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The feasibility of a limited foreign test fishery for redfish in NAFO Division 4VWX.

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Abstract

Analyses of historical data on redfish distribution indicate that the largest proportion of redfish biomass occurs at depths exceeding 183 m. These are also the depths found within the small mesh gear box. Analyses of survey data collected in March and April of 1982 indicate a biomass level of approximately 1244 mt within the 183-366 m depth zone in the small mesh gear box (from Browns Bank to 60°W), and a total biomass of 9556 mt within the 183-366 m depth zone of the extended small mesh gear box (Browns Bank to Banquerau Bank). In addition, catch rates at depths of 366-550 m equal or exceed those at 183-366 m, indicating a significant redfish biomass at these depths.

These analyses indicate that a 500-1000 mt foreign fishery is feasible within the confines of the extended small mesh gear box. Research vessel catches indicate that by-catches of cod, haddock, pollock and halibut can be significant at depths of 90-366 meters, with by-catch rates of cod, haddock and pollock exceeding those of redfish at depths less than 183 m. These by-catches fell to approximately 50% of the redfish catch by weight between 183 and 366 m, and were virtually non-existent at depths between 366-550 m. The only significant by-catches at these greater depths were of Atlantic halibut which represented approximately 5% of the redfish catch by weight.

In conclusion, analysis of available data indicates that a redfish test fishery of some 500-1000 mt is feasible within the confines of the extended small mesh gear box. By-catches of other commercially valuable species may be quite significant at depths between 90 and 366 m but negligible between 366 and 550 m. Since, at these greatest depths, redfish catch rates are highest, by-catches are minimal, and

modal lengths of redfish are largest, this may provide incentive for a foreign test fishery to catch their allocation at these depths thus avoiding by-catch problems. However, as a minimum precaution strict by-catch limits should be imposed on any such fishery.

Résumé

Des analyses de données historiques sur la distribution du sébaste indiquent que la plus grande proportion de la biomasse de cette espèce se trouve à des profondeurs dépassant 183 m. Ce sont également les profondeurs observées à l'intérieur de la case pêchée avec engin à petite maille. L'analyse des données recueillies au cours du relevé de mars et avril 1982 indique un niveau de biomasse d'environ 1 244 tm en dedans de la zone bathymétrique de 182-366 m dans la case pêchée avec petite maille (du banc Browns à 60°W), et une biomasse totale de 9 556 tm en dedans de la même zone bathymétrique, mais élargie, de la case à petite maille (du banc Browns au Banquereau). En outre, les taux de capture aux profondeurs de 366-550 m sont égaux ou supérieurs à ceux des profondeurs de 183-366 m, signe d'une importante biomasse de sebaste à ces profondeurs.

Ces analyses indiquent qu'une pêche pratiquée par les étrangers pourrait capturer 500-1 000 tm dans les limites de la case de petite maille élargie. Les prises par naivre de recherche démontrent que les prises secondaires de morue, aiglefin, goberge et flétan peuvent être importantes aux profondeurs de 90-366 m, les taux de capture de morue, aiglefin et goberge dépassant ceux du sébaste à des profondeurs inférieures à 183 m. A des profondeurs comprises entre 183 et 366 m, ces prises secondaires diminuent à environ 50 % en poids des prises de sébaste et sont pratiquement nulles à des profondeurs de 366 à 550 m. Les seules prises secondaires significatives à ces grandes profondeurs sont celles de flétan atlantique, représentant environ 5 % en poids des prises de sébaste.

En conclusion, l'analyse des données disponsibles indique qu'une pêche d'essai du sébaste de quelque 500 - 1 000 tm est possible dans les limites de la case élargie de pêche à petite maille. Les prises secondaires d'autres espèces de valeur commerciale peuvent être significatives à des profondeurs de 90-366 m, mais négligeables entre 366 et 550 m. Puisque, à ces grandes profondeurs, les taux de capture du sébaste sont à leur maximum, ceux des prises secondaires à leur minimum, et que les longueurs modales du sébaste sont aussi à leur maximum, ceci pourrait être un stimulant à une pêche d'essai par les étrangers qui leur permettrait de capturer leur contingent à ces profondeurs, évitant ainsi les problèmes de prises secondaires. Cependant, comme minimum de précaution, on devrait imposer de strictes limites aux prises secondaires dans une pêche de ce genre.

