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Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC
Research Document # 82/02

Status and assessment of the Iceland scallop, *Chlamys islandica* in the northeastern Gulf of St. Lawrence

by

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Abstract

A stock assessment of northeastern Gulf Iceland scallops is presented. Based on research-vessel surveys, relative age composition in research surveys and commercial catches and fishery performance, it represents the first assessment ever undertaken of this resource. As a result of an interaction of the availability and prices of other exploitable species by a multi-purpose fleet, a pulse fishing strategy for scallops has emerged in this area. In the third year of its second pulse, the fishery has enjoyed relatively stable CPUEs over the period and the assessment points to its continued short to medium-term stability. Long-term management options are discussed.

Résumé

Ce qui suit est une évaluation du stock de pétoncles d'Islande du nord-est du golfe du Saint-Laurent. Fondée sur des relevés par navire de recherche, la composition relative par âge des prises, tant expérimentales que commerciales, et enfin les rendements de la pêche, cette évaluation est la première à avoir été entreprise de cette ressource. A cause d'une interaction entre la disponibilité et le prix d'autres espèces exploitables par une flottille polyvalente, il s'est développé dans cette région une stratégie de pêche "pulsée". Les prises par unité d'effort ont été relativement stables dans la troisième année de la seconde phase. Notre évaluation donne à penser qu'elles continueront de l'être à court et moyen terme. Nous examinons les diverses options de gestion à long terme.

Introduction

The suspension-feeding Iceland scallop, Chlamys islandica, has its main distribution within the subarctic transitional zone - subarctic or northerly boreal (Ekman 1953). In Newfoundland, local populations are normally found in waters deeper than 30 fms (55 m), usually on hard bottom with variable substrate composition consisting largely of sand, gravel, shell fragments and stones. Being a filter feeder, the species is most abundant in areas where there are strong currents as in the Strait of Belle Isle in the northeastern Gulf of St. Lawrence. Other areas where Iceland scallops are found in quantity include St. Pierre Bank (3Ps) and along the Labrador coast, particularly off Nain and West St. Modeste where a small fishery is underway. Although sizeable beds of Icelandics occur on St. Pierre Bank, no commercial effort is expended here. Of the three areas, beds located in the northeastern Gulf are the most easily accessed, frequently occurring within 2 mi of the coast.

Although the day fishery in the Gulf for Iceland scallops began in 1969 when 224 MT (round) was landed, studies on the distribution and population dynamics of Chlamys did not commence until 1973. Landings receded slightly to 173 and 151 MT in the two succeeding years. In 1972 and 1973, however, landings from the hand-shucked fishery increased sharply, concomittant with a changeover to 2.5 from 3.0 in. rings, to 2342 and 1975 MT, respectively (Table 1). Towards the latter part of the 1973 season, scallop prices fell. Herring and cod were abundant and a new year-class recruited to make shrimping more lucrative. As effort expended on labor intensive scalloping depended on an interaction of the availability and prices of several other species then available to the mobile multi-purpose vessels, the percentage of vessels fishing scallops thus decreased. A combination of severe ice conditions and poor prices in 1974 resulted in a further diversion of effort into other species and decline in total landings (Table 1). There was no active fishery during the 1975-78 period. Unfortunately no systematic annual sampling of scallops was carried out during the first fishing pulse in the northeastern Gulf. Consequently, the data base on past stock characteristics is fragmented and at best inconclusive.

Scallop fishing resumed in 1979 when 406 MT were taken. Landings increased to 1022 and 1380 MT in 1980 and 1981 respectively, with a combined landed value exceeding 2 M dollars. The recent resurgence of this fishery has renewed our interest in this stock, particularly from the point of carrying out suitable assessments and, if needed, developing appropriate management strategies for the fishery. The second pulse has continued every summer for the past three consecutive years. An intensive commercial sampling program was initiated in 1980. In addition a two-dimensional systematic survey was conducted in 1980 to enumerate population numbers, and repeated in 1981. The assessment presented here is based largely on these surveys and on the fishery characteristics from the second pulse of exploitation.

The fishery remains unregulated with the exception of it being designated as a limited entry fishery for boats in excess of 40 ft (1980-81) and 35 ft (1982). Individuals holding licences for vessels over 35 ft who have not utilized the licences in 1980 or 1981 will not be eligible for renewal in 1982.

Materials and Methods

On the basis of individual interviews with active scallop fishermen and local DFO personnel, an area about 114 sq nautical miles was delineated as the principal fishing area. Sample surveys based on a systematic lattice design were carried out in this core area to explore and determine the spatial structure of the scallop population and to assess the suitability of this type of sampling design for resource management purposes (Naidu and Smith 1981). The procedures involved in setting up a systematic lattice design are described in Smith and Naidu (1981). Eleven latitudinal transects, each spaced one nautical mile apart, were run in the target area (Fig. 1). Stations were assigned at 0.5 mile intervals along these lines. One hundred and three stations were occupied in 1980 (Fig. 1, closed circles) but operational constraints reduced the coverage to 59 in 1981 (Fig. 1, open circles). Fishing stations in waters less than 30 fms (55 m) were deleted from the lattice as no commercial effort was expended at these depths.

Both surveys were conducted during July-August with the 18.6 m government research vessel, the M.V. MARINUS. All tows were made with a gang of four toothless Digby buckets mounted on a single tow bar. Dredges were equipped with 2.5 in (64 mm) rings and carried a 1.5 in (38 mm) polypropylene mesh liner to increase retention of smaller scallops. The liner was inspected frequently and repaired or replaced as necessary. Each tow attempted to cover exactly 0.25 nautical mile with a 3:1 wire scope.

Dredges were hauled up at the end of each tow and the catch was "bushelled" into baskets and weighed to the nearest pound. Individual live shell-height frequencies were recorded (to the nearest mm) on either the whole catch, or a weighed random subsample, depending on the amount caught. In the few (5) instances when subsamples were employed in 1981, counts were made of all animals not measured. All cluckers were counted and measured, again to the nearest mm. Random shell samples from throughout the survey grid were retained for subsequent age determinations. Notes were kept on the volumes and types of substrates encountered in the area fished. Biological sampling for individual adductor muscle weights was carried out at on-shore locations with fresh scallops.

During the 1980 scallop survey 10 scallops were tagged and released at each of the 108 fishing stations, ensuring that the tagged population of 1,080 scallops was evenly distributed over the fishing area. Tagging was accomplished by drilling a small hole through the one unequal wing protrusion and a numbered yellow Peterson disc manually secured in place with a Type 304, 0.4 mm diameter stainless steel wire (Fig. 2). Excess wire was trimmed to the twist and the latter tucked neatly over the disc.

In 1973, Mr. M.C. Mercer, scientist then in charge of scallop investigations, had conducted separate gear selectivity trials for Iceland scallops in the northeastern Gulf of St. Lawrence using Digby dredges of similar construction equipped with 2.5 in. and 3.0 in. rings. Dredge covers employed on alternate dredges consisted of 1.5 in. mesh courlene with a 2.0 in mesh double-braided courlene jacket for chafer. Both cover and chafer were attached to dredges as a "bag-like" affair, extending beyond the length of the dredges and terminating with a cod-end which facilitated dumping and separation of the catch. The unpublished data from these investiations have been analyzed for use in this assessment.

Information on scallop landed, either shucked meats or in the shell, fishing areas and size composition of catches was obtained from port samples, fishing logs, commercial sampling statistics and interviews with fishermen.

Results

Resource surveys

Estimates of exploitable scallop biomass in the northeastern Gulf of St. Lawrence based on resource surveys using a systematic lattice sampling scheme were given by Naidu and Smith (1982). The results are summarized in Table 2.

Assuming a Gaussion distribution for sample means we note that the 95% confidence intervals for estimated mean numbers of scallops for the two years do not quite overlap, although the confidence intervals for the estimated mean weight do. Minimum biomass in 1980 and 1981 is estimated at 2,465 and 3,000 MT respectively (Table 2). Coefficients of variation (SE/Y_{st}) range from 7.6 to 5.4% - a level of precision seldom attained in resource surveys of this sort. Overall average density of scallops in the area surveyed was 6-8/10m^2. Given the distributional assumptions this points to little change in abundance in the two years.

Tag returns have been too sparse and infrequent (3 and 9 returns in 1980 and 1981 respectively) to be of much use at this time. Of these only six were returned (all in 1981) with the shell intact. No appreciable growth was evident.

Broadly, the bottom may be characteristized by two general substrate types: a hard, rocky southern area (transects 1 to 7) and a smoother, softer bottom in the north (Transects 8-11) consisting mainly of coarse sand and shell fragments.

Growth

Rings on the left (upper) valve have been used in this study to determine ages and in back calculations (Fig. 2). Not all animals are readily aged from shells. Epifaunal organisms quite commonly found on the surface of the upper valve often conceal all clues, effectively precluding age determinations (Fig. 3). Shells that are likely to be aged are cleaned in a weak solution of HCL and brushed radially from the umbo outwards to the shell periphery. Thus prepared, approximately 30-40% of shells in a sample may be aged successfully by mere inspection. An even smaller percentage was used in back measurements. Expressing growth as a function of shell height in this species is further constrained by a phenomenon in some animals whereby growth beyond a certain size (variable) does not manifest itself through further increases in linear dimension, but becomes flush-laminal (Fig. 4). As many as four layers have been detected in some specimens, annual growth in these presumably expressing itself through the deposition of a distinct and separate lamina. With time the shell margin becomes thick. Infrequently the most recent lamina may resume feeble growth along the dorso-ventral axis, but the deposited shell appears to be delicate and easily damaged.

Von Bertalanffy growth parameters for northeastern Gulf Icelandics were calculated (Abramson 1963) from back measurements employing 284 scallops (Table 3, Fig. 5). Estimates of similar parameters for scallops from St. Pierre Bank are given for comparison (Table 4). Although depth had a profound effect on growth rate (K) and $L\infty$ values for scallops from St. Pierre Bank, no attempt is made in this assessment to factor depth into these parameters. Indeed an examination of mean shell heights within the three most important depth strata in the area, viz. 30-39, 40-49 and 50-59 fms showed little variation (79.03, 79.07 and 79.46 mm respectively). Comparisons of the means from the two extreme depth ranges indicated no significant statistical difference ($P < 0.05$). There was a tendency, however, for scallops to be somewhat larger northwards, particularly beyond transect No. 8 (Table 5). These differences are probably related to factors other than depth and are ignored in this first assessment.

In order to at least partly address the problems of shell curvature (Naidu 1975) and shell lamination, an age-length key was constructed using the complete shell height-at ring formation data (N = 2670) and used to generate scallop ages at given shell heights rather than using mean shell-height at age (Caddy and Jamieson 1977, Jamieson et al. 1980).

Shell height-meat weight relationship

Data from earlier resource surveys were combined with more current data obtained monthly through the 1981 fishing season to compute the relationship between $W = cL^b$, where W = weight of adductor muscle, c and b are constants. These are derived from the least squares regression of the logarithmic transformation $y = a + bx$ where $y = \log_e W$, $a = \log_e c$ and $x = \log_e L$ (length in mm and weight in g, Table 6)

$$\log_e y = 2.85 \log_e x - 4.44 \qquad \text{(Fig. 6)}$$

As manual shucking habits vary amongst fishermen and are frequently dictated by buyers, both the large smooth (quick) and smaller striated (catch) fractions were included in the computation of parameters. The relationship between muscle-on (both components of adductor muscle) and muscle-off (adductor muscle less catch fraction) was found to be linear ($r^2 = 0.99$, Fig. 7), with no discernable correlation ($r^2 = 0.02$) of the ratio of their weights with scallop size (Fig. 8). This facilitated conversions of landings from muscle-off to muscle-on and vice versa. But an analysis of covariance of the logarithmic transformations of muscle weight on shell height pointed to significant seasonal differences in the adjusted means ($P < 0.01$) for plant samples for the period April to August (Table 7). This required the use of different factors for conversions of meat to round weights.

The effect of depth on meat yield, if any, has not been investigated.

Gear Selectivity

Selectivity analyses (Tables 8 and 9) are preliminary. Scallop selectivity by commercial gear was approximated by comparing lined catch data (i.e. number actually entering gear) with the unlined catch data. Over the vulnerable size range, the 2.5 in unlined dredges caught 79% as many scallops as the lined dredges. The 50% retention shell heights for the 2.5 in (64 mm) and 3.0 in

(76 mm) mesh were 70 mm and 91 mm corresponding to mean retention ages of 8 and 13 respectively (Fig. 9). The extremely poor retention by the larger mesh was no doubt responsible for the somewhat rapid changeover to 2.5 in rings during the third year of the fishery. Lined dredges (2.5 in rings) were nearly five times (4.75) as efficient in retaining pre-recruit scallops (<70 mm) as the unlined. For scallops $\geq$ 70 mm, the unlined commercial was only marginally more retention efficient (8%, $\bar{N}$ = 637 vs 592) but resulted in an increased total yield of 10% by weight (6694 vs 6115 g, (Table 9). Actual retention rates for the commercial gear would be somewhat higher as fishermen usually tow to saturation. Retention ratios greater than 1.0 were observed in 77-100 mm range. Values for selectivity ogives exhibited a downward trend beyond the size where 100% retention was attained. A similar phenomenon was reported by Serchuk and Smolowitz (1980) for a 2.44 m research scallop dredge for the capture of Placopecten magellanicus. Research and commercial shell-height frequencies are compared in Fig. 11.

First fully vulnerable age group to commercial gear is 8 yrs (Fig. 10). It is apparent as well that the better research-gear estimate of to-be recruited year-class strength is based on 7 year olds since 6-ring scallops (61 mm) are only fractionally retained by the gear.

Because of the type of bottom commonly encountered in the northern Gulf fishery, the configuration of the rings itself is subject to change with fishing (Table 10). This is usually manifested by elongation of rings in the direction of tow and sometimes oblique to it. This departure from the near-circular configuration is problematic from the point of gear selectivity. As meshes become clogged with tow distance, most escapement must take place during the first few minutes of a tow. Typically, the longer the tow, the more tenuous becomes the relationship between escapement and mesh size, especially when the total capacity (volume) of each individual dredge is considered. Some, if not most escapement beyond a critical tow distance, must occur by accident (gear behavior on bottom) rather than by gear selection per se. As buckets become filled, the induced hydrodynamics of the water mass immediately preceding the moving dredge must also change, 'preselecting' sizes and weights of objects (including scallops) that enter it. Larger, heavier scallops in the path of such a dredge are more likely to gain entrance than smaller ones. This may explain the higher efficiency of commercial gear in retaining greater numbers of commercial-sized scallops. The few prerecruits that do gain entrance, of course, have a greater probability of escapement. This preselection is particularly critical for lined gear as it tends to fill up more rapidly than the unlined. For the tow duration used in our research surveys, however, the problem is not critical.

It should be noted that the 50% selection point for the dredge now in use in the commercial fishery (70 mm) is greater than the theoretical diameter of dredge rings (64 mm) which are variously linked with washers (usually two). This indicates that both the stretched configuration of the mesh (Table 10) and the inter-ring spaces feature prominently in selection.

No data are available for efficiency of capture of this species with Digby buckets. A maximum efficiency of 20% is assumed in this study.

Commercial Age Frequencies

Monthly comparisons of scallop age frequency landed in 1980 and 1981 (Tables 11, 12) show that 9 and 10 year olds represent some 45% of all scallops landed. This catch composition was maintained through both seasons. The numerical superiority of these age groups in two successive years is suggestive of good recruitment and reflects fleet-mobility. Nearly 80% of all scallops landed in the two years combined consisted of age groups 8 to 11 (Fig. 10). While older scallops are still represented in the catches it is evident that much of the harvested biomass is from recruitment during and immediately following the first fishing pulse. The 15+ age group in both research and commercial catch samples consists of a mixture of year-classes and therefore contains more individuals than the group immediately preceding it.

Research Age Frequencies

Apart from the better representation of pre-recruit age groups (≤ 7), research vessel age frequencies are not unlike those obtained from commercial catches, but with ages 8 and 9 being most abundant (Fig. 10). Relative abundance of prerecruits to recruits suggests that recruitment has not been subject to wild fluctuations as has often been reported for the giant or sea scallop (Dickie 1955). Prerecruits are moderately (Transects 2, 4, 7, 8, 10 and 11) to well represented (Transects 1, 3, 5, 6 and 9) in the survey area (Tables 13, 14 and 15), pointing to regular recruitment since production peak in 1972-73.

