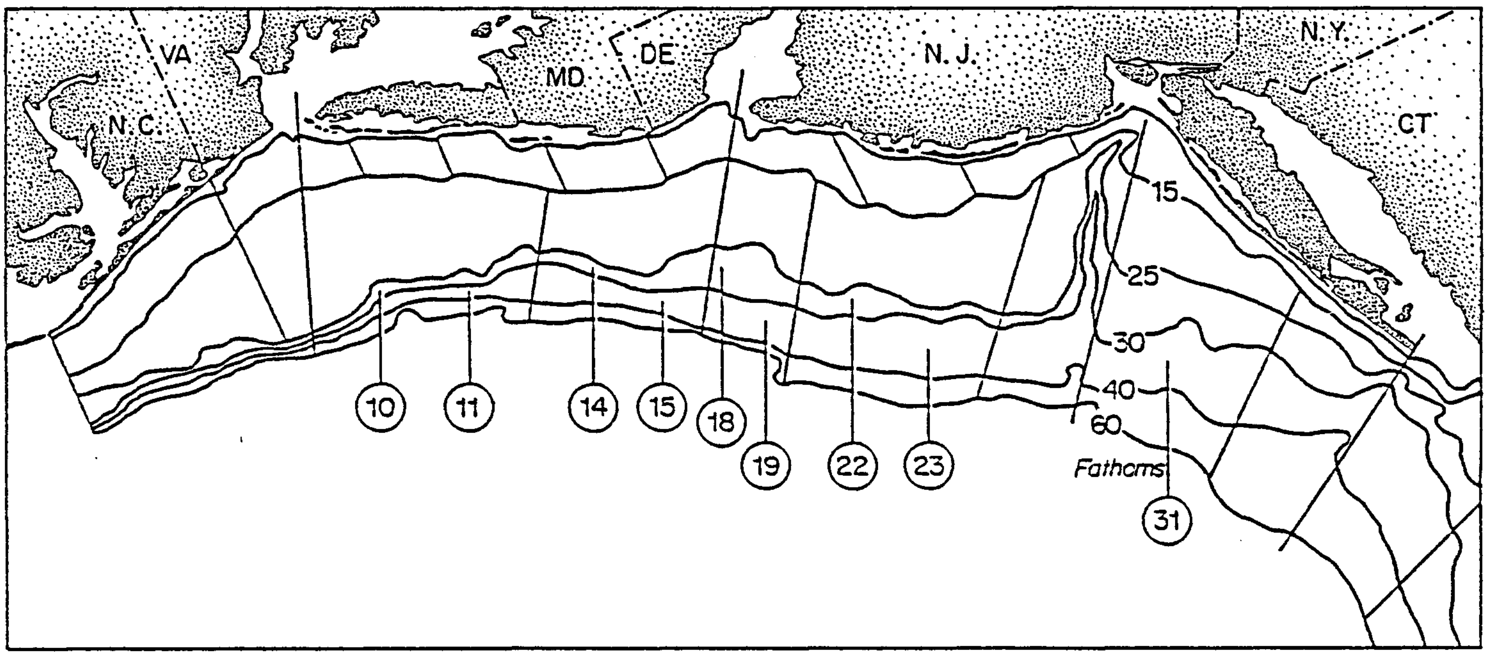
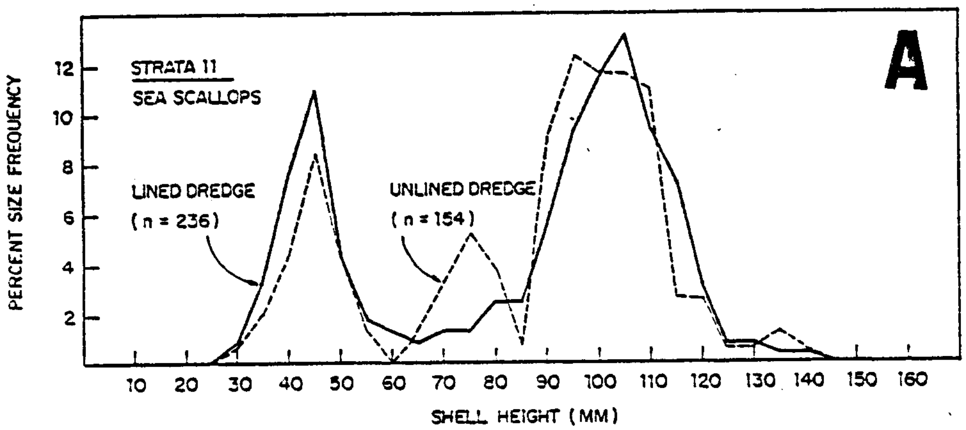


Figure 3. USA sea scallop research survey strata sampled in sea scallop gear selectivity experiments conducted during May - June 1980.



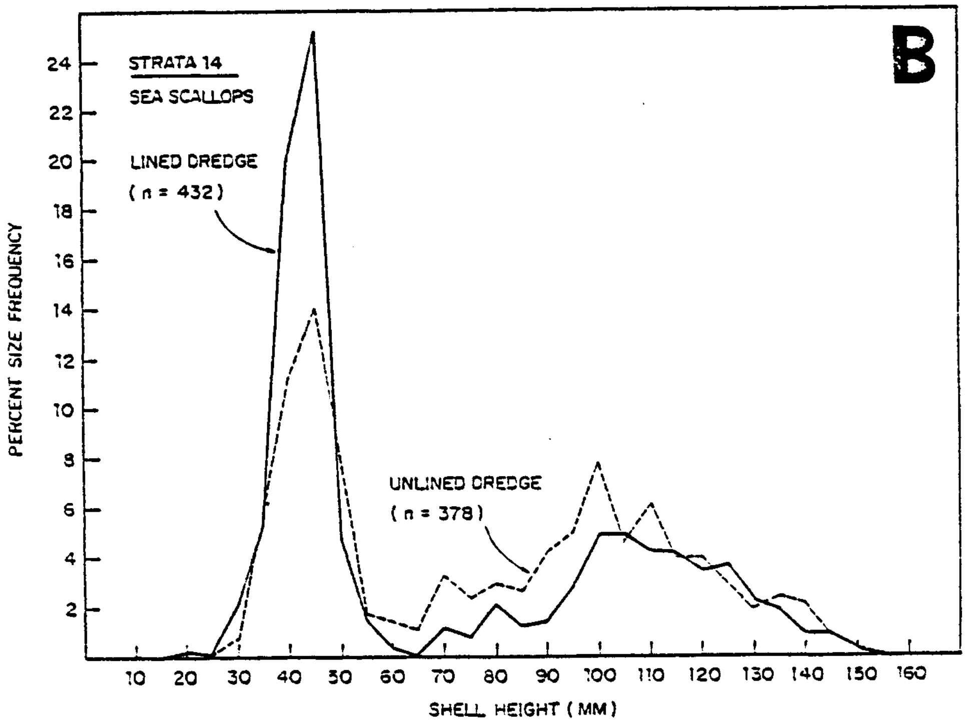
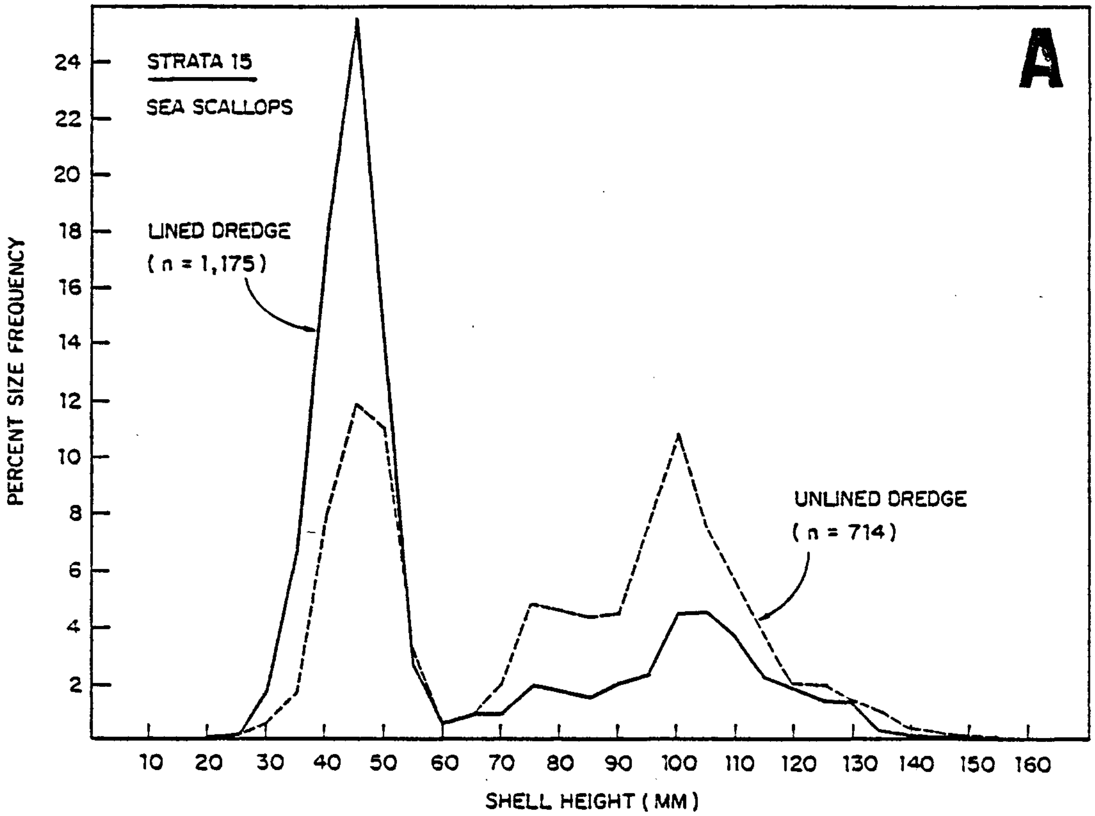