Introduction

In 1974, a total allowable catch (TAC) of 40,000 mt was imposed on NAFO Divisions 4VWX redfish. This TAC was subsequently reduced to 20,000 mt in 1976, and remained in effect until 1979, whereupon it was increased to 30,000 mt. This figure remains in effect to date. The rationale for imposition of this 30,000 mt TAC is twofold. The first stems from the fact that research vessel surveys in 1979 indicated a trawlable biomass of redfish of some 200,000 mt, and it was felt that the population could support a 15% exploitation rate (Anon 1980). Furthermore the resulting figure of 30,000 mt was close to the long-term average landings of redfish since the late 1950's, and it was felt that since these catches had been maintained for an extended period they might represent a sustainable yield from that population.

Since this TAC was imposed on the 4VWX redfish, landings have not achieved these levels. This fact has resulted in a contention to the effect that, since Canadian landings have not attained their total allowable levels, any remaining surplus should be allocated to foreign nations. Although it appears a relatively simple task to identify such a surplus, merely by examining total landings and total allowable catches, some care must be exercised.

Redfish in 4VWX have historically been an extremely difficult stock, or complex of stocks to assess. Difficulties arising from their unique distributional characteristics, make it questionable that present research vessel surveys adequately survey these populations. Difficulties in ageing individual animals has resulted in a paucity of information on population age structure thus not allowing for the usual age dependent cohort by cohort analysis of this stock. Finally difficulties in assessing whether landings were made via directed redfish effort using small meshed trawls, or from by-catches of other fisheries using larger meshed trawls, make commercial length frequency data difficult to interpret. Given these considerations it becomes somewhat more difficult to identify surplus redfish on the basis of simply subtracting total landings from total allowable catch figures.

If in spite of these considerations a surplus is identified, consideration must next be given to where and in what form this surplus exists. If a foreign fishery is to be allocated some amount of the redfish TAC it would be desirable if this quota could be fished within the confines of the present small mesh gear box, since fleet surveillance procedures are well established in this area and conflicts with the domestic fleet would be minimized (Fig. 1). This paper will therefore attempt to answer the following questions.

(1) If between 500 - 1000 metric tons of redfish were to be allocated to the Japanese or other foreign fishery, could this be caught within the confines of the small mesh gear box or its extension.

(2) If so what sort of catch rates, size compositions and by-catch rates can such a fishery expect.

(3) If such an amount could not be caught within the boundaries of the small mesh gear box, or its extension and this foreign fishery were permitted to pursue redfish on the Scotian Shelf proper, what would be the problems associated with this (i.e. by-catch problems).

Abundance and Distribution

The longest time series of data on redfish distribution and abundance are the records of the summer groundfish survey cruises which have been conducted each July since 1970. These surveys are of a random stratified design and cover the shelf to a depth of 200 fathoms. It must, however, be understood that the number of individual sets conducted in the 100-200 fathom strata are relatively few, and as such any measures of central tendency such as mean biomass estimates are necessarily associated with large variances.

Given this caveat we examined these data to determine how redfish distribution varies with depth since our main interest was to decide whether adequate amounts occur at the depths found within the confines the small extended mesh gear box. Figure 2 shows the mean biomass, in thousands of metric tons per stratum, with strata categorized by three distinct depth ranges. The stratum means were calculated as the arithmetic mean of all values observed within a particular stratum between 1970 and 1981.

It is obvious that strata whose mean depths are 50 fathoms or less, consistently contain the smallest amounts of redfish. In the 50-100 fathom range these estimates are higher and extremely variable, ranging from 23 mt to over 26,000 mt per stratum. The deepest strata, those whose depths are greater than 100 fathoms, consistently contain the largest amounts of redfish and are less variable than the next shallower series.

From these preliminary analyses we concluded that fishing in waters with depths exceeding 100 fathoms is most likely to produce consistently large catches of redfish relative to shallower waters.

More specifically the areas of interest to the present discussion are the deeper strata along the edge of the shelf in NAFO Divisions 4Vs, 4W, and 4X. The locations of these strata are shown in Figure 3. The most recent estimates of redfish biomass within these strata derived from the 1981 summer groundfish survey conducted during July of 1981 are given in Table 1 which follows.

Table 1. Mean redfish biomass estimates (1981) for strata 100-200 fathoms in depth lying within the extended small mesh gear box.

