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Scallop fishing grounds on the Scotian Shelf - 1992

by

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ABSTRACT

On the eastern Scotian shelf (NAFO SA 4W) the offshore scallop fishery operates on a competitive basis. Over the last 4 years catches have varied between 390 and 540 t while catch-rates were around 0.24 - 0.28 kg/crhm. CPUE dropped by 9 % from 1991 to 1992. An extension of fishing activities around Sable Island contributed to greater catches in 1992. According to the last 3 survey results, recruited densities (age 7+) have been similar but younger scallops are now less abundant than prior to 1990.

In 1992 the western Scotian shelf (NAFO SA 4X) has been fished under a TAC of 450 t, twice the 1991 level and catch-rates have increased by at least 50 %. The area of Browns Bank under exploitation is less than 500 km²; it has expanded little compared to the previous year and likely represents the size of the available scallop beds. Levels of recruited year-classes have not dropped appreciably since the beginning of the E.A. fishery 4 years ago. There are sizable quantities of prerecruits although in a patchy distribution. Mortality rates derived from survey catch curves for ages 4 - 10 indicate that fishing mortalities have been relatively stable. Given the rise in CPUE, the levels of recruited biomass, and stable fishing mortalities the TAC levels set have been conservative.

RESUME

La pêche au pétoncle hauturière opère sur une base compétitive dans la partie est du plateau néo-écossais (OPANO SA 4W). Durant les 4 dernières années les prises ont varié de 390 à 540 t et les taux de capture de 0.24 à 0.28 kg/crhm. Les PPUE ont baissé de 9 % de 1991 à 1992. Des prises plus grandes en 1992 proviennent d'une extension des activités de pêche vers l'île de Sable. D'après les 3 derniers indices de recherche les densités de recrues (age 7+) sont similaires mais les jeunes pétoncles sont moins abondants maintenant.

En 1992 on a pêché la partie ouest du plateau néo-écossais (OPANO SA 4X) sous un contingent de 450 t, le double du contingent pour 1991 et les taux de capture ont augmenté d'au moins 50 %. La région du banc Browns sous exploitation a moins de 500 km²; elle s'est peu agrandie comparé à l'année précédente et représente probablement la taille des bancs de pétoncles disponibles. Les niveaux des classes d'âge recrutées n'ont pas tellement baissé depuis le début de la pêche par allocation il y a 4 ans. Les quantités de prérecrues sont importantes bien que très localisées. Les taux de mortalité dérivés des résultats d'inventaire pour les ages 4 - 10 indiquent que la mortalité due à la pêche a été relativement stable. L'élévation des PPUE, les niveaux de biomasse recrutée, et la stabilité des taux de mortalité due à la pêche suggèrent que les contingents établis ont été conservateurs.

INTRODUCTION

Throughout the last 15 years scallop beds on the Scotian Shelf have offered alternatives to the lucrative Georges Bank even though catch-rates have been lower on Western - Sable Island Banks but comparable on Browns Bank. Traditionally, the Scotian Shelf fishery has been pursued on a competitive basis. An enterprise allocation (E.A.) plan was implemented for the western Scotian Shelf (Browns Bank and German / Lurcher, Fig. 1) in 1989. The fleet is still operating competitively on the eastern Shelf (Banquereau, Middle Grounds, and Western - Sable Island Banks). The 1992 fishery was characterised by slightly higher catches in the East and the continued exploitation of a small scallop bed on Browns Bank in the West. The Browns Bank TAC was twice the 1991 level and catch-rates increased by 50 %.

Another large year-class of prerecruits has been observed in the most recent survey of Browns Bank. Levels of recruited year-classes have not dropped appreciably since the beginning of the E.A. fishery four years ago.

METHODS

Fishery Information

There are two sources of information to estimate the respective fishery contributions of scallop fishing grounds on the Scotian Shelf. The Statistics Division, Department of Fisheries and Oceans, Halifax, compiles, on a yearly basis, landings by vessel size and by NAFO sub-subareas. Log information as to the origin of the catch provided by vessels is the other source. There are at times discrepancies between statistical and logged catches as NAFO sub-subareas are not tailored to the physical location of particular scallop beds and may cut a major scallop bed in two. This inadequacy of the statistics system was previously described in Robert et al. (1984).

All vessels (over 25.5 G.T. or 14 m L.O.A.) fishing the Scotian Shelf are required to keep logbooks to record daily fishing activities. Daily log records supply information on the catch and its location and fishing effort such as hours spent fishing, width of gear, and number of crew. Catch-rate estimates may be computed when complete effort data (location, hours fished, gear, etc.) are provided with respect to the catch (Class 1 data). Total effort may be estimated according to the effort that generated the Class 1 catch. The productivity in terms of removals of a specific scallop bed may also be established assuming that the catch with known location is representative of the total catch from that bed.

Scallop Fleets

Two components of the Canadian offshore fleet may drag for scallops on the Scotian Shelf. The deep-sea fleet, L.O.A. over 19.8 m, is excluded from a 12 nautical miles zone near-shore, and waters in the Bay of Fundy and approaches north of latitude 43° 40' N following the Inshore / Offshore Agreement (fall 1986). The Bay of Fundy fleet, mostly L.O.A. between 14 and 19.8 m (Bay of Fundy licensed vessels), has to restrict its activities on the Scotian Shelf to the upper parts of the Lurcher Shoals above latitude 43° 40' N following the Agreement. The status of scallop beds fished by the Bay of Fundy fleet above latitude 43° 40' N will not be addressed in this document.

The deep-sea fleet uses a New Bedford offshore scallop drag varying in width from 3.96 to 4.88 m. Two drags are fished simultaneously, one on each side of the vessel.

Catch Sampling

Sampling of the catch is sporadic and does not meet target levels to sample the catch adequately. Port coverage varies greatly, from none for southwest Nova Scotia ports like Yarmouth and Saulnierville to somewhat fair in the Lunenburg - Riverport area. Not all ports are necessarily involved in any particular Scotian Shelf fishery.

Survey Procedures on the Scotian Shelf

The catch distribution derived from log records for each particular fishing ground is used to stratify survey stations which are randomised within a low, medium, and high stratum. Catches from the deep-sea fleet over the year prior to the survey are considered. At times, an exploratory stratum may be added. Annual surveys are carried out during May on a Government research vessel. The 1992 eastern Shelf survey included Middle Grounds. After the experimental fishery on Browns Bank during August - September 1989, the survey focussed mainly on the exploited area to estimate a relative stock size toward the 1990 fishery. For two years the fishery focussed on a very small area; the 1991 survey covered this area but did not explore beyond it. The 1992 survey covered the grounds fished in 1991, an area about 450 km². The German Bank / Lurcher Shoals segment of the Scotian Shelf annual stock survey was not carried out because of the low levels of fishing activity.

The survey gear was a 2.44 m wide New Bedford offshore dredge (75 mm ring size) lined with 38 mm stretch mesh polypropylene netting. Tows were of ten minutes duration; distance towed was determined from the continuous recording of Loran C bearings via a microcomputer or, exceptionally, from bearings taken at the start and the end of the tow. Catches were later standardised to a tow length of 800 m. For each tow, the following data were recorded: 1) shell heights in 5 mm intervals for all live scallops and cluckers (shells with both valves still attached at the hinge); 2) tow location with Loran C bearings; 3) depth (m); 4) compass bearing for direction of tow; 5) duration of tow in minutes; 6) substrate type; 7) fullness of the drag (count of the number of vertical rings covered by the catch); and 8) total scallop catch as a round weight (kg).

Standardized survey catch-rates were contoured to represent the spatial distribution of the scallop aggregations. Data points describe a three dimensional surface with latitude, longitude, and number of scallops per tow to be plotted. A surface is formed by defining Delaunay triangles from an algorithm found in Watson (1982); the data points become the vertices of triangles connecting nearest neighbour points. The surface between adjacent contour levels, in this case the relative abundance of scallops, is represented as darkening shades of grey. Contours may be smoothed by interpolating the surface by inverse weighing of gradients (slopes of triangles). The sides of the Delaunay triangles are divided into equal segments (chords) to establish the interpolation points. For example, dividing the sides into 4 segments gives 16 subtriangles. The interpolation points become new vertices. This method assumes that the data points near the point in question contribute more than distant points (see also Watson and Philip 1985). Each triangle is assumed to have a flat surface. The summation of the volumes of all triangles under the contoured surface is equal to the total volume, a potential abundance estimate for the survey area. The degree of interpolation will affect the volume estimates. Experimental work indicates that volume estimates stabilise with a minimum of variation (5 %) (Robert et al. 1989) after 16 or more subtriangles. A complete description of the procedure may be found in Black (1988).

Relevant Biological Information

Biological information dealing only with growth rate and allometry of meat weight on shell height are given here. Biological data has been gathered since 1982 as part of an on-going study of somatic and gonadal growth cycles.

Areas such as Sable Island / Western Bank have better sampling coverage from the commercial fleet than Browns Bank where fishing activity has only recently resumed.

Samples from 1982 to 1989 surveys and samples collected from the fleet up to 1989 were

used in the analyses except for Browns Bank. Table 1 presents variables of von Bertalanffy growth curves and the number of scallop shells which rings have been read for each area. It also gives the regression parameters for estimating meat yield as a function of shell height and the number of animals examined. In an attempt to reduce seasonal effects in yield conditions, samples collected at all times of the year have been included in the analysis to approximate a 'year round' value. Some biological information was tentatively derived with a small sample from Banquereau Bank collected during earlier stock surveys until more material is assembled. The Sable Island area presents a wide range of depths (20 - over 100 m) where scallop concentrations occur, leading to a great deal of heterogeneity in growth patterns. However, all data were pooled together to generate one equation for the area. The growth curve parameters given for Browns Bank come from samples in the southern bank where about 500 shells were read; they might not exactly apply to the area fished now. Samples collected during 1989-92 from the grounds presently exploited were used for meat yield determination.