Figure 4. Percent size frequencies of sea scallops obtained in lined and unlined 2.44 m scallop dredges in stratum 11 (A) and stratum 14 (B) during replicate alternate-haul gear experiments in May - June 1980.



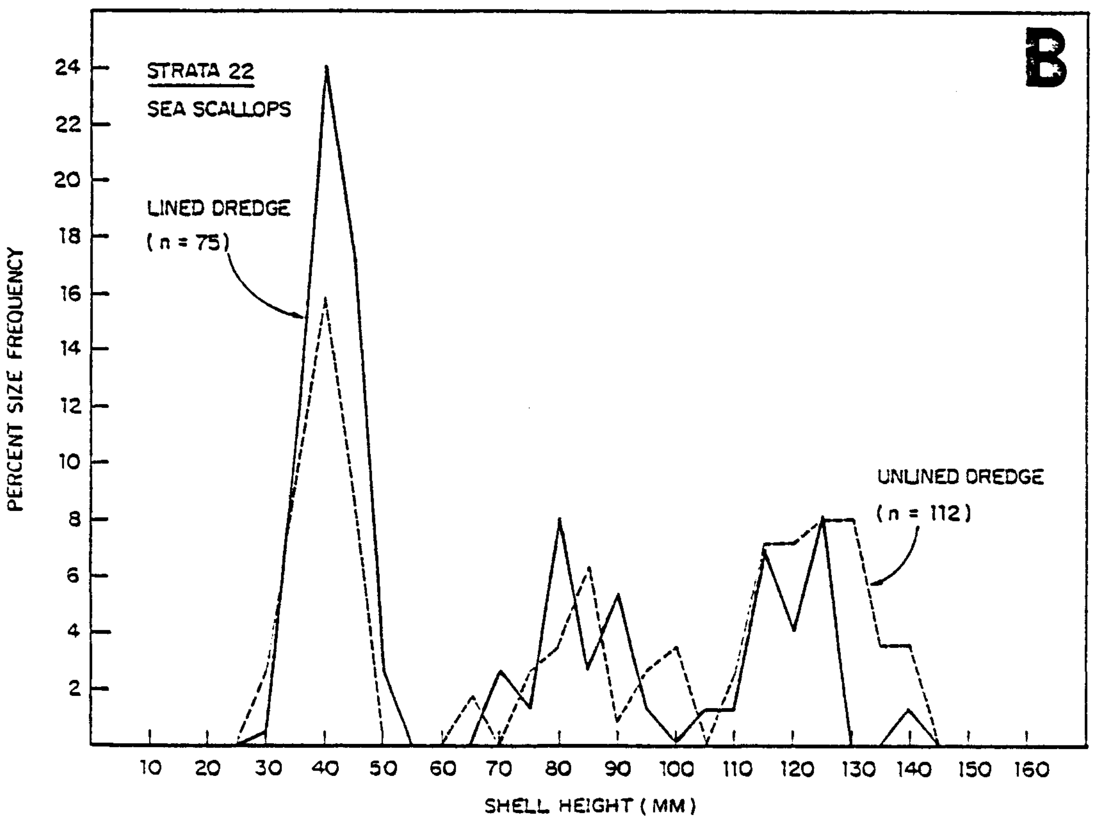


Figure 5. Percent size frequencies of sea scallops obtained in lined and unlined 2.44 m scallop dredges in stratum 15 (A) and stratum 22 (B) during replicate alternate-haul gear experiments in May - June 1980.