Stratum	1981 Estimated Mean Biomass(mt)	1970-1981 Estimated Mean Mean Biomass (mt)
49	0	143
51	306	1521
52	53	3464
53	8	2338
66	0	170
78	1825	636

These data indicate that the 1981 biomass estimates for most of these strata lie below their longer term average values, with the exception of stratum 78 (Division 4X) which indicates above average biomass levels. Summing these values across strata gives a total redfish biomass estimate of 2192 mt within the 100-200 fathom strata of Divisions 4Vs, 4W, and 4X.

This estimate should be viewed as a rough estimate of redfish biomass available within the extended small mesh gear box for several reasons. The individual stratum estimates are based on very small numbers of sets. These sets can represent either day or night fishing without correcting for the nighttime off-bottom migration of redfish which will tend to depress estimates of biomass. Finally, fishing only occurs to a depth of 200 fathoms. If significant concentrations of redfish reside beyond the 200 fathom limit, then these surveys would not be sampling this proportion of the population, thus underestimating levels of available redfish biomass.

Catch Rates

During March and April of 1982, a survey specifically designed for redfish was conducted on fishing grounds from 57°W to 63°W at depths from 50 fathoms to 300 fathoms along the edge of the Scotian Shelf. This survey was designed to sample redfish in that the number of sets per depth stratum was increased to 20 from the regular 2 to 4 in an attempt to more thoroughly cover each stratum thereby increasing the probability of adequately estimating available redfish biomass. For the most westerly strata, those between 57°W and 60°W (the SW edge of Banquerau Bank, The Gully, and the edge of Sable Island Bank), each set within a stratum was sampled both at night and during daylight hours in an attempt to reduce day-night variability.

Figure 4 shows that catch rates increase dramatically with depth. These findings are not surprising in light of the distributions of redfish biomass presented earlier, but do indicate that catch rates

below the 200 fathom line equal or even surpass those in the 100-200 fathom range. Again, catch rates in the 50-100 fathom range were lowest. The relatively high catch rates in deeper waters indicate that surveys which fish only to depths of 200 fathoms are missing substantial concentrations of redfish and are thus underestimating the biomass available to a commercial fishery. This conclusion is further substantiated by data presented in Figure 5. We found that standard one-half hour hauls at depths of 200-300 fathoms consistently contained larger amounts of redfish, and conversely, resulted in fewer hauls with small amounts (100 kg). This appears to be indicative of one of two things. It may be that concentrations of redfish are more densely packed in these deeper waters thus resulting in increased catch rates. It could also indicate that the number of schools or aggregations is larger in these deeper waters.

The relatively high catch rates in waters exceeding 200 fathoms may indicate the presence of previously unsurveyed concentrations of redfish, although these concentrations have been observed previously (eg. Templeman 1959).

Catch rates obtained from research vessel data series are questionable indicators of commercially attainable rates. The fact that tows are randomly distributed between preselected stations with no prior knowledge of redfish concentrations, and are made with no attempt to fish on observed concentrations of redfish, as is the case in a commercial fishery, tends to make these minimum estimates of catch rates within a given area. For this reason it was found informative to examine the ranges of catch rates observed, as well as mean values within predetermined strata. Figure 4 shows catch rates on a tow by tow basis for three depth zones. From this figure it is evident that catch rates increase dramatically with depth, ranging from 9 kg per tow at depths of 50-100 fathoms to a mean value of 136 kg per tow at depths of 200-300 fathoms. These catch rate data were again obtained from the 1982 March-April redfish survey.

Catch rate values ranged from 0-160 kg/hr in the shallower water to 0-4042 kg/hr at depths of 100-200 fathoms, and from 0-1650 kg/hr at depths of 200-300 fathoms.

Length Frequency Distributions

Previous investigators have indicated that redfish length distributions vary with depth (Gulland 1965, Hennemuth & Brown 1964, Templeman 1961) and that concentrations of redfish in deeper waters usually contain proportionally more larger individuals than concentrations occurring at lesser depths. Data from the 1982 redfish survey corroborate these findings. Two facts are particularly noteworthy in Fig. 6, 1) mean length increases from the 100-200 to the 200-300 fathom zones and 2) the proportion of smaller fish (5-15 cm) decreases with depth. Data presented by Jean and McCracken (1961) indicate similar results, although they did not present data for depths

beyond 230 fathoms.