Natural Mortality

Natural mortality was computed directly from the percent occurrence of cluckers (persistent paired valves still attached at the hinge line) that died from natural causes according to the equation:

$$a = 1-e^{-\left(\frac{c}{t}\right)\left(\frac{1}{L}\right)365}$$

where a is the natural mortality rate, c is the number of cluckers in a sample, L is the number of live scallops in the same sample, and t is the average time in days required for the valves of cluckers to separate naturally. Time required for natural clucker disarticulation (210.8 days) is that determined experimentally by Mercer (1974). The age-length key developed in this study was used to determine clucker ages at given shell heights and age-specific natural mortality rates calculated. These were computed separately for the two years (Table 16). Except for the 15+ age group, the rates so calculated were substantially lower during the second year of the survey. An analysis of covariance of the logarithmic transformations of M on age (Fig. 12) pointed to no significant differences in slopes ($P < 0.05$) but elevations were different ($P < 0.01$). The significant difference in the observed rates is probably an indication of the extent of indirect fishing mortality associated with repetitive tows in areas where significant fisheries occur for the mollusc. During the current pulse there has been a tendency for the fleets to move south particularly during 1981. In reality boats have moved away from areas of heavy exploitation into new, virgin grounds. The observed mean difference in the average mortality rates between the two years may be considered to be a first estimate of indirect fishing mortality, albeit provisional.

Fishery effort and landings

Annual landings (Table 17) have shown wide fluctuations. There is very little detailed information on fishery performance from the 1969-73 period. Mean annual catch from the second pulse (1979-81) is slightly above the average reported for the first (936 vs. 845 MT). Since nearly all the catch is sold to registered buyers, data on total landings by month for 1974, 1979, 1980 and 1981 are considered quite accurate (Tables 19-22). Effort levels have been quite variable (Tables 23-26) and appear to have caused the reported fluctuations in monthly and annual landings. There appears to be little doubt that the initial surge in landings in 1972 and 1973 was related to the changeover from 3.0 to more retention-efficient 2.5 in rings in a developing fishery.

Little is known of total fleet behavior during the 1969-73 period. Anecdotal information suggests that some boats operated in a fairly restricted general area whereas others moved as they fished out local concentrations. If this is indeed true, it is likely that boats still using the 3 in mesh were the ones that had to move about locating and removing concentrations of accumulated older (> 90 mm) scallops. Substantial quantities of scallops in the 70-90 mm range that would have escaped the 3 in gear would have been still available for capture by boats using dredges equipped with 2.5 in rings.

Voluntary logs were introduced into the fishery in 1980 (Fig. 13). To improve completion rate and ensure continued cooperation in completing logs, catch summaries were sent to individual fishermen. Only data relevant to the boat were provided. This feedback has been quite positive. Quality of catch and effort data has improved. In 1980, for example, because of variable reporting, only number of days fished could be used for effort. In 1981, however, information on numbers of hours fished is also available. More precise locational information is also being made available in contrast to 1980, where areas fished would be recorded simply as 4 mi NW of Anchor Point, etc.

No attempt has been made to either standardize vessels by size (42 to 55 ft range) or by gear (4 to 6 Digby buckets, the majority, 75%, using 5). The use of numbers of days fished is the only effort measure available and is fraught with difficulties. Neither the length of day nor the quality of the expended effort remain constant. In an attempt to remove some of these variables, we examined behavior of both the total fleet (Tables 27-30) and the core fleet (Tables 31-35), the latter consisting only of the more experienced vessels that enter the fishery early in spring and remain scalloping through the fall. Contributions to total catch notwithstanding, the core fleet should give a better idea of how CPUE has changed, if any, between and within seasons. Using such effort data as are available it is apparent that total effort by the core fleet increased by a factor of 1.9 and 1.2 in 1980 and 1981 resulting in 2.5 and 1.4-fold increases in landings (Table 17). Although catches have kept pace with effort, CPUEs for the core fleet increased by a factor of 1.3 in 1980 and suffered a 10% drop in 1981, but remained slightly above the 3 yr average of 2564 lb (round)/day. Monthly CPUE within the fishing season shows a decreasing pattern. From a usually sluggish start (first month), monthly catch/boat day for the fleet, for nearly every year for which data are available, increases to June/July, thereafter decreasing variously to record lows for the year. While weather and length of day may be factors at the start and termination of fishing seasons, it is difficult to explain the decreasing trend during the June-September period. Areas fished by the fleet in 1981 (Fig. 14, Table 36) and catch/tow and catch/hr of two boats with excellent logs (Table 37) were examined in detail. It is clear that the fleet operates farther from home ports during the long summer days and tends to shift to more readily accessed, even if less productive beds, later in the season (Table 38). In 1981, fishing was mostly directed in Sectors B, C and D (Fig. 14). Within these, approximately 66% of effort was in a 5 mi zone extending 10 to 15 mi W to NNW of Anchor Point. As is noted later, many boats operating out of Black Duck Cove shift from landing scallops in-the-shell to shucked meats around August. The additional work involved with manual shucking on board may well affect total quantity of scallops caught. There is very little culling at sea. Neither the mean shell height nor the mean meat count/lb between the two years for which detailed data are available (Table 18) show a pattern to suggest the exploitation of smaller scallops. Dispersal in *Placopecten* has been suggested as a factor contributing to reduced seasonal catchability (Jamieson 1980). A similar explanation in *Chlamys* would be somewhat less plausible on account of its reduced mobility, particularly of the commercial-sized animals. While it is difficult to isolate the cause(s) for the observed decreases in monthly CPUE, we must take a conservative approach and assume that localized stock depletion related to fishing is taking place, resulting in reduced availability and fleet movements.

The scallop fishery in this area has a very complex socio-economic base. In 1980 scallop prices on the island-side of the Strait of Belle Isle were stable ($3.25 meats/23¢ round at Fisheries Products in Black Duck Cove, $3.30 at T. J. Hardy Ltd. in Anchor Point) from the beginning of the fishing season (April) until the FPU strike in mid-July, during which both plants were closed. At this time Walter Biggins Ltd. of Port Saunders set up a freezer truck at Anchor Point and became the only purchaser of scallops (at $3.40). With the end of the strike in late August, both plants reopened. During the following two weeks all three buyers started raising prices. By the first week of September, T. J. Hardy Ltd. had ceased buying scallops, and prices had stabilized with the other buyers ($4.30/30¢ at Fisheries Products, $4.30 at Walter Biggins Ltd.). In early October, Biggins again raised his price, so that at the end of the season fishermen were receiving $4.50 from Walter Biggins Ltd. and $4.30/30¢ from Fisheries Products Ltd.

Black Duck Cove fishermen generally patronize their community fish plant (Fisheries Products Ltd.), landing mostly shell-on until late August when they begin shucking the animals themselves. This strategy allows members of the family to be gainfully employed as shuckers at the fish plant and facilitate the collection of UIC benefits during the ensuing winter. As soon as these benefits are secured fishermen begin to shuck scallops to improve the profit margin and boost incomes (assuming 100 lb round yields 11 lb meat, at a price of $4.30/30¢ 100 lb round = $30.00, while 11 lb meat = $47.30).

Anchor Point fishermen land some scallops shell-on at Black Duck Cove, but by and large land meats only. Prior to the strike they landed meats at T. J. Hardy Ltd. in Anchor Point, switching to Walter Biggins Ltd. for the remainder of the season.

Labrador fishermen landed only meats, selling to Northern Fisheries Ltd. of Lanse au Loup (at $3.30) for most of the season. In mid October, Walter Biggins

Ltd. arrived and started paying $4.40; this price held until the end of the season (mid-November). With the arrival of Walter Biggins Ltd., Northern Fisheries Ltd. ceased purchasing scallops.

During 1981 prices paid to island-based fishermen started high, and gradually declined over the course of the season. All three buyers from the previous years were again buying scallops at the start of the 1981 season ($4.70/35¢ at Fisheries Products Ltd. in Black Duck Cove, $4.75 at T. J. Hardy Ltd. and $4.70 at Walter Biggins Ltd., both in Anchor Point). By early May T. J. Hardy had discontinued buying and the others had started dropping their prices, so that by early June prices stood at $3.90/28¢ at Fisheries Products Ltd. and $4.05 at Walter Biggins Ltd. Following further reductions during July and August, prices stabilized in mid-August ($3.35 at Fisheries Products Ltd. and $3.40 at Walter Biggins Ltd.) and these remained in effect for the rest of the season.

As in 1980, Black Duck Cove fishermen sold their catch primarily to Fisheries Products Ltd. Again the catch was landed mainly shell-on until August, at which time they switched to landing meats. Starting in August, two boats began regularly selling to Walter Biggins Ltd. as he was buying meats with the catch muscle attached without price differential.

Most Anchor Point fishermen started selling to T. J. Hardy Ltd. When T. J. Hardy stopped buying in May, they sold their catch to Walter Biggins Ltd for the remainder of the season.

The Labrador season started in May, with Walter Biggins Ltd. being the only buyer ($4.10). In late May, Southern Labrador Fisheries Ltd. of Forteau started operation, buying both shell-on and meats ($4.00/28¢). Walter Biggins Ltd. stopped buying at this point because the fishermen started selling shell-on in an effort to provide employment for shuckers at the plant. For the remainder of the season Southern Labrador Fisheries Ltd. was the only buyer. Over the season the price for meats dropped to $3.75 while the price for shell-on rose to 30¢.

Labrador fishermen landed mainly shell-on for the whole season. In August the island fishermen started sending their meats to Southern Labrador Fisheries Ltd. to take advantage of the higher price. But the Labrador plant was mainly interested in buying shell-on in order to provide employment so they lowered the price for meats while at the same time raising the price for shell-on scallops. This had the effect of discouraging the island fishermen from selling meats there, while at the same time ensuring that Labrador fishermen landed their scallops shell-on.

Yield per recruit considerations

Adductor muscle weights at age were used to determine yield (kg) per 10,000 recruits for varying levels of F as in Thompson and Bell (1934). A family of yield curves were generated for t_p' between 6-12 yrs and varying rates of natural mortality (Table 16). All curves were essentially flat-topped and showed asymtotic yields as $F \rightarrow \infty$ (Fig. 15). Mean age at first capture (t_p') appears to be between 6 and 7 yrs, but it is apparent that scallops are not fully recruited until 8. Knife-edge recruitment has been assumed to occur at this age.

Estimates of annual $\bar{Z}$ for the 1980-81 period (Table 39) show F to increase with age with a weighted mean at $\bar{Z} = 0.74$, corresponding to an F of 0.59. This increase is probably related to the observed increase in natural mortality (M) with age. Senescence alone cannot explain the high M values associated, particularly with the fully recruited commercial sizes ($\geq$ 8 yrs). It is suggested that fishing itself contributes substantially to the higher total mortalities with age. Allowing for the indirect fishing mortality earlier estimated at 0.067, we approximate F at 0.52. Predicted yield per 10,000 recruits at this level of F is between 76 and 85 kg ($\bar{x}$ = 81 kg) close to the $F_{0.1}$ yield. Observed performance in the fishery in terms of yield is higher at 99 kg/10,000 recruits. This corresponds to a predicted meat count (muscle-on) of 55 per lb (121/kg) versus a realized yield of 46 meats/lb (100/kg; Table 18); i.e. present performance is greater than would be expected under equilibrium conditions. Numerical values notwithstanding, this is suggestive perhaps of the yet continued availability in this fishery of pockets of virgin biomass for first exploitation.

The yield equation is an explicit long-term representation of a fishery between yield and fishing activity and assumes equilibrium conditions. In fact changes in both gear selectivity and fishing effort have occurred and it would take several years of continued exploitation before steady-state conditions are attained, if indeed the fishery continues on a sustained rather than periodic basis. Yield per recruit considerations must therefore be viewed with caution in assessing the status of this non-stabilized fishery.

Discussion

The problems of enumerating populations from research-vessel surveys is not new in fisheries literature. In this study two major considerations in biomass estimation have been knowing the efficiency of the sampling gear and exact distribution of the target species. An attempt has been made to take the latter into consideration by limiting our surveys to the area delineated by the fishery itself. When surveys must cover large areas, stratified random designs are used with some arbitrary ranges of depths usually used as the stratifying variable. The presence of autocorrelation (the observation that samples taken close together in space are more likely to be similar than samples taken farther apart) in these types of surveys is usually ignored due to temporal changes affecting the spatial patterns in the case of mobile species and/or because samples are spaced at sufficiently large distances to reduce the effect of autocorrelation on variance estimates. For small-scale surveys of sedentary species where samples may be drawn very close, the degree of autocorrelation can have an effect. The sampling scheme used in our surveys provided the optimum design with respect to minimum variance (Smith and Naidu 1981). The problem of gear efficiency and selectivity is somewhat problematical, particularly in relation to the demonstrated instability associated with mesh size. Performance of gear is influenced by many variables including scope, slope, relative velocity of gear with current, nature of substrate, and type of bottom. It is likely that relative efficiency in the more northerly transects (Nos. 8 to 11) was higher than in the rougher bottom farther south. Until these factors are taken into consideration all estimates of biomass should be considered measures of relative rather than absolute biomass. Little is known on the locomotory abilities in *Chlamys*. For comparable sizes it is probably a less efficient swimmer than *Placopecten*.

The age matrix developed for scallop ages is suggested to be more realistic than conversions from mean-size-at-age data using von Bertalanffy growth parameters. The method used in this paper at least partly addresses the problem of laminating shells and, more importantly, factors variance in size-at-age, thus minimizing errors in conversion from size to age.

While the assessment is based on an admittedly short data series, it is apparent that in spite of increased landings in the last three years, predicted by one of us (Anon. 1981), and the marginal drop in overall CPUE in 1981, the likelihood of a major stock decline is minimal. While some seasonal decrease in CPUEs is evident, overall CPUEs have been maintained. Resource surveys in both 1980 and 1981 indicate fairly stable levels of recruitment. Because of the relatively high abundance of prerecruits, particularly of 6 and 7 year olds, whose abundance is known to be underestimated by the sampling gear, sufficient biomass within the area presently fished is available to provide continued stability to the landings over the next few years. Nine- and ten-year-olds will continue to be the mainstay of the fishery for yet another year or two. The availability farther south of yet-to-be exploited patches of accumulated virgin or recovered biomass would tend to add additional stability to the fishery. Fishery performance is likely to depend on total effort expended in relation to the abundance and availability of other exploitable species as and when they become available. Some effort diversion into fin-fish species, particularly cod, may be occurring this year. A decrease in landings could therefore result. On the other hand the failure of the Georges Bank fishery may prove providential to scallop fishermen here and elsewhere as scallop prices will tend to be quite firm through 1982. The present limited-entry designation in this fishery for boats exceeding 35 ft (11 m) with a provision for its utility would appear to provide the necessary check on explosive and sudden surges in effort as was evident during the first pulse. Additional restrictions might prove overly restrictive at this time. A management strategy based on effort regulation is probably more appropriate in an expanding fishery than catch limitations, particularly in that variations in production cannot be narrowly predicted.

As there is very little culling at sea the introduction of a meat count will have very little effect unless regulation mesh size is simultaneously increased. In any case this could be complicated by a pattern now well established in the fishery whereby boats are landing both meats and scallops in the shell, a strategy with immense socio-economic ramifications.

The following management options are recommended:

1. Efforts should be made to establish a Northern Gulf Scallop Advisory Committee to optimize management of the fishery.

2. The pursuit of a multi-species stock management strategy should be examined.

3. Pulse fishing is a form of voluntary closure that should not be discouraged, but perhaps formalized.

4. Promote measures to encourage fuller utilization of the Iceland scallop. A meat/roe fishery could result in a 50% increase in yield with only a marginal increase in effort. A somewhat persuasive argument may be advanced on this option by virtue of the fact of it being a day fishery.

5. Protection of prerecruits until they reach harvestable sizes and reducing loss through indirect fishing mortality should be legitimate management concerns.

6. With a prototype shucking machine now ready for field testing its introduction into the fishery appears imminent. It is recommended that such introductions be delayed until their impact on the total fishery is fully assessed.

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Table 1. Iceland scallop landings from the northeastern Gulf of St. Lawrence.