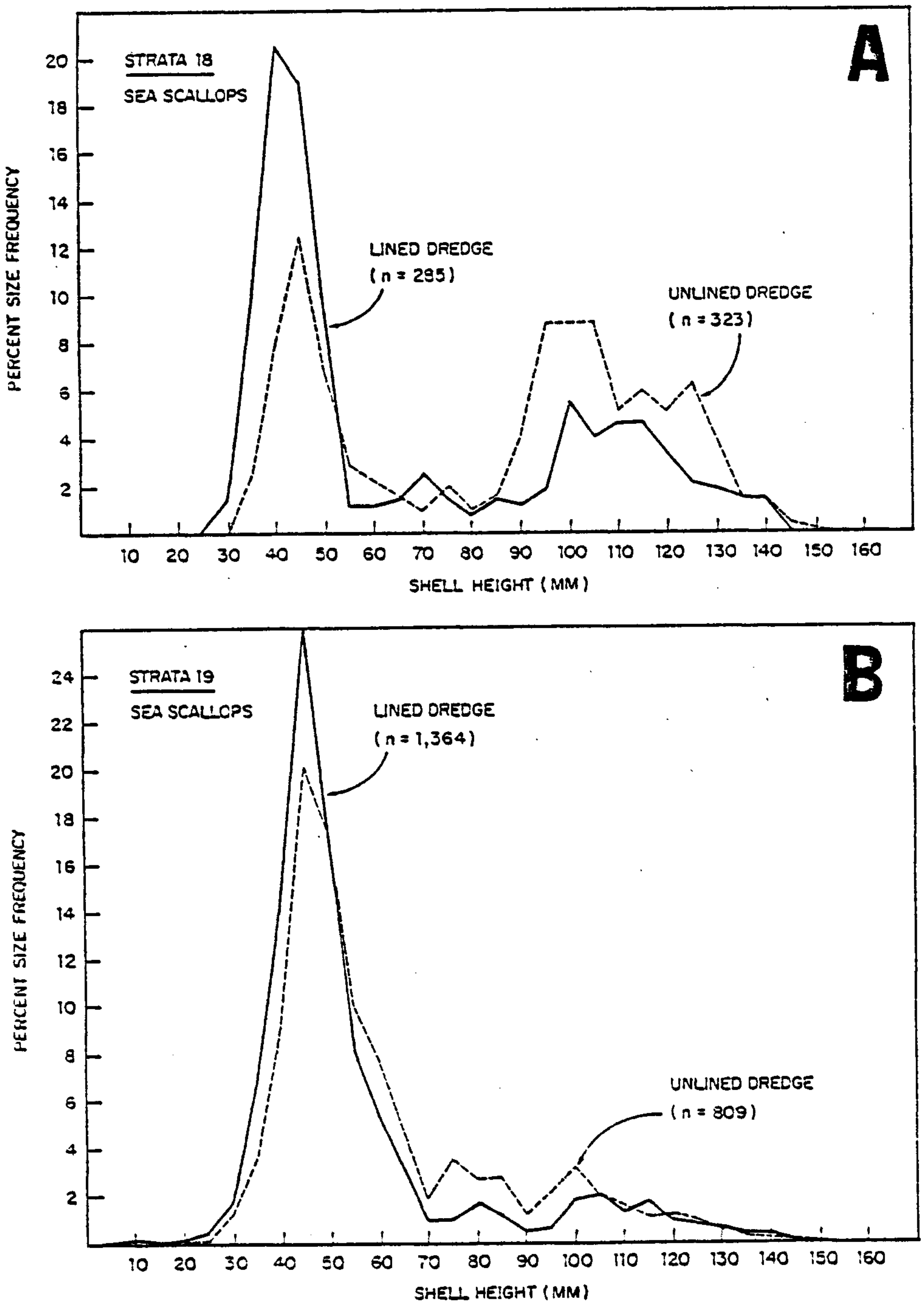


Figure 6. Percent size frequencies of sea scallops obtained in lined and unlined 2.44 m scallop dredges in stratum 18 (A) and stratum 19 (B) during replicate alternate-haul gear experiments in May - June 1980.

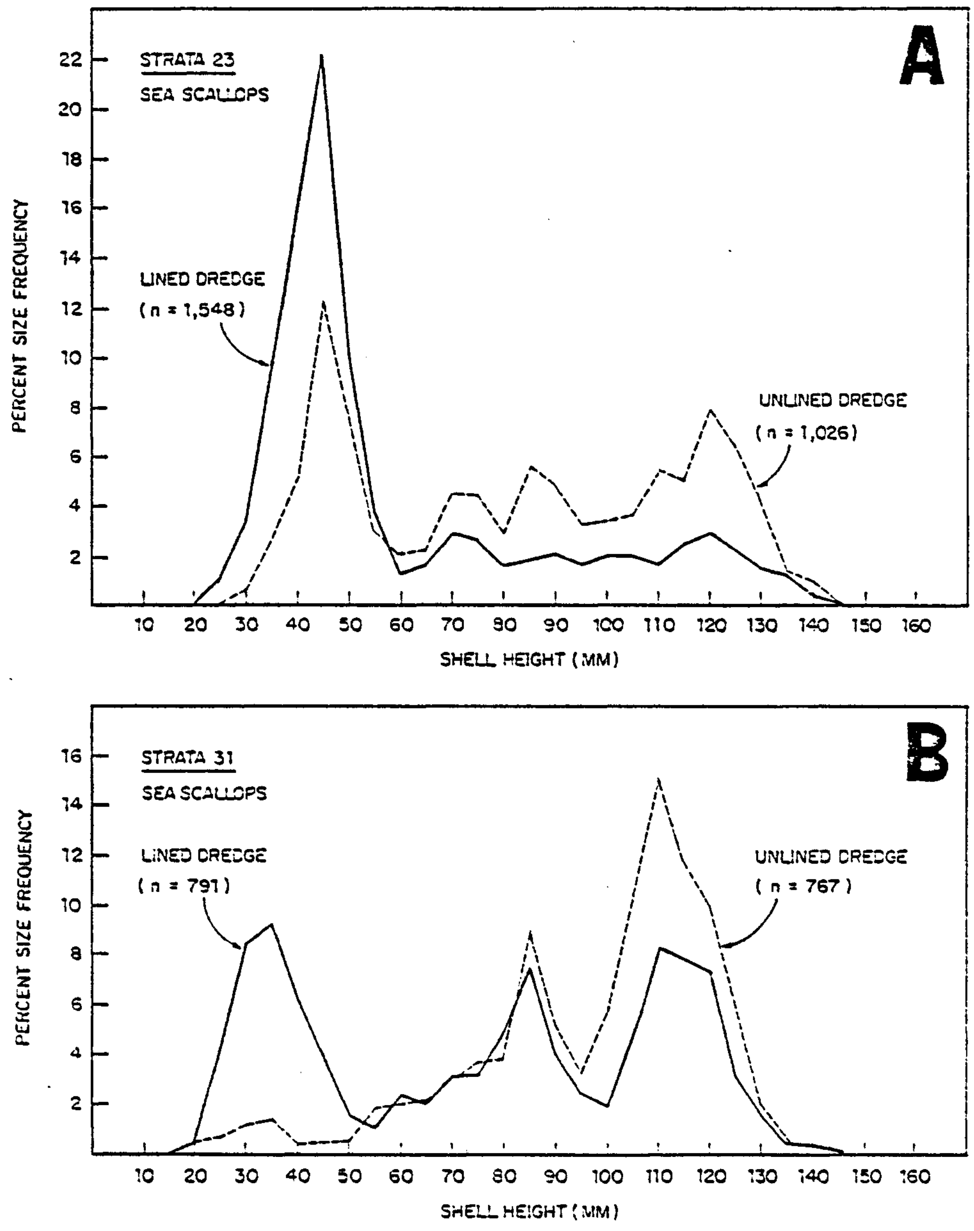


Figure 7. Percent size frequencies of sea scallops obtained in lined and unlined 2.44 m scallop dredges in stratum 23 (A) and stratum 31 (B) replicate alternate-haul gear experiments in May - June 1980.

