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# BAY OF FUNDY SCALLOP STOCK ASSESSMENT - 1979

by

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## ABSTRACT

The status of the Bay of Fundy scallop stock in 1979 is assessed on the basis of relative age frequency distribution. In numerical abundance, the modal age class of recruited scallops is seven, with eight year old scallops (1971 year-class) more abundant than those six years of age (1973 year-class). The continued high exploitation of older scallops and the relative low abundance of younger, recruited scallops suggests that the present above average landings from Bay of Fundy waters cannot be sustained much longer, and that a decline in catch remains likely in the future.

Yield per recruit analysis indicates that with M=0.1, maximal Y/R is achieved at about F=1.3 and age of first exploitation of 9. This corresponds to a 123 mm scallop, which has an average meat yield of 21 g, and indicates that

optimal Y/R could be achieved with a maximum meat count regulation of about 48 meats (adductor muscle)/kg (22 meats/lb). Present Y/R would thus only be increased by about 4% if optimal Y/R were achieved.

Analysis of individual bucket performance in a seven-gang drag on the same ground showed that location in the gang had no significant effect, although the trend was for the two end buckets and the very centre bucket to fish more scallops. Unlined buckets fished on average a greater number of recruited scallops (age 4+ yr) than did lined buckets whereas the converse applied with prerecruit scallops.

## RESUME

La distribution de la fréquence des âges a servi de base à l'évaluation de l'état des stocks de pétoncles de la baie de Fundy en 1979. En abondance numérique, la classe d'âge modale des pétoncles recrutés est sept, les pétoncles de huit ans (classe d'âge de 1971) étant plus abondants que ceux d'âge six (classe d'âge de 1973). Si l'exploitation intensive des pétoncles âgés et l'abondance relativement faible des jeunes continuent ainsi, le nombre de pétoncles recrutés suggère qu'on ne pourra maintenir bien longtemps les débarquements supérieurs à la moyenne qu'on retire présentement des eaux de la baie de Fundy, et qu'une diminution des prises est toujours probable dans un avenir rapproché.

L'analyse des rendements par recrue (R/R) indique qu'avec M=0,1 on atteint le R/R maximal à environ F=1,3 et que l'âge de première capture est de 9 ans. Ceci correspond à un pétoncle mesurant 123 mm, à rendement moyen en chair de 21 g, et indique qu'on pourrait réaliser un R/R optimal avec une réglementation fixant à environ 48 le nombre de chairs (muscle adducteur) /kg (22 chairs/lb). Si l'on obtenait un R/R optimal, le R/R actuel n'augmenterait que d'environ 4%.

L'analyse de la performance des baquets individuels dans une drague à sept unités sur un même lieu de pêche démontre que la position dans le groupe n'a pas d'effet marqué, bien que le baquet de chaque extrémité et celui du centre aient tendance à capturer plus de pétoncles. Les baquets non doublés capturent en moyenne plus de pétoncles recrutés (âge 4+) que les baquets avec doublure, alors que c'est l'inverse pour les pétoncles d'avant recrutement.

## INTRODUCTION

The scallop ground off Digby, N.S., is the primary scallop resource exploited in the Bay of Fundy. After a 25 year gap (see Dickie, 1955), a scallop stock assessment was carried out in 1978 (Jamieson and Lundy, 1979) based on stock age-composition and recent fishery performance. This report presents a follow-up stock assessment based on the age-frequency distribution a year later, and includes yield per recruit analysis. The effects of both bucket location in a seven-gang drag and the use of small-mesh liners in individual bucket performance are evaluated to describe potential bias arising from subsampling, thereby allowing projection as to the performance of unmodified, commercial gear. Management options to improve fishery yield are discussed.

## MATERIALS AND METHODS

### A. Sampling Procedures

Survey design and procedures were similar to that utilized by Jamieson and Lundy (1979), with number of stations in each stratum being determined from the distribution of commercial effort in 1978. This effort distribution was utilized since insufficient 1980 log data had been received at commencement of the survey to allow development of an adequate survey plan. Since fishing close to shore is hampered by rough bottom, the areas (stratas) surveyed began 3.2 km from shore, and consisted of five rectangular bands extending

offshore from major landmarks to a distance of 20.8 km (Fig. 1). Within each stratum, the portion of each band within 9.6 km of shore is termed "inshore", and the remainder called "offshore". The inshore region is exploited commercially only during the winter months (October - April inclusive), whereas the offshore region can be exploited throughout the year. The survey was conducted over a two week period in mid-June, 1979, from the chartered, 19.1 m, scallop dragger "M.V. Promise", skippered by Captain Doug Andrews. All stations sampled were at depths less than 60 fathoms.

To evaluate individual bucket performance in the 7-gang drag, 14 consecutive tows with experimental gear were made on the same bottom at an offshore station. During these tows, gear modifications differed from that described below for the resource survey: in the first seven tows, all seven buckets were unmodified commercial gear, whereas in the last seven tows, all seven buckets had 38 mm mesh liners. No hoods or covers were used in these tows.

The survey gear (Fig. 2) was a 7-gang Digby drag with 3-inch (76 mm) rings. Buckets 3, 4, and 7 (Fig. 2) contained 38 mm mesh liners, while similar mesh hoods extending to a height of 1 m above the bottom of the drag were attached to buckets 1, 4, and 7. Back covers of 38 mm mesh were attached to buckets 1 and 2. These modifications of commercial gear differed from those used in 1978 (Jamieson and Lundy, 1979) and improve the gear's balance in tow.