Year	Round lbs	Round MT	Meats lbs		Meats MT
1969	494,118	224	50,400		22.9
1970	382,352	173	39,000		17.7
1971	333,333	151	34,000		15.0
1972	5,161,764	2,342	526,500		238.9
1973	4,354,225	1,975	444,131		201.5
1974	485,805	220	52,583		23.9
				$\bar{x}$(1969-74)	86.7
1979	894,521	406	91,278		41.4
1980	2,252,580	1,022	229,855		104.3
1981	3,042,340	1,380	310,442		140.8
				$\bar{x}$(1979-81)	95.5

Table 2. Results of Iceland scallop surveys in the northeastern Gulf of St. Lawrence in 1980 and 1981 (from Naidu and Smith, 1982).

	1980	1981
A. Numbers		
$\bar{Y}st$	97.9	126.3
Vsy	55.8	46.3
S.E. ($\bar{Y}st$)	7.47	6.80
95% C.I. for mean	83.0-112.9	112.6-139.8
MIB (nos)	28.5 m	36.7 m
B. Weights		
$\bar{Y}st$	8.48	10.32
Vsy	0.195	0.328
S.E. ($\bar{Y}st$)	0.441	0.572
95% C.I. for mean	7.60-9.36	9.20-11.43
MIB (MT)	2,465	3,000
At 15% gear efficiency (MT)	16,436	20,002
At 20% gear efficiency (MT)	12,326	15,001

Table 3. Summary of back measurements of size-at-ring formation for 284 scallop shells taken in 1980.

Ring no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mean size (mm) (tangential dorso-ventral distance)	6.8	14.5	24.4	36.1	47.8	58.1	66.5	72.7	77.5	81.8	85.0	87.0	89.3	90.8
No. measurements	256	284	284	284	284	276	266	250	205	125	76	43	18	7
S.D. mean	1.6	2.9	4.3	5.3	5.7	5.6	5.6	5.4	5.5	5.7	5.2	5.2	5.3	5.1

Table 4. Summary of von Bertalanffy growth parameters for Iceland scallops from (a) northeastern Gulf of St. Lawrence and (b) St. Pierre Bank (for stratum codes see T. K. Pitt, 1976).

	Stratum	Depth (fms)	N	L∞	K	t_0
Northeastern Gulf of St. Lawrence			285	107.3	0.149	0.888
St. Pierre Bank	314	0-30	69	109.9	0.181	0.380
	320	0-30	50	106.5	0.203	0.367
			119			
	312	31-50	44	93.5	0.177	0.242
	315	31-50	40	92.4	0.173	0.174
	321	31-50	26	89.6	0.174	0.345
	325	31-50	42	102.0	0.126	0.148
			152			
	317	51-100	5	96.6	0.173	0.478
	319	51-100	5	89.9	0.166	0.239
	322	51-100	35	85.9	0.153	0.159
	323	51-100	5	97.1	0.131	0.100
	324	51-100	13	114.0	0.120	0.051
			63			

Table 5. Mean shell heights (mm) by transects (from 1980 MARINUS survey data).

Transect No.	N	Mean (mm)
1	1037	76.6
3	1806	78.9
4	629	78.0
5	1261	79.0
6	947	76.3
7	786	76.8
8	1273	79.7
9	845	81.4
10	939	84.7
11	419	83.0
Totals	9942	79.2

Table 6. Mean adductor muscle weight at age of northeastern Gulf Iceland scallops.

Age (yr)	Mean shell height (mm)	Mean adductor muscle wt (gm) (quick + catch fractions)
1	9.08	0.02
2	22.61	0.26
3	34.42	0.87
4	44.52	1.81
5	53.22	3.02
6	60.72	4.39
7	67.17	5.85
8	72.73	7.34
9	77.52	8.81
10	81.65	10.21
11	85.20	11.53
12	88.26	12.75
13	90.89	13.86
14	93.16	14.87
15	95.12	15.78

Table 7. Seasonal regressions of mean adductor muscle weight (g) on shell height (mm) for Gulf scallops (1981 data).

Month	N	Regression	r^2
April	69 (25)	$\log y = 2.12 \log x - 3.05$	0.927
May	146 (33)	$\log y = 1.97 \log x - 2.78$	0.882
June	102 (32)	$\log y = 2.29 \log x - 3.36$	0.963
July	156 (35)	$\log y = 2.24 \log x - 3.27$	0.973
August	140 (35)	$\log y = 2.47 \log x - 3.70$	0.960

Table 8. Relationship between size of scallops, proportion of those entering drags which are retained by 3 in. (76 mm) rings in the northeastern Gulf of St. Lawrence. (Based on 31 tows made by M.V. Harengus Cruise No. 116, 1974, under the direction of M. C. Mercer).

Shell height	Covered gear A Dredges + covers	Covered gear B Covers	Covered gear C Dredges	Uncovered Gear Totals D	% retention covered (C as % of A) E	% retention uncovered (D as % of A F
0-4.9						
5.0-9.9						
10.0-14.9	2	1	1		50.0	
15.0-19.9	0	0	0		-	
20.0-24.9	2	2	0		0.0	
25.0-29.9	6	6	0		0.0	
30.0-34.9	19	19	0		0.0	
35.0-39.9	26	23	3	1	11.5	3.8
40.0-44.9	43	34	9	0	20.9	0.0
45.0-49.9	53	42	11	0	20.8	0.0
50.0-54.9	70	56	14	1	20.0	1.4
55.0-59.9	127	94	33	0	26.0	0.0
60.0-64.9	172	119	53	2	30.8	1.2
65.0-69.9	237	155	82	13	34.6	5.5
70.0-74.9	295	173	122	21	41.4	7.1
75.0-79.9	461	205	256	53	55.5	11.5
80.0-84.9	475	137	338	101	71.2	21.3
85.0-89.9	280	47	233	120	83.2	42.9
90.0-94.9	105	9	96	74	91.4	70.5
95.0-99.9	13	1	12	10	92.3	76.9
100.0-104.9	1		1	1	100.0	100.0
105.0-109.9	1		1		100.0	
Totals	2388	1123	1265	397		

Table 9. Relationship between size of scallops, proportion of those entering drags which are retained by 2.5 in. (64 mm) rings in the northeastern Gulf of St. Lawrence. (Based on 14 tows made by M.V. Harengus Cruise No. 116, 1974, under the direction of M. C. Mercer).

	Covered gear			Uncovered	% retention covered	% retention uncovered
	A	B	C	gear	(C as	(D as
Shell height	Dredges + covers	Covers	Dredges	totals D	% of A) E	% of A F
0-4.9						
5.0-9.9						
10.0-14.9						
15.0-19.9						
20.0-24.9	1	1				
25.0-29.9	4	3	1		25.0	
30.0-34.9	7	7	0	1	0.0	14.3
35.0-39.9	8	7	1	0	12.5	0.0
40.0-44.9	19	16	3	1	15.8	5.3
45.0-49.9	17	9	8	3	47.1	17.6
50.0-54.9	43	24	19	3	44.2	7.0
55.0-59.9	47	23	24	9	51.1	19.1
60.0-64.9	72	47	25	15	34.7	20.8
65.0-69.9	81	36	45	31	55.6	38.3
70.0-74.9	116	21	95	80	81.9	69.0
75.0-79.9	145	5	140	175	96.6	120.7
80.0-84.9	157	1	156	194	99.4	123.6
85.0-89.9	103		103	109	100.0	105.8
90.0-94.9	60		60	68	100.0	113.3
95.0-99.9	9		9	10	100.0	111.1
100.0-104.9	2		2	1	100.0	50.0
105.0-109.9						
Totals	891	200	691	700		

Table 10. Altered ring sizes (mm) in a 64 mm (2.5 inch) mesh Digby bucket used in the Gulf fishery (based on 20 paired measurements, 10 from each 'top' and 'bottom' of dredge).

	N	Range	Mean	S.D.
Minimum diameter	20	43-64	57.5	4.9
Maximum diameter	20	64-86	72.5	5.1

Table 11. Estimated monthly age-specific scallop numbers at age in the commercial catch in 1980.

Age	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Cumulative
1									
2									
3									
4				2,874					2,874
5				-	2,022				2,022
6	3,218	16,431	20,287	28,720	20,218	17,644	27,650	1,082	135,250
7	29,884	152,559	134,412	192,421	113,233	126,203	141,493	5,524	895,729
8	82,755	422,467	393,093	496,843	293,187	291,761	356,175	13,901	2,350,182
9	121,370	619,614	608,660	717,984	469,102	359,608	458,636	17,902	3,372,876
10	97,005	495,221	547,792	605,977	444,840	264,620	312,263	12,188	2,779,906
11	68,044	347,358	385,488	410,688	313,406	161,485	190,286	7,426	1,884,181
12	36,782	187,762	238,393	241,240	179,954	90,920	100,834	3,936	1,079,821
13	13,795	70,412	114,125	100,518	97,053	32,571	30,898	1,207	460,579
14	4,596	23,469	30,431	34,462	34,371	6,785	6,508	256	140,878
≥15	1,840	9,386	60,868	40,209	54,595	4,074	-	-	170,972
Totals	459,289	2,344,679	2,533,549	2,871,936	2,021,981	1,355,671	1,624,743	63,422	13,275,270

Table 12. Estimated monthly age-specific scallop numbers at age in the commercial catch in 1981

Age	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Cumulative
1									
2									
3									
4									
5					3,155				3,155
6	6,740	19,004	95,993	69,044	53,667	24,877	12,918		282,243
7	45,152	186,260	443,974	282,743	372,522	242,560	125,960		1,699,171
8	109,172	554,984	931,945	667,395	801,866	646,818	335,891		4,048,071
9	169,152	836,280	1,083,933	910,685	924,991	880,045	457,007		5,262,093
10	140,850	824,875	727,954	598,357	542,996	628,159	326,203		3,789,394
11	99,068	646,218	411,974	384,659	271,498	379,381	197,014		2,389,812
12	62,000	361,120	211,989	233,424	135,753	183,473	95,274		1,283,033
13	20,219	205,270	71,998	75,617	34,729	80,856	41,989		530,678
14	6,740	53,216	15,997	26,299	12,628	24,877	12,918		152,675
≥15	14,824	117,837	-	42,738	-	21,768	11,303		208,470
Totals	673,917	3,805,064	3,995,757	3,290,961	3,153,805	3,112,814	1,616,477		19,648,795

Table 13. 1980 age composition (%) by transect using covered gear (Marinus 027/1980).

Age	Transect Numbers 1	2	3	4	5	6	7	8	9	10	11
1	0		0	0.3	0	0	0	0.2	0	0.1	0
2	0.2		0.1	0.2	0	0.1	0.1	0	0	0.2	0
3	0.3		0.3	0	0.1	0.2	0.1	0.2	0	0.4	1.2
4	0.4		0.8	1.3	0.6	0.6	0.5	0.1	0.5	0.7	1.2
5	1.4		1.8	3.5	1.3	0.8	1.0	0.5	0.9	0.5	1.2
6	3.3		2.8	3.0	4.0	5.0	3.4	2.0	2.1	1.4	0.7
7	12.7		9.3	9.2	10.9	14.1	13.0	8.9	6.4	3.6	5.0
8	23.4		19.5	19.2	18.9	23.9	24.6	19.7	16.4	10.5	10.8
9	26.6		24.3	21.3	22.6	24.7	26.2	26.4	24.0	18.5	19.6
10	16.3		18.4	17.3	17.5	14.9	15.6	19.3	20.8	20.9	22.5
11	8.8		11.5	10.8	12.3	8.6	8.8	12.3	14.6	17.4	17.2
12	4.3		6.7	6.5	6.7	4.8	4.7	6.4	8.5	13.0	10.5
13	1.4		2.7	2.9	2.6	1.5	1.5	2.8	3.4	8.0	5.3
14	0.5		1.0	0.6	1.5	0.6	0.3	0.9	1.3	3.8	3.8
15	0.1		0.7	0.8	1.0	0.2	0.1	0.3	1.2	0.9	1.0

Table 14. 1981 age composition (%) by transect using covered gear (Marinus 038/1981).

Age	Transect Numbers 1	2	3	4	5	6	7	8	9	10	11
1	0.1	0	0.1	0.3	0.1	0	0.1	0	0.1	0.1	0
2	0.1	0	0.1	0	0.1	0	0.1	0.2	0.2	0.1	0
3	0.1	0	0.1	0	0	0.1	0.5	0	0	0	0
4	0.5	0.3	1.1	0	0.4	0.2	0.4	0.2	0.1	0.3	0.7
5	1.1	0.9	2.5	1.1	1.2	1.7	2.2	0.2	0.6	1.0	0.3
6	3.3	3.0	3.9	2.0	3.7	3.1	2.0	0.8	4.1	2.2	1.4
7	12.3	10.8	12.3	8.3	11.8	10.4	6.1	5.4	16.7	7.4	5.9
8	24.4	22.6	21.8	17.7	22.3	20.7	15.5	15.6	29.0	18.4	11.0
9	26.5	26.2	24.6	22.9	25.1	24.2	23.4	25.0	26.1	25.5	21.4
10	16.2	18.1	15.6	20.6	16.7	17.8	20.7	22.0	13.8	20.3	23.8
11	9.1	10.0	9.3	12.9	10.1	11.5	14.3	15.3	5.9	12.7	16.6
12	4.4	5.2	5.1	8.0	5.5	6.2	8.5	8.0	2.8	7.1	16.0
13	1.4	1.9	2.1	3.9	1.9	2.5	3.8	4.5	0.6	2.7	5.2
14	0.4	0.6	0.9	1.7	0.8	0.8	2.0	1.3	0.1	1.0	2.4
15	0.2	0.4	0.4	0.5	0.2	0.8	0.4	1.4	0	1.0	0.3

Table 15. Pre-recruit abundance in 1980 and 1981.

Transect no.	1980		1981	
	No. <70 mm	% composition	No. <70 mm	% composition
1	126	12.2	256	10.8
2	-	-	471	9.3
3	186	10.3	175	14.9
4	79	12.6	48	7.5
5	166	13.2	198	11.9
6	151	16.0	195	10.9
7	87	11.1	61	8.2
8	81	6.4	20	3.2
9	50	5.9	218	15.4
10	46	4.9	79	6.8
11	28	6.7	14	4.8
Totals	1,000		1,735	
Overall percent composition		10.1		10.2

Table 16. Age-specific natural mortality rates computed from clucker-live scallop frequencies for 1980 and 1981.

Age	1980	1981	Mean
4	.0543		
5	.0785	.0753	.0769
6	.1447	.0934	.1191
7	.1163	.0848	.1006
8	.1287	.0881	.1084
9	.1475	.1019	.1247
10	.1892	.1289	.1591
11	.2162	.1567	.1864
12	.2762	.1924	.2343
13	.2678	.2388	.2533
14	.4075	.3213	.3644
15	.1344	.1457	.1400

$\overline{M}_{(5-14)} = 0.1740$ $\quad\quad$ $\overline{M}_{(5-14)} = 0.1178$

$\overline{M}_{(1980,\ 1981)} = 0.1390$

Table 17. Catch (lb) and effort (boat days) in the *Chlamys* fishery in the Gulf of St. Lawrence.

Year	No. Boats actively fishing	Landings (total)	Landings (core)	Effort (total)	Effort (core)	CPUE (total)	CPUE (core)
1969		494,118					
1970		382,352					
1971		333,333					
1972		5,161,764					
1973		4,354,225	753,363		325		2,322
1974	24	485,805	261,047	269	151	1,809	1,735
1979	16	894,521	842,151	459	387	1,949	2,176
1980	14	2,252,580	2,084,166	774	720	2,910	2,897
1981	24	3,042,340	2,337,436	1262	893	2,412	2,619

Table 18. Meat counts (lbs. muscle off) and mean shell-heights (mm) in the northeastern Gulf Iceland scallop fishery, 1980/81.

Date	N (scallops)	$\bar{x}$ shell height (mm) ± 1 S.D.	N (meats)	Weight (lb)	Meat count /lb.
1980					
29 May	923	81.7 ± 6.1	843	16.0	52.7
17 June	1,187	82.9 ± 6.7	6,000	123.3	48.7
2 July	1,707	82.4 ± 6.7	4,000	81.0	49.4
30 July	386	79.7 ± 6.8	500	9.8	51.3
28 Aug.	863	83.3 ± 7.4	2,000	42.0	47.6
27 Sept.	614	80.0 ± 6.0	4,000	76.3	52.5
16 Oct.	515	79.6 ± 5.7	4,000	71.0	56.3
Totals	6,195	81.8 ± 6.7	21,343	419.4	50.9
1981					
9 April	406	82.6 ± 7.0	-	N/A	-
12 May	577	83.9 ± 6.7	2,000	42.8	46.8
13 June	506	78.5 ± 6.0	2,000	36.5	54.8
7 July	523	80.2 ± 6.7	2,000	37.0	54.1
29 July	1404	77.8 ± 5.5	2,000	36.0	55.6
5 Oct.	615	80.4 ± 5.6	2,000	45.2	44.2
Totals	4,031	79.9 ± 6.5	10,000	197.5	50.6

Table 19. Landings (lbs. in shell) of Iceland scallops by month in northeastern Gulf of St. Lawrence, 1974.