Bycatch

Since it appears feasible to allow a limited foreign redfish fishery to be directed within the confines of the extended small mesh gear box, a question as to potential bycatches of other commercially valuable species arises. Data from the March/April redfish cruise were used to calculate bycatch rates of the four most commonly occurring, commercially valuable groundfish species, namely halibut, cod, pollock and haddock. The rather striking results of this analysis is given in Fig. 7. In the 50-100 fathom range catch rates for these other species exceeded catch rates for redfish. The only species which showed mean catch rates lower than those of redfish was halibut. Tows made at depths of 101-200 fathoms had mean catch rates of redfish which exceeded those of the four bycatch species, however, cod and pollock bycatch rates still amounted to approximatedly 50% of the redfish catch rates. The most striking feature of this analysis is the nearly complete lack of bycatch in the 200-300 fathom zone. At these depths bycatches of cod, pollock, and haddock are negligible, while redfish show the highest mean catch rates. At these depths the species which had the highest by-catch rate was halibut with catch rates equal to approximately 5% of the redfish catch rates.

Conclusions and Discussion

From analysis of a 12 year long data series we have demonstrated that the major proportion of redfish biomass on the Scotian Shelf is found in waters deeper than 100 fathoms. Both biomass estimates and catch rates indicate the presence of larger numbers of redfish in these deeper water than in adjacent shallower waters. The boundaries of the extended small mesh gear box, within which it would be desirable to limit any foreign fishery, include these deeper waters. Initially, it would seem then that allocating some amount of redfish to a foreign fishery within the confines of this box should present little problem, however, analysis of the most recently available data from the annual groundfish cruises, indicate biomass estimates within these deeper strata, accessible within the small mesh gear box, total only 2192 mt, allowing for a catchability of 25% (Kenchington 1981) gives a total biomass of 9340 mt. Using the most recent data from the 1982 March/April redfish survey gives an estimate of 9556 mt for this same area. Using the same catchability coefficient for this estimates results in a total available biomass of 38,224 mt. This later estimate is based on twice the number of sets within this area and is thus felt to be more reliable. If we assume, conservatively, a total lack of interchange between these deeper water fish and ones inhabiting shallower waters we can calculate, according to Rivard (1980) a 2-3% surplus production of 760-1146 mt.

The above estimates include only those strata from 100-200 fathoms

deep. We have presented data that indicates large amounts (as evidenced by catch rate information) of redfish at depths greater than 200 fathoms. It might be argued that these concentrations merely represent aggregations of redfish which have moved down the continental slope, to deeper waters during the winter months. However, this seems unlikely in view of the fact that biomass estimates of the 100-200 fathom zone exceed those derived from the summer survey data. If it were the case that redfish had migrated down the slope during the winter months, we would have expected to find lower biomass levels due to redfish emigration to deeper waters.

From these data we may conclude that if 500-1000 metric tons of redfish were to be allocated to a foreign fishery, it would be possible to catch these within the confines of the extended small mesh gear box. From the most recently available data it would seem that these amounts could be taken with minimum catch rates of over 200 kg/hr with possible catch rates exceeding 1.5 mt/hr. If, as seems likely, it is desirable to catch larger, more marketable redfish it would be advisable for this fishery to operate in waters between 200 and 300 fathoms deep. This would have the added benefit of keeping bycatches of other commercially valuable species to a minimum. At these depths the only significant bycatches may be due to incidental halibut catches If our latest bycatch estimated for this species is correct, this would amount to approximately 5% of the redfish catch, or 50 mt for a 1000 mt catch of redfish.