Individual scallop heights were measured on all scallops and cluckers fished by each bucket, cover, or hood, with recording at five millimeter intervals. Scallop age was inferred from height using the Von Bertalanffy growth parameters given by Jamieson and Lundy (1979). Depth was recorded, tow location was determined from Loran A bearings, and tow duration was standardized at ten minutes. Tow length at each station was determined a posteriori, and for analysis purposes, catches were weighted to a tow length of 800 m. A total of 78 stations were completed (Table 1), including the 14 experimental tows.

All statistical tests of significance utilized Tukey's HSD multiple range test (Steele and Torrie, 1960).

B. Meat weight - shell height relationships

Weight-height relationships for Bay of Fundy scallops collected from depths of less than 60 fathoms (110 m) in 1978 and 1979 off Digby, N.S. were utilized to derive a meat yield regression (Fig. 3). This regression,

$$\log_e (\text{weight}) = -12.55 + 3.23 \log_e (\text{height})$$

differs from that determined for Passamaquoddy Bay scallops (Jamieson and Lundy, 1979), and has been in subsequent analyses. It combines data obtained throughout the fishing season.

## RESULTS

### A. Individual Bucket Performance

#### a) Experimental gear

This section describes the results obtained doing the 14 tows at the same offshore location. In both lined and unlined drags respectively (Table 2), no significant difference in abundance of recruits (4+ year old scallops) or prerecruits (3 year old scallops) was evident between bucket location in the seven-gang drag. However, the trend was for the two end buckets and centre bucket to fish more scallops. With comparable bucket locations in lined versus unlined drags, unlined buckets fished on average a greater number of recruited scallops than did lined buckets ($P > .05$), whereas the converse applied for prerecruits ($P < .05$). This confirms previous observations made by Jamieson and Lundy (1979) in 1978.

#### b) Survey gear

With respect to bucket location in a gang, a significant difference ($P < .05$) in catch between similar bucket types (lined or unlined) was observed only between the four, unlined bucket catches in the offshore area (Table 3): bucket 1 in the survey gear fished significantly more recruits than did buckets 2 and 6. No trend was otherwise obvious between catch magnitude and location in the drag gang, although regional differences in catches existed and are discussed below.

No significant ($P > .05$) catch differences were observed between either the two back covers or between the three hoods.

B. Relative Age Class Abundance

In both inshore and offshore areas, the major modal age class in terms of number of scallops fished with unlined gear (Table 4 and 5) was the same as in 1978: seven year old scallops. However, in 1978, six year old scallops (1972 year class) were also relatively abundant while eight year old scallops (1970 year class) were much reduced in abundance (Jamieson and Lundy, 1979). In 1979, the converse was found in the inshore region, with eight year old scallops (1971 year class) more abundant than six year old scallops (1973 year class). In the offshore region in 1979, both age classes were about equal abundance.

Relative abundance (Tables 4 and 5) of prerecruits to recruits increased in 1979, even though the 1976 year class appears below average. The recruiting 1975 year class is well represented, and although it now appears that the age three abundance of this year class is not as great as was that of either the 1971 or 1972 year classes, which are now the mainstay of the fishery.

C. Regional Variation in Population Age Structure

Inshore scallop ground off Centreville had a significantly ($P > .05$) greater number of recruited scallops

than did ground off Gullivers Head, Digby Gut, or Delaps Cove. No other significant differences in either prerecruit or recruit abundance were evident between other inshore regions or between offshore regions (Table 6 and 7). Average scallop density was greater inshore than offshore. Scallop abundance at age (Tables 6 and 7) is weighted by estimated gear efficiency (Dickie, 1955): 5% for the inshore area and 12% for the smoother, offshore area.

In comparison to 1978 observations (Jamieson and Lundy, 1979) of scallop abundance, estimated overall scallop abundance remained about the same in 1979 off Centreville, but appeared to decline off Gullivers Head, Broad Cove, and Digby Gut. Insufficient offshore sampling was conducted in 1978 to allow offshore abundance comparisons.

D. Yield per Recruit

Von Bertalanffy growth parameters (Jamieson and Lundy, 1979) for Bay of Fundy scallops off Digby, N.S., ($W_\infty$ [adductor muscle] = 34.32 g), and M = 0.1 (Dickie, 1955) were used to determine yields per 10,000 recruits, as in Beverton and Holt (1957) (Fig. 4). These yield per recruit values are only relevant for scallops from depths less than 60 fathoms (110 m), since Caddy et al. (1970) demonstrated that depth profoundly influenced asymptotic size. Meat yield data from deep water, Bay of Fundy scallops is not available.

Maximum yield per 10,000 recruits, 120 kg, is achieved at about F = 1.3 and age of first exploitation of 9 years.

This corresponds to a 124-126 mm scallop which has a meat (adductor muscle) yield of 20.4-21.5 g. This would be achieved by a 22 meat count/lb (48 meats/kg).

At present, the age classes most heavily exploited are seven to eight year old scallops, which have a meat count between 25-31/lb (55-68/kg). Present yield per recruit would thus only be increased by about 4% if the maximal Y/R were achieved, as F is estimated to be greater than 0.4.