RESULTS

Scallop Fleets

Following the 1986 Inshore / Offshore Agreement, the Bay of Fundy fleet was restricted to a very small section of the Scotian Shelf, i.e. the northern Lurcher Shoals. The deep-sea fleet however, continued to exploit scallop grounds on the Scotian Shelf (Table 2), especially in the eastern area. During 1989-91 about half of the vessels of the deep-sea fleet have also fished the northern section of Browns Bank in the western area of the Shelf. There has been a greater interest in 1992 where 31 of the 42 vessels visited these grounds.

With Georges Bank catch removals limited under an E.A. system, the deep-sea fleet is shifting some of the traditional effort to scallop grounds on the Scotian Shelf in NAFO subareas 4V and 4W. Catch-rates in NAFO 4W have usually been below average compared to Georges Bank rates. NAFO SA 4X on Browns Bank and its northern approaches (Tusket area) were fished under TAC for the fourth consecutive year. One vessel conducted minimal activity on German Bank.

To give methodical coverage to all fishing areas (Fig. 1) (from east to west), each area is looked at with respect to: a fishery profile, an estimate of its productivity in terms of distribution of scallop beds and abundance, catch sampling, and survey results. The Eastern Shelf includes Banquereau Bank, Middle Grounds, Western Bank, and the Sable Island area. The Western Shelf includes Browns Bank, the Tusket area, and German Bank / Lurcher Shoals.

Banquereau Bank

Historically speaking, Banquereau Bank (NAFO subarea 4V) has never been reported as a scallop-producing area. Catches average less than 10 t per year (Table 3). It is a natural, geographical extension of Sable Island Bank to the east. Highest landings (16 t) were reported in 1986. This trend could not be maintained as less than 1 t was landed annually since, according to logged catches. These catches have originated from Ten Minute Squares (TMS) on Banquereau Bank adjacent to Sable Island Bank. Logged catches indicate 2.5 t for 1992 with slightly higher CPUE's. Catch levels and the profile of catch-rates thus far do not indicate the presence of an important stock biomass.

The six exploratory tows carried out on Banquereau Bank in 1989 indicated as in previous surveys an extremely low abundance; furthermore, the most recent survey suggests the presence of only the oldest age class (Robert et al. 1990). The area has not been surveyed since.

Middle Grounds

Middle Grounds is a shallow bank of which 900 km² may carry commercial densities of scallops. Scallop production has been fairly sporadic over the last ten years (Table 4). The last four years have seen catches vary between 20 and 40 t per year. Catch-rates had been moderate at best, 0.500 kg/crhm in 1982, but declined gradually to stabilise around 0.300 kg/crhm for the last four years. Catches are higher in 1992 but catch-rates dropped 20 % from 1991.

Sampling of the catch (Table 5) indicates that a wide range of meats are shucked with an average meat weight comparable to the ones obtained from Georges Bank. This profile varies little between years although only a small number of meats are weighed. Very low catches in 1988 prevented sampling of the catch. Since 1989 there has been an important weight drop (33 %) in the average meat, from 21.4 to 14.4 g which later stabilised around 15 g. Low catch volumes made it difficult to sample in 1991 and 1992.

Stock surveys had shown low abundance of scallops at age except for the first survey in 1983. The prerecruit index rose significantly in 1988 but overall mean numbers at age are very low. Given the relatively low fishery performance no survey work was carried out between 1989-91. The 1992 Scotian Shelf survey had 8 tows on Middle Grounds (Table 6) to check on the status of the stock. Tables 7 and 8 indicate a lower abundance than in the last survey (1988) especially prerecruits, although they are more numerous now than pre-1988.

Sable Island / Western Bank

When the deep-sea fleet began to fish scallop grounds in the Sable Island area in 1980, it confined itself to a small area of Western Bank at the edge of the continental shelf within the 100 m isobath (Fig. 1). Gradually, fishing activities expanded not only along the edge of the shelf (in a northeasterly direction) but also over Western Bank, Sable Island Bank, and in the immediate vicinity of Sable Island up to Banquereau Bank (NAFO sub sub-areas 4Wf, g, h, j, l, and u designated here under the label of SA 4Wf-j). Figure 2 shows the distribution of commercial effort for 1992. Prior to 1985 the fishery had low landings, usually under 100 t and low catch-rates (compared to Georges Bank) (Table 4). After this exploration period, landings increased substantially but CPUE's remained in the low range. The extension of fishing activities around Sable Island and to the western part of Banquereau Bank (Fig 2) in 1992 contributed to greater catches than in 1991; CPUE's concurrently dropped by 9 %. A map of catch-rate isopleths (Fig 3) shows the discrete patterns obtained with the best rates on Western Bank. Since the beginning, this fishery has had a strong seasonal component related to activities on Georges Bank; the vast majority of the effort is expanded during spring and summer.

Except for 1985, the mean weight of scallop meats shucked has been considerably smaller than in neighbouring Middle Grounds, (Table 5) 12 versus 20+ g. Scallops between 7 and 10 years of age made up about 50 % of the catch. The size distribution of the catch was fairly typical (Table 5) of the historical profile for the area over 1989-91. Meats were slightly larger (15 g) in 1992.

The 1992 eastern Shelf stock survey had 82 stations randomly stratified by catch (Table 6). Since the start of annual stock surveys, the 1988 survey had observed the second greatest abundance at age (Table 9) with sizable quantities of prerecruits and quite a few recruits as well (Table 10), especially young recruits (ages 5-6). These age groups have passed through. In 1992 higher numbers of ages 4-6 have been found compared to the previous year except for the low stratum. The exploratory stratum yielded very low densities at all ages and is not included in the abundance estimates. The stratified average number of scallops at age for each of the last 3 surveys (Table 9) are fairly similar, especially for ages 7 +. Numbers of scallops less than age 7 are considerably lower than before the 1990 survey.

Browns Bank / Tusket Area

Prior to 1989 scallop aggregations, when commercially important, had been found along the southern edge of Browns Bank (NAFO sub-subarea 4Xp) around the 100 m isobath and on the

northern side of the Bank (Tusket, NAFO sub-subarea 4Xo) but in much deeper waters.

With the 1986 Inshore / Offshore Agreement these scallop beds are to be exploited by the deep-sea fleet only. Table 11 has fishery characteristics data for the deep-sea fleet only. Despite discrepancies between statistical landings and logged catches, the scallop production from the Browns Bank area has decreased erratically until a small resurgence of landings in 1988 associated with very high catch-rates at 1.8 kg/crhm.

At industry's request, steps were initiated in 1989 to undertake an experimental fishery in NAFO SA 4X covering Browns Bank, Tusket and German / Lurcher scallop grounds. Although there was no indication of important recruitment from prior research surveys, biomass had had an opportunity to accumulate because of the low fishing effort in previous years. The low activity resulted partially from the management plan grouping both the fast growing Georges Bank stock and the slowest Browns Bank's, under the same meat count regime. The 33 meats per 500 g regime contributes to yield optimisation on Georges Bank. It does not reciprocate to the same extent for the stocks of Browns, Tusket or German / Lurcher because of different growth-rates and allometric relationships (shell height - meat weight). For the same shell height, Browns Bank scallops have smaller meats than Georges Bank. The experimental fishery stipulated a meat count of 55 per 500 g was to be adhered to, until a quota of 400 t was caught. The quota was arrived at by industry members of the Offshore Scallop Advisory Committee. This meat count is an improvement, as it allows fuller exploitation of these scallop beds although it is not necessarily an optimum figure.

Over 90 % of the 350 t caught in 1989 came from a very small area of the northern side of Browns Bank overlapping SA 4Xp and 4Xo (Robert et al. 1990). The Tusket area had the highest mean CPUE (Table 11) but Browns Bank was still adequate at 0.660 kg/crhm. Table 11 also provides values for Browns prior to the TAC setting period; they represent, for NAFO 4Xp, grounds from the south part of the Bank not the area under present exploitation.

In 1990 the deep-sea fleet requested a second year of experimental fishery under a quota of 200 t allocated among the different enterprises. The fishery took place in August except for one November trip and caught 210 t approximately (logged catches), exceeding the set TAC by 5 %. Catch-rates were still very good, over 0.500 kg/crhm but lower than in 1989 by about 20 %. Fishing activities were highly concentrated in the northern approaches of Browns Bank like in 1989 (Robert and Butler 1991).

The deep-sea fleet operated under a quota of 220 t allocated by enterprises in 1991. 210 t were landed according to sales slips compilation. It would appear that vessels from the Bay of Fundy fleet have ventured on Browns Bank during the year, especially after the fishery opened for the deep-sea fleet on August 1st. It is not possible to quantify what might have been caught by the Bay of Fundy fleet. One may reasonably assume that the quota was fished in its entirety. The catch-rates varied little from 1990 (Table 11). Figure 4 reproduces the distribution of CPUE's. The fishery is still concentrated over a very small area as in previous years. But activities have slightly expanded along longitude 66° 00' W and below latitude 42° 42' (42°.7) N and providing for relatively high catch-rates.

In 1992, the TAC was set at 450 t and the fishery opened in June. By early July 454 t had been caught at catch-rates at least 50 % greater than the previous year. CPUE's over 1 kg/crhm were not uncommon (fig 5). Basically, the size of scallop beds are the same (fig 4 vs fig 5); the area under exploitation covered about 450 km² in 1991 and 510 km² in 1992.

The meat weight distribution in the catch (Table 12) varies greatly on an annual basis but the percentage examined is too small to draw any conclusion. Browns Bank catches were not sampled after 1984 until the beginning of the experimental fishery in 1989. According to catch sampling the average meat weight of the 1989 experimental fishery was quite small, under 9 g; in fact, it is one of the main reasons why the fishery shut down before reaching its quota. Meat weights landed have been rising steadily after that. The 1992 average weight corresponds to a count of 34 which, from a yield point of view, is far superior to the 55 meats per 500 g, count now in

effect. The improvement in meat count is not due to the pursuit of a single large year-class that would have sustained the fishery over the last four years but to the exploitation of multiple relatively good year-classes and careful blending. The percentage of the catch examined has improved markedly in 1991 and 1992; the data could eventually be used in analytical assessments.

