Evaluation of the Bay of Fundy scallop stock and its fishery - (plus a yield per recruit analysis)

By

G. Robert M.A.E. Butler-Connolly and M.J. Lundy
Invertebrates Fisheries and Aquaculture Division
Biological Sciences Branch
Halifax Fisheries Research Laboratory
Department of Fisheries and Oceans
Scotia-Fundy Region
P. O. Box 550
Halifax, N. S.
B3J 2S7

ABSTRACT

With the Inshore / Offshore Agreement of September 1986 grounds fished by the offshore and inshore fleets are formally segregated at latitude 43^0 40' North with the offshore to the south of that line and the inshore to the north of it. New conservation measures were introduced in December 1987 for the Bay of Fundy and its approaches (meat count, minimum shell height, maximum gear width, and expansion of the inside fishing zone).

In 1987, an extremely low stock abundance led to poor performance during the outside zone fishing season between May and September. The opening of the inside fishing zone in October allowed phenomenal catches to be observed. Officially, only 70 t. were statistically recorded for the first half of the season (to Dec. inclusive) because of poor log compliance. We estimate that over 600 t. were taken from this zone. With no reason to believe that this trend would change in the near future, catches from the 1987 - 88 inside season will be the highest since the beginning of the fishery in 1922, peaking at 1,200 t. CPUEs were also outstanding at 14.82 kg / hm but shucking was slowed down because of the small meat size (mean: 10 g, range: 3 - 55 giving 50 meats / 500 g on average). A yield per recruit analysis indicate that under high F an optimal meat count would be 24 / 500 g while under low F it would be 33 / 500 g for this zone.

Given the state of the stocks, especially in the inside zone where surveys have found great quantities of young scallops (at or below age 5), the fishery will continue in its boom phase although with significant yield losses.

RESUME

La flotte hauturière et les flottilles côtières en sont venues à une entente en Septembre 1986 pour se partager les zones de pêche à la latitude 43^0 40' Nord avec la flotte hauturière demeurant au sud de cette ligne et les côtières au nord. Des nouvelles mesures de conservation furent introduites en Décembre 1987 pour la Baie de Fundy et ses approches (compte de chairs, hauteur de coquille minimale, largeur d'engin de pêche maximale et agrandissement de la zone de pêche intérieure).

En 1987, une abondance de stock extrêmement basse conduisit à des rendements pauvres pendant la saison de pêche extérieure durant Mai - Sept. L'ouverture de la zone de pêche intérieure en Octobre permit d'observer des prises phénoménales. Officiellement, rien que 70 t. ont été enregistrées dans les Statistiques pour la première moitié de la saison (jusqu''à Décembre inclus) à cause d'un très faible retour des journaux de bord. Nous estimons que plus de 600 t. proviennent de cette zone. Comme rien ne laisse supposer de changements dans cette direction, les prises de la saison de pêche 1987 - 88 seront probablement les plus élevées depuis le début de cette pêcherie en 1922, atteignant près de 1,200 t. Les P.U.E. sont aussi à la hausse à 14.82 kg / hm mais l'écaillage est ralenti par la petite taille des viandes (moyenne: 10 g; de 3 à 55 g donnant un compte de chairs moyen de 50 / 500 g). Une analyse du rendement par recrue indique qu'avec des valeurs de F élevées, un compte optimal serait de 24 / 500 g et avec des valeurs de F plus petites, 33 / 500 g pour cette zone.

Etant donné l'état des stocks, surtout la zone de pêche intérieure où les inventaires de recherche ont trouvé d'importantes quantités de jeunes pétoncles (5 ans ou moins), la pêche va continuer son expansion malgré des pertes significatives au point de vue du rendement.

INTRODUCTION

Prior to the Inshore / Offshore agreement of September 1986 between the different scallop sectors, competition for the resource located on common grounds led to over-capitalisation and intense pressure on the scallop stocks. As of 1987 the formal separation of the fleets (inshore: vessels under 19.8m and offshore: vessels over 19.8m) at latitude 43^0 40' North and major conservation initiatives in Bay of Fundy waters and approaches were put in place. Changes to existing regulations and new measures came into effect in December 1987 (Canada Gazette Part II, Vol. 121 no.25, SOR / DORS / 87-672). With respect to the traditional grounds near Digby, N.S. the changes concern the introduction of meat counts, 72 meats per 500 g during the period May 1 to September 30 and 55 meats per 500 g during the period October 1 to April 30 and a minimum shell height of 76 mm. Regulations dealing with scallop fishing gear were modified and expanded; a maximum over-all width of the gear (5.5 m) was re-introduced. Furthermore the inside zone where fishing is only allowed between October and April was expanded from 6 to 8 nautical miles from shore within an area between Parker's Cove and Sandy Cove, N.S.

The important recruitment pulse identified in the 1986 stock survey (Robert et al 1987) began to show up in the commercial gear when the 1986-87 inside fishing season opened. The extensive depletion of the stocks led to a great deal of effort on the incoming year-class characterised by abundant but small size meats. Bay of Fundy fishermen requested that the inside zone be closed (on a voluntary basis from Jan. 1, 1987) until some management measures were in place to prevent or slow down the harvesting of low yield age groups.

Little fishing activity took place in the outside zone during the summer (May-Sept.) because of the extremely low abundance of the stocks. The Bay of Fundy fleet expended considerable amounts of effort on Georges Bank where they were allowed to fish 548 t of scallop meats under trip limits. The fleet faced extreme difficulties trying to keep out of the productive inside zone before the season actually opened in October; we estimate that about 100 t were caught illegally.

When the inside fishing season did open, no regulations were in place to have a conservation-oriented harvesting. The fishery was opened from October 1st to the 7th with high catches, tremendous CPUE, and low meat yields; it was then closed until November 14th. At that point there were some indications of compliance toward a rationalisation of the harvesting of the incoming recruitment until regulations became effective a month later. At the end of December (1987), catches and CPUE remain outstanding but yields are far from optimal. High catches are not reflected in the official statistics because of the very poor log compliance. Officially, the first half of the inside fishing season of 1987 - 88 (Oct.-Dec. inclusive) recorded under 70 t. landed and the superlative catches, highest encountered since the beginning of the fishery will not be adequately represented.

The Upper Bay of Fundy scallop fishery is also reporting an increase in landings but with higher effort.

This report puts into perspective the latest developments of the fishery on the traditional grounds and examines the results of a yield per recruit analysis since meat counts are becoming a management tool for the Bay of Fundy scallop fishery. .

METHODS

Fishing Information

All vessels over 25.5 G.T. are required to maintain logbooks where daily fishing activities are recorded. Catch-rates are computed from Class 1 data when information is provided on the

catch and its location, and effort in terms of hours fished and width of the gear. It is not possible to get effort data and areas fished from vessels less than 25.5 G.T. and/or under 14 m L.O.A.. However, their participation rate in the fishery and landings on a vessel basis may be estimated through sales slip records. This type of information collection was recently initiated by the Statistics Division, Department of Fisheries and Oceans, Halifax for scallop-licensed vessels.

Survey Procedures

Survey stations are randomly stratified according to the catch distribution. Stations are distributed in 3 to 4-mile bands running perpendicular to the shore. A description of the survey procedures may be found in Robert et al (1984). Combined logged data of 1986 and 1987 (to June) were used to establish the randomly catch-stratified stations; the depleted state of the stocks contributed to much lower availability of logged data. As in 1985 and 1986 the scallop beds explored during the 1987 stock survey extended upstream, beyond the conventional survey area. Stations off Hampton and off Young's Cove were added to cover those extra grounds visited by the Bay of Fundy fleet. At the analysis stage, survey data are also post-stratified according to fishing areas, usually referred to by a proeminent location or a headland, and fishing zones. An 'inside' fishing zone which used to be 6 nautical miles, presently set at 8 miles from shore between Parker's Cove and Sandy Cove is preserved for fishing during the winter months, from October to April inclusive when weather conditions might be less than ideal for small vessels in the open waters of the Bay. An 'outside' fishing zone, by opposition to inside, defines areas in the Bay where the majority of fishing activities are carried out between May and September inclusive.