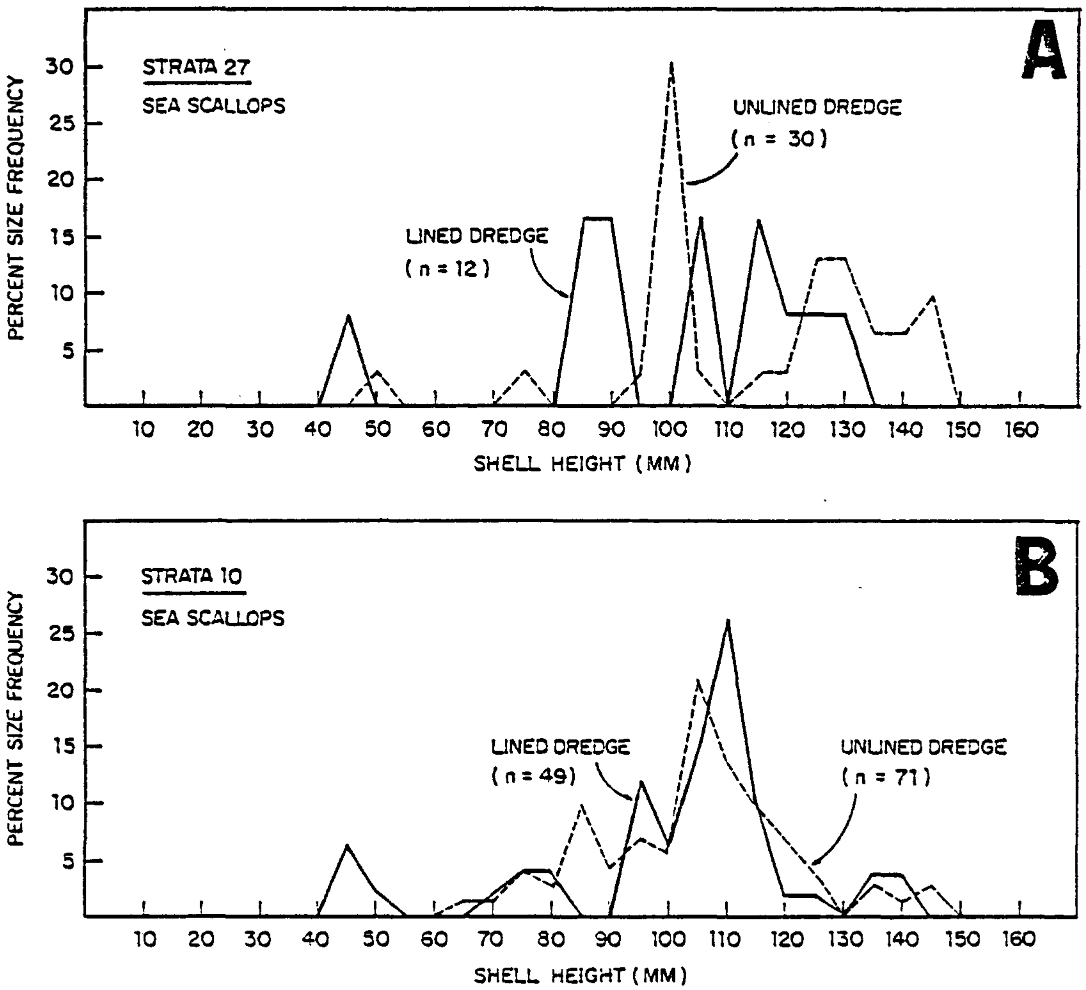


Figure 8. Percent size frequencies of sea scallops obtained in lined and unlined 2.44 m scallop dredges in stratum 27 (A) and stratum 10 (B) during replicate alternate-haul gear experiments in May - June 1980.

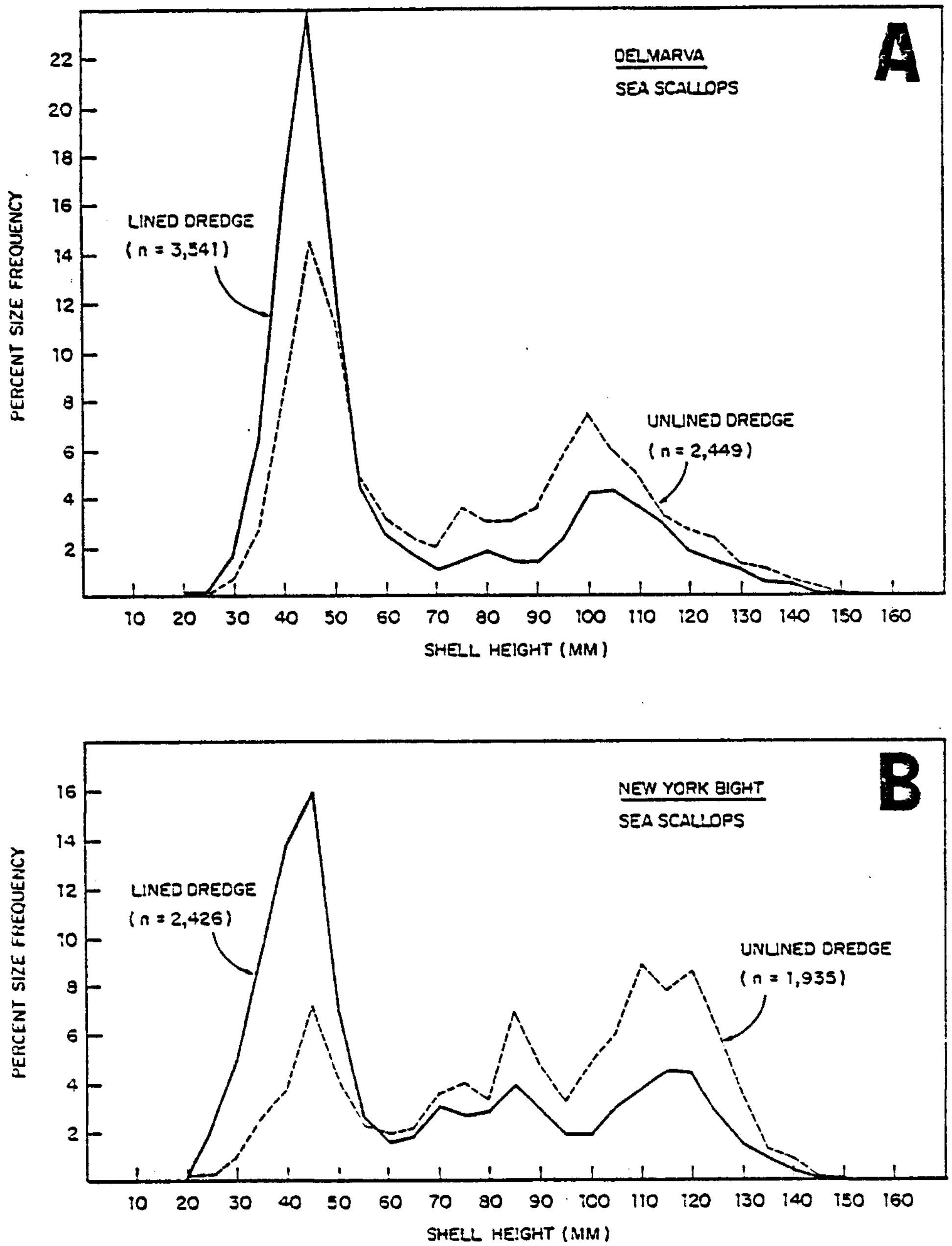


Figure 9. Percent size frequencies of sea scallops obtained in lined and unlined 2.44 m scallop dredges in Delmarva (A) and the New York Bight during replicate alternate-haul gear experiments in May - June 1980.