Previous surveys had found high concentrations of age 2 juveniles in a well delimited area of southeastern Browns Bank. However, these year classes did not contribute to a fishery renewal. Very heavy mortality rates appear to have been experienced by possibly 3 successive year classes of scallops on the southern edge of Browns Bank (Robert et al. 1986). Both the 1986 and 1987 surveys established the paucity of prerecruits and recruits (Table 13). Survey work was interrupted after that.

Stock surveys were resumed after the experimental fishery started. In 1990 survey results from 23 stations indicated that, except for the area where the fleet was concentrating its efforts, scallop densities were very low. In the area of interest, recruited densities were good (Table 14) and, more importantly, prerecruits and juveniles were present in sizable quantities (Table 13). The 1991 survey again focussed on the area that was intensively exploited in 1990. Recruited densities were as good and the high abundance of prerecruits (ages 2-3) observed in 1990 was confirmed. However, large amounts of prerecruits were not found at all stations. Abundance levels improved even more according to the 1992 survey results. Elevated densities of prerecruits were found in highly localised areas.

Estimates of Z - rates from 1990-92 survey catch curves were computed for ages 4-10:

| Survey | Z - rate | 95 % conf. int. |
|--------|----------|-----------------|
| 1990 | 0.50 | 0.42 - 0.58 |
| 1991 | 0.54 | 0.47 - 0.60 |
| 1992 | 0.53 | 0.49 - 0.58 |

Using a natural mortality rate, M at 0.1, (Merrill and Posgay 1964) fishing mortalities would not have varied much over this period.

Since the growth curve used to establish abundance results on an age basis has not been derived for this scallop bed specifically but from a more southern location on Browns, survey results are also presented according to 5-mm shell height intervals in the histograms of figures 6 and 7 for 1991 and 1992 respectively. Shell height classes may lead to a more precise relative biomass estimate (bottom of table 14), the class interval being smaller than age classes. Estimates for the first mode of prerecruits below 40 mm is not reliable as the dredge is lined with 38-mm mesh. The 1992 histogram (fig 7) shows a large mode of prerecruits (50 - 60 mm). Densities of recruits drop steadily for sizes over 100 mm in both years.

Using the meat weight - shell height allometric relationship developed for this scallop bed, the biomass per standard tow for scallops over 100 mm is given in table 14. All scallops above 100 mm (11.7 g meat) readily meets the 55 meat count without blending. On a tow basis, the 1992 biomass is 2.1 times the 1991 biomass. The figures are not corrected for dredge efficiency on those substrates.

German Bank / Lurcher Shoals and the Outer Reaches of the Bay of Fundy

NAFO sub-subarea 4Xq includes German Bank and the lower half of the Lurcher Shoals (up to latitude 44° N); the upper half of Lurcher Shoals is part of sub-subarea 4Xr. Statistical landings and logged catches for the Bay of Fundy and the deep-sea fleets diverge for these respective areas illustrating the misrepresentation resulting from the statistical area boundaries as presently set. Biological differences exist between German Bank and Lurcher Shoals; growth rate being slower on German Bank relative to Lurcher Shoals and the outer reaches of the Bay of Fundy (Robert et al. 1986).

During the recent exploitation of this area, the amount of fishable stocks steadily declined from its initial level until 1985 (Table 15). Catch-rates were also following the same trends. A slight reversal of the downward trend appears to take place in 1986. The deep-sea fleet landed under 2 t ; the Bay of Fundy fleet took relatively small quantities but at catch-rates similar to the high values encountered in 1979. In 1987 this fleet conducted only one fishing trip landing less than 1 t of meats at moderate catch-rates (7 kg/hm). No fishing activity is reported for 1988. As part of the 1989 experimental fishery, over 5 t were caught on German Bank, at a moderate CPUE. Sampling of the catch has been scanty or did not take place. The large meat weight (mean, 48 g) sampled in 1989 suggests that the effort was expanded on remnants of the population that had sustained the German Bank fishery prior to 1985. No fishing activity was recorded for 1990 and 1991. One vessel got 250 kg in 1992 at a high CPUE in one fishing day but did not pursue this interest.

The abundance of large, old scallops was declining according to the last survey results available. Very low levels of fishing activity took place between 1985-89. The annual stock survey did not extend to the German Bank / Lurcher Shoals area after 1985.

DISCUSSION AND CONCLUSION

After 13 years of continuous exploitation on the eastern Scotian Shelf (NAFO 4V - W) targeting scallop beds on Western and Sable Island Banks, catch-rates, on average 0.225 kg / crhm, have kept to the low range relative to Georges Bank and have varied little. Relatively good year-classes have passed in the fishery but never important enough to bring major improvements to its performance.

Scallop grounds on the western Scotian Shelf (NAFO 4X) have been more productive, over a smaller area. The most recent case is northern Browns Bank. The following table provides TAC figures and catch landed since the exploitation of that ground began under the E.A. plan.

| Year | TAC (t) | Catch (t, 4X total) |
|------|-----------------------|---------------------|
| 1989 | 400 set by industry | 363 |
| 1990 | 200 biological advice | 212 |
| 1991 | 220 " " | 210 |
| 1992 | 450 " " | 454 |

The initial catch expectations of the industry could not be entirely met; the actual meat count becoming smaller than the posted count put an end to the 1989 season before the TAC was reached. With what appears to be a more appropriate TAC set afterward, catches have been rising while CPUE's relatively similar in 1990-91, rose sharply in 1992. Such rates are on a par with values obtained on Georges Bank. No difficulties were experienced in meeting the meat count. Survey catch-rates have also improved showing successive strong year-classes of prerecruits. Mortality patterns according to survey catch curves indicate that despite increases in TAC's, fishing mortalities have been relatively stable, average $F = 0.4$.

Given the rise in catch-rates, the abundance indices of recruits and the stable fishing mortalities, the TAC levels set have been conservative. The 1992 TAC had been set at twice the 1991 level since the stock survey conducted prior to the fishery had indicated that the biomass of scallops below the 55 count, with no blending, had doubled from 1991. The TAC was reached while CPUE's went up and the average meat weight in the catch corresponded to a count of 34. The area fished in 1992 has expanded 13 % from 1991 but this extension may only have had a small contribution to the increased levels of stock biomass in the area which generated the 1992 fishery performance.

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Table 1.- Updated biological data on growth-rate and meat yield (year round values) for scallop fishing grounds on the Scotian Shelf. N = number of scallops examined.

| | Growth | Yield |
|---------------------|--|---|
| Banquereau Bank | N = 60 $H_{\infty} = 128.105$ mm $t_0 = 1.5233$ $k = 0.2579$ | N = 90 intercept = -11.003 slope = 2.913 |
| Middle Grounds | N = 414 $H_{\infty} = 156.210$ mm $t_0 = 1.3650$ $k = 0.1980$ | N = 289 intercept = -10.305 slope = 2.801 |
| Sable, Western Bank | N = 3,716 $H_{\infty} = 136.628$ mm $t_0 = 1.3375$ $k = 0.2269$ | N = 3,734 intercept = -11.381 slope = 2.999 |
| Browns Bank | N = 459 $H_{\infty} = 109.910$ mm $t_0 = 1.4402$ $k = 0.2873$ | N = 600 intercept = -10.968 slope = 2.914 |

Table 2.- Number of vessels from the deep-sea fleet fishing scallop grounds on the Scotian Shelf as per log information. The Western Shelf includes German Bank / Lurcher Shoals, Browns Bank, and the Tusket area. The Eastern Shelf includes Middle Grounds, Western Bank, the Sable Island area, and Banquereau Bank. The last column indicates the number of vessels that used both areas of the Shelf.

| Year | Western Shelf | Eastern Shelf | Scotian Shelf |
|------|---------------|---------------|---------------|
| 1986 | 4 | 55 | 3 |
| 1987 | 0 | 33 | 0 |
| 1988 | 3 | 15 | 1 |
| 1989 | 29 | 35 | 16 |
| 1990 | 24 | 34 | 13 |
| 1991 | 22 | 30 | 12 |
| 1992 | 31 | 30 | 20 |

Table 3.- Fishery characteristics for the Banquereau Bank area (NAFO 4V) for the deep-sea fleet. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertains to Class 1 catch only.

| Year | Landings | Logged catches | Class 1 catch | Effort (crhm) | CPUE (kg/crhm) |
|------|----------|----------------|---------------|---------------|----------------|
| 1980 | 3.30 | 7.17 | 7.17 | 20,171 | 0.355 |
| 1981 | 0.00 | 0.00 | -- | -- | -- |
| 1982 | 0.69 | 0.42 | 0.42 | 1,092 | 0.387 |
| 1983 | 5.37 | 3.26 | 3.26 | 7,343 | 0.444 |
| 1984 | 3.18 | 0.63 | 0.63 | 939 | 0.672 |
| 1985 | 0.24 | N/A | N/A | N/A | N/A |
| 1986 | 15.64 | 11.15 | 10.98 | 45,849 | 0.239 |
| 1987 | 0.65 | 0.51 | 0.51 | 4,617 | 0.110 |
| 1988 | 0.00 | 0.00 | 0.00 | 0,000 | -- |
| 1989 | 0.00 | 0.00 | 0.00 | 0,000 | -- |
| 1990 | 0.83 | 0.00 | 0.00 | 0,000 | -- |
| 1991 | 0.63 | 0.81 | 0.81 | 3,388 | 0.240 |
| 1992 | 2.82 | 2.50 | 2.50 | 8,231 | 0.303 |

Table 4.- Fishery characteristics for the Middle Grounds area (NAFO 4We) for the deep-sea fleet. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertains to Class 1 catch only.