## DISCUSSION

### A. Biomass Estimation

The difficulties in accurately estimating exploitable scallop biomass have been previously documented (Jamieson and Lundy, 1979; Jamieson and Chandler, 1980) as depending on three main factors: knowing the accuracy of the sampling gear in assessing the total biomass, knowing the locations of scallop concentrations, and knowing the propensity of dispersed scallops to establish new concentrations.

Gear performance is influenced by many variables, including gear type, nature of the substrate, gear velocity over the substrate, and scallop size. This factor is thus site specific and at best can only be approximated for a fishing ground. Assessing locations of commercial scallop concentration is attempted by using the recent distribution of scallop yielding areas in the assignment of survey station location. However, since this is based on an earlier time

series of data, it can only approximate the situation at a later time period since scallops are both capable of dispersal and concentrations may be depleted by fishing. The total number of survey stations was determined by available funding and manpower resources.

Since bucket type (lined or unlined) and location can affect fishing performance (even if not statistically significant at the P = .05 level, trends are evident), projections as to an average exploitable density (Table 6 and 7) use the average catch of an end, unlined bucket multiplied by the number of buckets in the hypothetical drag gang. Although this has some inherent bias, it facilitates stock comparisons in a manner meaningful to fishermen.

With these qualifications, average inshore scallop densities in the survey area were similar to those observed in 1978, about 1.7-2.8 scallops/$m^2$, all recruited age classes combined (Table 6).

B. Relative Year-Class Strength

The shift in relative age class abundance of recruited scallops in the inshore region reflects the movement of the peak year class (1971) through the population's age structure, while the shift in modal year class abundance from 1971 to 1972 reflects the ability of the fishing fleet to exploit the resource. Being on average of larger meat yield, 1971 year class scallops have been selectively fished when commercially

abundant, and the actual abundance of this year class has now been sufficiently reduced to permit the 1972 year class to assume numerical dominance, even though this latter year class was initially less abundant.

C. Fishing Performance

The 1979 Bay of Fundy scallop meat landing of 442 MT (Table 8) is slightly less than that fished in 1978 (483 MT) but still well above the average meat yield for the previous 27 years (1950-1977: 325 MT). Annual effort expended in the Bay of Fundy appears to fluctuate, recently because of very productive fishing on Georges Bank in 1978 and on the Scotian Shelf in 1979. No accurate estimates of effort (hours gear is on the bottom times gear width) are presently available and so neither annual fishing mortality nor CPUE variance can be assessed.

There is presently no maximum meat count per unit weight regulation in the Bay of Fundy scallop fishery, and because of the present abundance of large scallops, average age of exploitation is close to that giving maximal Y/R. However, as with the Georges Bank scallop fishery, a period of average to low subsequent recruitment will reduce the availability of scallops, causing the average age of exploitation to decrease and hence reduce Y/R.

## MANAGEMENT OPTIONS

Over the past year, the main change in the status of the Bay of Fundy scallop stock has been a slight reduction in overall recruit abundance (Table 6). There is no clearly defined evidence of future above average recruitment, and so as the 1971 and 1972 year classes are depleted, landings can be expected to decline over the near future. Relative abundance of the most recently recruited year classes (1973-1975) indicates that these year classes may well be below average. There is to date no way of knowing when landings will once again peak following the expected continued decline in landings in 1980. How pronounced this reduction will be is difficult to ascertain; but on the basis of historical data, catches in a declining fishery have often been as little as half that of the previous year's landings (Jamieson and Lundy, 1979).

With the continued above average landings in 1979, and anticipating an imminent significant decline in landings, management options remain the same as presented last year (see Jamieson and Lundy, 1979). Regardless of whether pulse fishing is opted for or not, yield per recruit can be optimized. The most effective way of achieving this in a scallop fishery is through introduction of a meat count regulation. The optimal count is about 22 meats/lb (48 meats/kg), and with the present average age of exploitation, introduction of a meat count slightly above the optimum is not

expected to reduce landings. Introduction of a meat count regulation now will help maximize yield and conserve prerecruits during the expected low landings in future years. Meat counts regulations were proposed for the Scotian Shelf (Jamieson et al., 1980), and together these areas are the only regions with no scallop management. Historically, the inshore fleet has opposed any management measures but with sufficient biological data to manage effectively, failure by government to introduce optional regulations now would seem inappropriate.

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TABLE 1. Catch data and comments for each sample station. Region 1 = Centreville; 2 = Gullivers Head; 3 = Broad Cove; 4 = Digby Gut; 5 = Delaps Cove; 6 = between the above regions; 7 = Annapolis Basin. Location: 1 = inshore; 2 = offshore.