Biological Data

Data has been collected since 1982 to study ageing, somatic and gonadal growth cycles in Bay of Fundy waters. Like previous investigators we have observed (Robert et al 1985) that growth (age) measured by shell ring-reading was a function of depth. Three depth-intervals have shown the most significance, under 85 m, 86-105 m, and over 105 m. This is an on-going study. At this point, 7051 scallops have been examined from materials sampled between 1982 and 1985. Three von Bertalanffy growth curves have been established with the following parameters:

Depth(m)	Height $_{\infty}$ (mm)	t_0	k
00-85	143.210	1.3800	0.2221
86-105	133.763	1.4011	0.2414
> 105	125.989	1.4469	0.2610

The meat weight on shell height allometric relationship was fitted by a least square regression. Allometric values derived from samples collected throughout the year from 1982 to 1986 were selected to represent year round conditions to incorporate as age specific meat weights in a yield per recruit analysis. Summaries of the data specifications are found in table 1. Equations generated by grouping data on an annual basis and a general one combining data from all years were derived (Fig. 1). This type of data is presented in this report only to the extent that it supports the yield per recruit analysis. Briefly, it may be said that there is a general overlap in the meat weight - shell height allometry between data from most years that were looked at, except for the odd 1983 set. The equation for 1982-86 combined data has parameters similar to the ones for 1985.

Yield per Recruit

The yield per recruit model used is the Thompson and Bell model. It allows for the input of age specific meat weights which is felt most important in the case of the deep-sea scallop. *Placopecten magellanicus* is characterised by a rapid growth rate especially for the ages that are fished commercially in Bay of Fundy waters. For modeling purposes natural mortality was set at 0.1 after Dickie (1955); age at first capture set at 5 years which corresponds to the first age group with a shell height greater than 76 mm, the minimum shell height that may be legally retained. In addition

to steady state conditions, the model assumes that all ages over 5 are fully selected.

RESULTS

The spatial distribution of scallop beds and their exploitation by numerous scallop fishing fleets in Bay of Fundy waters is quite complex. In this report, Bay of Fundy waters have been divided into three main areas of scallop-producing grounds: 1) the traditional beds in the vicinity of Digby, N.S.; 2) the Saint Mary's Bay scallop beds; 3) the Upper Parts of the Bay of Fundy.

The Traditional Beds in the Vicinity of Digby, N.S.

Ever since 1981 the total number of vessels carrying a Bay of Fundy scallop license has remained virtually constant both in Nova Scotia and in New Brunswick with the vast majority of vessels being in the largest category of vessels allowed (Table 2). After a gradual decline in participation rate from 1984 to 1986, activity has risen again in 1987 (Table 3) to 20 % over the previous year's level with an important segment conducted on Georges Bank. Log compliance is markedly reduced in 1987; 55 % of vessels supposed to log, filled at least one log. It is becoming increasingly difficult to have a representative data base for fishery performance.

The vast majority of Bay of Fundy scallop license holders carry one or more additional license(s) (Table 4); only 13 out of 96 license holders rely entirely on scallop fishing for their livelihood. Most vessels also carry a 'groundfish' license and / or swordfish; other species fished include herring, mainly in New Brunswick, lobster, squid, shrimp, and mackerel. Fishery performance for scallop and groundfish justify to a great extent the involvement from one fishery to the other and vice versa. As the Bay of Fundy scallop fleet experienced poor catch-rates in the Bay recently (1986-87), one could have presumed a low participation in the scallop fishery and heavy turnout in groundfish. But the exploitation of the lucrative Georges Bank scallop beds attracted 68 vessels in 1987, some of which did not fish the Bay at all.

Annual landings on the Nova Scotia side of the Bay of Fundy may indicate general trends in this fishery. Tables 5 and 6 list an historical profile of landings for statistical district 37 (Digby Neck), 38 (Digby), and 39 (Annapolis). After record high landings in 1981 and 1982 they have decreased steadily and markedly, until 1987. These figures may be misleading. When the traditional Digby stocks were not as abundant, the Bay of Fundy fleet ventured opportunistically on the western Scotian Shelf and sometimes, for a considerable fraction of the fleet's landings, to Georges Bank. During the 1980's this has taken place on a regular basis. Landing figures do not make the distinction as to location of the catch. In 1986 and 1987, Georges Bank contributed appreciably to the landings of the Bay of Fundy fleet (in the order of 500 t +).

Moreover, it is very difficult to get a reliable estimate of the total catches of the inner Bay of Fundy because of the delineation of the statistical areas 4Xr and 4Xs and the involvement of more than one fleet in the pursuit of the Bay of Fundy scallop fishery. In the early 1980s stocks in the Brier Island area located in the approaches to the Bay of Fundy sustained a fair exploitation according to logged catches (Robert et al 1984); statistically speaking, these catches were recorded from NAFO sub-subarea 4Xr to the same extent as catches from the traditional grounds. During 1986, fishing around Brier Island has been minimal. Statistical catches from NAFO sub-subarea 4Xs include catches from the Upper Bay of Fundy fleet near the upper end of the Bay, some of the catches from the distant side of the traditional grounds and all the catches from the Grand Manan area and the nearshore beds along the New Brunswick coast fished mainly by the Mid-Bay license holders of New Brunswick. Lately, for 1986 and 87 a sizable fraction of catches are statistically recorded under the generalistic sub-area 4X.

Adequate estimates for catches on the traditional grounds are difficult to obtain as, for one main reason, all catches which should be logged are not. The non-compliance with logbooks completion has developed into a serious problem over the last few years. Since this fishery operates on the equivalent of seasonal closures i.e. inside and outside fishing zones, catches may

be partitioned according to the zones and we may assume that catches from October to April, coming from the inside zone and statistical catches for sub-subarea 4Xr covering that time period should match relatively well. We further assume that effort and catch-rates associated with Class 1 catch data for that area during that time period are representative of the overall fishing performance. Statistical catches from the outside fishing zone (4Xr + 4Xs) i.e. May-September fit more loosely with Class 1 logged catches (Table 7a). If we relate the inside statistical catches and catch-rates on a per season basis (Table 7a), catch-rates around 7 kg/hm and about 250 t per season were maintained prior to 1980-81. Then catches increased sharply, up to 565 t in 1982-83, while CPUE went down to 5 kg/hm. This was followed by a dramatic decline both in terms of quantities caught and catch-rates with a very poor performance for 1985-86. Catch-rates continued to drop when the 1986-87 season opened and catches were very low. Only small size scallops were beginning to get caught in any amounts. Concerned with threats of growth-overfishing to their best grounds, fishermen requested that the inside fishing season be closed prematurely at the end of December (rather than carry its course until the end of April). During the summer of 1987, catches appear to be low but CPUE improved to 3.52 kg/hm; most of the fleet's effort was diverged to Georges Bank. The 1987-88 inside season had a tumultuous opening (see introduction), catch-rates rising significantly. Catch figures are highly misleading though. Statistical records (sub-subarea 4Xr) compiled about 70 t from October to December; logged catches amount to 47 t. But 450 t of catches supported by sales slips from those vessels fishing the inside zone were statistically recorded as 4Xu (u stands for unknown). Logged catches represent only 10 % of statistical catches from 4Xr and 4Xu. Confronted with such huge discrepancies between logged catches, statistics for 4Xr, and the tremendous quantities of scallops that were landed mostly in Digby we undertook an independent compilation of sales slips to estimate the possible production of the inside fishing zone. Selected fishermen interviews and surveillance reports corroborated the estimates. Our estimates relate to the total catches of statistical sub-subareas 4Xr and 4Xu; therefore, 4Xu statistics should be appropriated properly. In brief, about 630 t (including 100 t caught illegally prior to the opening of the season in October) were caught in the inside zone until the end of December, 1987. Preliminary indications for 1988 are that this trend continues.

Table 7b gives a monthly distribution in percentages of statistical catches for the inside zone. The first and last month of each season generally produce the most catches with December and January having the lowest figures. Already in 1955 Dickie (1955) had identified a very strong seasonal component to the fishery that he attributed to weather conditions. Although one would expect modern-day vessels to be more rugged, weather still plays a major role in the conduct of fishing activities. According to the logged data, it is not only the first and last month but the first and last 2 weeks of the fishing season that are of significance to the catch levels.

A 65-year time series of catches for the inside zone (or time period October-May when a restricted fishing zone was not in effect) illustrates (Fig. 2) that sharp rises and steep downfalls have taken place quite often during the existence of this fishery. However, the amplitude of the last fluctuation cycle (1975-1985?) is quite spectacular and has been matched only once previously in the 1930s. It appears that only a very short interval will separate the 1975-85 cycle from the next rise as it is anticipated, according to our estimates, that the 1987-88 season will go above the peak of the last cycle (600 t as of December 1987).

Monthly catch-rates (kg/hm) during the inside fishing season (Fig. 3) show a slight decrease from the beginning to the end within each fishing season. There is also a general decline in CPUE performance between seasons from the 1981-82 one to the last season for which a complete data set exists.

There is relatively little information available on meat weight distribution of catch from the inside zone. Port sampling activities outside of the summer season have always been minimal and the fragmentary data may not be representative. It seems that, until the 1987-88 season, meat weights were of good size giving meat counts in the 20 - 30 (meats per 500 g) range (Table 8). Meats fished in October 1987 weighted 10 g on average and belonged to the abundant pulse coming into the fishery. This is an important reduction in size compared to the traditional meat size associated with the Digby fishery. A 50 meat count became regulation in December 1987 so that this meat size is the smallest that may be legally caught.