| Year | Landings | Logged catches | Class 1 catch | Effort (crhm) | CPUE (kg/crhm) |
|--|----------|----------------|---------------|---------------|----------------|
| 1979 | - | - | - | - | - |
| 1980 | 3.65 | 1.42 | 1.42 | 5,434 | 0.262 |
| 1981 | - | - | - | - | - |
| 1982 | 72.39 | 62.09 | 61.12 | 122,106 | 0.501 |
| 1983 | 105.16 | 104.92 | 100.59 | 309,055 | 0.325 |
| 1984 | 11.90 | 9.94 | 8.34 | 47,585 | 0.175 |
| 1985 | 26.89 | 21.59 | 21.59 | 99,345 | 0.217 |
| 1986 | 51.27 | 51.28 | 50.46 | 345,552 | 0.146 |
| 1987 | 6.70 | 7.03 | 6.64 | 44,274 | 0.150 |
| 1988 | 0.28 | 0.29 | 0.29 | 1,707 | 0.169 |
| 1989 | 20.84 | 21.70 | 21.70 | 66,551 | 0.326 |
| 1990 | 19.04 | 33.63 | 33.63 | 109,777 | 0.306 |
| 1991 | 31.54 | 35.18 | 35.18 | 96,411 | 0.365 |
| 1992 | 38.68 | 43.12 | 43.12 | 151,744 | 0.284 |
| Fishery characteristics for Sable Island and Western Bank (NAFO 4Wf-j) | | | | | |
| 1979 | - | - | - | - | - |
| 1980 | 60.99 | 50.48 | 50.48 | 219,987 | 0.229 |
| 1981 | 0.56 | 0.00 | 0.00 | 0 | - |
| 1982 | 64.10 | 61.40 | 61.40 | 243,779 | 0.252 |
| 1983 | 185.15 | 166.47 | 164.45 | 886,072 | 0.186 |
| 1984 | 71.30 | 64.65 | 63.58 | 370,231 | 0.172 |
| 1985 | 64.93 | 76.00 | 76.00 | 294,217 | 0.258 |
| 1986 | 618.35 | 585.26 | 551.88 | 3,070,138 | 0.180 |
| 1987 | 415.80 | 412.01 | 394.23 | 2,339,915 | 0.168 |
| 1988 | 100.43 | 100.42 | 93.99 | 414,920 | 0.227 |
| 1989 | 516.39 | 515.36 | 489.54 | 1,830,668 | 0.267 |
| 1990 | 414.25 | 403.94 | 387.07 | 1,615,586 | 0.240 |
| 1991 | 356.40 | 352.57 | 337.34 | 1,188,495 | 0.284 |
| 1992 | 482.57 | 477.88 | 460.75 | 1,900,188 | 0.242 |

Table 5.- Nature of the catch from NAFO SA 4W determined by analyses of scallop meat weights.

| | % | catch examined | meat weight (g) | | | | n meats |
|---------------------------|---|----------------|-----------------|-------|-------|------|------------|
| | | catch landed | mean | min | max | s.e. | |
| Middle Grounds | | | | | | | |
| 1983 | | 0.0240 | 20.00 | 3.04 | 69.99 | 0.13 | 1259 |
| 1984 | | 0.0392 | 14.84 | 4.23 | 46.97 | 0.14 | 314 |
| 1985 | | 0.0175 | 22.88 | 6.31 | 66.40 | 0.22 | 217 |
| 1986 | | 0.0134 | 22.73 | 4.33 | 61.51 | 0.23 | 302 |
| 1987 | | 0.0436 | 21.48 | 2.34 | 68.23 | 0.30 | 137 |
| 1988 | | - | - | - | - | - | - |
| 1989 | | 0.0441 | 14.46 | 4.22 | 61.45 | 0.11 | 636 |
| 1990 | | 0.0417 | 16.45 | 5.74 | 59.69 | 0.16 | 483 |
| 1991 | | - | - | - | - | - | - |
| 1992 | | - | - | - | - | - | - |
| Sable Island/Western Bank | | | | | | | |
| 1980 | | 0.0133 | 9.46 | 3.87 | 22.11 | 0.04 | 860 |
| 1981 | | - | - | - | - | - | - |
| 1982 | | 0.0015 | 9.15 | 4.65 | 15.38 | 0.11 | 102 |
| 1983 | | 0.0339 | 13.49 | 2.25 | 72.43 | 0.04 | 4658 |
| 1984 | | 0.0161 | 11.10 | 2.65 | 42.48 | 0.07 | 1034 |
| 1985 | | 0.0025 | 27.41 | 11.27 | 54.30 | 0.52 | 62 |
| 1986 | | 0.0271 | 15.03 | 2.33 | 79.13 | 0.03 | 11397 |
| 1987 | | 0.0319 | 14.35 | 2.22 | 98.14 | 0.04 | 9226 |
| 1988 | | 0.0045 | 11.57 | 4.07 | 34.60 | 0.09 | 394 |
| 1989 | | 0.0215 | 13.14 | 3.16 | 72.91 | 0.02 | 8440 |
| 1990 | | 0.0099 | 13.97 | 2.52 | 71.89 | 0.05 | 2994 |
| 1991 | | 0.0050 | 13.08 | 4.25 | 31.31 | 0.04 | 1365 |
| 1992 | | 0.0114 | 15.37 | 3.46 | 59.51 | 0.04 | 3526 |

Table 6.- Number of survey stations in NAFO SA 4V and 4W by year and by stratum type.

| Banquereau Bank | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|-----------------|------|------|------|------|------|------|
| exploratory | 5 | 5 | 6 | 0 | 0 | 0 |
| total | 5 | 5 | 6 | 0 | 0 | 0 |

| Middle Grounds | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 |
|-----------------|------|------|------|------|------|------|------|
| explo/low catch | 4 | 6 | 6 | 0 | 0 | 0 | 8 |
| medium catch | - | - | - | - | - | - | - |
| high catch | 6 | 6 | - | - | - | - | - |
| total | 10 | 12 | 6 | 0 | 0 | 0 | 8 |

| Sable/Western Bank | 1987 | 1988 | 1989 | 1990 | 1991* | 1992 |
|--------------------|------|------|------|------|-------|------|
| low catch | 5 | 4 | 11 | 10 | 4 | 20 |
| medium catch | 27 | 14 | 33 | 30 | 22 | 24 |
| high catch | 58 | 72 | 62 | 50 | 50 | 26 |
| exploratory | - | - | - | - | - | 12 |
| total | 90 | 90 | 106 | 90 | 76 | 82 |

* The original allocation by stratum was not followed in 1991. Shipcrew overtime restrictions did not allow for the scheduled coverage of the sampling area.

Table 8.- Summary of average number of scallops at age caught for prerecruits, shell height under 75mm or age less than 5 years, and recruits, shell height over 75mm by catch stratum, for the Middle Grounds area.

| | Age (years) | | |
|-------------------|-------------|------|-----|
| | 2-4 | 5-10 | 11+ |
| Middle Grounds | | | |
| 1983 stock survey | | | |
| low | 0 | 1 | 0 |
| medium | 2 | 23 | 1 |
| high | 3 | 40 | 1 |
| 1984 stock survey | | | |
| low | 0 | 6 | 0 |
| high | 0 | 16 | 1 |
| 1985 stock survey | | | |
| low | 3 | 13 | 0 |
| high | 0 | 6 | 1 |
| 1986 stock survey | | | |
| low | 0 | 4 | 1 |
| high | 1 | 16 | 1 |
| 1987 stock survey | | | |
| low | 2 | 4 | 1 |
| high | 0 | 3 | 2 |
| 1988 stock survey | | | |
| exploratory | 31 | 10 | 1 |
| 1992 stock survey | | | |
| exploratory | 10 | 12 | 0 |

Table 9.- Average number of scallops at age caught in a lined 2.44 m New Bedford offshore dredge by catch stratum in the Sable Island - Western Bank area. A stratified average for each survey has also been computed.

| | Age (years) | | | | | | | | | | Mean | s.d. | |
|-------------------------------------|-------------|----|----|----|----|----|---|---|-----|---|------|------|-----|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | | | | |
| 1987 stock survey | | | | | | | | | | | | | |
| low | 0 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | 14 | 12 |
| medium | 2 | 4 | 6 | 9 | 6 | 2 | 1 | 1 | 1 | 1 | 6 | 37 | 51 |
| high | 12 | 23 | 35 | 34 | 16 | 5 | 3 | 3 | 2 | 2 | 5 | 134 | 149 |
| 1988 stock survey | | | | | | | | | | | | | |
| low | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 7 | 4 |
| medium | 3 | 6 | 8 | 11 | 10 | 4 | 1 | 1 | 1 | 1 | 4 | 48 | 70 |
| high | 25 | 41 | 48 | 50 | 29 | 10 | 3 | 3 | 2 | 2 | 3 | 210 | 222 |
| 1989 stock survey | | | | | | | | | | | | | |
| low | 3 | 8 | 5 | 7 | 3 | 2 | 0 | 0 | 0 | 0 | 3 | 33 | 57 |
| medium | 0 | 2 | 4 | 7 | 6 | 3 | 1 | 1 | 1 | 1 | 4 | 28 | 38 |
| high | 8 | 34 | 50 | 42 | 24 | 10 | 4 | 4 | 1 | 1 | 2 | 181 | 229 |
| 1990 stock survey | | | | | | | | | | | | | |
| low | 4 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 21 | 34 |
| medium | 2 | 2 | 6 | 8 | 8 | 4 | 2 | 2 | 1 | 1 | 3 | 38 | 47 |
| high | 22 | 9 | 26 | 31 | 23 | 9 | 3 | 3 | 1 | 1 | 2 | 130 | 107 |
| 1991 stock survey | | | | | | | | | | | | | |
| low | 1 | 9 | 7 | 11 | 8 | 10 | 6 | 6 | 4 | 4 | 5 | 60 | 60 |
| medium | 1 | 9 | 5 | 8 | 9 | 6 | 2 | 2 | 1 | 1 | 3 | 45 | 47 |
| high | 2 | 16 | 7 | 9 | 11 | 7 | 3 | 3 | 1 | 1 | 2 | 57 | 83 |
| 1992 stock survey | | | | | | | | | | | | | |
| low | 13 | 3 | 8 | 8 | 6 | 4 | 2 | 2 | 1 | 1 | 3 | 49 | 77 |
| medium | 4 | 8 | 22 | 12 | 12 | 7 | 3 | 3 | 2 | 2 | 3 | 74 | 69 |
| high | 14 | 8 | 20 | 17 | 15 | 8 | 3 | 3 | 1 | 1 | 1 | 88 | 95 |
| Stratified average for each survey: | | | | | | | | | | | | | |
| 1987 | 8 | 16 | 24 | 25 | 12 | 4 | 2 | 2 | 2 | 2 | 5 | | |
| 1988 | 21 | 34 | 40 | 42 | 25 | 9 | 3 | 3 | 2 | 2 | 3 | | |
| 1989 | 5 | 21 | 31 | 27 | 16 | 7 | 3 | 3 | 1 | 1 | 3 | | |
| 1990 | 13 | 6 | 17 | 20 | 16 | 7 | 2 | 2 | 1 | 1 | 2 | | |
| 1991 | 2 | 14 | 6 | 9 | 10 | 7 | 3 | 3 | 1 | 1 | 2 | | |
| 1992 | 10 | 7 | 17 | 13 | 11 | 7 | 3 | 3 | 1 | 1 | 2 | | |