| Station | Region | Location | Total round catch (kg) | Remarks |
|---|---|---|---|---|
| 1 | 3 | 2 | 55 | Commercial gear |
| 2 | 3 | 2 | 24 | " " |
| 3 | 3 | 2 | 64 | " " |
| 4 | 3 | 2 | 41 | " " |
| 5 | 3 | 2 | 53 | " " |
| 6 | 3 | 2 | 69 | " " |
| 7 | 3 | 2 | 60 | " " |
| 8 | 3 | 2 | 45 | Commercial gear with liners |
| 9 | 3 | 2 | 42 | " " " " |
| 10 | 3 | 2 | 46 | " " " " |
| 11 | 3 | 2 | 53 | " " " " |
| 12 | 3 | 2 | 58 | " " " " |
| 13 | 3 | 2 | 33 | " " " " |
| 14 | 3 | 2 | 62 | " " " " |
| 15 | 4 | 1 | 32 | Survey gear for rest of survey |
| 16 | 4 | 1 | 20 | Drag #1, 2, 6 flipped over |
| 17 | 4 | 1 | 19 | Drag #4, 2 flipped over |
| 18 | 3 | 2 | 34 | |
| 19 | 3 | 2 | 29 | |
| 20 | 3 | 2 | 24 | |
| 21 | 3 | 2 | 42 | |
| 22 | 4 | 2 | 20 | |
| 23 | 4 | 2 | 32 | |
| 24 | 4 | 2 | 38 | Hake found in scallops |
| 25 | 4 | 2 | 38 | |
| 26 | 4 | 2 | 49 | |
| 27 | 3 | 2 | 28 | |
| 28 | 4 | 2 | 58 | |
| 29 | 4 | 2 | 24 | |
| 30 | 4 | 2 | 34 | |
| 31 | 4 | 2 | 16 | |
| 32 | 4 | 2 | 17 | Some old scallops with epiphytes |
| 33 | 4 | 2 | 29 | |
| 34 | 4 | 2 | 35 | |
| 35 | 4 | 2 | 25 | |
| 36 | 4 | 2 | 41 | |
| 37 | 3 | 2 | 61 | |
| 38 | 4 | 2 | 51 | |
| 39 | 4 | 2 | 54 | |
| 40 | 3 | 2 | 39 | |

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TABLE 1 Contd...

| Station | Region | Location | Total Round Catch (kg) | Remarks |
|---|---|---|---|---|
| 41 | 3 | 1 | 53 | |
| 42 | 4 | 1 | 31 | |
| 43 | 3 | 1 | 46 | |
| 44 | 3 | 1 | 35 | |
| 45 | 3 | 1 | 29 | |
| 46 | 3 | 1 | 29 | |
| 47 | 3 | 1 | 59 | |
| 48 | 4 | 1 | 27 | |
| 49 | 3 | 1 | 29 | |
| 50 | 4 | 1 | 29 | |
| 51 | 4 | 1 | 61 | Liners torn in #3, 4. |
| 52 | | omitted | | |
| 53 | 2 | 2 | 33 | Drag turned over |
| 54 | 2 | 1 | 90 | Tow bar flipped; hoods full of mussels |
| 55 | 2 | 2 | 39 | " " " " " " |
| 56 | 2 | 1 | 22 | |
| 57 | 2 | 1 | 18 | |
| 58 | 2 | 1 | 30 | |
| 59 | 2 | 1 | 42 | |
| 60 | 2 | 1 | 50 | |
| 61 | 2 | 1 | 29 | |
| 62 | 4 | 1 | 27 | |
| 63 | 4 | 1 | 27 | |
| 64 | 4 | 1 | 21 | |
| 65 | 4 | 1 | 37 | #4 hood full of moss or gravel. |
| 66 | 6 | 1 | 47 | |
| 67 | 5 | 1 | 30 | |
| 68 | 5 | 2 | 19 | |
| 69 | 7 | 1 | 39 | |
| 70 | 1 | 1 | 13 | |
| 71 | 1 | 1 | 75 | |
| 72 | 1 | 1 | 78 | |
| 73 | 6 | 1 | 58 | |
| 74 | 2 | 2 | 46 | |
| 75 | 2 | 2 | 31 | |
| 76 | 2 | 1 | 34 | |
| 77 | 2 | 1 | 43 | |
| 78 | 2 | 2 | 28 | |
| 79 | 6 | 1 | 32 | |

TABLE 2. Individual bucket catch comparisons of both an unlined and lined, experimental, 7-gang Digby drag fishing the same offshore location.

A. Unlined Buckets

| | | Number | | | |
|---|---|---|---|---|---|
| | | Prerecruit | | Recruit | |
| Bucket No. | n | mean | SE | mean | SE |
| 1 | 7 | 4.7 | 4.7 | 78.4 | 9.0 |
| 2 | 7 | 7.1 | 5.0 | 52.4 | 9.0 |
| 3 | 7 | 0 | | 57.9 | 9.9 |
| 4 | 7 | 11.9 | 6.0 | 58.6 | 9.3 |
| 5 | 7 | 0 | | 55.7 | 6.4 |
| 6 | 7 | 0 | | 46.9 | 7.0 |
| 7 | 6 | 0 | | 66.7 | 13.2 |
| Total | 48 | 3.4 | | 58.2 | |

B. Lined Buckets

| | | | | | |
|---|---|---|---|---|---|
| 1 | 7 | 47.1 | 12.4 | 55.0 | 6.0 |
| 2 | 7 | 45.1 | 15.3 | 48.6 | 5.1 |
| 3 | 7 | 37.0 | 9.1 | 48.4 | 6.7 |
| 4 | 7 | 65.3 | 16.0 | 65.3 | 12.6 |
| 5 | 7 | 47.7 | 17.3 | 50.7 | 6.7 |
| 6 | 7 | 33.0 | 11.9 | 41.4 | 8.1 |
| 7 | 7 | 45.1 | 14.9 | 60.6 | 15.9 |
| Total | 49 | 45.9 | | 52.9 | |

TABLE 3. Individual average bucket catches using the survey gear (Fig. 2). Catches are averaged over all the locations fished in either the offshore or inshore area.