Results from annual stock surveys are presented in tables 9 to 15 with detailed results of the three most recent surveys in tables 10 - 12. Survey locations for 1987 are plotted in figure 4. Quite an extensive area was covered with the expansion of the fleet's activities upstream from Digby, to Young Cove. Detailed survey results (Tables 10 - 12) announce a major improvement in the recruitment to the stocks on the traditional beds. The significant quantities of small scallops (ages 2 and 3) encountered in localised areas in 1986 were better observed in 1987 as their size increased. Although the lined gear is not 100 % efficient at catching small size animals, numbers obtained are an indication of significant changes from the bleak recruitment picture offered by the 1985 survey results. This strong recruitment pulse was, however, preceded by a few year-classes of much lower abundance. Most commercial age groups remain fairly stable at low levels or, in some instances, have decreased further since 1985 (i.e. upstream from Digby). The stock improvement as announced by large aggregations of juvenile scallops, is localised off Digby Gut and Delaps Cove (Table 14) and off Gulliver's Head to a lesser extent. While the inside zone carries high quantities of juveniles (Table 15), the outside zone typically, has greater numbers of older scallops.

The Saint Mary's Bay Scallop Beds

In early 1985, a few (5-10) vessels exploited scallop beds in the vicinity of ledges on the Long Island side of Saint Mary's Bay and near the tip of Digby Neck in depths of 27 to 66 m. Lobster fishermen in the Bay got concerned as to the impact of scallop gear on lobster bottoms. The Bay was temporarily closed off to scallop draggers. By June a gentlemen's agreement was reached between the two groups with scallop dragging allowed between January 15th and February 28th and during the month of June. Catches approximated 7000 kg in 1985 with a mean catch-rate of 2.98 kg/hm; 1986 catches fell by 50 % to 3671 kg with a slightly lower CPUE at 2.26 kg/hm. In 1987 some dragging took place early in the year, 1872 kg only, but with improved catch-rates at 6.04 kg/hm. No biological information is available for those scallop beds.

A study (Robichaud et al 1987) suggests little adverse impact by scallop dragging. Although lobster fishing occurs over most of Saint. Mary's Bay, dragging takes place in less than 7 % of the Bay in areas of low lobster density.

The Upper Parts of the Bay of Fundy

The Upper Parts of the Bay of Fundy designation applies to the waters of the Bay included in the Upper Bay Management Zone. This zone includes the area east of a line drawn between Annapolis and Kings County on the Nova Scotia side of the Bay and between Saint John and Albert Co. on the New Brunswick side. Historically speaking, Minas Basin and Chignecto Bay at the upper end of the Bay of Fundy are not scallop-producing areas. Until recently, landings of less thant 10 t of meats per year had been recorded. Local fishermen have become interested in the scallop fishery in the 1980's. To participate in the fishery, vessels, all under 14 m L.O.A., are issued a Upper Bay (3-mile) scallop license. Up to 1986 there had been 14 licenses issued annually with only one vessel over 25.5 G.T. (Table 16); licenses have inceased by 2 since then. About 60 % of these licenses used the privilege. A few of these licenses are issued in New Brunswick (Albert Co. where there are also Mid-Bay scallop license holders) with the remainder in Colchester and Cumberland, Kings Counties, Nova Scotia. In all likelihood these small vessels land their catches at home ports in Cumberland Co. (statistical districts 24, 40, and 44) and Albert Co. (79). Landings from these districts reflect the productivity of the Upper Parts of the Bay of Fundy. Since 1983, landings were gradually increasing (Table 18) with fishing taking place between April and October; 1986 shows a temporary decline before rebounding in 1987. Landings for district 79 include catches from both Mid-Bay and Upper Bay license holders. Landings by statistical district compare well with the summation of landings of all vessels located in the area. On a per vessel basis, active vessels averaged about 1600 kg for 1985; the figure dropped sharply in 1986 to rise twofold in 1987 (Table 17). Some vessels have landed considerably more than average while others landed as little as 100 kg. Scallop fishing may only be considered as an accessory activity in a multi-fishery system. Since these vessels are under 25.5 G.T. they are not required to provide effort data by logbooks; hence there is little fishery information available. As a whole scallop abundance is fairly limited in the immediate area. The 1987 catch improvement is more likely the result of increased effort rather than a rise in available stocks as verbally reported by some fishermen.

Yield per Recruit

Important annual variability had been observed when a yield per recruit analysis was carried out (Robert et al 1985) with the two years of meat yield data available at the time. A larger data base now exists and the aspects of inter-annual variability may be examined more thoroughly. Considered on an individual basis, 1984 and '85 data share the highest value of yield at age, then 1982, '83 with 1986 data with the lowest values. A difference of 23 - 25 % exists between the sets of annual data with the lowest and highest yields, the greater difference (25 %) belonging to older ages (10 yrs +). All available data have also been combined together to generate a single equation. A smaller difference of 7 - 8 % exists between yields at age using the combined values of 1982 - 86 data compared to using the highest values that would have been produced by a single set of annual data. In this case, the greater difference (8 %) relates to the younger ages (under 7 yrs). Meat weights at age obtained from the combined values 1982 - 86 equation were used to map yield at age of selected ages for different fishing mortality (F) rates according to the three depth strata (Fig. 5). Depending on F rates the best yield at age changes slightly. For F rates less than 0.8, age 8 scallops produce the best yields; a small downward gradient of yields occurs from the shallow to the deep stratum. For F rates greater than 0.8, age 10 scallops give the best yields and at levels slightly higher than for lower F's; once again deeper waters yield less for the same ages at the same rates. Yields decrease significantly for scallops older than 10 yrs, regardless of depth. The highest possible yield is identified with age 10 scallops at F rates of 1.4. F rates selected for the most yield at age follow the same pattern for the 0 - 85 m and 86 - 105 m strata 0.4, 0.4, 0.6, 1.0, 1.4, ... for ages 5, 6, 7, 8, 9 - 12 respectively (0 - 85 m: 7.4 g, 8.7, 10.0, 11.0, 11.9, 12.2, 11.7, 9.3). Below 105 m, F rates are a bit higher for the same ages 0.4, 0.6, 0.8, 1.2, 1.4, ...

DISCUSSION

Logbook compliance

Logbook completion by the Bay of Fundy fleet has dropped substantially over the last three years and has reached a critical level in 1987. Only 10 % of the catches from the first half of the inside fishing season 1987 - 88 would have been logged. Almost non-existent compliance with logbooks completion has serious consequences with respect to the evaluation of the fishery performance and, ultimately, sound management strategies.

"Official" catch records are the statistical catches as compiled by the Statistics Division of the Department of Fisheries and Oceans. To continue with the example mentionned above, if one considers only the "official" catch data, the productivity of the scallop beds in the inside zone (Table 7b) would be seriously underestimated. It would appear that the Bay of Fundy fleet continues to have another season of poor results. But any one remotely connected to the Bay of Fundy fleet activities, even informally, is presently aware of the Digby area's good fortune. The collection of inaccurate catch data may mislead the analysis, jeopardise the interpretation of current events, and draw the wrong conclusions.

Erroneous conclusions do not provide support toward better fishery management. Lack of adequate analytical data may seriously impede proper management. Not only are catch data not identified properly as far as quantities caught and location of origin but effort information is not gathered and it becomes quite difficult to assess catch-rates and fishery performance in general. It is doubtful that lack of knowledge about this long standing fishery has any advantages even to neglectful fishermen.

Effort Rationalisation

The dismal fishery performance of the recent past illustrates the overcapacity of the Bay of Fundy fleet. Although catch-rates are presently at record levels, they will not be maintained forever and the fleet's problems are sidelined only temporarily. The multiplicity of licenses of the Bay of Fundy fleet has been considered by some as a possible tool toward effort rationalisation. Table 4 shows that the vast majority of scallop license holders do carry other licenses. Some suggestions

have come forward such as the selective activation of license when applied for at the beginning of the year. If one chooses scallop over groundfish, one would not be able to switch back and forth between the 2 licenses during the year period but would have to stay with the selected license for the whole year. This proposal would limit the short term opportunities of fishermen who developed an interest in the fishery only when the going is good. However, it could inject long term stability in spreading the available fishable biomass over a longer period of time.

Another approach to reduce pressure on the stocks would be to modify the duration of the inside fishing season now taking place from October 1 to April 30, 7 months. Shortening by any lengths of time, 2-week, 1-month, at the beginning or the end of the season would be more effective than a month period in the middle of the season. December represents 6 % of inside catches on average while October's range 33 - 55 % (Table 7b). December and January have very low production (2 - 8 % of season); they also coincide with the worst weather conditions of the year. Suspending the fishery during that time would have the least effects.