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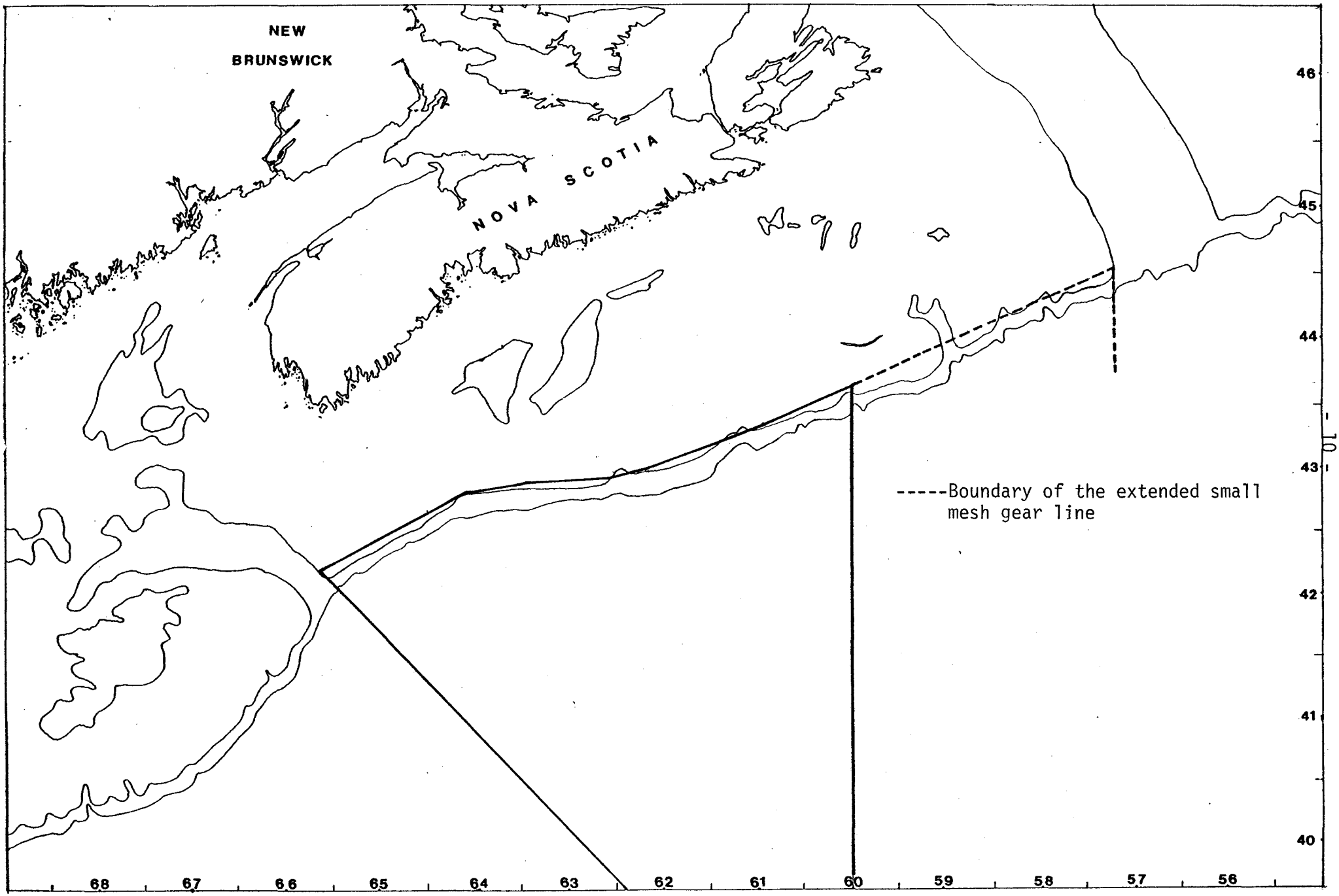

Fig. 1. Present boundaries of the small mesh gear box.