| Bucket No. | n | Number | | | |
|---|---|---|---|---|---|
| | | Prerecruit | | Recruit | |
| | | mean | SE | mean | SE |
| OFFSHORE | | | | | |
| A. Unlined Buckets | | | | | |
| 1 | 29 | 5.7 | 3.5 | 50.4 | 7.6 |
| 2 | 29 | 3.0 | 1.5 | 30.6 | 3.2 |
| 5 | 30 | 2.8 | 1.8 | 38.4 | 3.6 |
| 6 | 29 | 4.0 | 2.4 | 32.6 | 2.7 |
| Total | 117 | 3.9 | | 38.0 | |
| B. Lined Buckets | | | | | |
| 3 | 29 | 33.6 | 6.8 | 31.1 | 3.5 |
| 4 | 29 | 35.9 | 7.9 | 32.0 | 3.3 |
| 7 | 28 | 41.6 | 4.5 | 30.2 | 3.1 |
| Total | 86 | 37.0 | | 31.1 | |
| INSHORE | | | | | |
| C. Unlined Buckets | | | | | |
| 1 | 35 | 8.8 | 3.9 | 27.4 | 3.1 |
| 2 | 34 | 10.9 | 4.4 | 24.6 | 3.2 |
| 5 | 34 | 13.1 | 5.7 | 33.4 | 3.2 |
| 6 | 30 | 3.4 | 1.5 | 32.1 | 3.5 |
| Total | 133 | 9.2 | | 29.3 | |
| D. Lined Buckets | | | | | |
| 3 | 34 | 51.7 | 12.1 | 29.3 | 3.6 |
| 4 | 34 | 46.0 | 11.3 | 25.5 | 3.6 |
| 7 | 34 | 34.6 | 11.2 | 25.7 | 3.0 |
| Total | 102 | 44.1 | | 26.9 | |

TABLE 4. Mean number at age of scallops fished by the different drag types in inshore, Bay of Fundy waters off Digby, N.S. in both 1978 and 1979.

| Year class (fished in 1979) | Age (yr) | A. Unlined drag | | B. Lined drag | |
|---|---|---|---|---|---|
| | | 1978 | 1979 | 1978 | 1979 |
| 1977 | 2 | 0.0 | 12.8 | 3.0 | 34.0 |
| 1976 | 3 | 4.0 | 3.3 | 31.0 | 18.7 |
| 1975 | 4 | 5.0 | 16.9 | 10.8 | 48.2 |
| 1974 | 5 | 28.0 | 8.3 | 14.0 | 8.3 |
| 1973 | 6 | 84.0 | 17.6 | 37.0 | 11.6 |
| 1972 | 7 | 122.0 | 56.7 | 69.0 | 42.8 |
| 1971 | 8 | 46.0 | 49.1 | 25.0 | 37.5 |
| 1970 | 9 | 18.0 | 21.0 | 11.0 | 20.2 |
| 1969 | 10 | 11.0 | 13.1 | 5.0 | 9.7 |
| | 11+ | 12.0 | 10.5 | 6.0 | 7.6 |

| | | C. Back cover* | D. Hood* |
|---|---|---|---|
| 1977 | 2 | 1.6 | 1.9 |
| 1976 | 3 | 1.1 | 0.2 |
| 1975 | 4 | 3.5 | 0.7 |
| 1974 | 5 | 0.3 | 0.0 |
| 1973 | 6 | 0.0 | 0.2 |
| 1972 | 7 | 0.0 | 0.3 |
| 1971 | 8 | 0.0 | 0.3 |
| 1970 | 9 | 0.0 | 0.2 |
| 1969 | 10 | 0.0 | 0.1 |
| | 11+ | 0.0 | 0.2 |

*1979 only

TABLE 5. Mean number at age of scallops fished by the different drag types in offshore Bay of Fundy waters in 1979.

| Year class (fished in 1979) | Age (yr) | A. Unlined drag | B. Lined drag |
|---|---|---|---|
| 1977 | 2 | 0.2 | 2.5 |
| 1976 | 3 | 1.7 | 16.1 |
| 1975 | 4 | 13.8 | 48.7 |
| 1974 | 5 | 13.4 | 9.4 |
| 1973 | 6 | 51.0 | 27.9 |
| 1972 | 7 | 106.5 | 80.5 |
| 1971 | 8 | 42.3 | 34.6 |
| 1970 | 9 | 31.3 | 11.8 |
| 1969 | 10 | 4.6 | 3.9 |
| | 11+ | 2.5 | 1.5 |
| | | C. Back cover* | D. Hood* |
| 1977 | 2 | 0.0 | 0.6 |
| 1976 | 3 | 0.1 | 0.5 |
| 1975 | 4 | 3.1 | 0.7 |
| 1974 | 5 | 0.3 | 0.1 |
| 1973 | 6 | 0.3 | 0.8 |
| 1972 | 7 | 0.3 | 1.5 |
| 1971 | 8 | 0.0 | 1.1 |
| 1970 | 9 | 0.0 | 0.3 |
| 1969 | 10 | 0.0 | 0.1 |
| | 11+ | 0.0 | |

* 1979 only

TABLE 6. Age-specific drag selectivity and relative mean inshore age class numbers per tow path of a 7-gang Digby drag, projected from an end, unlined bucket's catch in 1979. Estimated area per tow is 2919 $m^2$, and recruits are scallops older than age three.