Boat	June	July	August	September	October	Total
Belle Isle	7,002	28,124	25,948	10,530	3,865	75,469
Tena	7,209	29,124	27,560	4,248	-	68,141
Eastern Lilly	8,995	6,584	13,395	6,103	10,493	45,570
Donald Bennett	-	4,573	23,857	7,778	-	36,208
Donald L.	2,040	15,481	14,014	4,123	-	35,658
Greenley Island	3,026	6,795	11,755	-	-	21,576
White Foam II	13,197	6,657	-	-	-	19,854
Emily Nadine	-	-	10,180	8,075	-	18,255
Lady Genge	6,175	12,001	-	-	-	18,176
Mary and Beatrice II	5,929	799	1,144	4,517	3,883	16,272
Marie and Donna	13,808	2,360	-	-	-	16,168
Ocean Floor II	-	-	10,939	4,508	-	15,447
Coopers Island	-	-	5,249	8,828	1,183	15,260
Englee Twin Stem	13,300	-	-	-	-	13,300
Northern Peninsula	-	-	2,062	7,026	2,443	11,531
Gulf Stream	11,279	-	-	-	-	11,279
Minnie D.	10,696	-	-	-	-	10,696
Corbett Island	6,936	-	-	-	-	6,936
Anna Mildred	-	-	-	5,350	1,519	6,869
Miss Way	-	-	-	5,306	1,510	6,816
Cape Fare	-	-	2,728	3,585	-	6,313
Lady May	-	-	4,265	-	-	4,265
Cape Harrigan	-	-	2,934	-	-	2,934
Summerville II	-	-	2,812	-	-	2,812
Totals	109,592	112,498	158,842	79,977	24,896	485,805

Table 20. Landings (lbs. in shell) by month of Iceland scallop in northeastern Gulf of St. Lawrence, 1979

Boat	July	August	September	October	November	Total
Minnie D. II	-	20694	29028	46521	12613	108856
Seafisher	19417	38702	17823	20732	9428	106102
Maytag	1250	33932	16502	24720	13799	90203
White Foam II	-	25465	28463	35466	-	89394
Marie and Donna	-	16188	25646	37576	7218	86628
Mauritania	578	26929	18117	13029	13357	72010
Lady Thomas	-	18995	22071	26176	-	67242
Lady Genge	-	16697	17941	22401	8235	65274
Englee Twin Stem	-	13059	14944	26336	-	54339
Emily Nadine	-	17572	16175	18853	-	52600
Early Bird	-	8841	15643	18549	6470	49503
Carol and Susan	-	-	1353	11534	4338	17225
Snowjet	-	-	3422	7005	1604	12032
Miss Pamela	-	910	6956	2410	-	10276
Cape Fare	-	-	-	8501	-	8501
Pamella B.	-	-	3880	456	-	4336
Totals by month	21245	237984	237964	320266	77062	894521

Table 21. Landings (lbs. in shell) by month of Iceland scallop in northeastern Gulf of St. Lawrence, 1980.

Boat	April	May	June	July	August	September	October	November	Boat totals
Minnie D II	21891	65607	58475	67768	46804	27423	22000	-	309968
Maytag	18858	68809	50533	61006	50690	23899	24232	-	298027
Seafisher	5210	56932	45865	49698	46397	20243	18809	-	243154
Lady Genge	5947	56528	41837	47620	45633	21066	20394	-	239025
White Foam II	-	-	56850	60511	51684	23091	26483	-	218619
Mauritania	11955	54258	41939	22812	8069	16765	24658	5506	185962
Marie and Donna	-	-	55812	41749	41017	23681	22505	-	184764
Miss Genge	-	-	22165	50014	38149	21337	20246	4172	156083
Early Bird	-	-	6835	39463	40665	24291	23342	-	134596
Sylvia and Shirley	1117	-	8178	41085	28920	16591	18077	-	113968
Emily Nadine	-	-	44632	32957	-	-	-	-	77589
Anna Mildred	3742	48692	6409	-	-	-	-	-	58843
Admiral Point	-	-	-	-	-	4807	16283	-	21090
Labrador View	-	-	-	-	-	-	10892	-	10892
Totals by month	68720	350826	439530	514683	398028	223194	247921	9678	2252580

Table 22. Landings (lbs. in shell) by month of Iceland scallop in northeastern Gulf of St. Lawrence, 1981.

Boat	April	May	June	July	August	September	October	November	Boat totals
White Foam II	5503	76863	56271	47146	30096	35947	15920	-	267746
Marie and Donna	5130	71490	48590	43357	33104	35484	14722	-	251877
Maytag	24168	52439	45725	32044	27870	38891	22688	-	243825
Minnie D. II	6085	67186	56844	38539	29672	30397	12059	-	240782
Lady Thomas	-	40791	54668	57478	40509	43715	3429	-	240590
Seafisher	14467	53258	46249	26570	23419	32655	23207		219825
Lady Genge	18812	49598	35998	26859	28489	30622	20274	-	210652
Miss'Genge	18514	42066	35399	27555	26661	33854	23515		207564
Sylvia and Shirley	5511	44771	35974	27282	26669	22153	10485		172845
Admiral Point	-	42962	37236	41267	21427	-	-	-	142892
Early Bird	-	-	25642	29766	29778	38065	15587	-	138838
Labrador View	-	34639	38856	32738	20518	-	-	-	126751
Emily Nadine	-	7555	31706	23586	27236	22384	7195	-	119662
Mauritania	7736	38583	22553	-	-	21965	17407	-	108244
Vina Wavey	-	-	-	10236	28376	30739	21748	-	91099
Anna Mildred	9867	46533	11706	-	-	-	-	-	68106
Sher-Li	-	-	5429	24112	15960	12579	8824	-	66904
Mary Louise	-	8169	5169	5941	9569	11745	1488	-	42081
La Tour	-	-	-	2228	9534	12607	10566	-	34935
Angie Louise	-	-	-	-	-	10333	11909	-	22242
Carol and Susan	-	12488	-	-	-	-	-	-	12488
Englee Cruiser	-	-	2074	3395	1498	-	-	-	6967
Wolf Rock	-	-	-	1070	3860	-	-	-	4930
Pamela B.	-	495	-	-	-	-	-	-	495
Total by month	115793	689886	596089	501169	434245	464135	241023	-	3042340

Table 23. Effort (days fished) distribution by month in northeastern Gulf of St. Lawrence, 1974.

Boat	June	July	August	September	October	Total
Belle Isle	4.5	17.5	17	6.5	2.5	48
Tena	4.5	18	16.5	3	-	42
Eastern Lilly	5	3.5	6	4.5	6.5	25.5
Donald Bennett	-	3	11.5	5	-	19.5
Donald L.	1.5	6	6	2	-	15.5
Greenley Island	2	2.5	6.5	-	-	11
White Foam II	4.5	3	-	-	-	7.5
Emily Nadine	-	-	3.5	4.5	-	8
Lady Genge	3.5	7.5	-	-	-	11
Mary and Beatrice II	4	0.5	0.5	2.5	3	10.5
Marie and Donna	5.5	1	-	-	-	6.5
Ocean Floor II	-	-	7	2.5	-	9.5
Coopers Island	-	-	2	4.5	1	7.5
Englee Twin Stem	6	-	-	-	-	6
Northern Peninsula	-	-	1.5	5	1.5	8
Gulf Stream	6	-	-	-	-	6
Minnie D.	4	-	-	-	-	4
Corbett Island	4	-	-	-	-	4
Anna Mildred	-	-	-	4	1	5
Miss Way	-	-	-	3.5	1	4.5
Cape Fare	-	-	1	2	-	3
Lady May	-	-	3	-	-	3
Cape Harrigan	-	-	2	-	-	2
Summerville II	-	-	1	-	-	1
Totals	55	62.5	85	49.5	16.5	268.5

Table 24. Effort (days fished) distribution by month in northeastern Gulf of St. Lawrence, 1979.

Boat	July	August	September	October	November	Total
Minnie D. II	-	7	9	18	6	40
Seafisher	9	16	9	12	6	52
Maytag	1	16	10	13	9	49
White Foam II	-	9	9	14	-	32
Marie and Donna	-	6	9	16	4	35
Mauritania	1	17	10	7	10	45
Lady Thomas	-	7	8	8	-	23
Lady Genge	-	6	11	13	6	36
Englee Twin Stem	-	6	6	12	-	24
Emily Nadine	-	8	7	10	-	25
Early Bird	-	5	8	10	3	26
Carol and Susan	-	-	2	10	3	15
Snowjet	-	-	8	9	2	19
Miss Pamela	-	2	14	4	-	20
Cape Fare	-	-	-	6	-	6
Pamella B.	-	-	10	2	-	12
Totals	11	105	130	164	49	459

Table 25. Effort (days fished) distribution by month in northeastern Gulf, 1980.

Boat	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
Minnie D. II	7.0	15.5	14.5	18.5	15.5	10.0	10.0	-	91.0
Maytag	4.0	17.0	16.5	21.0	18.0	9.0	10.5	-	96.0
Seafisher	2.0	17.0	13.5	20.0	17.5	8.5	8.0	-	86.5
Lady Genge	2.0	17.0	13.0	18.5	18.0	9.5	10.0	-	88.0
Whitefoam II	-	-	15.0	18.0	15.5	8.0	11.0	-	67.5
Mauritania	4.0	14.0	13.5	8.0	3.5	7.5	10.0	2.0	62.5
Marie and Donna	-	-	13.5	11.5	13.0	10.0	9.5	-	57.5
Miss Genge	-	-	10.0	21.5	16.0	10.0	9.5	2.0	69.0
Early Bird	-	-	2.5	15.5	14.0	10.0	9.0	-	51.0
Sylvia and Shirley	0.5	-	3.5	17.0	11.5	8.0	10.0	-	50.5
Emily Nadine	-	-	13.5	10.0	-	-	-	-	23.5
Anna Mildred	1.5	13.5	1.5	-	-	-	-	-	16.5
Admiral Point	-	-	-	-	-	2.0	7.0	-	9.0
Labrador View	-	-	-	-	-	-	5.5	-	5.5
Totals by month	21.0	94.0	130.5	179.5	142.5	92.5	110.0	4.0	774.0

Table 26. Effort (days fished) distribution by month in northeastern Gulf, 1981.

Boat	April	May	June	July	August	September	October	November	Boat total
White Foam II	2.5	19	16.5	13	13.5	16	7.5		88
Marie and Donna	2.5	19	15	13.5	12.5	16.5	8.5		87.5
Maytag	9	17.5	13	12	11	17	13		92.5
Minnie D. II	3	19	16.5	12.5	12.5	15.5	7.5		86.5
Lady Thomas		13	14.5	14	13.5	13.5	1.5		70
Seafisher	7	18	15	11.5	11.5	15.5	13.5		92
Lady Genge	10.5	19	13.5	12	13	16.5	13		97.5
Miss Genge	8.5	16	14	11.5	11.5	16	12		89.5
Sylvia and Shirley	3.5	17	13.5	11.5	13	13.5	6.5		78.5
Admiral Point		14.5	14	15	7.5				51
Early Bird			9.5	11	11	17	11		59.5
Labrador View		12.5	15	11.5	7.5				46.5
Emily Nadine		3.5	12	10	14	16.5	5.5		61.5
Mauritania	4	17	8			12.5	9		50.5
Vina Wavey				7.5	13	17.5	11.5		49.5
Anna Mildred	4.5	17	4.5						26
Sher-Li			3.5	12	10.5	11.5	9.5		47
Mary Louise		7	4.5	4	7	9.5	1.5		33.5
La Tour				1.5	7	8	6		22.5
Angie Louise						7.5	7.5		15
Carol and Susan		5							5
Englee Cruiser			2	3	1.5				6.5
Wolf Rock				1	4				5
Pamela B.		0.5							0.5
Total	55	234.5	204.5	188	195	240	144.5		1261.5

Table 27. Catch (lbs. in shell) per boat day per month in northeastern Gulf of St. Lawrence, 1974.

Boat	June	July	August	September	October	Wt. ave. catch/day
Belle Isle	1556	1607	1526	1620	1546	1572
Tena	1602	1618	1670	1416	-	1622
Eastern Lilly	1799	1881	2233	1356	1614	1787
Donald Bennett	-	1524	2075	1556	-	1857
Donald L.	1360	2580	2336	2062	-	2301
Greenley Island	1513	2718	1808	-	-	1961
White Foam II	2933	2219	-	-	-	2647
Emily Nadine	-	-	2909	1794	-	2282
Lady Genge	1764	1600	-	-	-	1652
Mary and Beatrice II	1482	1598	2288	1807	1294	1550
Marie and Donna	2511	2360	-	-	-	2487
Ocean Floor II	-	-	1563	1803	-	1626
Coopers Island	-	-	2625	1962	1183	2035
Englee Twin Stem	2217	-	-	-	-	2217
Northern Peninsula	-	-	1375	1405	1629	1441
Gulf Stream	1880	-	-	-	-	1880
Minnie D.	2674	-	-	-	-	2674
Corbett Island	1734	-	-	-	-	1734
Anna Mildred	-	-	-	1338	1519	1374
Miss Way	-	-	-	1516	1510	1515
Cape Fare	-	-	2728	1793	-	2104
Lady May	-	-	1422	-	-	1422
Cape Harrigan	-	-	1467	-	-	1467
Summerville II	-	-	2812	-	-	2812
No. of boat days	55	62.5	85	49.5	16.5	268.5
Mean catch/boat day	1993	1800	1869	1616	1509	1809

Table 28. Catch (lbs. in shell) per boat day per month in northeastern Gulf of St. Lawrence, 1979.

Boat	July	August	September	October	November	Wt. ave. catch/day
Minnie D. II	-	2956	3225	2585	2102	2721
Seafisher	2157	2419	1980	1728	1571	2040
Maytag	1250	2121	1650	1902	1533	1841
White Foam II	-	2829	3163	2533	-	2794
Marie and Donna	-	2698	2850	2349	1805	2475
Mauritania	578	1584	1812	1861	1336	1600
Lady Thomas	-	2714	2759	3272	-	2924
Lady Genge	-	2783	1631	1723	1373	1813
Englee Twin Stem	-	2177	2491	2195	-	2264
Emily Nadine	-	2197	2311	1885	-	2104
Early Bird	-	1768	1955	1855	2157	1904
Carol and Susan	-	-	677	1153	1446	1148
Snowjet	-	-	428	778	802	633
Miss Pamela	-	455	497	603	-	514
Cape Fare	-	-	-	1417	-	1417
Pamella B.	-	-	388	228	-	361
No. of boat days	11	105	130	164	49	459
Mean catch/boat day	1931	2267	1830	1953	1573	1949

Table 29. Catch (lbs. in shell) per boat day in northeastern Gulf of St. Lawrence, 1980

Boat	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Wt. ave. catch/day
Minnie D II	3127	4233	4033	3663	3020	2742	2200	-	3406
Maytag	4715	4048	3063	2905	2816	2655	2308	-	3104
Seafisher	2605	3349	3397	2485	2651	2382	2351	-	2811
Lady Genge	2974	3325	3218	2574	2535	2217	2039	-	2716
White Foam II	-	-	3790	3362	3334	2886	2408	-	3239
Mauritania	2989	3876	3107	2852	2305	2235	2466	2753	2975
Marie and Donna	-	-	4134	3630	3160	2368	2369	-	3213
Miss Genge	-	-	2217	2326	2384	2134	2131	2086	2262
Early Bird	-	-	2734	2546	2905	2429	2594	-	2639
Sylvia and Shirley	2234	-	2337	2417	2515	2074	1808	-	2257
Emily Nadine	-	-	3306	3296	-	-	-	-	3302
Anna Mildred	2495	3607	4273	-	-	-	-	-	3566
Admiral Point	-	-	-	-	-	2404	2326	-	2343
Labrador View	-	-	-	-	-	-	1980	-	1980
Landings by month	68720	350826	439530	514683	398028	223194	247921	9678	2252580
No. of boat days	21	94	130.5	179.5	142.5	92.5	110.0	4.0	774.0
Mean catch/boat day	3272	3732	3368	2867	2793	2413	2254	2420	2910

Table 30. Catch (lb. in shell) per boat day in northeastern Gulf of St. Lawrence, 1981.