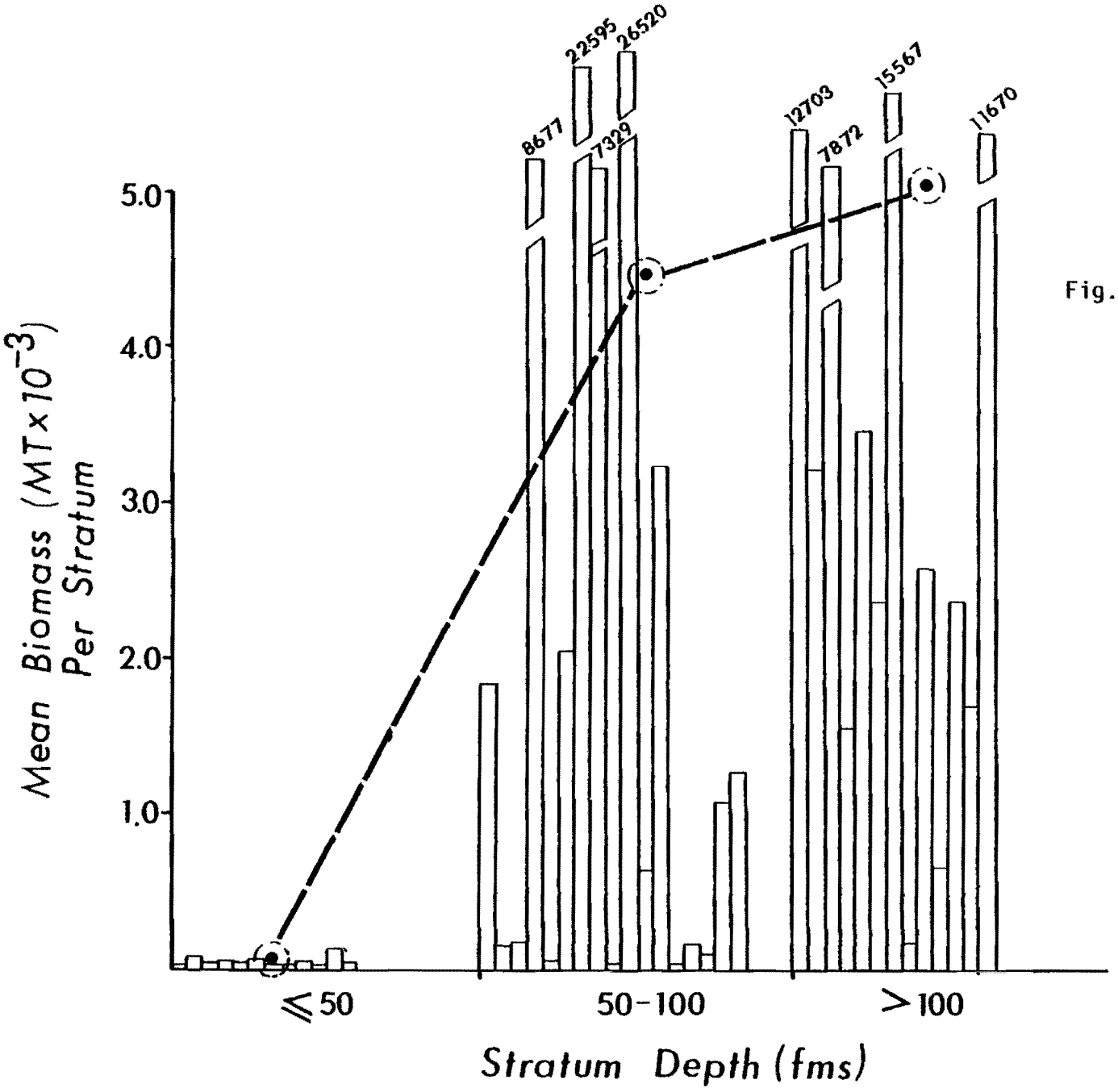

Fig. 2. Mean redfish biomass estimates on a per stratum basis. Each bar represents the mean value of 12 years of survey data and strata have been divided on the basis of depth - θ indicate group means.