Table 10.- Summary of average number of scallops at age per tow for prerecruits (shell height under 75 mm or age less than 5 years) and recruits (shell height over 75 mm) by catch stratum in the Sable Island - Western Bank area.

| | Age (years) | | |
|-------------------|-------------|------|-----|
| | 2-4 | 5-10 | 11+ |
| 1985 stock survey | | | |
| low | 153 | 43 | 8 |
| medium | 40 | 27 | 6 |
| high | 212 | 69 | 0 |
| 1986 stock survey | | | |
| low | 6 | 5 | 5 |
| medium | 8 | 8 | 5 |
| high | 2 | 8 | 5 |
| exploratory | 0 | 0 | 1 |
| 1987 stock survey | | | |
| low | 3 | 6 | 5 |
| medium | 12 | 20 | 5 |
| high | 70 | 61 | 4 |
| 1988 stock survey | | | |
| low | 4 | 2 | 2 |
| medium | 17 | 28 | 3 |
| high | 114 | 95 | 2 |
| 1989 stock survey | | | |
| low | 16 | 12 | 3 |
| medium | 6 | 19 | 3 |
| high | 92 | 82 | 1 |
| 1990 stock survey | | | |
| low | 6 | 9 | 2 |
| medium | 11 | 24 | 2 |
| high | 56 | 67 | 1 |
| 1991 stock survey | | | |
| low | 17 | 41 | 3 |
| medium | 15 | 27 | 2 |
| high | 25 | 32 | 1 |
| 1992 stock survey | | | |
| explo/very low | 4 | 10 | 4 |
| low | 24 | 22 | 2 |
| medium | 34 | 37 | 2 |
| high | 42 | 43 | 1 |

Table 11.- Fishery characteristics for the Browns Bank - Tusket area (NAFO 4Xp and 4Xo) for the deep-sea fleet. Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertains to Class 1 catch only.

| Year | Landings | Logged catches | Class 1 catch | Effort (crhm) | CPUE (kg/crhm) |
|------|----------|----------------|---------------|---------------|----------------|
| 4Xo | | | | | |
| 1979 | 0.00 | 13.70 | 13.70 | 21,964 | 0.624 |
| 1980 | 13.17 | 40.79 | 33.41 | 60,979 | 0.548 |
| 1981 | 0.36 | 1.40 | 1.40 | 2,219 | 0.632 |
| 1982 | 47.55 | 70.87 | 65.76 | 86,204 | 0.763 |
| 1983 | 42.70 | 53.11 | 44.96 | 78,613 | 0.572 |
| 1984 | 10.57 | 13.24 | 13.24 | 45,619 | 0.290 |
| 1985 | 0.00 | 0.84 | 0.84 | 2,155 | 0.389 |
| 1986 | 0.00 | 0.00 | 0.00 | 0 | - |
| 1987 | 0.00 | 0.00 | 0.00 | 0 | - |
| 1988 | 4.22 | 0.00 | 0.00 | 0 | - |
| 1989 | 16.14 | 42.31 | 35.04 | 44,918 | 0.780 |
| 1990 | 8.95 | 34.73 | 34.73 | 61,132 | 0.568 |
| 1991 | 4.76 | 24.31 | 20.13 | 35,358 | 0.569 |
| 1992 | 0.96 | 12.50 | 12.50 | 12,058 | 1.037 |
| 4Xp | | | | | |
| 1979 | 73.05 | 77.90 | 76.62 | 145,118 | 0.528 |
| 1980 | 258.23 | 205.91 | 199.25 | 479,388 | 0.416 |
| 1981 | 24.98 | 12.86 | 12.65 | 19,578 | 0.646 |
| 1982 | 114.07 | 83.40 | 82.84 | 217,580 | 0.381 |
| 1983 | 63.32 | 34.83 | 33.46 | 135,526 | 0.247 |
| 1984 | 16.60 | 4.95 | 4.95 | 26,565 | 0.186 |
| 1985 | 6.93 | 15.54 | 15.54 | 36,413 | 0.427 |
| 1986 | 4.64 | 4.00 | 4.00 | 6,948 | 0.576 |
| 1987 | 0.00 | 0.00 | 0.00 | 0 | - |
| 1988 | 0.00 | 5.16 | 5.16 | 2,853 | 1.808 |
| 1989 | 321.20 | 277.76 | 189.98 | 287,667 | 0.660 |
| 1990 | 172.44 | 170.95 | 146.01 | 275,101 | 0.531 |
| 1991 | 197.29 | 177.01 | 145.70 | 262,186 | 0.556 |
| 1992 | 452.84 | 441.11 | 393.93 | 524,935 | 0.750 |

Table 12.- Nature of the catch from Browns Bank / Tusket area determined by analyses of scallop meat weights.

| % | catch examined | meat weight (g) | | | |
|------|----------------|-----------------|-------|-------|------|
| | catch landed | mean | min | max | s.e. |
| 1979 | 0.0022 | 16.29 | 4.01 | 58.66 | 0.18 |
| 1980 | 0.0195 | 10.54 | 1.37 | 87.46 | 0.04 |
| 1981 | 0.0080 | 35.75 | 13.71 | 55.37 | 0.35 |
| 1982 | 0.0020 | 16.39 | 2.90 | 47.13 | 0.18 |
| 1983 | 0.0000 | --- | --- | --- | --- |
| 1984 | 0.0062 | 21.98 | 6.46 | 68.63 | 0.51 |
| 1985 | 0.0000 | --- | --- | --- | --- |
| 1986 | 0.0000 | --- | --- | --- | --- |
| 1987 | 0.0000 | --- | --- | --- | --- |
| 1988 | 0.0000 | --- | --- | --- | --- |
| 1989 | 0.0388 | 8.93 | 3.70 | 49.90 | 0.01 |
| 1990 | 0.0022 | 10.43 | 4.13 | 42.79 | 0.07 |
| 1991 | 0.0115 | 12.65 | 4.69 | 49.46 | 0.04 |
| 1992 | 0.0187 | 14.62 | 5.71 | 48.36 | 0.02 |

Table 13.- Summary of average number of scallops at age per tow for prerecruits (shell height under 75 mm or age less than 5 years) and recruits (shell height over 75 mm) by catch stratum.

| | Age (years) | | |
|---------------------------|-------------|------|-----|
| | 1-4 | 5-10 | 11+ |
| Browns Bank / Tusket 1983 | | | |
| low | 416 | 6 | 1 |
| high | 308 | 9 | 7 |
| Browns Bank / Tusket 1984 | | | |
| low | 0 | 0 | 0 |
| medium | 156 | 11 | 11 |
| high | 61 | 34 | 1 |
| Browns Bank / Tusket 1985 | | | |
| exploratory | 247 | 6 | 11 |
| low | 0 | 0 | 0 |
| high | 1 | 0 | 2 |
| Browns Bank / Tusket 1986 | | | |
| exploratory | 1 | 8 | 4 |
| low | 0 | 0 | 1 |
| high | 1 | 0 | 1 |
| Browns Bank / Tusket 1987 | | | |
| exploratory | 12 | 2 | 2 |
| Browns Bank / Tusket 1990 | | | |
| exploratory | 362 | 165 | 20 |
| Browns Bank / Tusket 1991 | | | |
| exploratory | 563 | 152 | 27 |
| Browns Bank / Tusket 1992 | | | |
| exploratory | 1227 | 356 | 60 |

Table 14.- Average number of scallops per tow caught in a lined 2.44 m New Bedford offshore dredge in the Browns Bank / Tusket area on an age basis and estimated minimum dredgeable biomass per tow for 5-mm shell height intervals over 100 mm corresponding to a meat count of 55 or less at survey time.

| | Age (years) | | | | | | | | | | Mean | s.d. |
|----------------------------------|------------------------|---------|---------|---------|---------|---------|---------|----|-----|----|-----------|------|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10+ | | | |
| 1990 stock survey exploratory | 174 | 122 | 65 | 60 | 35 | 26 | 20 | 15 | 29 | 29 | 547 | 713 |
| 1991 stock survey exploratory | 250 | 186 | 127 | 55 | 29 | 25 | 21 | 15 | 34 | 34 | 742 | 1100 |
| 1992 stock survey exploratory | 600 | 385 | 242 | 115 | 107 | 63 | 35 | 23 | 73 | 73 | 1702 | 2409 |
| | Shell height intervals | | | | | | | | | | total (g) | |
| | 100-105 | 105-110 | 110-115 | 115-120 | 120-125 | 125-130 | 130-135 | | | | | |
| 1991 survey | 190 | 147 | 84 | 57 | 38 | 33 | 4 | | | | 553 | |
| 1992 survey | 336 | 314 | 262 | 160 | 65 | 20 | 5 | | | | 1162 | |