Boat	April	May	June	July	August	September	October	November	Wt. ave. catch/day
White Foam II	2201	4045	3410	3627	2229	2247	2123		3043
Marie and Donna	2052	3763	3239	3212	2648	2151	1732		2879
Maytag	2685	2997	3517	2670	2534	2288	1745		2636
Minnie D. II	2028	3536	3445	3083	2374	1961	1608		2784
Lady Thomas		3138	3770	4106	3001	3238	2286		3437
Seafisher	2067	2959	3083	2310	2036	2107	1719		2389
Lady Genge	1792	2610	2667	2238	2191	1856	1560		2161
Miss Genge	2178	2629	2529	2396	2318	2116	1960		2319
Sylvia and Shirley	1575	2634	2665	2372	2051	1641	1613		2202
Admiral Point		2963	2660	2751	2857				2802
Early Bird			2699	2706	2707	2239	1417		2333
Labrador View		2771	2590	2847	2736				2726
Emily Nadine		2159	2642	2359	1945	1357	1308		1946
Mauritania	1934	2270	2819			1757	1934		2143
Vina Wavey				1365	2183	1757	1891		1840
Anna Mildred	2193	2737	2601						2619
Sher-Li			1551	2009	1520	1094	929		1423
Mary Louise		1167	1149	1485	1367	1236	992		1256
La Tour				1485	1362	1576	1761		1553
Angie Louise						1378	1588		1483
Carol and Susan		2498							2498
Englee Cruiser			1037	1132	999				1072
Wolf Rock			1070	965					986
Pamela B.		990							990
Landings by month	115793	689886	596089	501169	434245	464135	241023		3042340
No. of boat days	55	234.5	204.5	188	195	240	144.5		1261.5
Mean catch/boat day	2105	2942	2915	2666	2227	1934	1668		2412

Table 31. Catch data for core fleet, 1973. Numbers of days fished are in parentheses.

Boat	May	June	July	August	September	October	November	Total
Belle Isle	693 (2.5)	3039 (9)	4434 (14.5)	3654 (11)	384 (2)	2475 (10.5)	588 (4)	15267 (53.5)
Eastern Lilly		352 (2)	2520 (10.5)	1837 (11)	314 (1.5)	1409 (8)	360 (2)	6792 (35)
Emily Nadine	1260 (7)	1418 (8.5)	1182 (5)		874 (4.5)	3383 (13.5)	404 (2)	8521 (40.5)
Gulf Stream				2950 (12)	2496 (12)	2842 (11.5)	893 (4.5)	9181 (40)
Miss June		202 (1.5)	2325 (10)	3555 (13)				6082 (24.5)
Lady Thomas			4099 (13)	3264 (10)	1203 (6)	2658 (9)		11224 (38)
White Foam II	1399 (5)	4098 (15)	6073 (18)	1838 (6)	1727 (6.5)	3071 (11.5)	334 (2)	18540 (64)
Anna Mildred				860 (4)	2524 (10)	2852 (13)	260 (2)	6496 (29)
Total by month (meat)	3352	9109	20633	17958	9522	18690	2839	82103
Total (round)	33336	85615	189452	168338	85336	166061	25225	753363
Fishing days	14.5	36	71	67	42.5	77	16.5	324.5
Mean catch/boatday (round)	2299	2378	2668	2513	2008	2157	1529	2322

Table 32. Catch data for core fleet, 1974. Numbers of days fished are in parentheses.

Boat	June	July	August	September	October	Total
Belle Isle	745 (4.5)	3063 (17.5)	2768 (17)	1175 (6.5)	435 (2.5)	8186 (48)
Tena	767 (4.5)	3172 (18)	2940 (16.5)	474 (3)		7353 (42)
Eastern Lilly	957 (5)	717 (3.5)	1429 (6)	681 (4.5)	1181 (6.5)	4965 (25.5)
Donald Bennett		498 (3)	2545 (11.5)	868 (5)		3911 (19.5)
Donald L.	217 (1.5)	1686 (6)	1495 (6)	460 (2)		3858 (15.5)
Totals by month (meat)	2686	9136	11177	3658	1616	28273
Total (round)	25246	83887	104773	32783	14358	261047
Fishing days	15.5	48	57	21	9	150.5
Mean catch/boat day (round)	1629	1748	1838	1561	1595	1735

Table 33. Catch (lbs. in shell) data for core fleet, 1979.

Boat	July	August	September	October	November	Total
Minnie D. II		20694	29028	46521	12613	108856
Seafisher	19417	38702	17823	20732	9428	106102
Maytag	1250	33932	16502	24720	13799	90203
White Foam II		25465	28463	35466		89394
Marie and Donna		16188	25646	37576	7218	86628
Mauritania	578	26929	18117	13029	13357	72010
Lady Thomas		18995	22071	26176		67242
Lady Genge		16697	17941	22401	8235	65274
Englee Twin Stem		13059	14944	26336		54339
Emily Nadine		17572	16175	18853		52600
Early Bird		8841	15643	18549	6470	49503
Total by month	21245	237074	222353	290359	71120	842151
Fishing days	11	103	96	133	44	387
Mean catch/boat day	1931	2302	2316	2183	1616	2176

Table 34. Catch (lbs. in shell) data for core fleet, 1980.

Boat	April	May	June	July	August	September	October	November	Boat total
Minnie D II	21891	65607	58475	67768	46804	27423	22000	-	309968
Maytag	18858	68809	50533	61006	50690	23899	24232	-	298027
Seafisher	5210	56932	45865	49698	46397	20243	18809	-	243154
Lady Genge	5947	56528	41837	47620	45633	21066	20394	-	239025
White Foam II	-	-	56850	60511	51684	23091	26483	-	218619
Mauritania	11955	54258	41939	22812	8069	16765	24658	5506	185962
Marie and Donna	-	-	55812	41749	41017	23681	22505	-	184764
Miss Genge	-	-	22165	50014	38149	21337	20246	4172	156083
Early Bird	-	-	6835	39463	40665	24291	23342	-	134596
Sylvia and Shirley	1117	-	8178	41085	28920	16591	18077	-	113968
Totals by month	64978	302134	388489	481726	398028	218387	220746	9678	2084166
Fishing days	19.5	80.5	115.5	169.5	142.5	90.5	97.5	4	719.5
Mean catch/boat day	3332	3753	3364	2842	2793	2413	2264	2420	2897

Table 35. Catch (lbs. in shell) data for core fleet, 1981.

Boat	April	May	June	July	August	September	October	November	Boat total
White Foam II	5503	76863	56271	47146	30096	35947	15920	-	267746
Marie & Donna	5130	71490	48590	43357	33104	35484	14722	-	251877
Maytag	24168	52439	45725	32044	27870	38891	22688	-	243825
Minnie D II	6085	67186	56844	38539	29672	30397	12059	-	240782
Lady Thomas	-	40791	54668	57478	40509	43715	3429	-	240590
Seafisher	14467	53258	46249	26570	23419	32655	23207	-	219825
Lady Genge	18812	49598	35998	26859	28489	30622	20274	-	210652
Miss Genge	18514	42066	35399	27555	26661	33854	23515	-	207564
Sylvia and Shirley	5511	44771	35974	27282	26669	22153	10485	-	172845
Admiral Point	-	42962	37236	41267	21427	-	-	-	142892
Early Bird	-	-	25642	29766	29778	38065	15587	-	138838
Totals by month	98190	541424	478596	397863	317694	341783	161886	-	2337436
Fishing days	46.5	172	155	137.5	130.5	157	94	-	892.5
Mean catch/boat day	2112	3148	3088	2894	2434	2177	1722	-	2619

Table 36. Effort (days fished) distribution of core fleet in 1981 (see Fig. 14).

Sector	Subsector 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total	% days fished by sector
A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	
B	-	1	1	3	1	7	15	14	13	22	19	26	17	8	6	13	3	1	170	23
C	-	3	4	13	7	9	13	12	20	52	56	49	35	27	15	9	-	-	324	44
D	-	-	3	5	10	2	6	14	15	27	47	31	25	27	8	-	-	-	220	30
E	-	-	-	1	-	1	-	3	-	-	5	5	5	1	-	-	-	-	21	3
F	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-
G	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	2	-
	-	4	8	22	18	20	34	43	48	101	128	112	82	63	29	22	3	1	738	-

Table 37. Within-season 1981 CPUEs for two unidentified boats in the northeastern Gulf.

Month	Catch (lb round)/tow		Catch (lb. round)/hour	
	Boat 1	Boat 2	Boat 1	Boat 2
April	-	64.7	-	207.7
May	-	92.5	-	345.1
June	86.6	86.6	279.3	337.8
July	71.9	90.5	234.6	320.6
August	70.1	60.5	229.2	225.6
September	68.7	63.4	218.1	216.2
October	51.9	65.1	160.5	208.1

Table 38. Percent distribution of fishing effort by core fleet by month for 1981.

Sector	April	May	June	July	Aug.	Sept.	Oct.	Totals
A	-	-	-	-	-	-	-	
B	5	15	9	18	12	29	12	100
C	8	23	24	15	13	12	5	100
D	17	23	12	14	7	19	8	100
E	-	-	-	-	-	-	-	0
F	-	-	-	-	-	-	-	0
G	-	-	-	-	-	-	-	0

Table 39. Estimates of $\bar{Z}$ and F for 1980/81 in the northeastern Gulf of St. Lawrence using the equation $\bar{Z} = -\ln [c_2/f_2]/]c_1/f_1]$ and varying M (see Table 16). c_1, c_2 = catch in numbers in year I and year II and f_1, f_2 = effort (boat days) in year I and II.

Age	Z	M	F
9-10	0.463	0.125	0.338
10-11	0.731	0.159	0.572
11-12	0.964	0.186	0.778
12-13	1.290	0.234	1.056
13-14	1.684	0.253	1.431
$\bar{Z}_{(9-13)}$ 0.7417	$\bar{M}_{(9-13)}$ = 0.156		

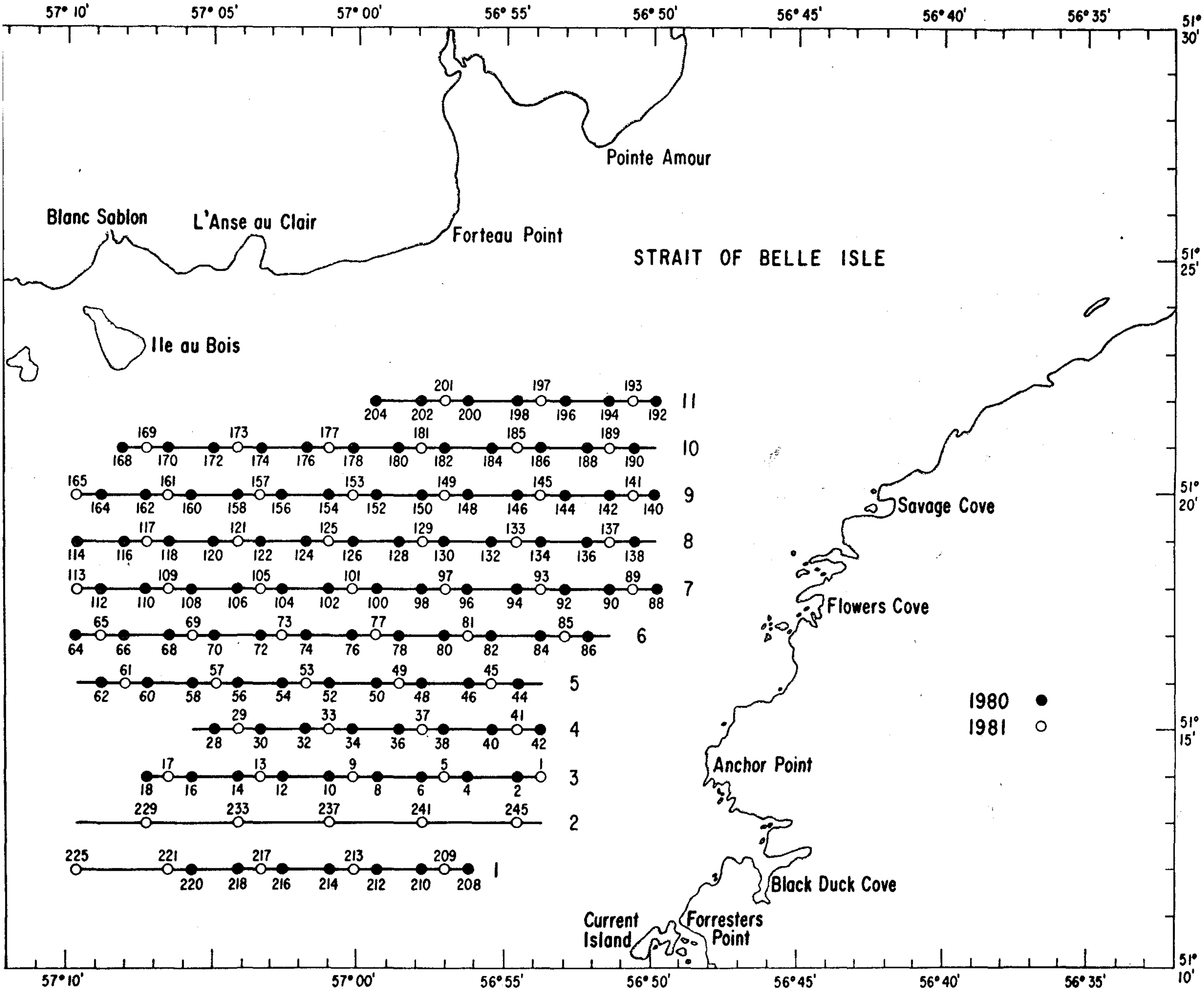

Fig. 1. Distribution of fishing stations in 1980 and 1981 in the northeastern Gulf of St. Lawrence.

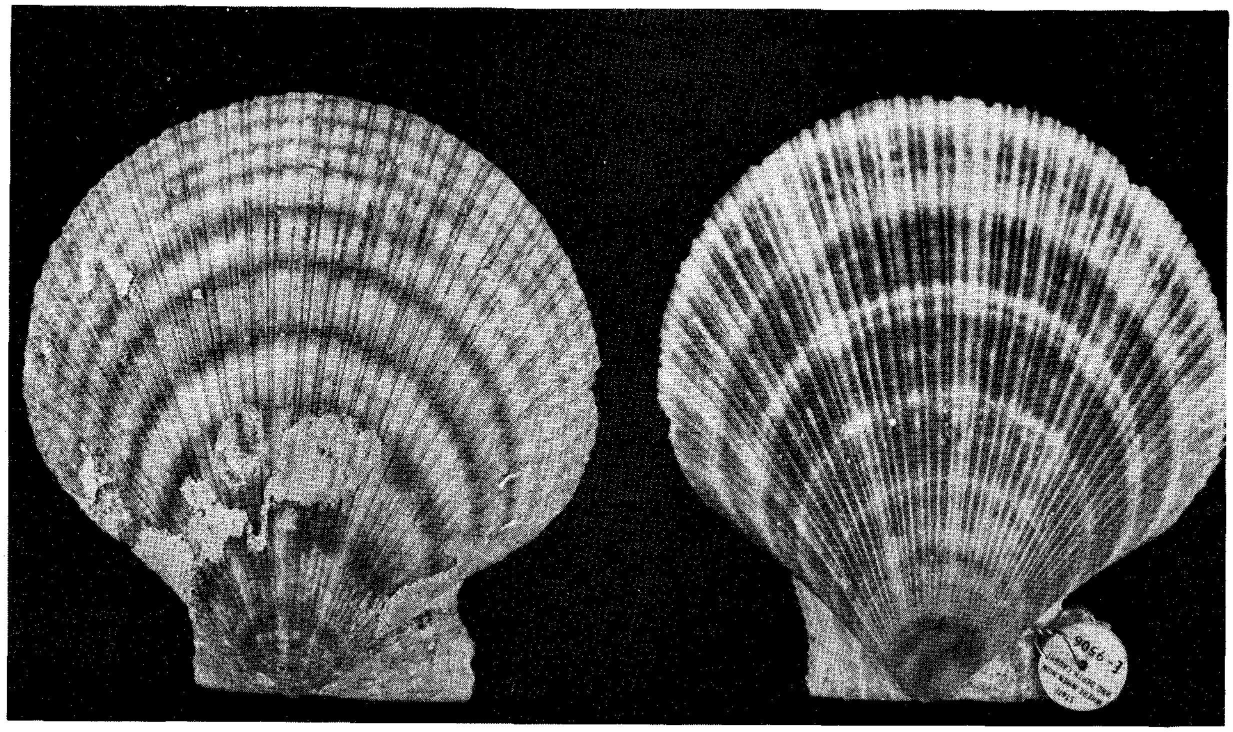

Fig. 2. Growth rings and a tagged Iceland scallop. Scallop on left is 88 mm.