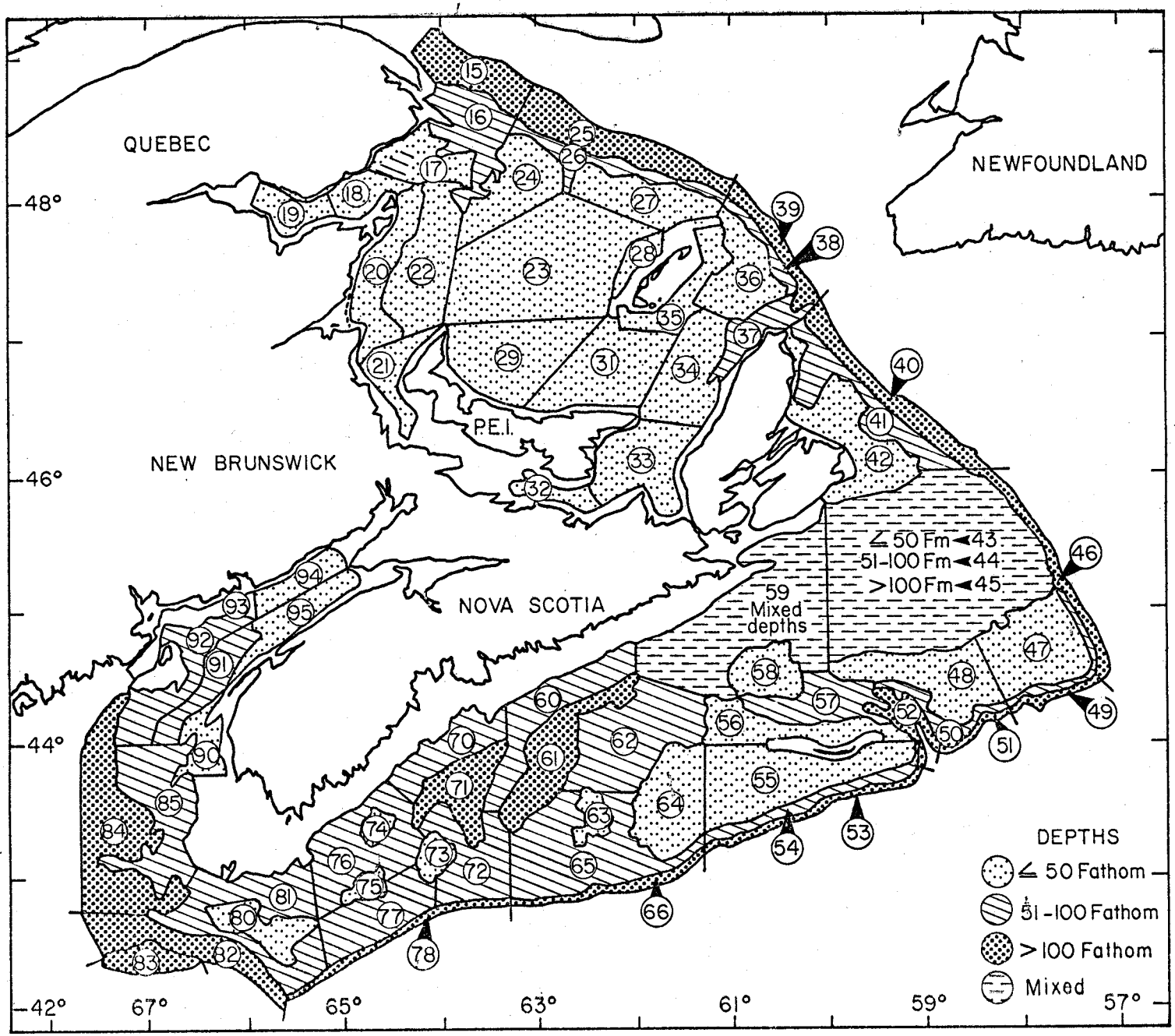

Fig. 3. Locations of stratum numbers mentioned in the text.