Table 15.- Fishery characteristics for the German Bank / Lurcher Shoals area (NAFO 4Xq). Landings and catches are in t of scallop meats. Landings are from Statistics Division, Fisheries and Oceans, Halifax. Effort pertains to Class 1 catch only.

| Year | Landings | Logged catches | Class 1 catch | Effort (crhm) | CPUE (kg/crhm) |
|------|----------|----------------|---------------|---------------|----------------|
| 1979 | 102.32 | 147.10 | 145.20 | 157,729 | 0.921 |
| 1980 | 1269.71 | 1132.69 | 1021.86 | 1,614,441 | 0.633 |
| 1981 | 379.69 | 207.63 | 188.78 | 318,221 | 0.593 |
| 1982 | 659.74 | 535.84 | 403.51 | 954,628 | 0.423 |
| 1983 | 587.76 | 465.88 | 420.45 | 1,092,569 | 0.385 |
| 1984 | 207.13 | 175.83 | 156.45 | 581,969 | 0.269 |
| 1985 | 33.76 | 16.60 | 15.91 | 46,295 | 0.344 |
| 1986 | 1.59 | 0.00 | 0.00 | 0 | --- |
| 1987 | 0.00 | 0.00 | 0.00 | 0 | --- |
| 1988 | 0.00 | 0.00 | 0.00 | 0 | --- |
| 1989 | 5.54 | 4.54 | 4.01 | 9,112 | 0.440 |
| 1990 | 0.00 | 0.00 | 0.00 | 0 | --- |
| 1991 | 0.00 | 0.00 | 0.00 | 0 | --- |
| 1992 | 0.25 | 0.25 | 0.25 | 254 | 0.998 |

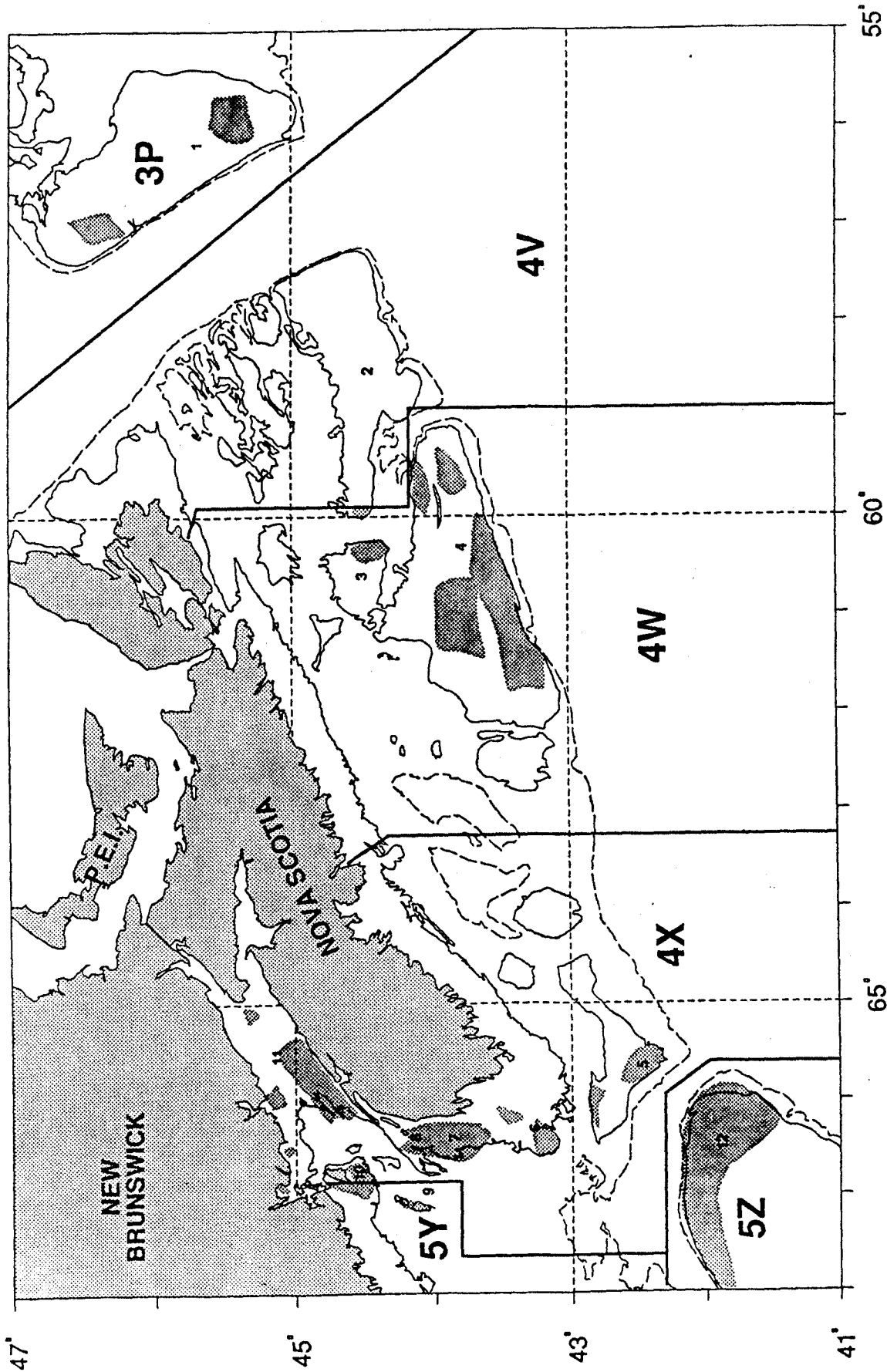


Figure 1.- Scallop fishing areas on the Scotian Shelf and St. Pierre Bank. The 100 and 200-m isobaths are represented. Areas in numerical order are: (1) St. Pierre Bank; (2) Banquereau Bank; (3) Middle Grounds; (4) Sable Island area; (5) Browns Bank; (6) German Bank; (7) Lurcher Shoals; (8) Outer reaches of the Bay of Fundy; (9) Southwest Bank; (10) Grand Manan area and (11) the Bay of Fundy area. Georges Bank (12) is also shown.

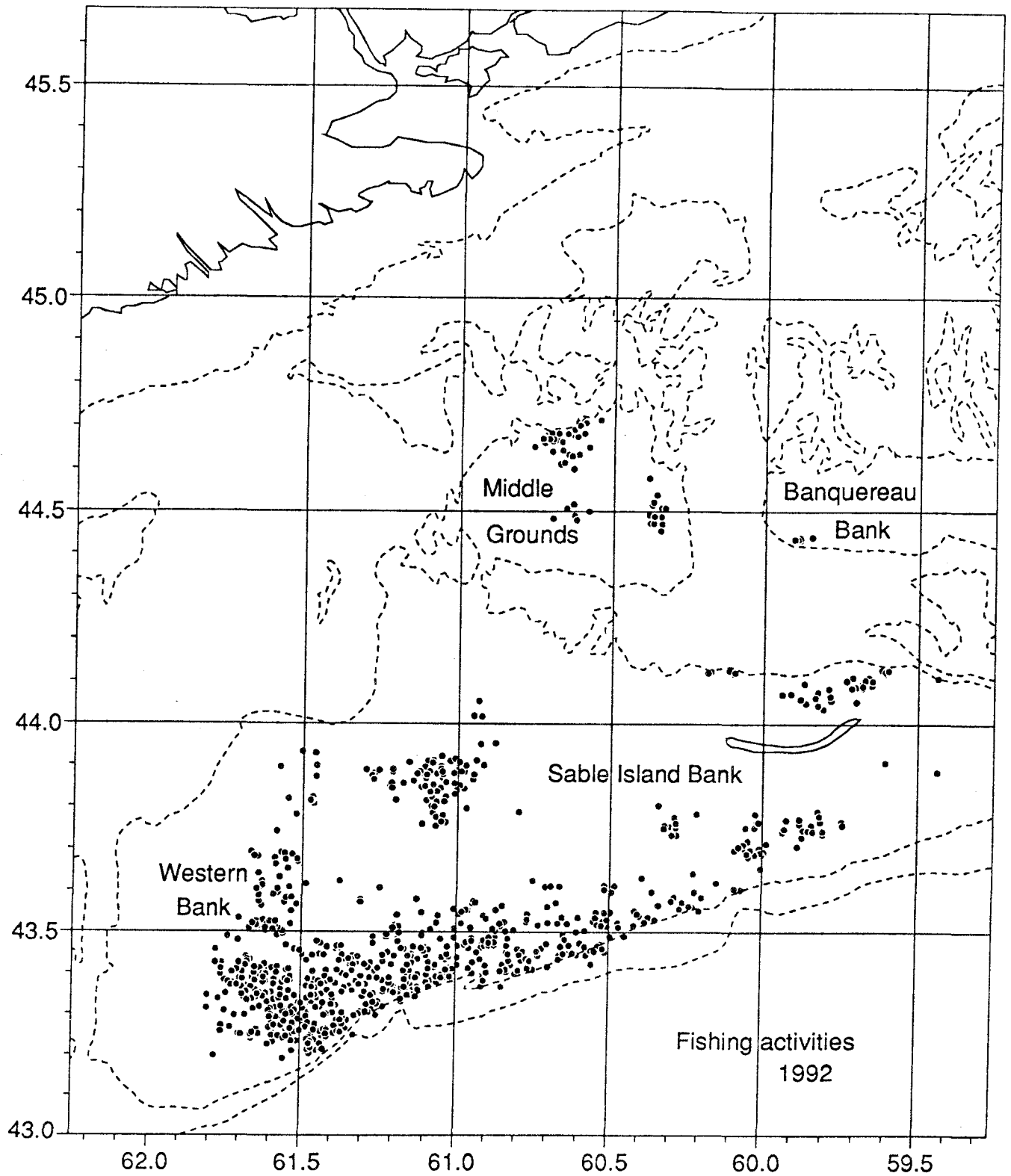


Figure 2.- Distribution of commercial effort by the deep-sea fleet on the eastern Scotian Shelf in 1992. Each dot corresponds to a fishing location visited at least once.