Yield improvement

Since variability in the yield of scallop meats may amount to 25 % between different years, it would be misleading to apply an allometric relationship meat weight - shell height derived from a single year of data directly to another time period. Since it may not always be possible to carry extensive sampling and analytical programmes every year, let alone apply the findings to one particular aspect of management, 5 years of available data were pooled together, the 1982 - 86 combined values, to generate an equation that would include a much larger sampling variability than the one encountered within a single year. The equation derived from combined values has reduced to 8 % the difference between this equation and the maximum value given by any equation representing one year of data.

Catch sampling when the 1987 - 88 inside fishing season opened revealed a significant departure from the traditional meat size encountered in this fishery. Targeting the newly recruited abundant year-class, meat counts were 50 per 500 g on average instead of the usual 20 - 30 range (Table 8). High densities of scallops in the fished areas improved catch-rates no doubt but the yield from shucked meats could have been better and increase the total rate of return. A yield per recruit analysis shows that under high exploitation rates, F over 0.8, age 10 scallops would give the heaviest meats at an approximate count of 24 while under light exploitation rates, F under 0.8, a count of 33 meats per 500 g, age 8 scallops would offer the most meat yield. Regardless of how hard the exploitation on the inside stocks is, the meat counts presently obtained, of 50 meats per 500 g are too high and losing significant quantities of yield to the fishery. In the outside zone, meat count levels for optimum yields are a bit lower because of slower growth; counts of 30 and 40 would correspond to high and low fishing mortality rates respectively.

REFERENCES

Caddy, J.F. 1979. Long-term trends and evidence for production cycles in the Bay of Fundy scallop fishery. Rapp. P.-v. Reun. Cons. Int. Explor. Mer 1975: 97-108.

Dickie, L.M. 1955. Fluctuations in abundance of the giant scallop, *Placopecten magellanicus* (Gmelin), in the Digby area of the Bay of Fundy. J. Fish. Res. Bd Can. 12(6): 797-857.

Robert, G., M.J. Lundy, and M.A.E. Butler-Connolly. 1984. Recent events in the scallop fishery of the Bay of Fundy and its approaches. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 84/71: 41p.

Robert, G., M.A.E. Butler-Connolly, and M.J. Lundy. 1985. Bay of Fundy scallop stock assessment, 1984. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 85/27: 29p.

Robert, G., M.A.E. Butler-Connolly, and M.J. Lundy. 1987. Perspectives on the Bay of Fundy scallop stock and its fishery. Can. Atl. Fish. Sci. Adv. Comm. Res. Doc. 87/27: 30p.

Robichaud, D.A., A.M. Williamson, and D.E. Graham. 1987. Characteristics of the St. Mary's Bay lobster stock in relation to scallop gear impact. Can. MS Rep. Fish. Aquat. Sci. 1955: 17p.

Table 1.- Characteristics of scallop samples collected from the commercial fleet for meat yield analysis from 1982 to 1986.

Temporal variability of collection. N(n): Number of samples(number of scallops in samples).

	1982	1983	1984	1985	1986	Totals
First quarter	2(57)	2(48)	2(60)	8(240)	3(90)	17(495)
Second "	5(149)	9(268)	4(118)	9(270)	6(180)	33(985)
Third "	9(267)	10(300)	7(210)	13(390)	7(209)	46(1376)
Fourth "	2(44)	2(60)	7(190)	7(208)	1(30)	19(532)
Totals	18(517)	23(676)	20(578)	37(1108)	17(509)	115(3388)

Statistics of scallop data collected

Year	N	Mean	S.D.	Min	Max
Shell height (mm)					
1982	517	102	13.5	65	145
1983	676	105	11.7	75	145
1984	578	105	13.8	53	150
1985	1108	102	12.6	65	145
1986	509	99	10.2	72	129
Meat weight (g)					
1982	517	13.38	7.39	2.95	55.75
1983	676	12.53	6.98	3.60	53.52
1984	578	14.91	7.49	1.44	46.71
1985	1108	13.67	6.71	2.94	47.63
1986	509	9.05	3.76	2.48	23.44

Grouping on a percentage basis according to:

Shell height

Year	N	% <100mm	% ≥100mm
1982	517	44	56
1983	676	36	64
1984	578	30	70
1985	1108	42	58
1986	509	52	48

Meat weight

Year	N	% <10g	% 10-11.9g	% 12-14.9g	% ≥15g
1982	517	38	12	20	30
1983	676	43	20	16	21
1984	578	26	16	19	39
1985	1108	36	11	18	35
1986	509	67	16	9	8

Table 2.- Number of vessels carrying a Bay of Fundy scallop license from 1979 to 1987. Eligible and banked licenses are not included here. Source: Licensing Unit, Fisheries and Oceans, Halifax. Number of vessels based in Nova Scotia + number of vessels based in New Brunswick.

Year	under 25.5 G.T.		over 25.5 G.T.		Total
	under 14m	14-19.8m	under 14m	14-19.8 m	
1979	9 + 13	2 + 0	1 + 0	41 + 7	73
1980	5 + 13	1 + 0	2 + 0	52 + 7	80
1981	8 + 14	1 + 0	3 + 0	64 + 6	96
1982	8 + 8	1 + 0	4 + 4	65 + 4	94
1983	3 + 7	1 + 0	7 + 5	67 + 5	95
1984	2 + 7	0 + 0	7 + 5	70 + 5	96
1985	2 + 7	0 + 0	7 + 4	71 + 3	94
1986	1 + 7	0 + 0	7 + 5	70 + 3	93
1987	0 + 6	0 + 0	8 + 4	68 + 5	91

Table 3.- Number of (1) Bay of Fundy licensed vessels (Source: Licensing Unit, Fisheries and Oceans, Halifax), (2) active fishing licenses for vessels over 25.5 G.T. supposed to follow log procedures, and (3) vessels complying with log procedures.

Year	(1)	(2)	(3)
1981	96	68	65
1982	94	66	63
1983	95	77	74
1984	96	82	76
1985	94	70	67
1986	93	67	57
1987	91	80	44

Table 4.- Additional licenses carried by Bay of Fundy scallop license-holders for the year 1987. This table considers 96 Bay of Fundy scallop licenses only. During 1987, 4 Bay of Fundy licenses were banked; another one was eligible but not renewed. Source: Licensing Unit, Department of Fisheries and Oceans, Halifax.

Types and number of other licenses	
Groundfish (otter trawl, long lining, etc.)	65
Swordfish	42
Herring	16
Lobster	9
Squid	8
Shrimp	2
Mackerel	1
None	13
total	143

Number of Bay of Fundy scallop license-holders with ' n' additional licenses.

13	license-holders	do not carry	additional license(s).		
40	"	carry	1	additional license.	
31	"	"	2	additional licenses.	
9	"	"	3	"	"
1	"	"	4	"	"
2	"	"	5	"	"
total 96					

Table 5.- Annual landings (t of scallop meats) by statistical district (Digby Neck, Digby, and Annapolis); by vessel tonnage, (1): ≤ 25.5 G.T., (2): > 25.5 G.T. Prior to 1967, landings were not segregated by vessel tonnage. Source: Statistics Division., Fisheries and Oceans, Halifax..

District	37		38		39	
Tonnage	(1)	(2)	(1)	(2)	(1)	(2)
1960		102.17		157.23		0.84
1961		80.60		303.49		1.93
1962		-		355.42		8.43
1963		17.47		512.29		0.48
1964		90.48		530.48		2.89
1965		-		476.99		19.16
1966		-		234.94		7.23
1967	0.96	5.42	39.04	115.66	-	4.94
1968	-	5.42	53.49	329.28	-	5.42
1969	4.10	56.27	33.13	176.87	-	6.75
1970	2.29	74.82	18.55	161.93	0.48	1.81
1971	4.94	69.88	10.00	104.34	3.61	3.61
1972	17.23	24.94	16.75	222.77	-	4.10
1973	0.96	10.00	16.39	130.24	-	7.23
1974	-	0.60	11.69	54.22	-	3.13
1975	-	-	22.29	96.99	-	6.27
1976	-	21.81	24.46	479.76	-	21.33
1977	10.00	96.75	35.66	766.99	1.08	24.22
1978	-	120.00	33.49	570.24	1.45	20.96
1979	2.29	54.94	22.53	685.42	6.27	15.90
1980	10.60	49.40	18.31	696.02	4.34	5.90
1981	28.55	147.35	3.98	1080.24	0.48	1.69
1982	28.31	106.51	21.20	915.42	-	7.95
1983	12.05	43.61	19.28	722.53	0.72	26.99
1984	5.90	53.98	7.59	564.22	0.24	29.88
1985	-	28.67	8.18	554.34	0.48	18.31
1986	-	45.05	2.52	398.43	1.68	10.34
1987	-	56.75	21.55	844.23	-	26.99

Table 6.- Annual landings (t of scallop meats) by vessel category for Digby Neck (statistical district 37), Digby (38), and Annapolis (39). Inshore landings originate from vessels ≤ 25.5 G.T., while offshore landings refer to vessels > 25.5 G.T. Source: Statistics Division, Fisheries and Oceans, Halifax.