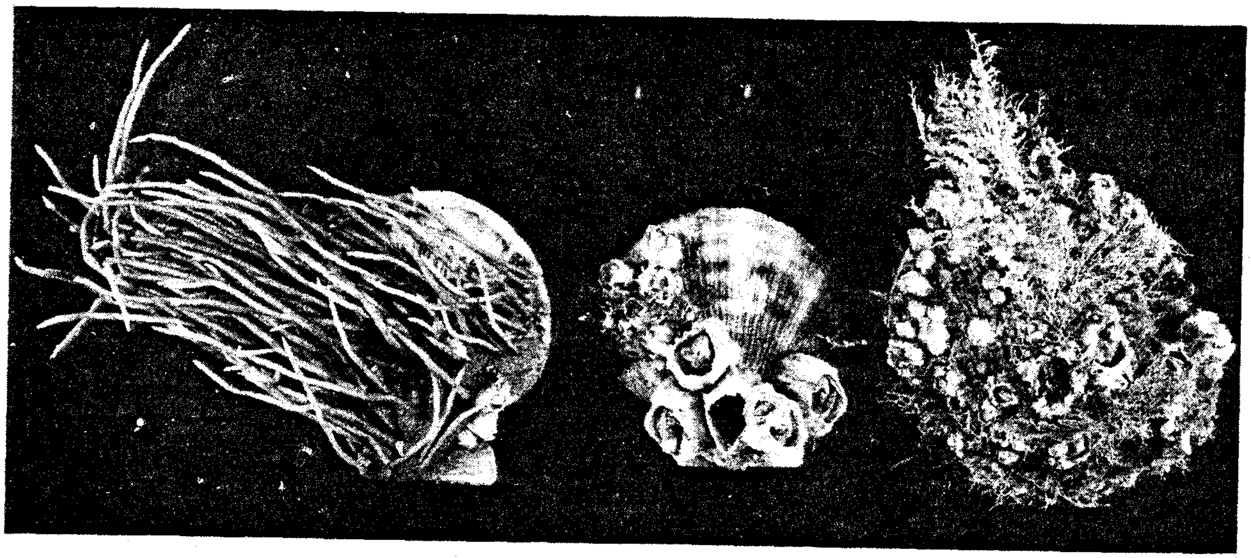

Fig. 3. Typical epifaunal growth on the left valve of Chlamys (x 1/3).

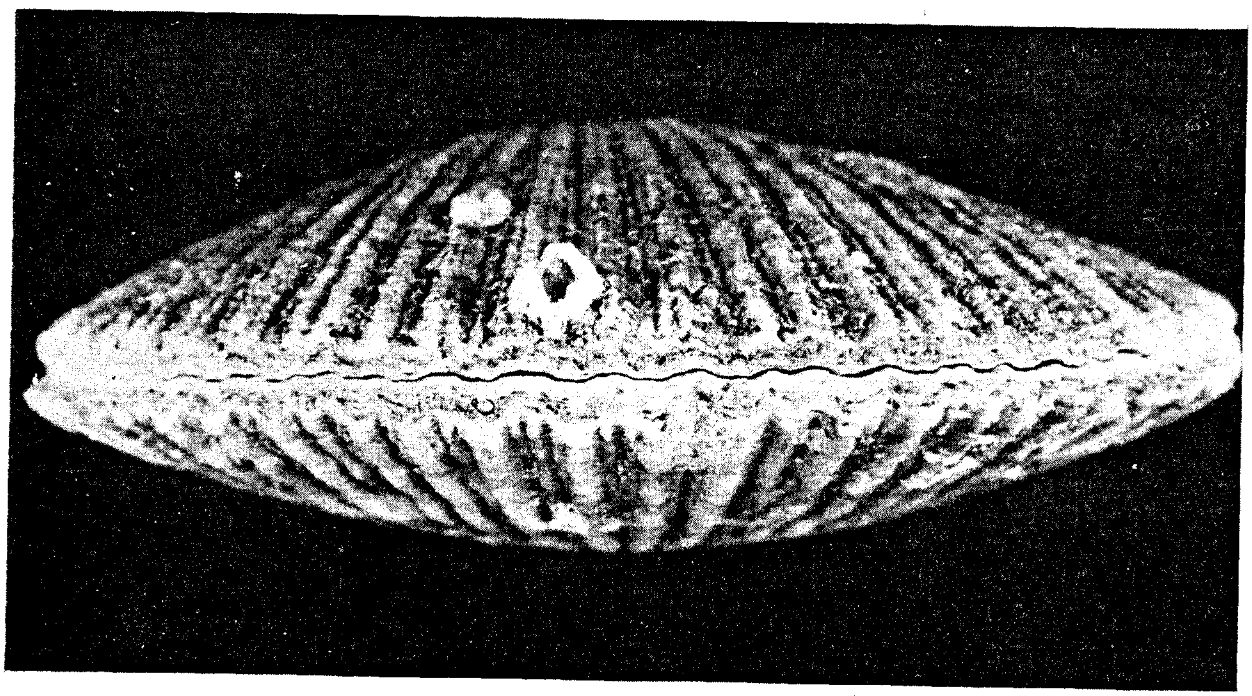

Fig. 4. Laminated shell edge in Chlamys (x 2).

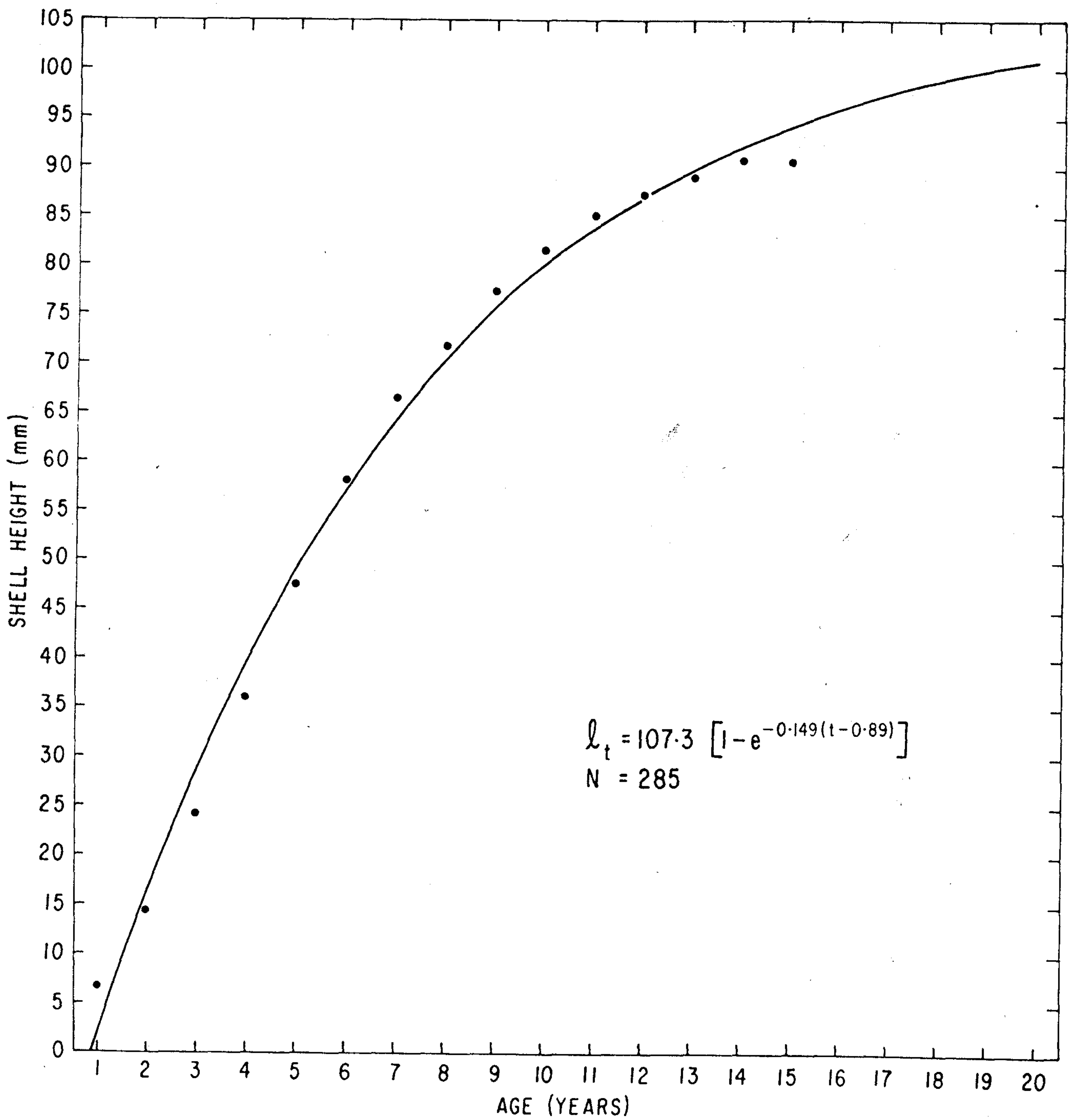

Fig. 5. Von Bertalanffy growth curve for northeastern Gulf Iceland scallops. Sample means shown.

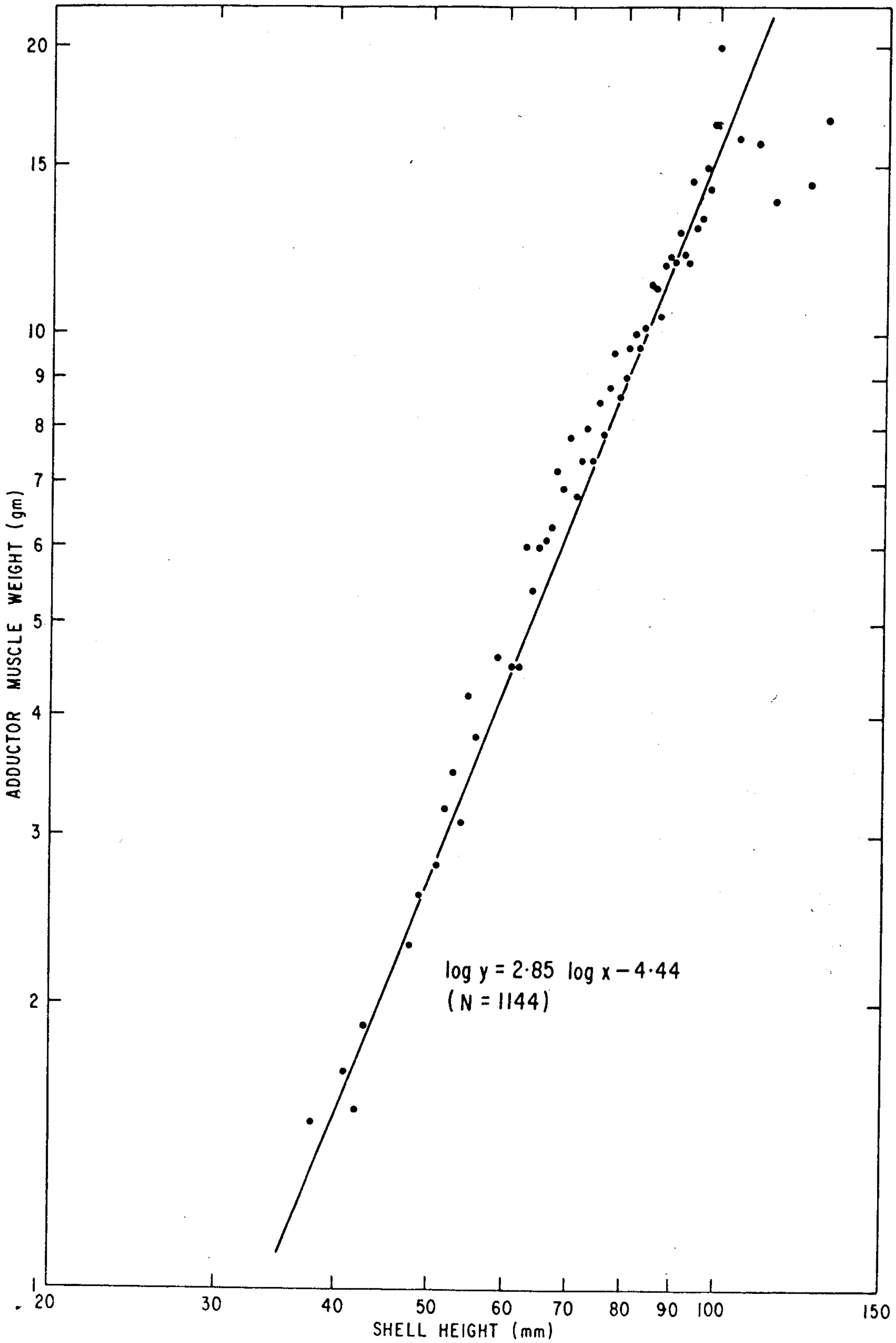

Fig. 6. Regression of adductor muscle weight (g) on shell height (mm) (r^2 = 0.96) for northeastern Gulf scallops.

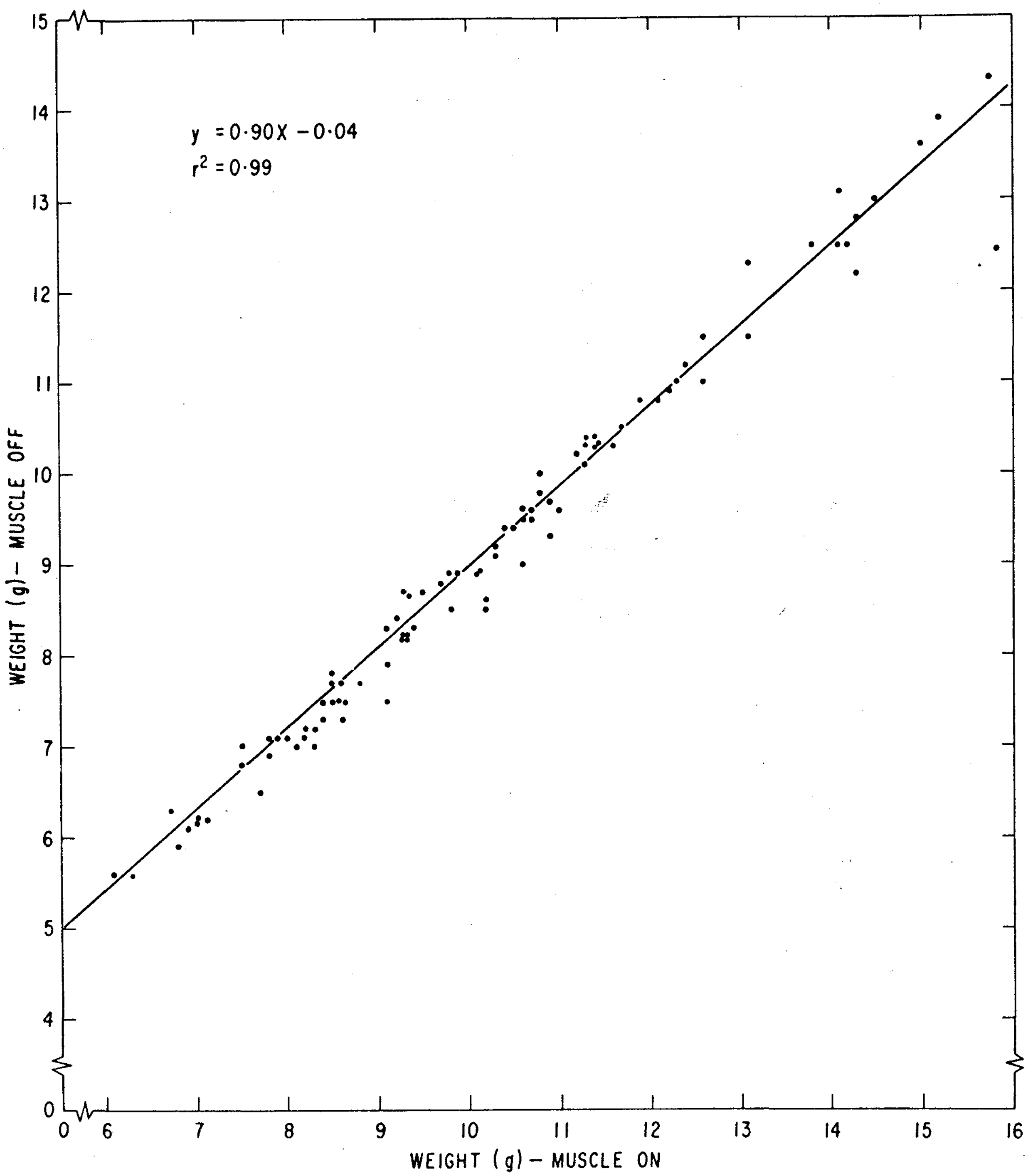

Fig. 7. Relationship between 'muscle-on' to 'muscle-off' weights in <u>Chlamys</u>. (muscle-on = both components of adductor muscle; muscle-off = adductor muscle less small catch fraction).