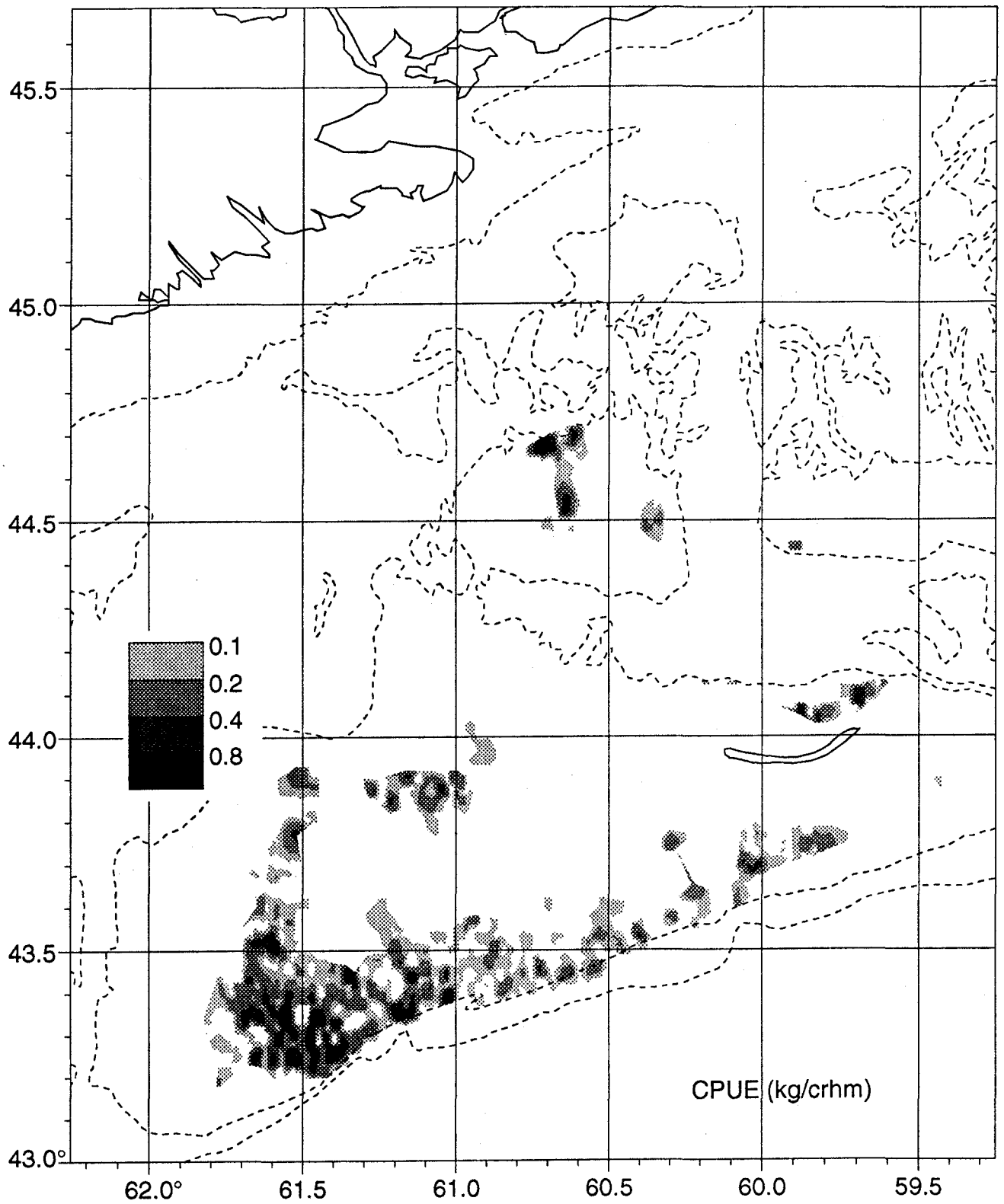


Figure 3.- Distribution of commercial CPUE by the deep-sea fleet on the eastern Scotian Shelf in 1992. The darkest shade represents over 0.8 kg/crhm.

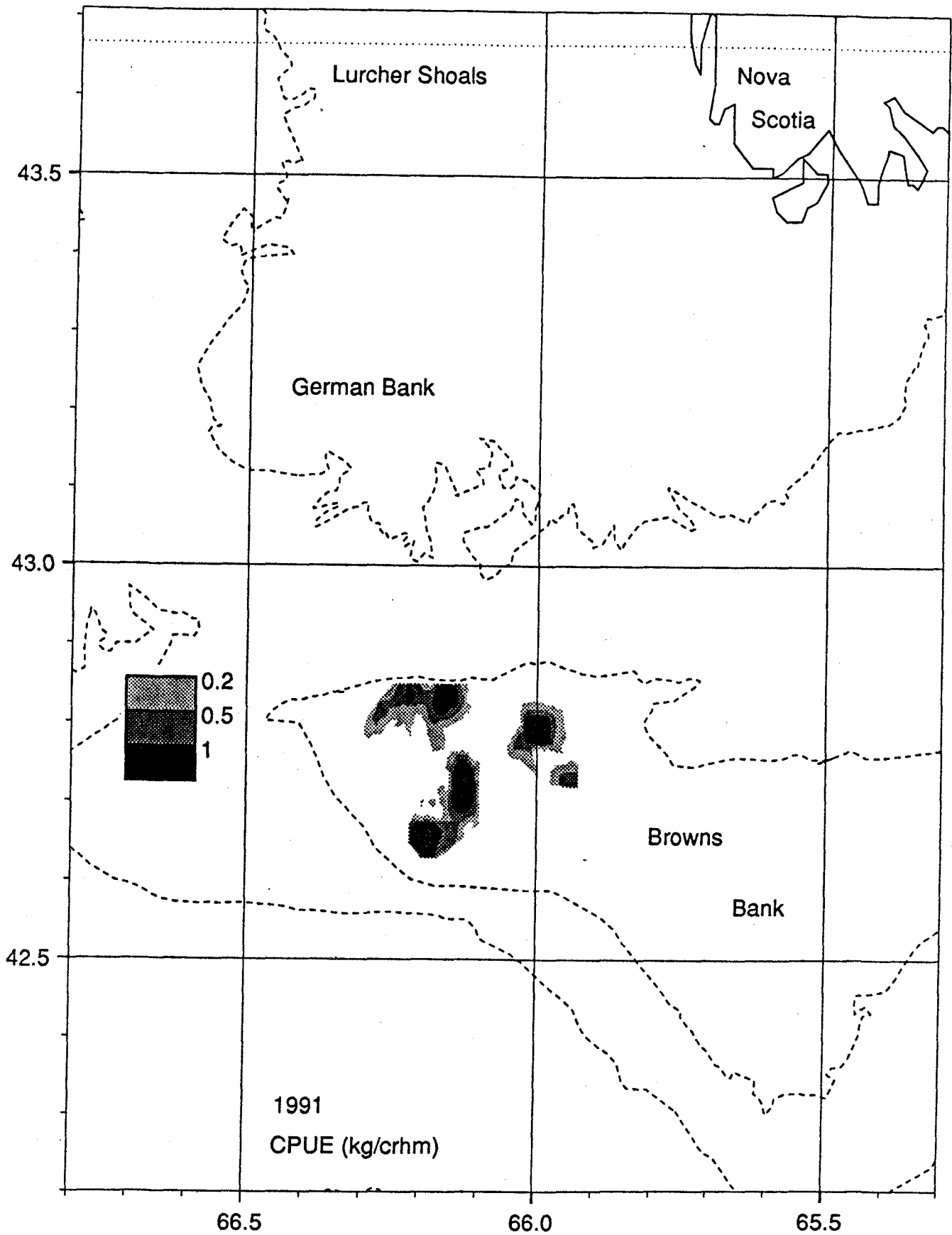


Figure 4.- Distribution of commercial CPUE by the deep-sea fleet on the western Scotian Shelf in 1991. The darkest shade represents over 1 kg/crhm. The dotted line on the Lurcher Shoals indicates the Inshore / Offshore Agreement line at latitude $43^{\circ} 40'$.