Year	37			38			39		
	IN	OFF		IN	OFF		IN	OFF	
		≤14m	>14m		≤14m	>14m		≤14m	>14m
1979	2.29	-	54.82	22.53	10.60	647.71	6.27	-	15.90
1980	10.48	6.02	36.63	18.19	8.67	668.80	4.34	-	5.90
1981	28.31	30.84	110.60	4.10	12.77	1046.39	0.48	-	1.81
1982	28.43	19.28	87.11	21.08	15.90	888.43	-	0.36	7.59
1983	12.05	20.00	21.93	19.28	24.10	698.31	0.72	2.89	23.98
1984	5.90	29.64	24.34	7.59	20.48	543.74	0.24	0.48	29.40
1985	-	20.12	8.55	8.18	50.72	503.62	0.48	-	18.31
1986	-	11.56	33.49	2.52	30.72	367.71	1.68	0.36	9.98
1987	-	33.26	23.49	21.55	79.04	765.19	-	-	26.99

Table 7a.- Fishery characteristics for Bay of Fundy licensed vessels (14-19m) on a fishing zone basis. Statistical catches (Stats) for the inside zone corresponds to NAFO sub-subarea 4Xr; statistical catches for the outside zone are for NAFO sub-subareas 4Xr plus 4Xs. Class 1 logged catches were used to estimate CPUE.

Year	Inside zone (Oct-Apr)			Outside zone (May-Sep)		
	Catches (t meats)		CPUE	Catches (t meats)		CPUE
	Stats	Class 1	kg/hm	Stats	Class 1	kg/hm
1976-77	251.71	99.83	7.99	122.80	24.33	3.38
1977-78	238.27	180.18	7.29	188.02	141.84	4.88
1978-79	247.70	220.01	6.85	214.02	167.89	4.54
1979-80	280.22	245.44	6.95	161.33	131.80	3.88
1980-81	413.60	290.15	6.87	390.07	173.04	4.78
1981-82	417.80	304.40	6.86	429.65	160.74	4.65
1982-83	565.16	372.57	5.03	479.49	205.00	4.71
1983-84	319.15	267.66	3.59	397.35	267.22	3.06
1984-85	270.26	277.85	3.15	322.77	262.13	2.56
1985-86	121.33	142.37	2.36	282.51	274.86	2.25
1986-87	39.24	**21.21	1.81	90.54	56.62	1.92
1987-88	*66.72	46.58	14.82	***25.47	26.39	3.52

*Oct-Dec only; our estimate: 530 t.
**The inside zone was closed from Jan. 1 to April 30, 1987 (end of season). During that time period, CPUE was 2.09 kg / hm in the remainder of the Bay (NAFO 4Xr plus 4Xs).
***over 100 t. is estimated to have been caught in the inside zone during Aug - Sept.

Table 7b.- Bay of Fundy fleet (14 - 19.8m). Monthly percentages of NAFO 4Xr catches on a fishing season basis for the inside zone during 1981 - 1987.

Month	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	
Oct	39	33	36	34	40	55	
Nov	11	19	12	14	19	20	
Dec	5	6	6	6	8	25	
Jan	2	4	8	5	4	**	
Feb	7	7	12	10	12	**	
Mar	25	11	11	11	9	**	
Apr	11	20	15	20	8	**	
Fractional catches in October and April (ratio of class 1 logged data)							Avge
01-15 Oct	52	65	69	50	71	69	63
16-31 Oct	48	35	31	50	29	31	37
01-14 Apr	34	35	45	32	49	**	39
15-30 Apr	66	65	55	68	51	**	61

** inside fishing zone closed Jan - Apr, 1987.

Table 8.- Characteristics of the meat size distribution in the commercial fishery while fishing the inside zone.

Season	Month	Meat weight				Sample size	Meat count
		Mean	Min	Max	S.E.	(n meats)	per 500 g
1978-79	Apr	17.9	5.6	33.7	0.4	78	27.9
1979-80	Oct	20.6	6.5	86.4	0.4	229	24.3
	Nov	21.8	5.3	44.4	0.3	374	23.0
1980-81	Oct	26.0	5.6	60.2	0.5	329	19.2
	Dec	24.5	5.1	59.5	0.8	137	20.5
	Feb	22.0	5.2	50.5	0.3	681	22.8
	Mar	22.0	6.3	50.0	0.3	572	22.8
1981-82	Oct	27.2	5.7	54.2	0.6	177	18.4
	Nov	24.1	3.7	77.9	0.3	849	20.8
1982-83	Oct	24.9	5.0	69.4	0.4	632	20.1
	Nov	27.4	5.9	62.6	0.6	231	18.3
1983-84	Apr	18.8	2.3	55.5	0.1	1807	26.6
1984-85	Oct	25.1	4.2	63.6	0.1	2250	19.9
	Apr	19.6	3.7	57.5	0.3	503	25.5
1985-86	Oct	28.5	5.9	56.2	0.2	809	17.6
1986-87	Oct	17.7	2.3	57.5	0.2	1743	28.2
1987-88	Oct	10.0	2.5	55.1	0.1	3215	50.3

Table 9.- Number of survey stations in the Digby area by year and by stratum types.

Year	1981	1982	1983	1984	1985	1986	1987
Catch stratum:							
low (0 - 1%)	15	29	40	40	48	49	48
medium (1 - 3%)*	17	20	20	20	28	27	27
high (> 3%)*	38	22	15	15	14	14	14
exploratory	--	30	25	25	30	30	30
total	70	101	100	100	120	120	119
Area stratum:							
Centreville	3	19	20	20	21	16	4
Gulliver's Head	22	20	28	23	29	21	23
Digby Gut	41	49	35	40	30	42	45
Delaps Cove	4	9	14	12	18	14	13
Parker's Cove	--	4	3	5	14	12	13
Young Cove	--	--	--	--	--	3	10
Hampton	--	--	--	--	8	9	11
Zone stratum:							
inside 6-mile	27	50	40	49	58	48	38**
outside 6-mile	43	51	60	51	62	72	81**

* 2% in 1981.
** ratio is 53, 66 stations for inside / outside 8-mile.

Table 10.- 1985 stock survey. Average number of scallops at age caught in a seven-gang Digby drag projected from an end, unlined bucket for recruits (age >4 years) and from a centre, lined bucket for prerecruits (age <4 years).

	Age (years)								
	2	3	4	5	6	7	8	9	10+
Catch stratum:									
low	1	2	5	15	28	29	27	21	30
medium	1	4	11	19	17	18	16	12	25
high	2	4	4	10	4	10	9	8	28
exploratory	1	6	13	23	24	28	21	11	27
Area stratum:									
Centreville	2	6	18	27	23	32	28	18	31
Gulliver's Head	1	3	9	23	30	26	22	10	27
Digby Gut	2	5	7	12	18	23	21	16	27
Delaps Cove	0	3	6	17	18	20	15	15	41
Parker's Cove	0	0	3	10	18	17	12	8	13
Hampton	0	0	0	4	15	20	25	27	15
Zone stratum:									
inside 6-mile	1	2	6	13	10	11	11	9	27
outside 6-mile	1	4	10	21	33	37	30	20	27

Table 11.- 1986 stock survey. Average number of scallops at age caught in a seven-gang Digby drag projected from an end, unlined bucket for recruits (age >4 years) and from a centre, lined bucket for prerecruits (age <4 years).

	Age (years)								
	2	3	4	5	6	7	8	9	10+
Catch stratum:									
low	146	19	12	33	41	38	25	15	18
medium	556	157	16	18	20	21	17	16	23
high	482	110	25	19	19	18	18	13	20
exploratory	534	136	23	16	24	29	26	20	42
Area stratum:									
Centreville	77	24	22	13	29	37	33	22	35
Gulliver's Head	201	72	20	22	29	33	30	19	27
Digby Gut	671	176	22	20	21	24	25	22	34
Delaps Cove	744	97	19	24	20	21	19	13	24
Parker's Cove	15	5	3	34	44	25	10	2	4
Young Cove	40	4	0	27	51	69	6	4	6
Hampton	48	7	7	45	51	39	8	7	7
Zone stratum:									
inside 6-mile	591	186	18	10	16	17	10	9	17
outside 6-mile	230	26	17	33	38	38	31	21	30

Table 12.- 1987 stock survey. Average number of scallops at age caught in a seven-gang Digby drag projected from an end, unlined bucket for recruits (age >4 years) and from a centre, lined bucket for prerecruits (age <4 years).