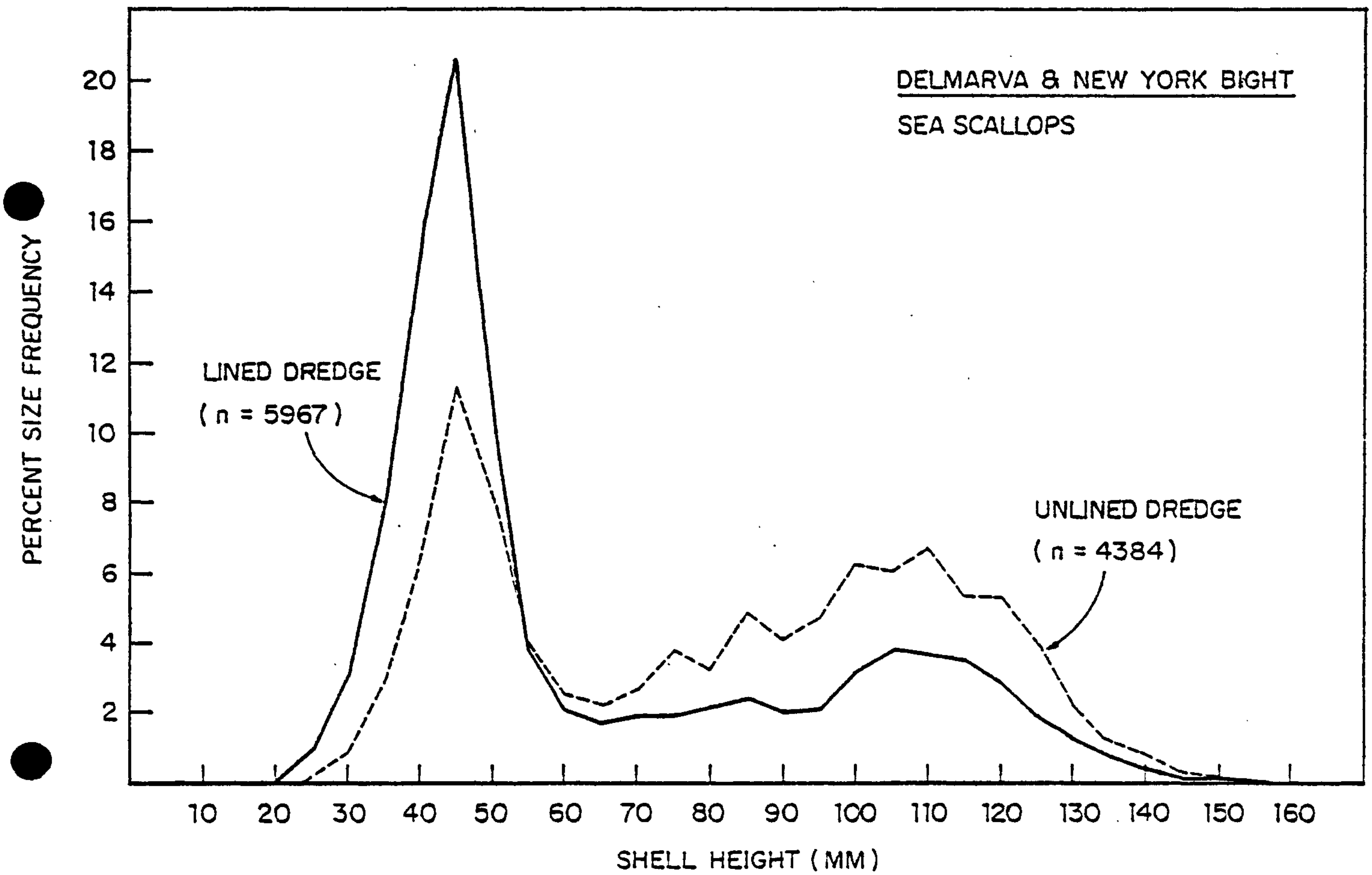


Figure 10. Percent size frequencies of sea scallops obtained in lined and unlined 2.44 m scallop dredges throughout the Mid-Atlantic region during replicate alternate-haul gear experiments in May - June 1980.

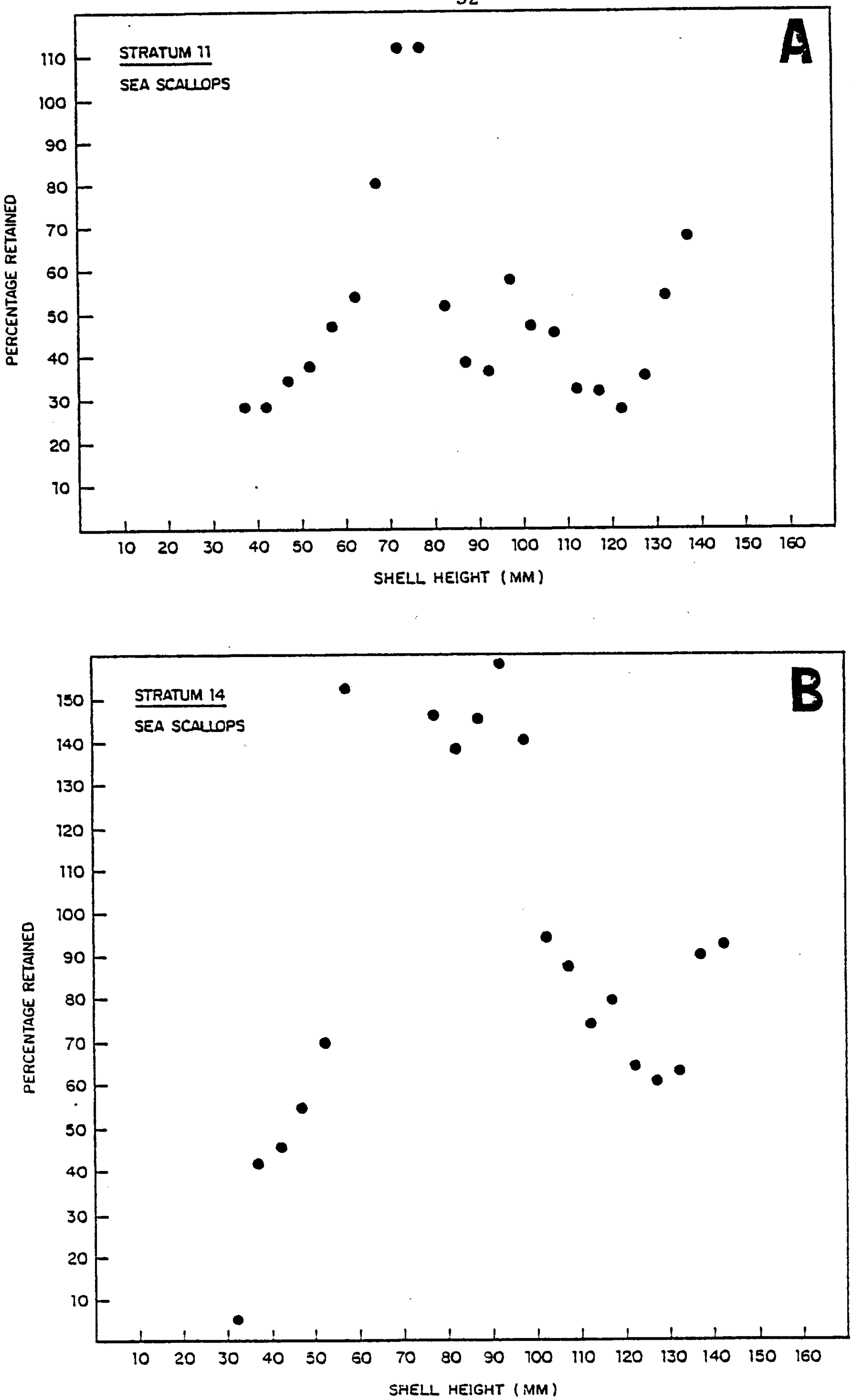


Figure 11. Retention percentages, by size group, of sea scallops obtained in the 2.44 m unlined sea scallop dredge in alternate-haul experiments in stratum 11 (A) and stratum 14 (B) during May - June 1980.