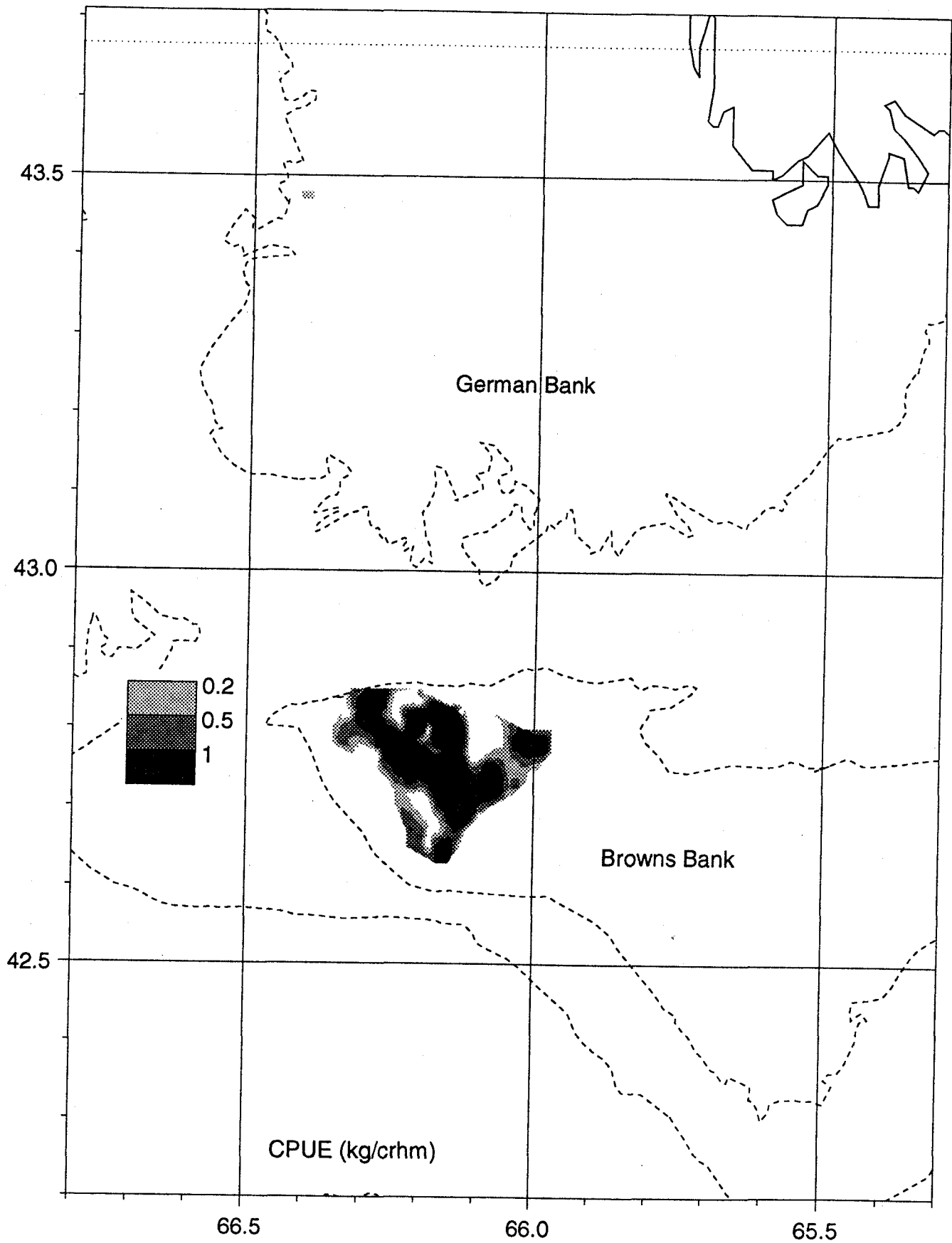


Figure 5.- Distribution of commercial CPUE by the deep-sea fleet on the western Scotian Shelf in 1992. The darkest shade represents over 1 kg/crhm. The dotted line on the Lurcher Shoals indicates the Inshore / Offshore Agreement line at latitude 43 ° 40'.

Browns Bank 1991 survey

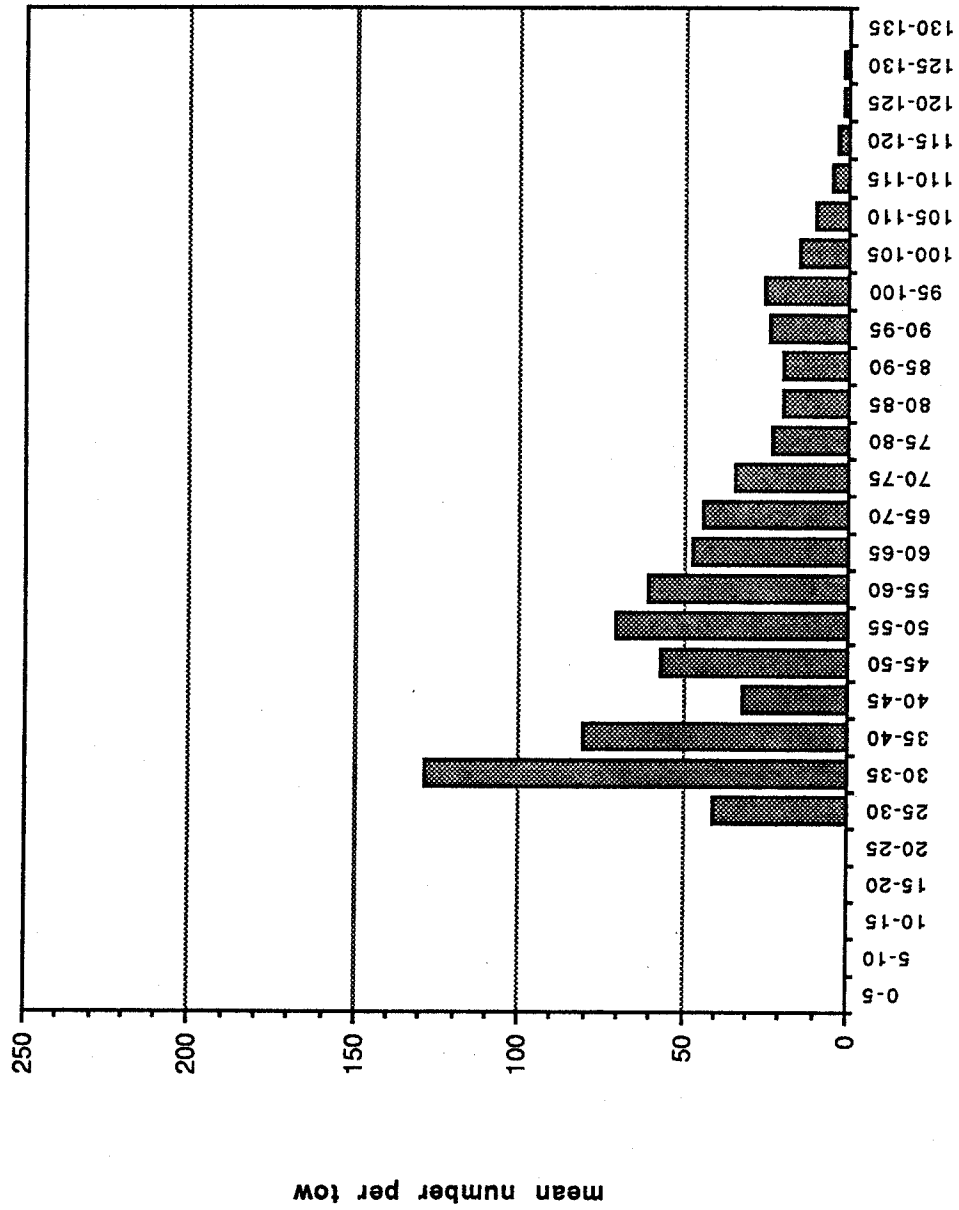


Figure 6.- Distribution according to shell height of the mean number of scallops per standard tow from the 1991 Browns Bank survey. N = 742

Browns Bank 1992 survey

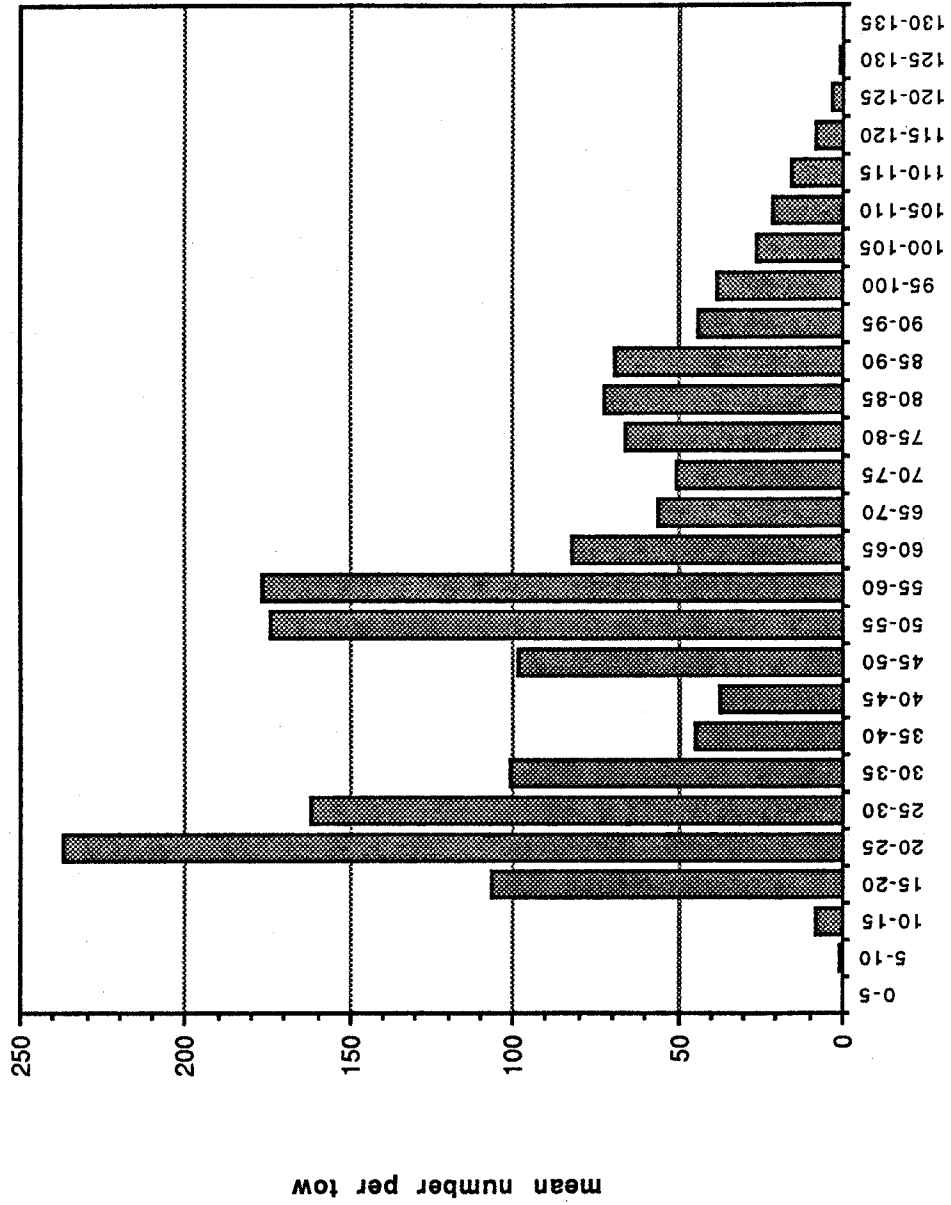


Figure 7.- Distribution according to shell height of the mean number of scallops per standard tow from the 1992 Browns Bank survey. N = 1,702