	Age (years)								
	2	3	4	5	6	7	8	9	10+
Catch stratum:									
low	167	445	469	71	25	23	17	10	22
medium	217	328	617	124	24	15	8	9	19
high	480	464	490	333	45	20	10	2	7
exploratory	29	209	184	26	23	21	20	16	31
Area stratum:									
Centreville	14	76	53	31	66	52	56	38	92
Gulliver's Head	220	195	208	83	28	22	21	15	24
Digby Gut	276	554	775	182	25	19	14	11	34
Delaps Cove	208	641	824	101	20	18	22	8	19
Parker's Cove	19	154	48	18	32	21	11	3	3
Young Cove	39	82	13	37	42	24	7	6	13
Hampton	55	189	20	13	23	26	11	3	1
Zone stratum:									
inside 6-mile	457	373	727	253	18	10	8	7	22
outside 6-mile	51	355	296	31	31	26	18	11	22

Table 13.- Summary of average number of scallops at age caught for prerecruits and recruits by catch stratum.

	Age (years)		
	2-4	5-7	8 +
1981			
low	27	146	123
medium	66	213	101
high	289	169	89
1982			
low	15	155	102
medium	15	107	105
high	31	180	81
exploratory	42	156	85
1983			
low	21	146	84
medium	30	129	75
high	50	73	59
exploratory	31	142	79
1984			
low	18	80	43
medium	37	109	64
high	14	50	51
exploratory	20	99	54
1985			
low	8	72	78
medium	16	54	53
high	10	24	45
exploratory	20	75	59
1986			
low	177	112	58
medium	729	59	55
high	617	56	51
exploratory	693	69	88
1987			
low	1081	119	49
medium	1162	163	36
high	1434	398	19
exploratory	422	70	67

Table 14.- Summary of average number of scallops at age caught for prerecruits and recruits by area stratum.

	Age (years)		
	2-4	5-7	8 +
1981			
Centreville	31	222	174
Gulliver's Head	475	208	85
Digby Gut	47	167	94
Delaps Cove	13	35	172
1982			
Centreville	35	237	129
Gulliver's Head	41	175	123
Digby Gut	23	130	74
Delaps Cove	10	93	90
Parker's Cove	0	1	29
1983			
Centreville	24	113	73
Gulliver's Head	38	166	75
Digby Gut	32	122	81
Delaps Cove	22	139	96
Parker's Cove	0	3	0
1984			
Centreville	31	71	44
Gulliver's Head	33	147	71
Digby Gut	17	75	49
Delaps Cove	12	57	50
Parker's Cove	0	30	4
1985			
Centreville	26	82	77
Gulliver's Head	13	79	59
Digby Gut	14	53	64
Delaps Cove	9	55	71
Parker's Cove	3	45	33
Hampton	0	39	67
1986			
Centreville	123	79	90
Gulliver's Head	293	84	76
Digby Gut	869	65	81
Delaps Cove	860	65	56
Parker's Cove	23	103	16
Young Cove	46	147	16
Hampton	62	135	22

continued

Table 14.- Continued. Summary of average number of scallops at age caught for prerecruits and recruits by area stratum.

	Age (years)		
	2-4	5-7	8 +
1987			
Centreville	143	149	186
Gulliver's Head	623	133	60
Digby Gut	1605	226	59
Delaps Cove	1673	139	49
Parker's Cove	221	71	17
Young Cove	134	103	26
Hampton	264	62	15

Table 15.- Summary of average number of scallops at age caught for prerecruits and recruits by zone stratum.

	Age (years)		
	2-4	5-7	8 +
1981			
inside 6-mile	313	143	103
outside 6-mile	94	194	97
1982			
inside 6-mile	25	110	90
outside 6-mile	29	192	98
1983			
inside 6-mile	36	65	67
outside 6-mile	25	174	84
1984			
inside 6-mile	26	58	57
outside 6-mile	17	112	45
1985			
inside 6-mile	9	34	47
outside 6-mile	15	91	77
1986			
inside 6-mile	795	43	36
outside 6-mile	273	109	82
1987			
inside 6-mile	1557	281	37
outside 6-mile	702	88	51

Table 16.- Vessels licensed for scallop fishing in the upper parts of the Bay of Fundy. These licenses used to be called 'Cumberland' or 3-mile licenses.Their present appellation is 'Upper Bay of Fundy'. All vessels are less than 14 m long. Numbers in parenthesis indicate active licenses that submitted at least one sales slip during the year.

Year	under 25.5 G.T.	over 25.5 G.T.	Total
1983	14 (N / A)	0	14
1984	13 (N /A)	1 (1)	14
1985	13 (6)	1 (1)	14 (7)
1986	16 (10)	0	16 (10)
1987	16 (13)	0	16 (13)

Table 17.- Mean annual landings per active vessel with an Upper Bay of Fundy or a Mid-Bay license landing in the Upper Bay statistical districts.

Year	Active licenses	Mean landing (kg)
	Upper Bay + Mid-Bay	
1985	7 + 11	1,597
1986	10 + 6	1,050
1987	13 + 4	1,903

Table 18.- Landings in t of scallop meats by statistical districts in the upper parts of the Bay of Fundy. Districts 24 and 44 are in Cumberland Co., district 40 in Kings Co., Nova Scotia; district 79 is in Albert Co., New Brunswick. Source: Statistics Division, Fisheries and Oceans, Halifax, N.S.

Year	District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1983	24	--	--	--	0.24	--	--	--	--	--	--	--	--
	44	--	--	--	0.60	0.12	1.57	2.17	0.84	0.36	0.48	0.48	--
	79	--	--	--	2.77	0.24	0.72	0.84	4.22	2.89	0.60	--	0.24
		--	--	--	3.61	0.36	2.29	3.01	5.06	3.25	1.08	0.48	0.24
	total for year:	19.38											
1984	24	--	--	--	--	--	--	--	0.12	--	--	--	--
	44	0.12	0.24	0.84	--	--	--	--	--	--	--	--	--
	79	0.12	--	0.84	1.69	4.10	5.18	1.93	3.86	3.25	2.65	0.84	0.36
		0.24	0.24	1.68	1.69	4.10	5.18	1.93	3.98	3.25	2.65	0.84	0.36
	total for year:	26.14											
1985	24	--	--	--	--	--	--	--	--	--	--	--	--
	44	--	--	--	--	--	--	--	0.48	0.48	0.36	--	--
	79	--	--	--	4.46	4.94	3.01	3.37	6.14	4.10	0.72	--	--
		--	--	--	4.46	4.94	3.01	3.37	6.62	4.58	1.08	--	--
	total for year:	28.06											

Table 18.- Continued.

Year	District	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1986	40	--	--	--	--	0.12	--	0.24	0.12	0.24	--	--	--
	44	0.12	0.24	--	0.24	0.72	0.24	0.36	0.24	0.12	0.12	--	0.24
	79	--	--	--	2.65	4.34	2.29	1.93	2.41	1.69	0.24	--	--
		0.12	0.24	--	2.89	5.18	2.53	2.53	2.77	2.05	0.36	--	0.24
	total for year:	18.91											
1987	24	--	--	--	--	--	--	--	--	0.72	2.89	--	--
	40	--	--	--	0.12	0.24	--	--	--	0.24	--	--	--
	44	0.24	0.12	0.24	1.33	1.20	0.96	3.73	4.10	5.42	1.93	0.72	1.08
	79	--	--	--	1.20	0.72	0.12	--	7.71	5.66	0.36	--	--
		0.24	0.12	0.24	2.65	2.16	1.08	3.73	11.81	12.04	5.18	0.72	1.08
	total for year:	41.05											