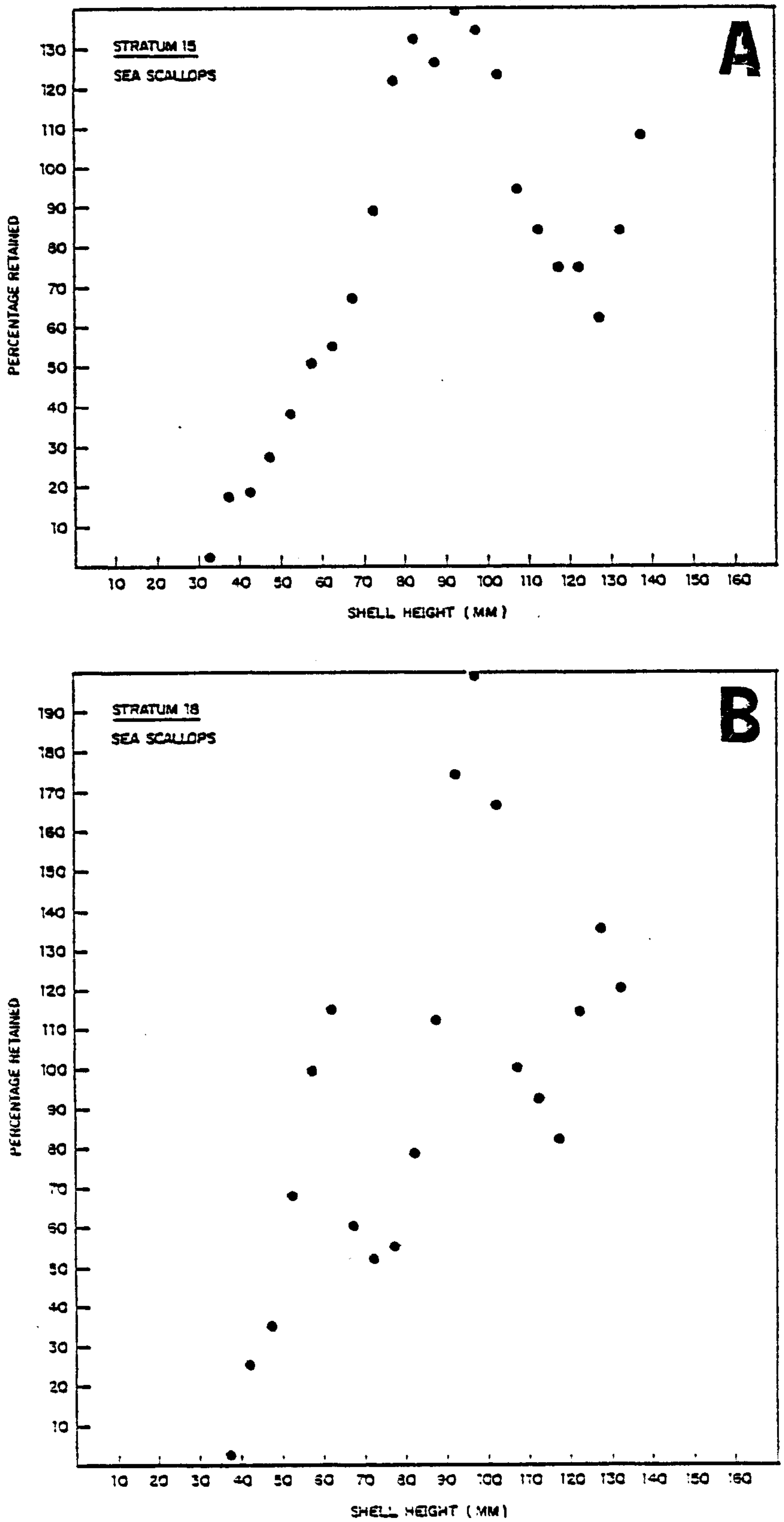


Figure 12. Retention percentages, by size group, of sea scallops obtained in the 2.44 m unlined sea scallop dredge in alternate-haul experiments in stratum 15 (A) and stratum 18 (B) during May - June 1980.

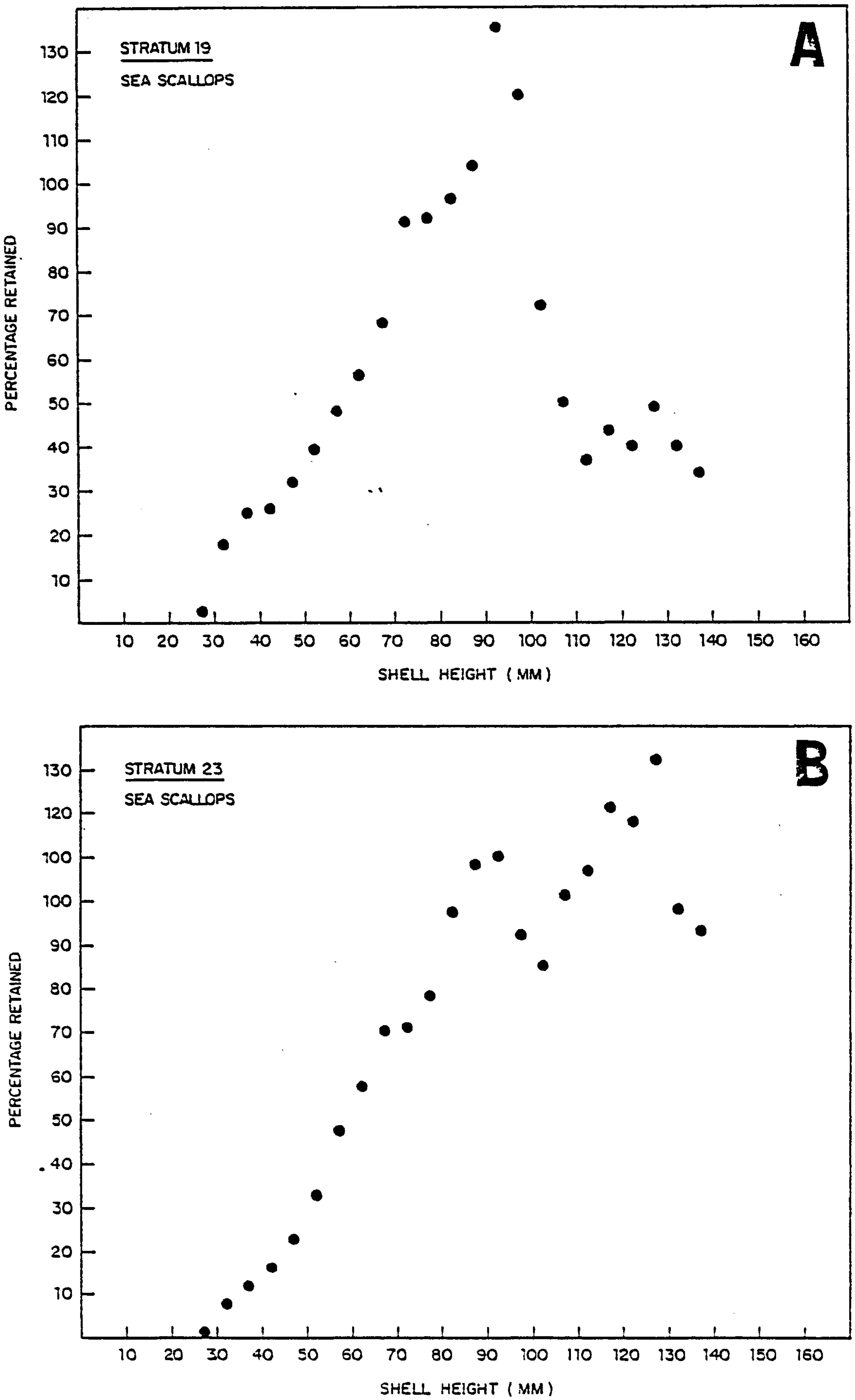


Figure 13. Retention percentages, by size group, of sea scallops obtained in the 2.44 m unlined sea scallop dredge in alternate-haul experiments in stratum 19 (A) and stratum 23 (B) during May - June 1980.