| Age | % Efficiency | % Retention | % Fished | Estimated number at age | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Centreville | Gullivers Head | Broad Cove | Digby Gut | Delaps Cove |
| 3 | 1.25 | 25 | 0.3 | 5440 | 3368 | 6536 | 3736 | 0 |
| 4 | 4.75 | 95 | 4.5 | 353 | 303 | 450 | 456 | 0 |
| 5 | 5.0 | 100 | 5.0 | 372 | 128 | 140 | 162 | 120 |
| 6 | 5.0 | 100 | 5.0 | 1412 | 322 | 168 | 210 | 100 |
| 7 | 5.0 | 100 | 5.0 | 2800 | 1108 | 1112 | 740 | 256 |
| 8 | 5.0 | 100 | 5.0 | 2480 | 900 | 872 | 734 | 1330 |
| 9 | 5.0 | 100 | 5.0 | 620 | 354 | 406 | 440 | 806 |
| 10 | 5.0 | 100 | 5.0 | 106 | 202 | 396 | 304 | 490 |
| 11+ | 5.0 | 100 | 5.0 | 46 | 162 | 198 | 306 | 756 |
| | | | No. stations | 3 | 9 | 7 | 11 | 1 |
| | | | Total recruits | 8189 | 3479 | 3742 | 3352 | 3858 |
| | | | Avg. density recruits per $m^2$ in 1979 | 2.81 | 1.19 | 1.28 | 1.15 | 1.32 |
| | | | Avg. density recruits per $m^2$ in 1978 | 2.83 | 2.51 | 1.73 | 1.94 | - |

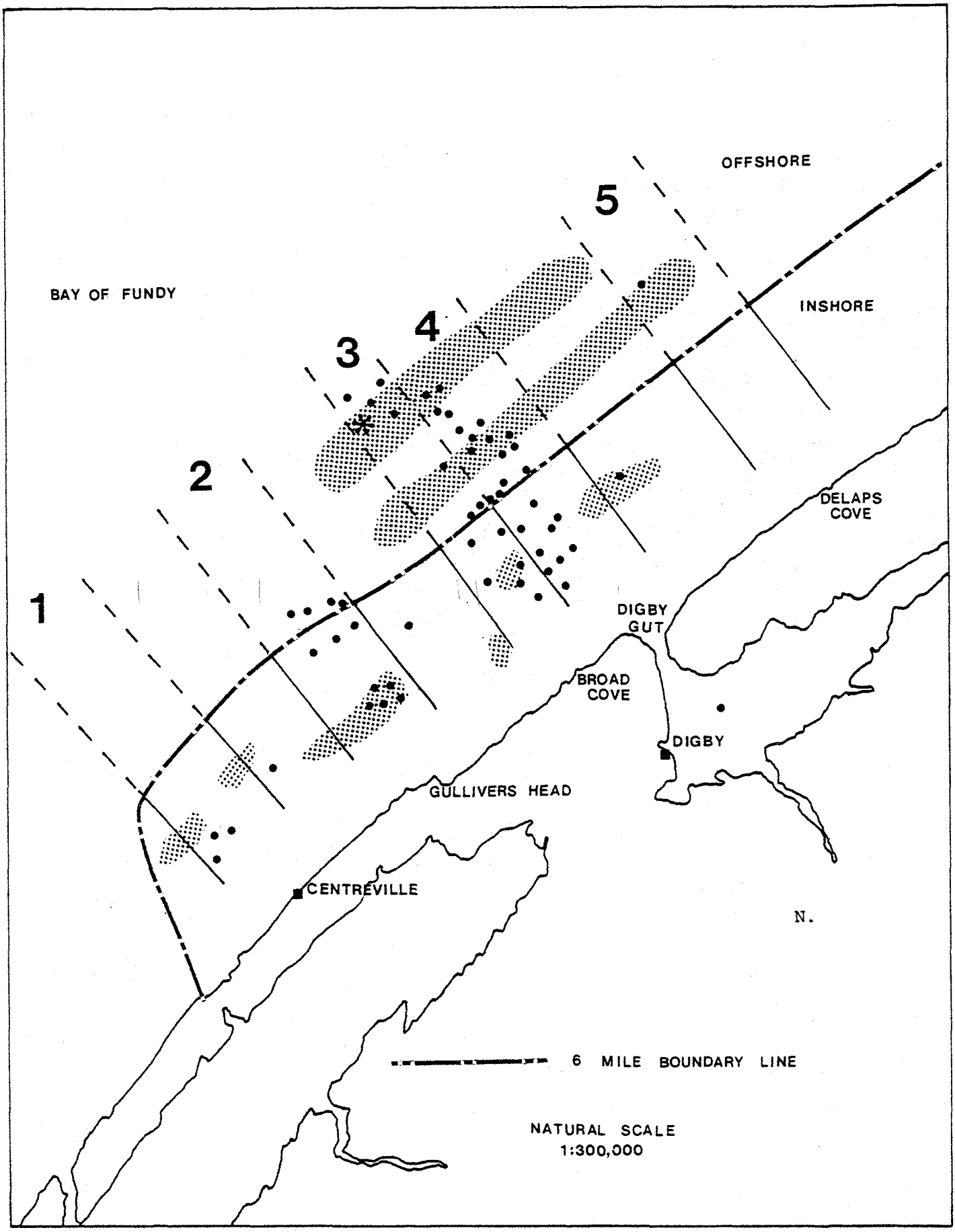
TABLE 7. Age-specific drag selectivity and relative mean offshore age class numbers per tow path of a 7-gang Digby drag in 1979, projected from an end, unlined bucket's catch. Estimated area per tow is 2919 $m^2$, and recruits are scallops older than age three.