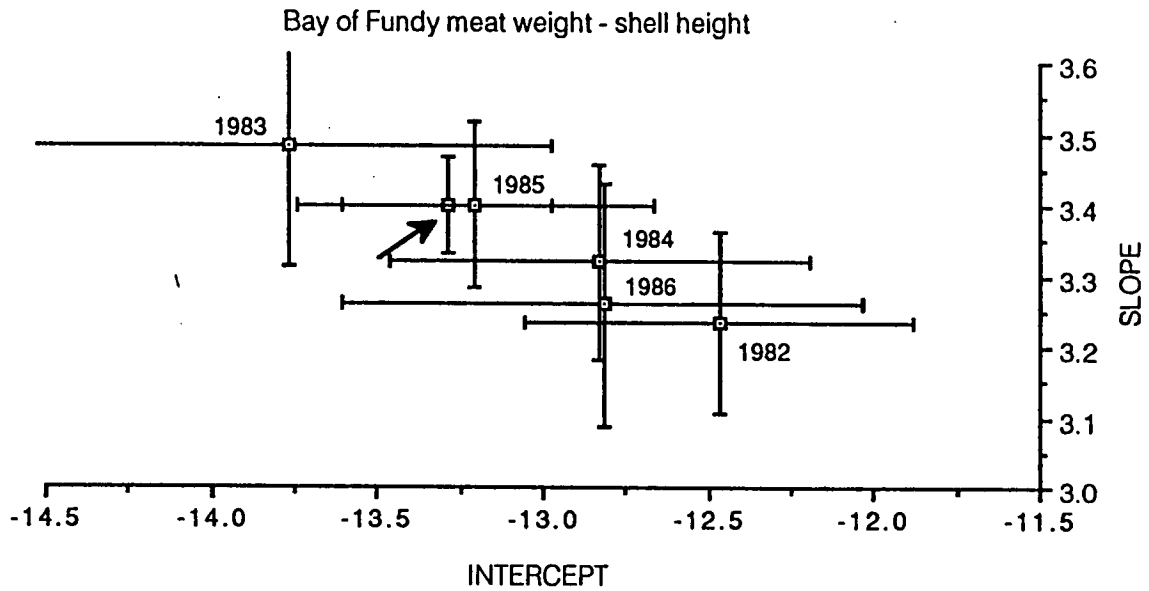

Figure 1.- Bay of Fundy meat weight - shell height allometric relationship. Samples collected from the commercial fleet 1982 - 1986. Slope and y-intercept (mean and 95 % confidence range) of least square regressions derived for each set of data collected in any one year. Parameters for each equation are identified by the year "1985" of data it represents. The arrow points to the set derived from combining all data 1982-86 in a single equation.

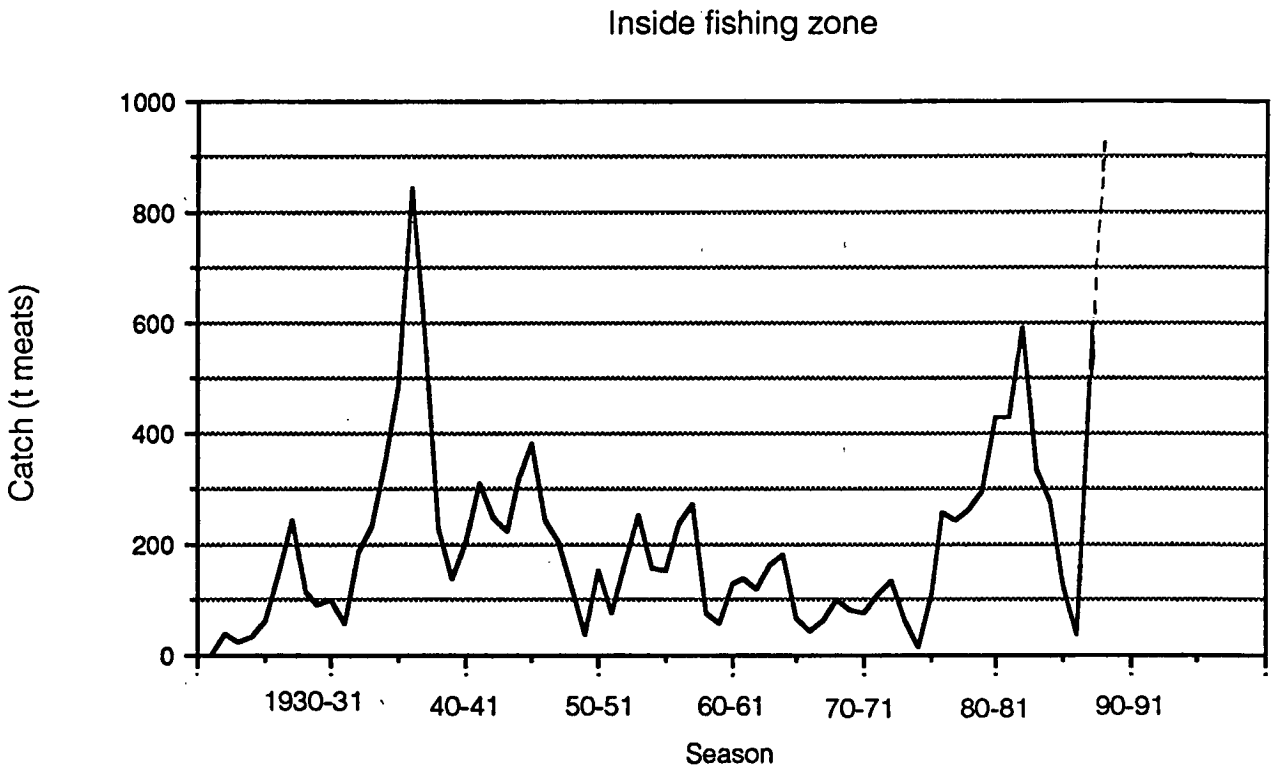

Figure 2.- Catch profile of a 65 - year time series for the traditional grounds off Digby of the inside fishing zone or catches recorded from October to April in NAFO sub-subarea 4Xr when a fishing zone did not exist. Source: Caddy (1979) up to 1972; then catches in NAFO sub-subarea 4Xr from October to April for vessels under 19.8m, Statistics Division, Fisheries and Oceans, Halifax. Catches for 1987 - 88 (preliminary) are from our estimates.

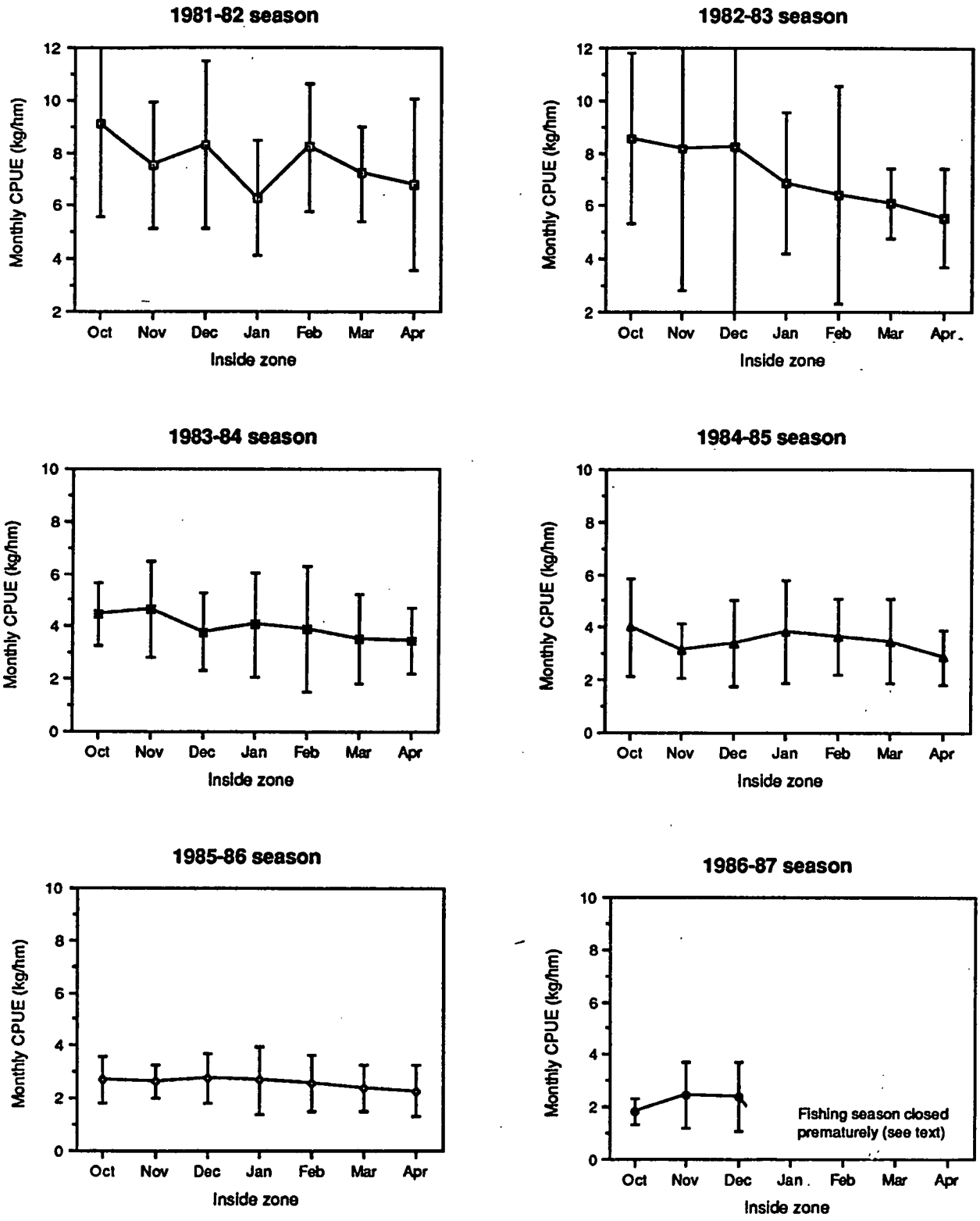

Figure 3.- Bay of Fundy fleet fishery performance. Monthly catch-rates (kilograms per hour-meter) during the inside fishing season in Nova Scotia for the period 1981 to 1987. Means and standard deviations are plotted.