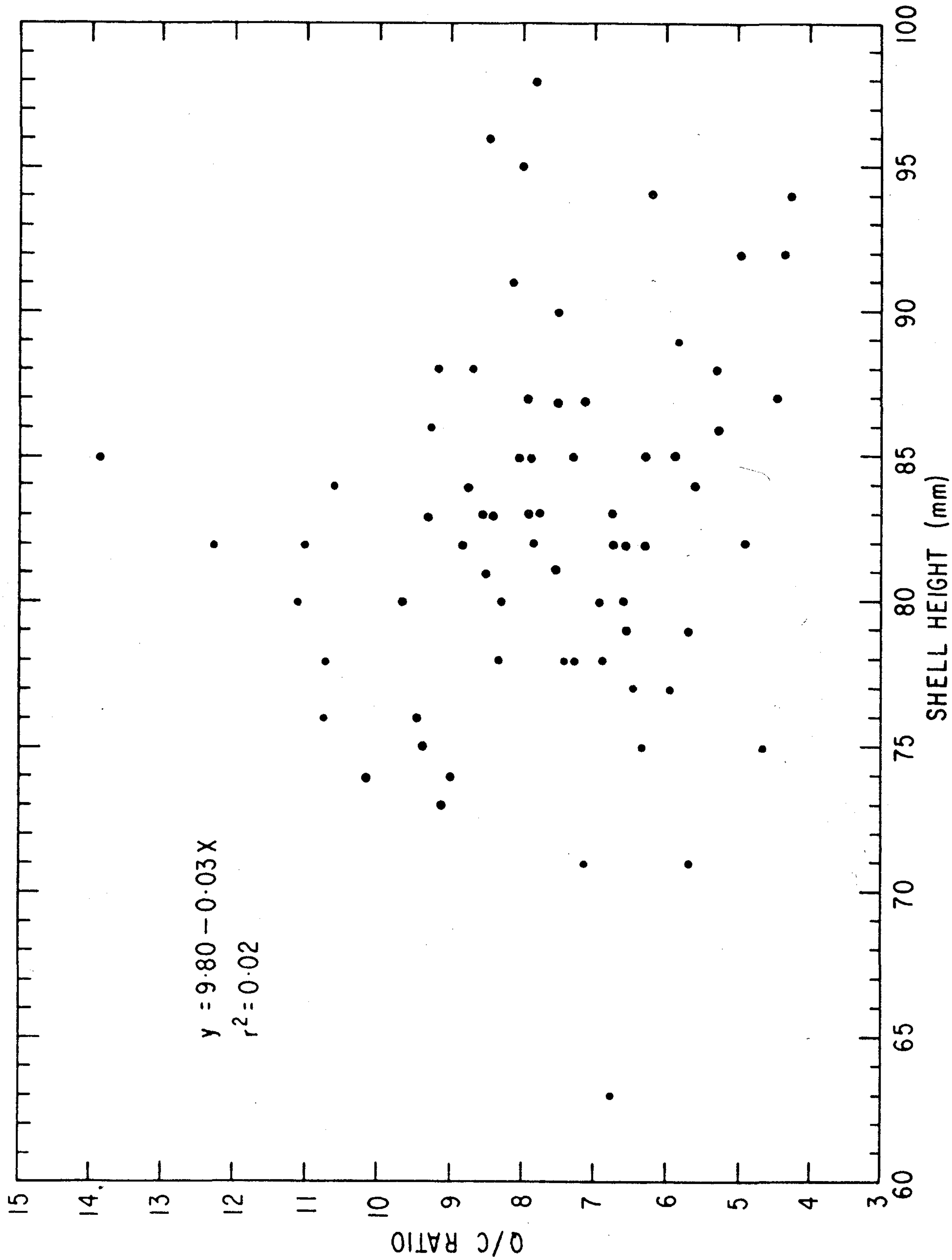

Fig. 8. Scatter diagram: Ratio of quick to catch fractions with scallop size.

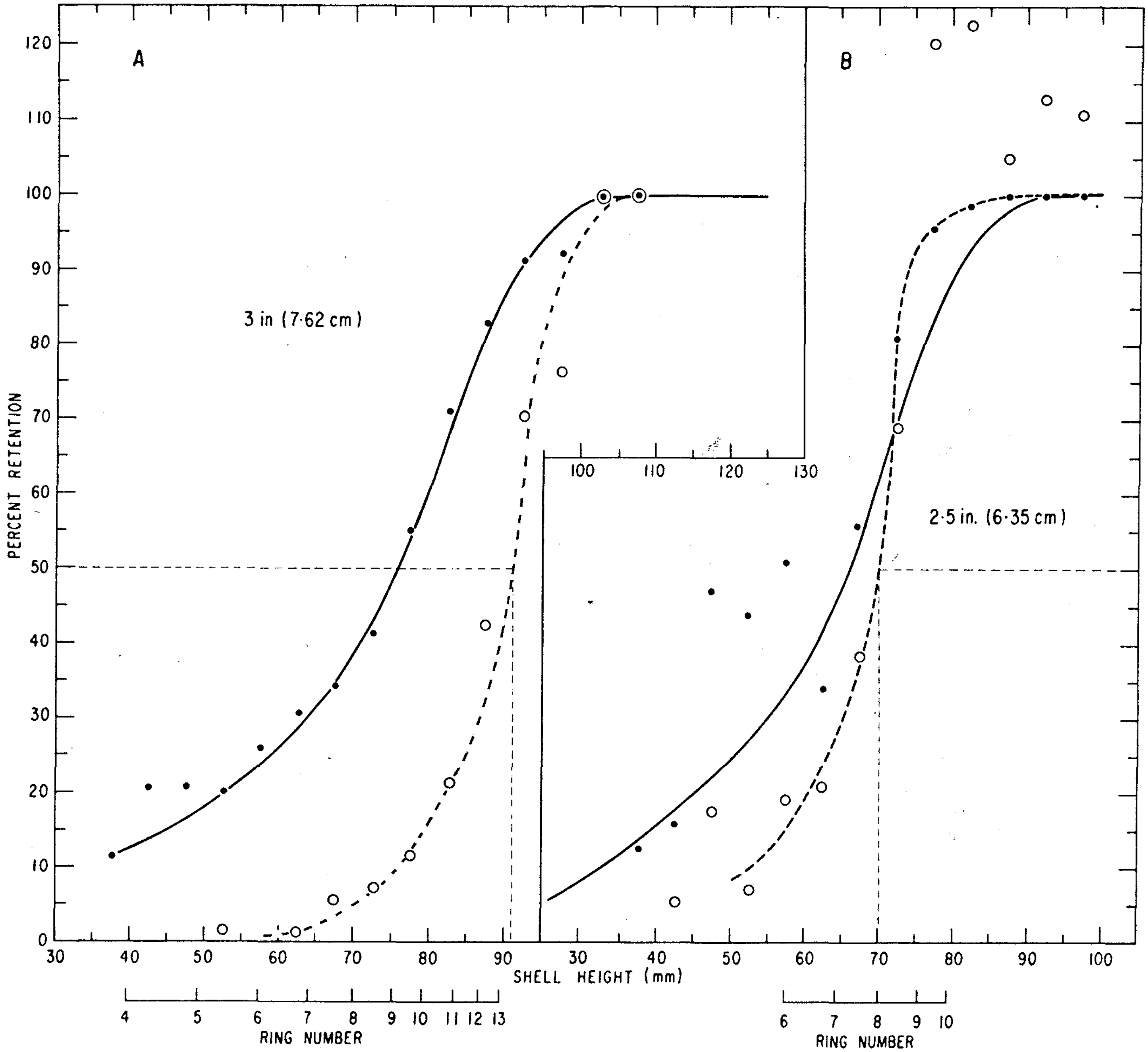

Fig. 9. Selectivity ogives for Digby buckets equipped with (A) 3.0 in (76 mm), and (B) 2.5 in (64 mm) rings: solid lines for covered gear; broken lines for commercial gear. All curves drawn by eye.

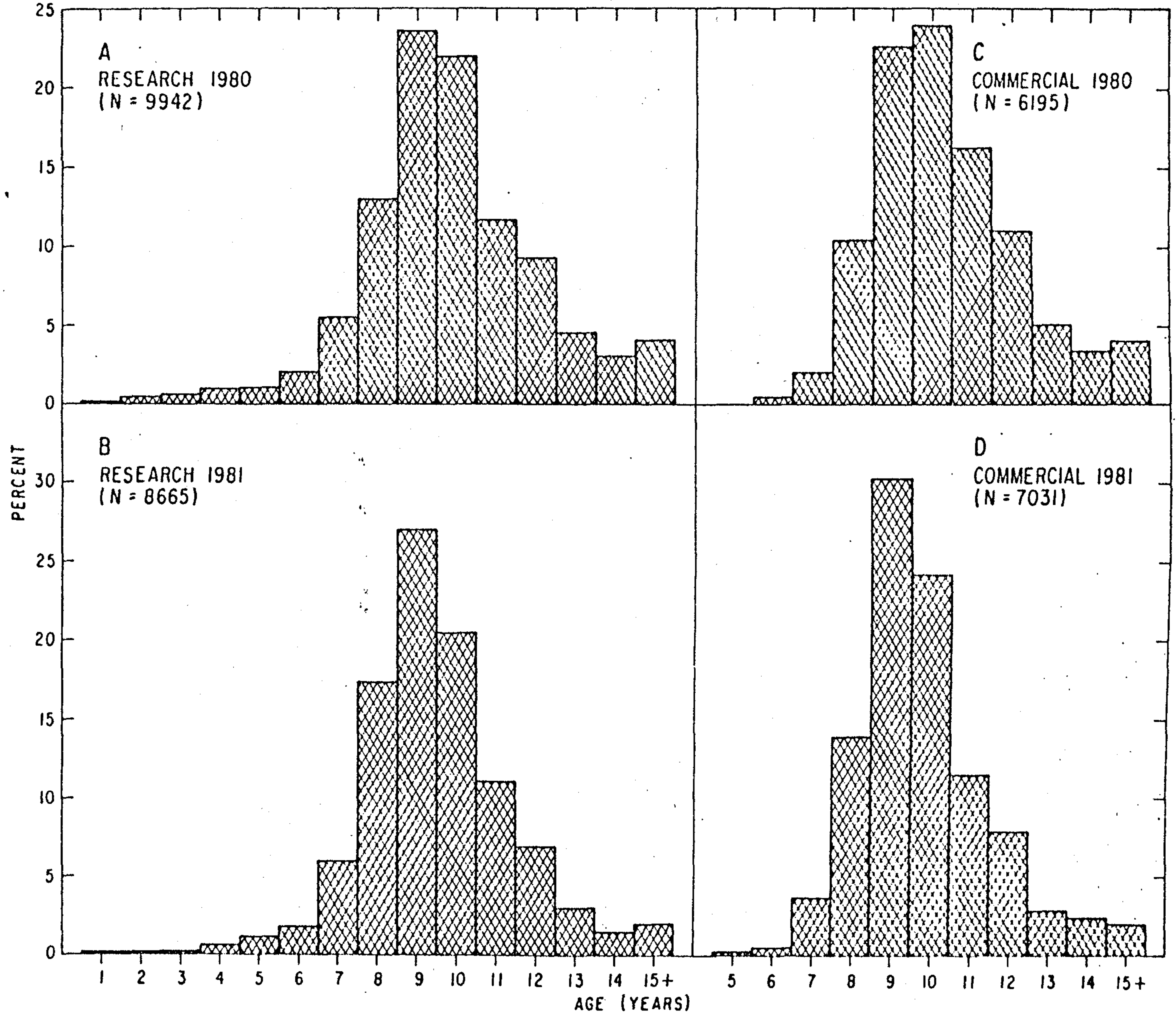

Fig. 10. Commercial and research age frequencies.

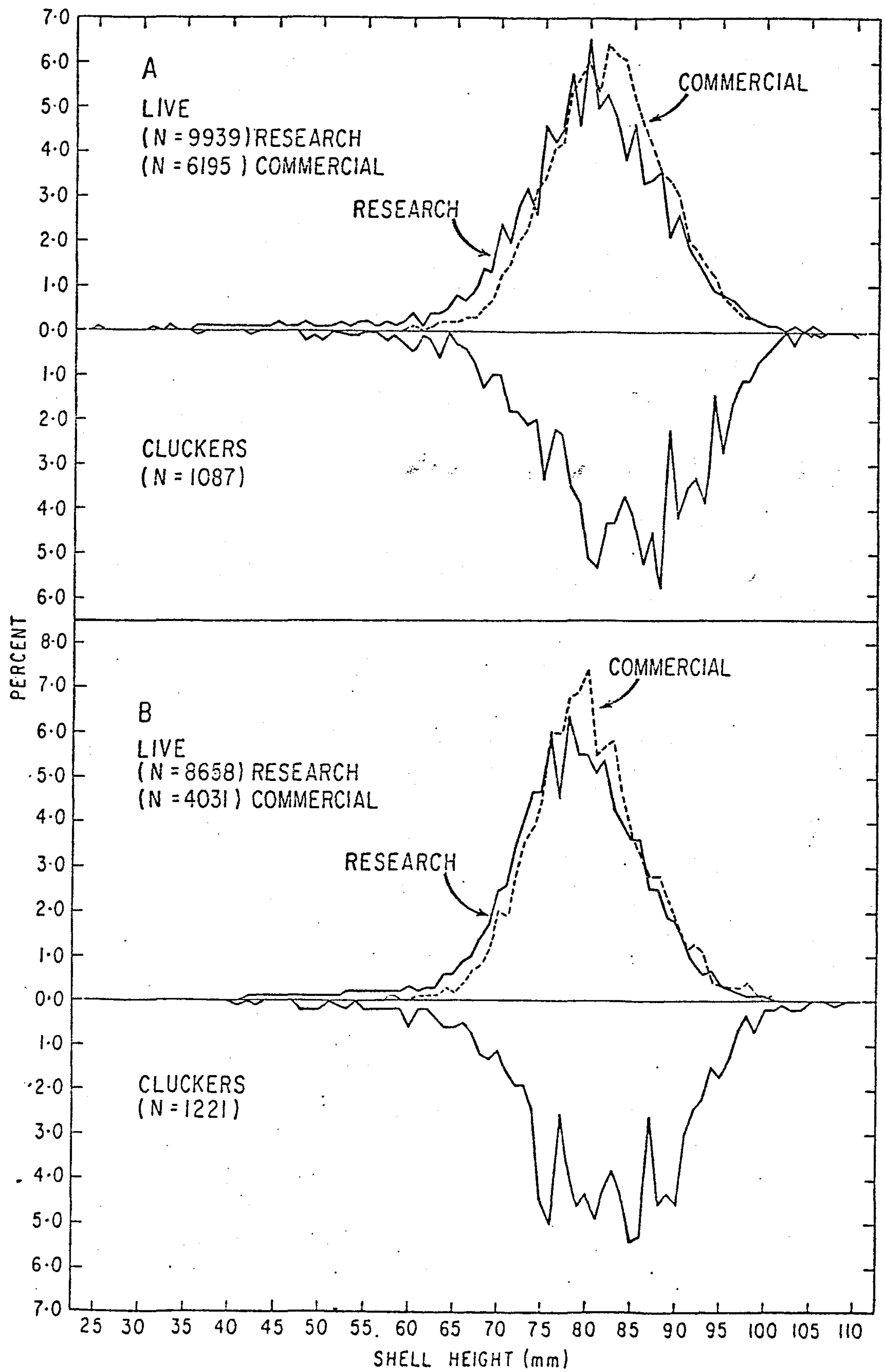

Fig. 11. Commercial and research shell-height frequency distributions (A) 1980, (B) 1981.