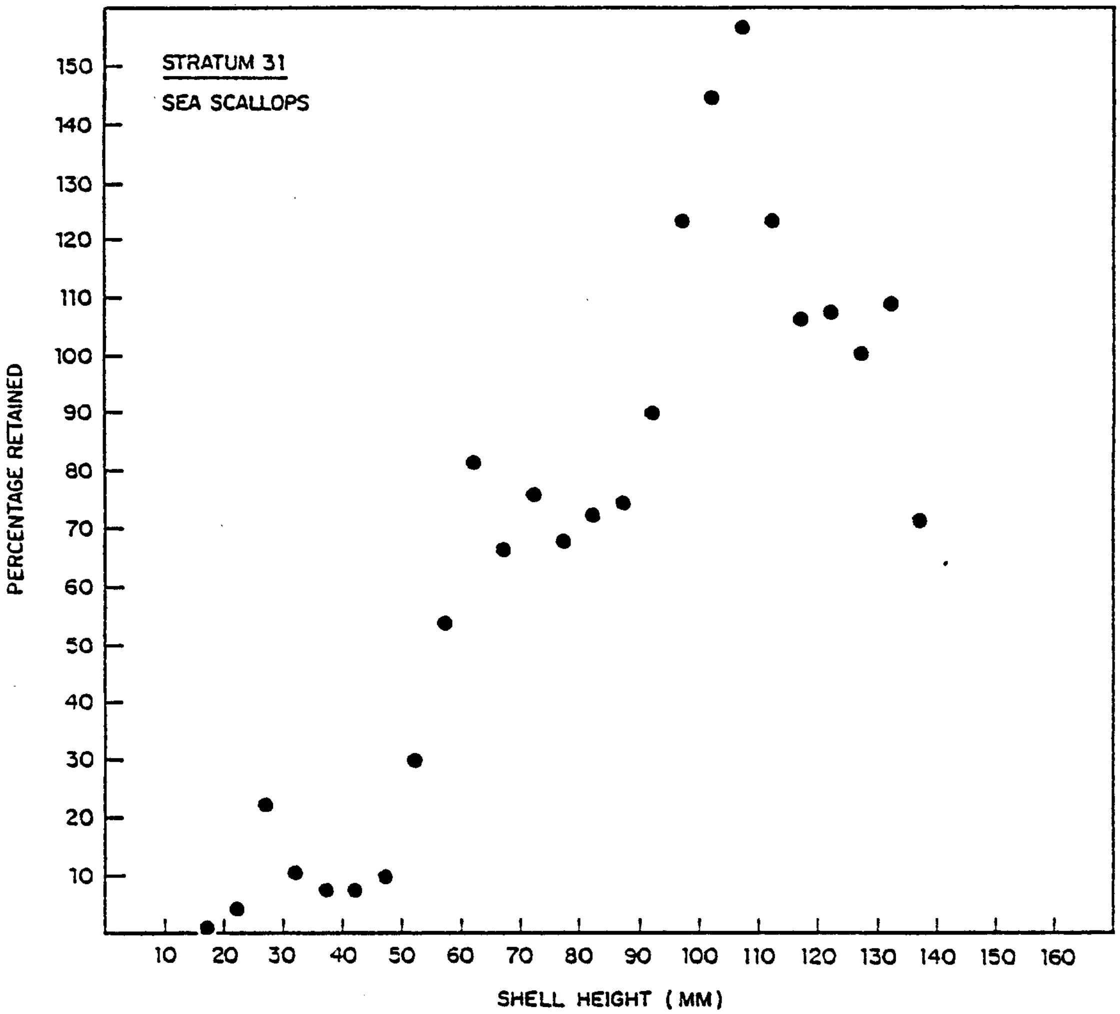
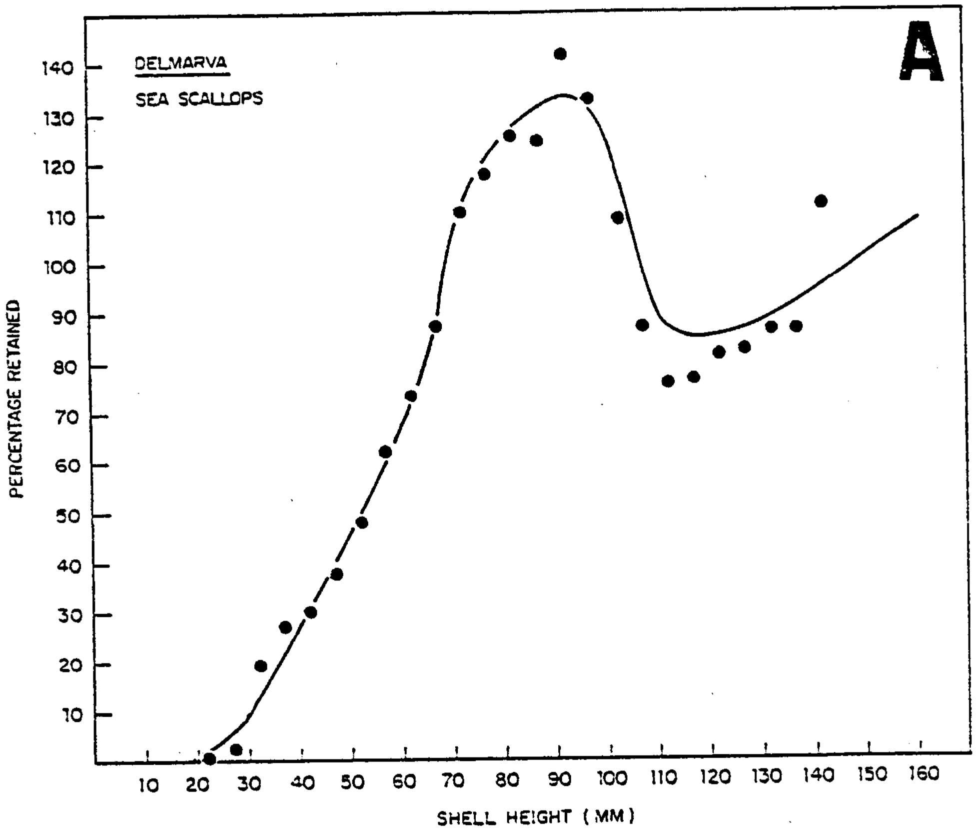


Figure 14. Retention percentages, by size group, of sea scallops obtained in the 2.44 m unlined sea scallop dredge in alternate-haul experiments in stratum 31 during May - June 1980.



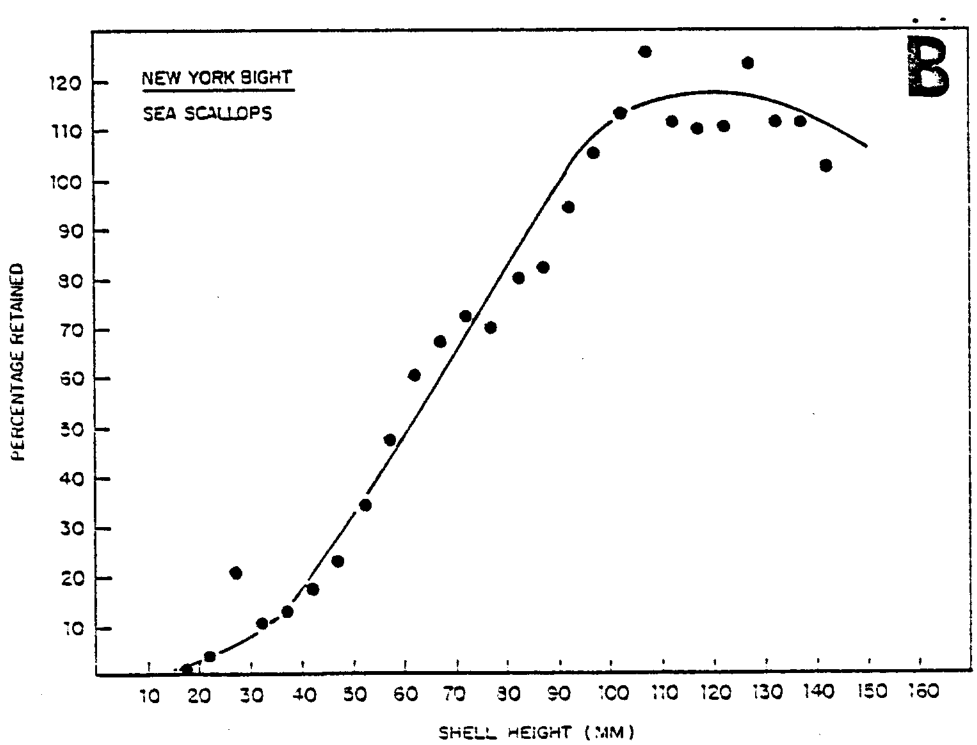


Figure 15. Retention percentages, by size group, and selection ogive for sea scallops obtained in the 2.44 m unlined sea scallop dredge in alternate-haul experiments in Delmarva (A) and the New York Bight (B) during May - June 1980.