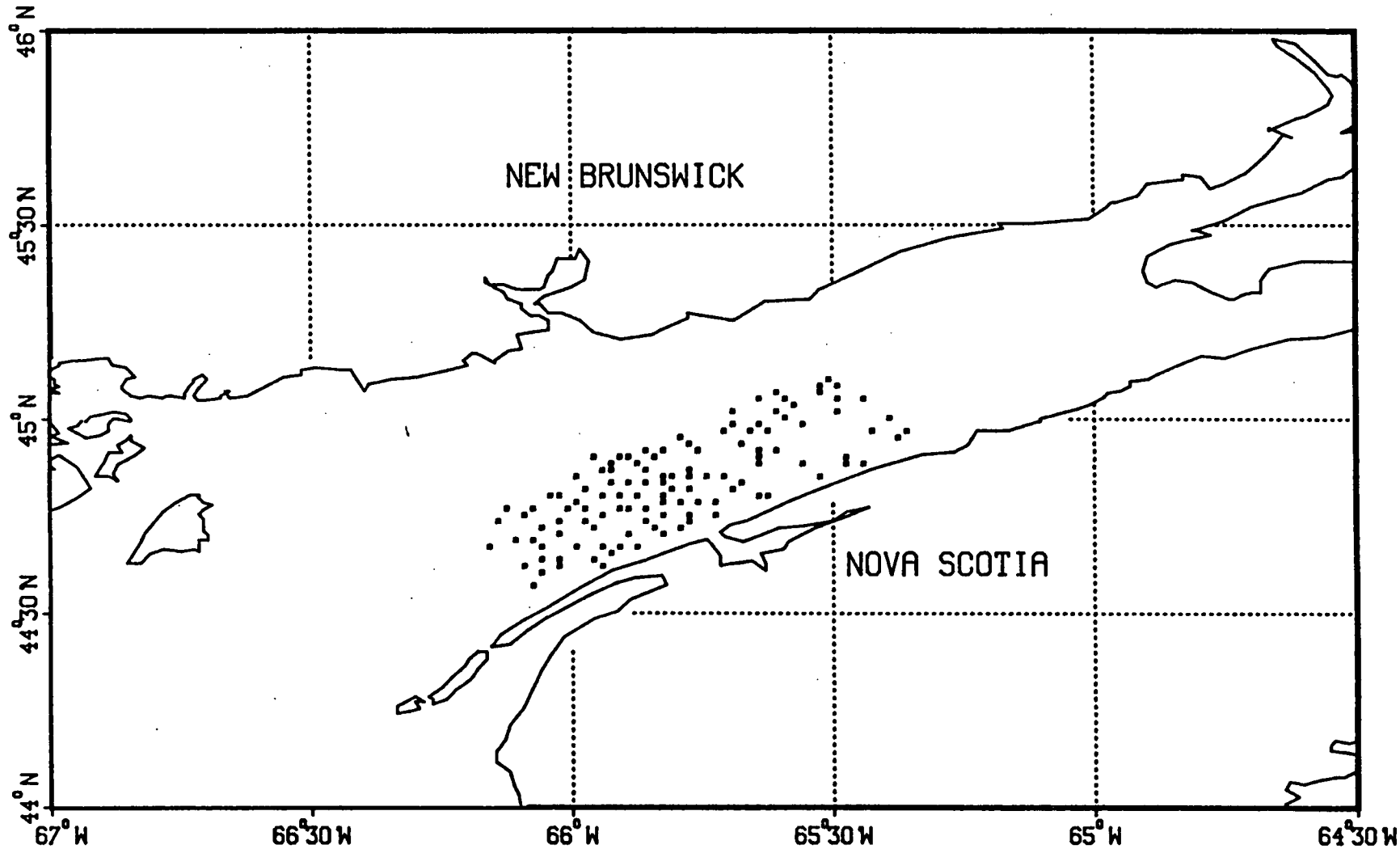

Figure 4.- Location of the survey stations of the 1987 inventory of the traditional scallop beds near Digby, Nova Scotia.

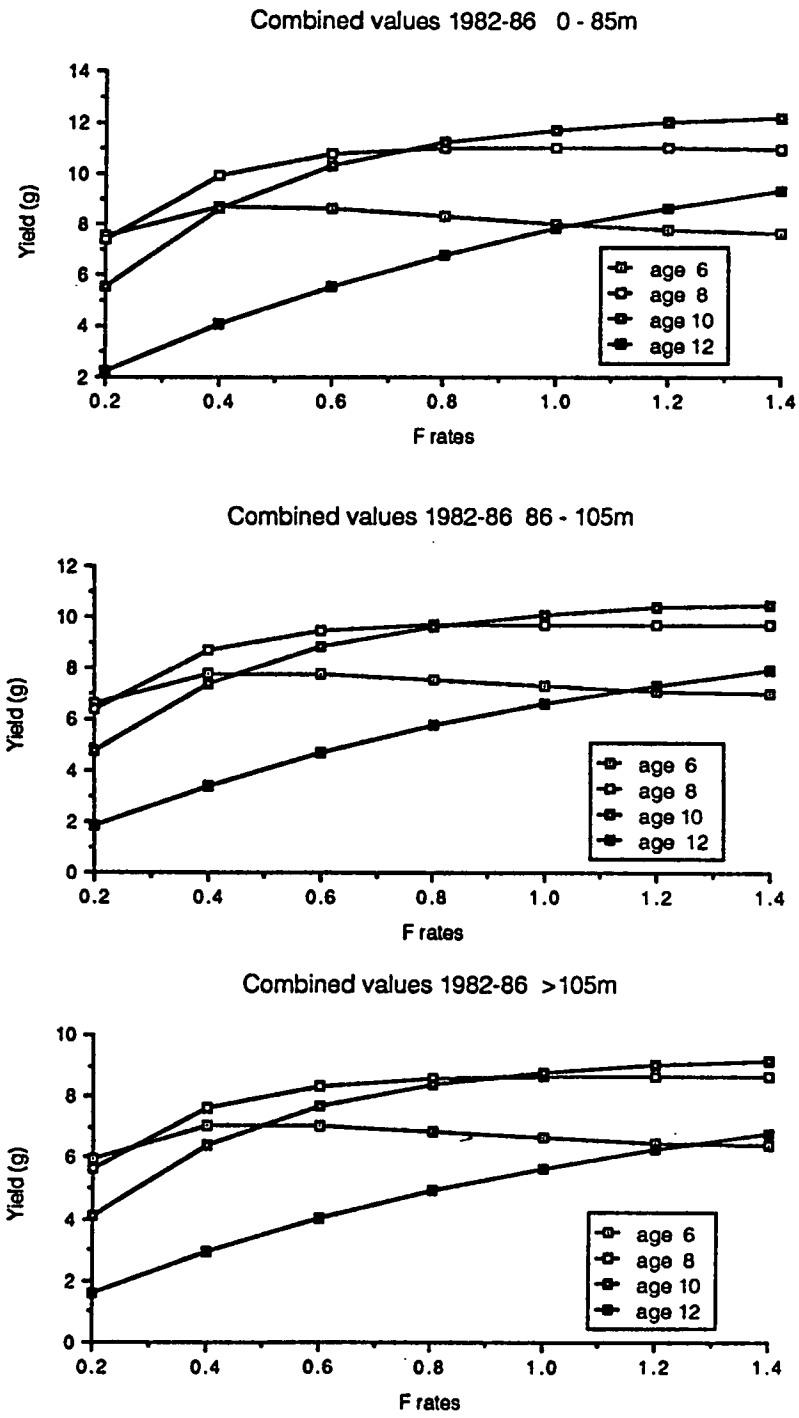

Figure 5.- Yield (g) per recruit for selected ages using age specific meat weights obtained from the combined 1982 - 86 data in a Thompson and Bell yield per recruit model for a range of fishing mortality rates according to 3 depth strata.