| Age | % Efficiency | % Retention | % Fished | Estimated number at age | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Centreville | Gullivers Head | Broad Cove | Digby Gut | Delaps Cove |
| 3 | 3.0 | 25 | 0.75 | | 780 | 833 | 1049 | |
| 4 | 11.4 | 95 | 10.8 | | 68 | 173 | 139 | |
| 5 | 12.0 | 100 | 12.0 | | 69 | 182 | 93 | |
| 6 | 12.0 | 100 | 12.0 | | 325 | 618 | 371 | |
| 7 | 12.0 | 100 | 12.0 | | 515 | 1119 | 901 | |
| 8 | 12.0 | 100 | 12.0 | | 319 | 386 | 352 | |
| 9 | 12.0 | 100 | 12.0 | | 29 | 123 | 395 | |
| 10 | 12.0 | 100 | 12.0 | | 21 | 27 | 49 | |
| 11+ | 12.0 | 100 | 12.0 | | 27 | 7 | 34 | |
| | | | No. stations | 0 | 5 | 7 | 16 | 0 |
| | | | Total recruits | | 1373 | 2635 | 2334 | |
| | | | Avg. density recruits per $m^2$ | | 0.47 | 0.90 | 0.80 | |

Table 8. Landings (mt meat) by the Bay of Fundy scallop fleet in 1978 and 1979

| Area | 1978 | 1979 |
|---|---|---|
| Bay of Fundy | 482.9 | 442.0 |
| Georges Bank | 262.0 | 3.3 |
| Scotian Shelf | 4.8 | 440.7 |
| (Browns) | (4.8) | (172.5) |
| (German) | - | (268.2) |
| Total | 749.7 | 886.0 |

Figure 1. The fishing ground sampled off Digby, N.S. in 1979. 1 = Centreville; 2 = Gullivers Head; 3 = Broad Cove; 4 = Digby Gut; 5 = Delaps Cove. Shaded areas = commercial beds as outlined by Dickie (1955) * = location of experimental tows.