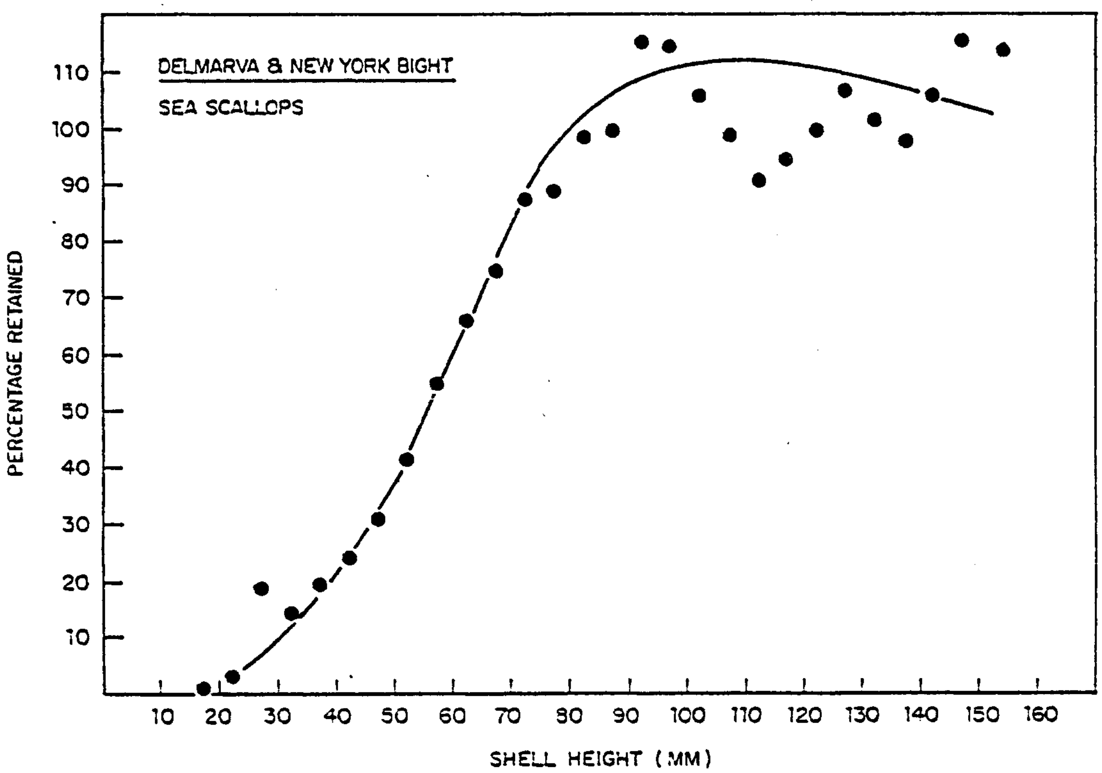


Figure 16. Retention percentages, by size group, and selection ogive for sea scallops obtained in the 2.44 m unlined sea scallop dredge in alternate-haul experiments throughout the Mid-Atlantic region during May - June 1980.

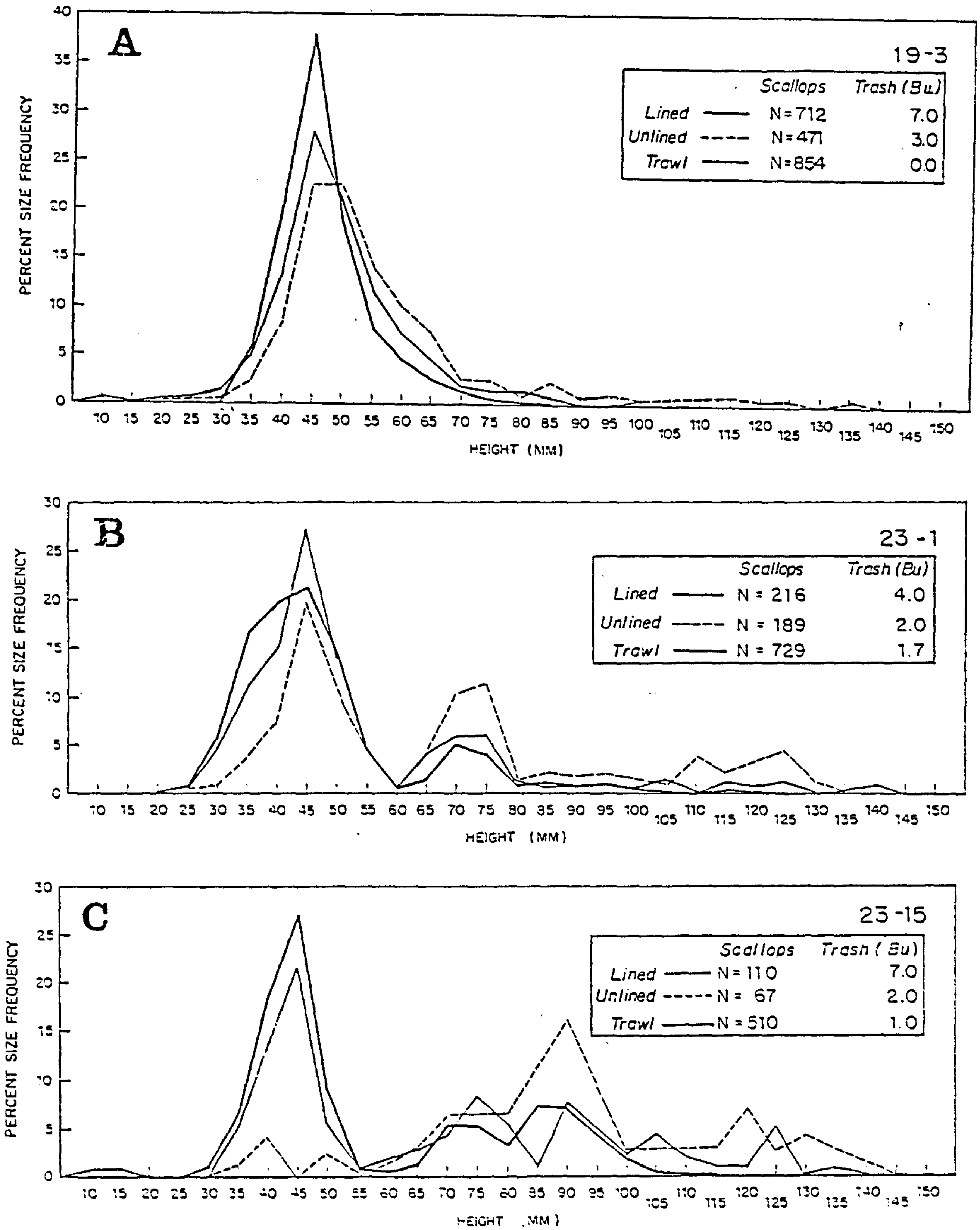


Figure 17. Percent size frequencies of sea scallops obtained with the lined and unlined 2.44 m sea scallop dredges and the 7.6 m Woods Hole scallop trawl at sampling stations 19-3 (A), 23-1 (B), and 23-15 (C) during gear comparison experiments in May - June 1980.