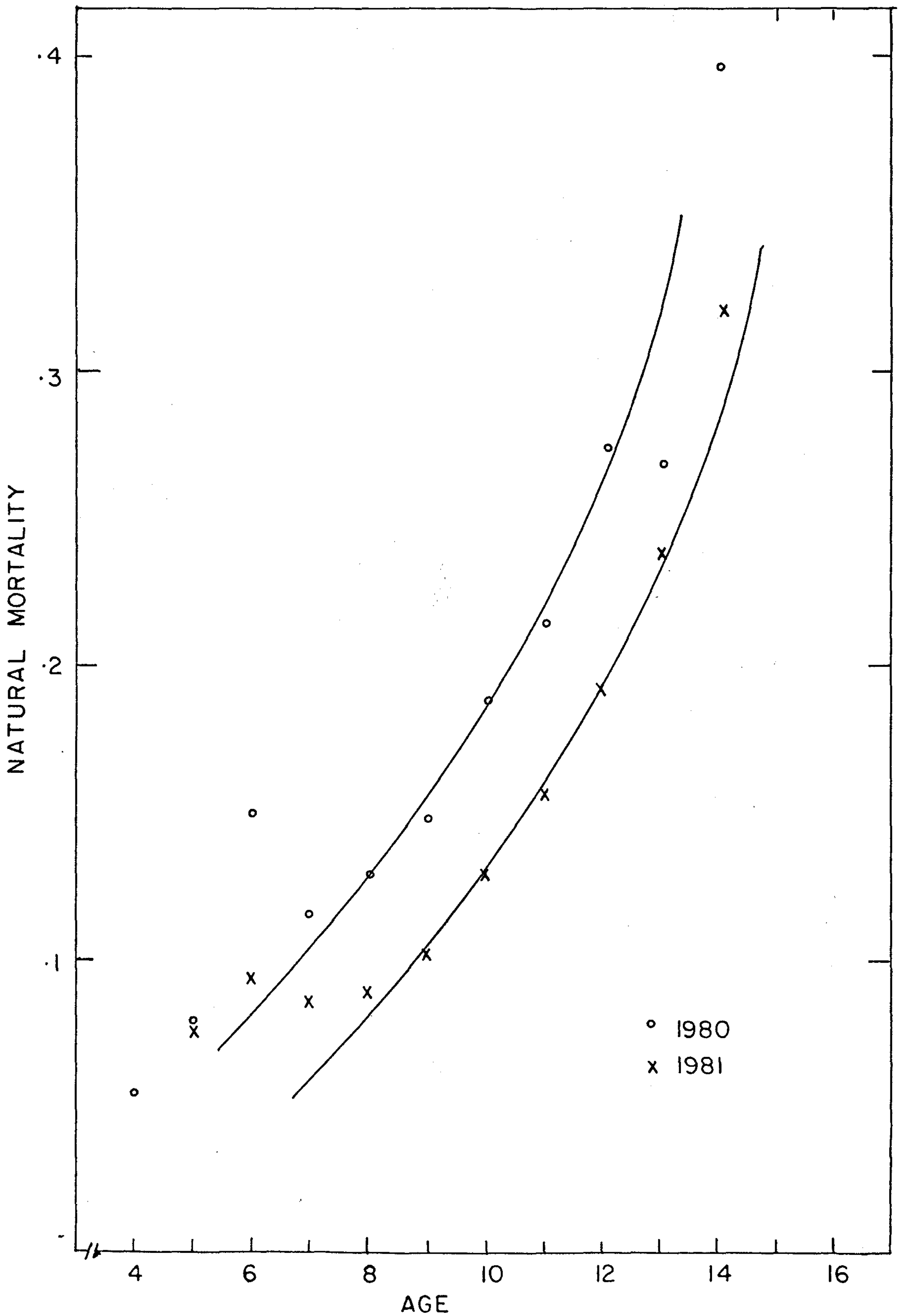

Fig. 12. Relationship between annual mortality and age in scallop beds subject to different levels of fishing.

SCALLOP LOG

(use a new sheet each fishing day)

DATE ______________________ BOAT ______________________

TOTAL NUMBER OF TOWS ______________________

TIME OF FIRST TOW ______________________ TIME OF LAST TOW ____________

AMOUNT CAUGHT: SHELL ON ________________ (estimate these if you do not

MEAT ONLY ________________ have actual weigh-in figure)

ACTUAL HOURS SPENT FISHING: 2 4 6 8 10 12 14 16

(circle number of hours)

TIME LOST FOR ENGINE TROUBLE OR REPAIRS 2 4 6 8 10

(circle number of hours)

PLEASE MARK AN "X" IN AREAS FISHED THIS DAY:

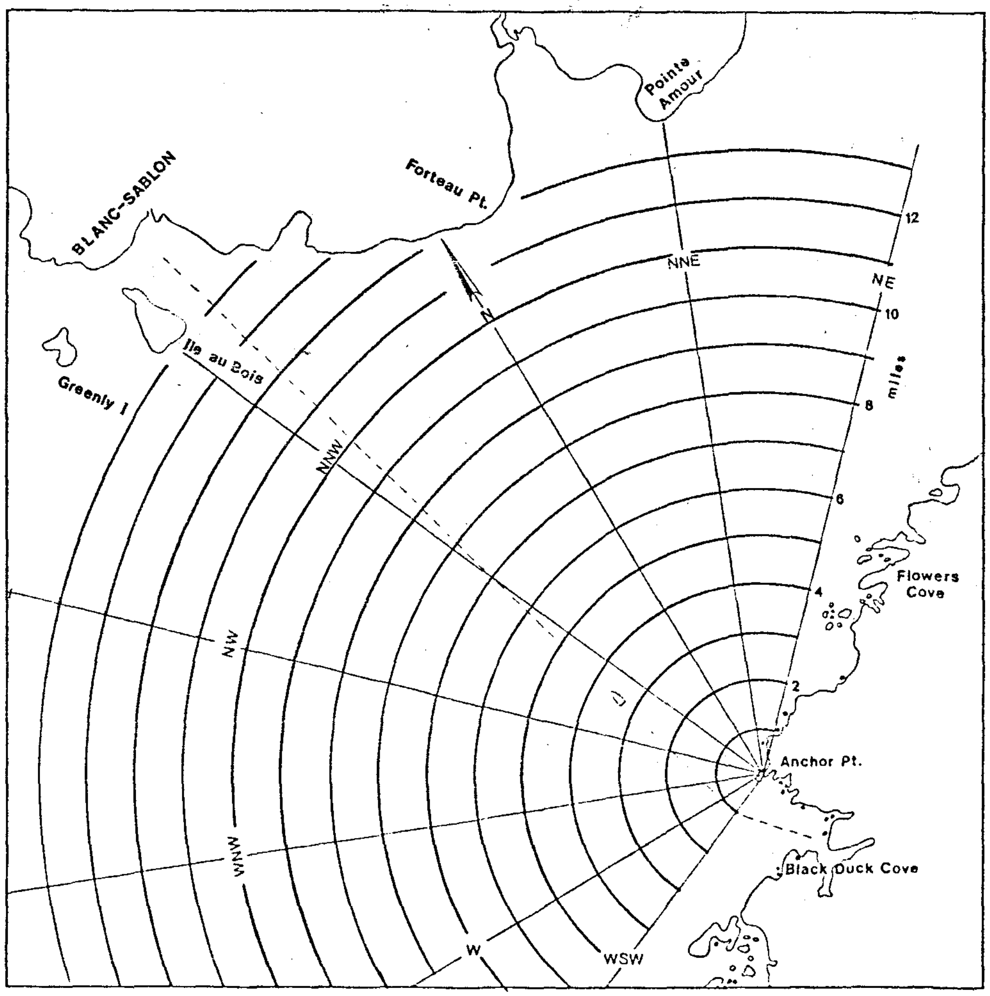

Fig. 13. Scallop log used in 1981 (reduced in size).

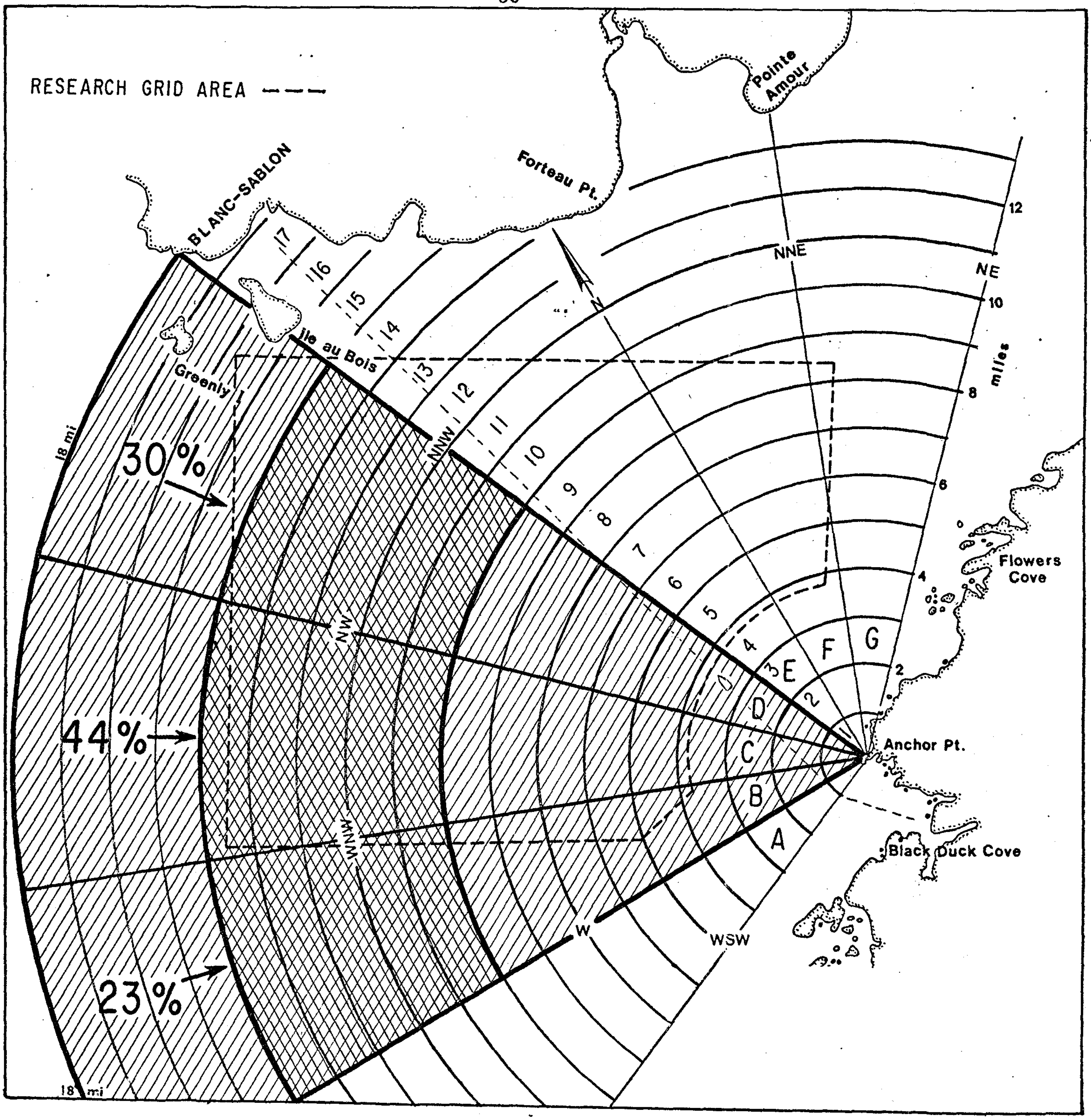

Fig. 14. Distribution of fishing effort in 1981 and aereal expansion in the fishery. Percentage indicate effort in each of the three sectors (B,C, and D). Cross-hatched area indicates where approximately 66% of effort was expended.

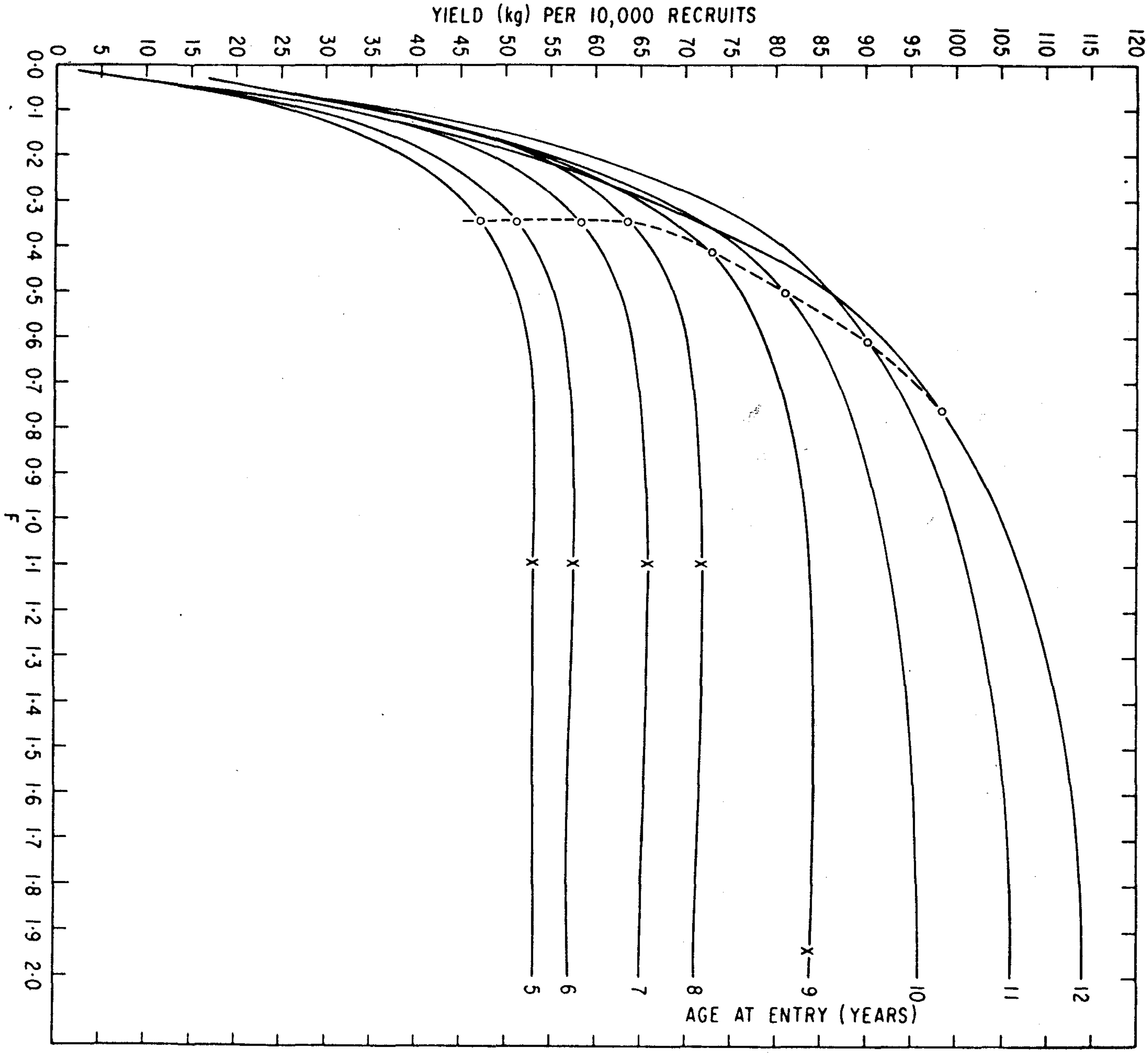

Fig. 15. Yield curves for northeastern Gulf Iceland scallops $F_{0.1}$ values represented by open circles, x represent F_{max}.