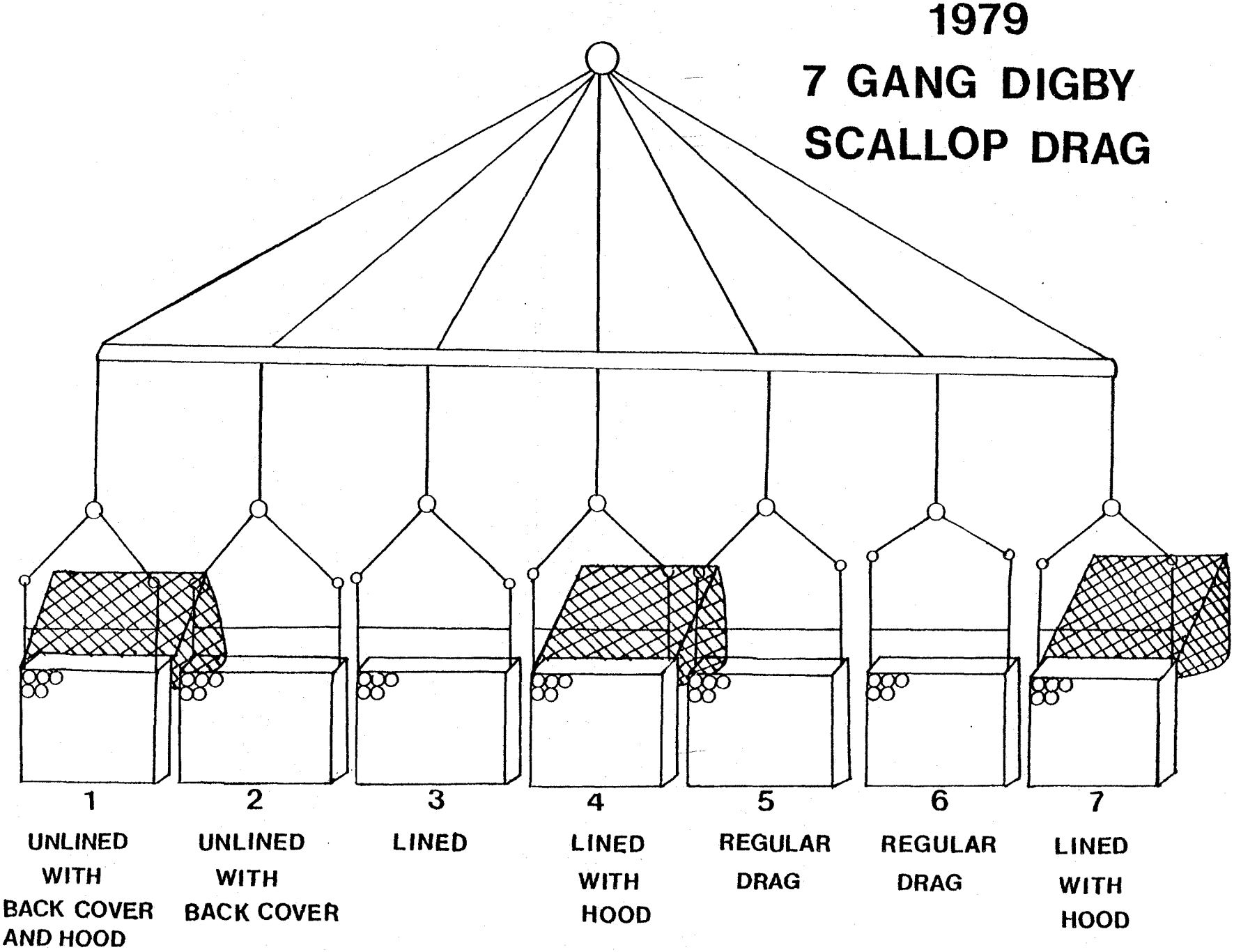



Figure 2. The commercial, 7-gang drag used in the 1979 Bay of Fundy resource survey and its modifications for research purposes. Individual bucket dimensions are given in Jamieson and Lundy (1979).

Figure 3. Meat weight - shell height relationships for scallops exploited by the Bay of Fundy scallop fishing fleet. A, Georges Bank; B, Passamaquoddy Bay; C, off Digby, N.S. at depths less than 60 fathoms; D, Browns Bank.

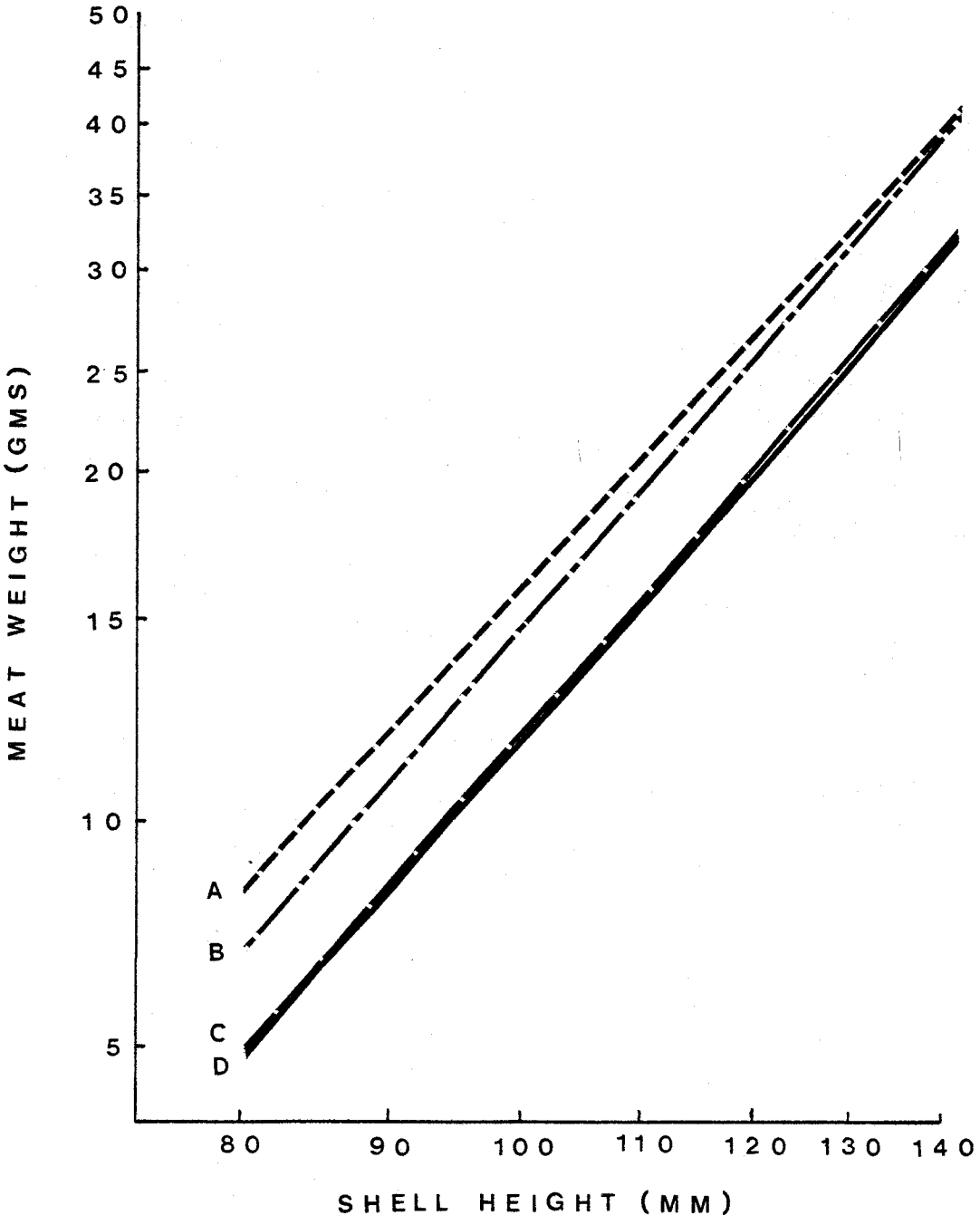


Figure 4. Yields and yield isopleths (kg) per 10,000 recruits calculated for Bay of Fundy scallop off Digby, N.S. at depths of less than 60 fathoms. $t_o'$ = age (years) of first capture.
F = fishing mortality