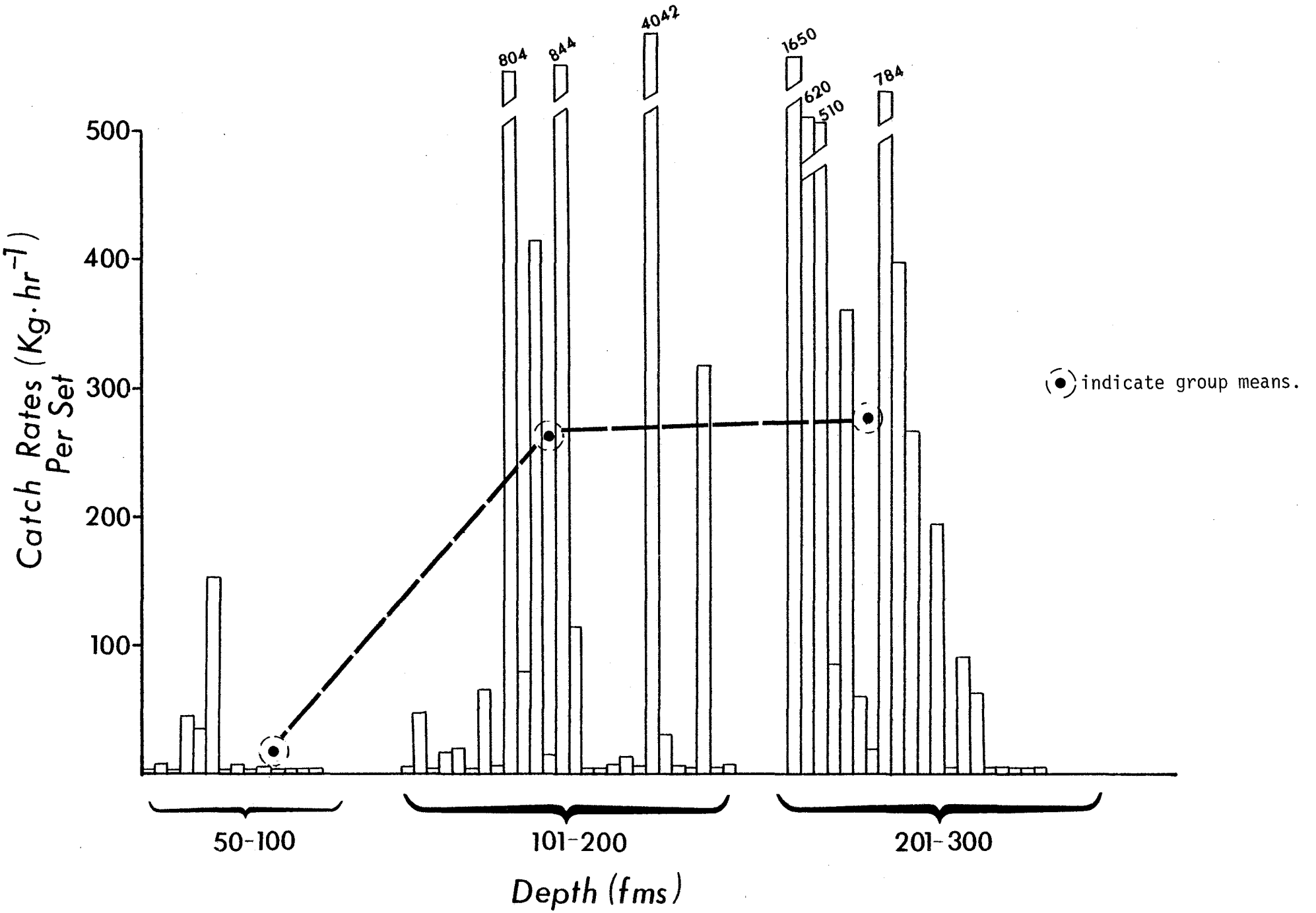

Fig. 4. Redfish catch rates during the March/April redfish survey, stratified by depth.

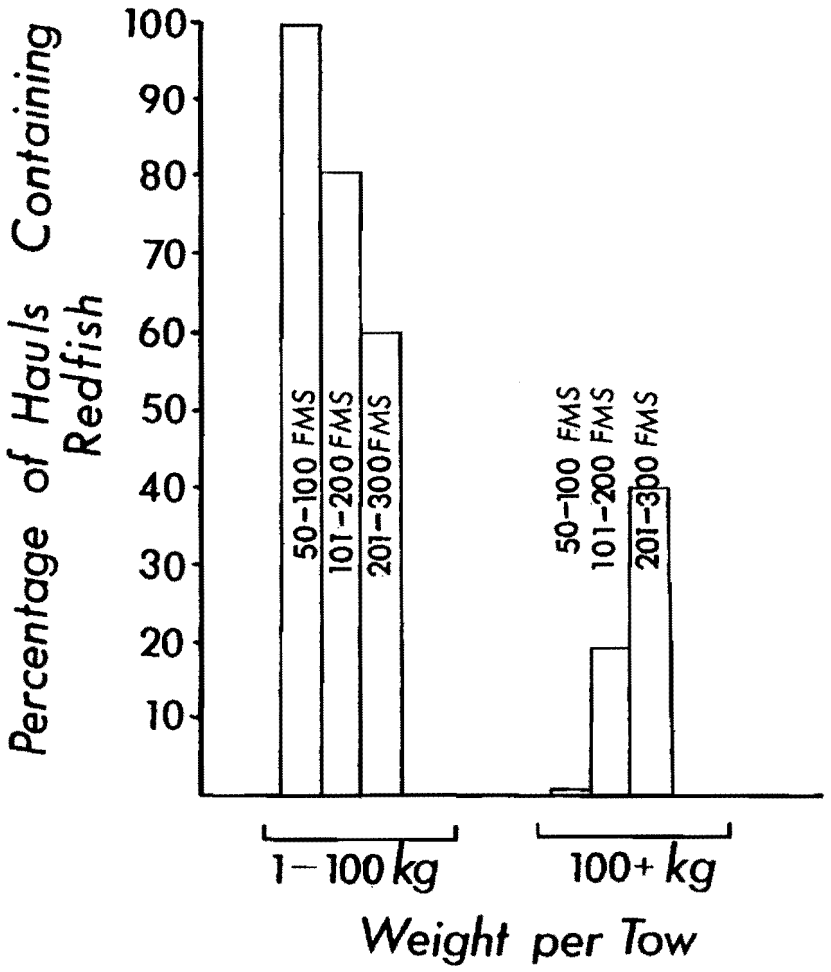

Fig. 5. Distribution, by depth, of redfish weight per tow for the March/April redfish survey.

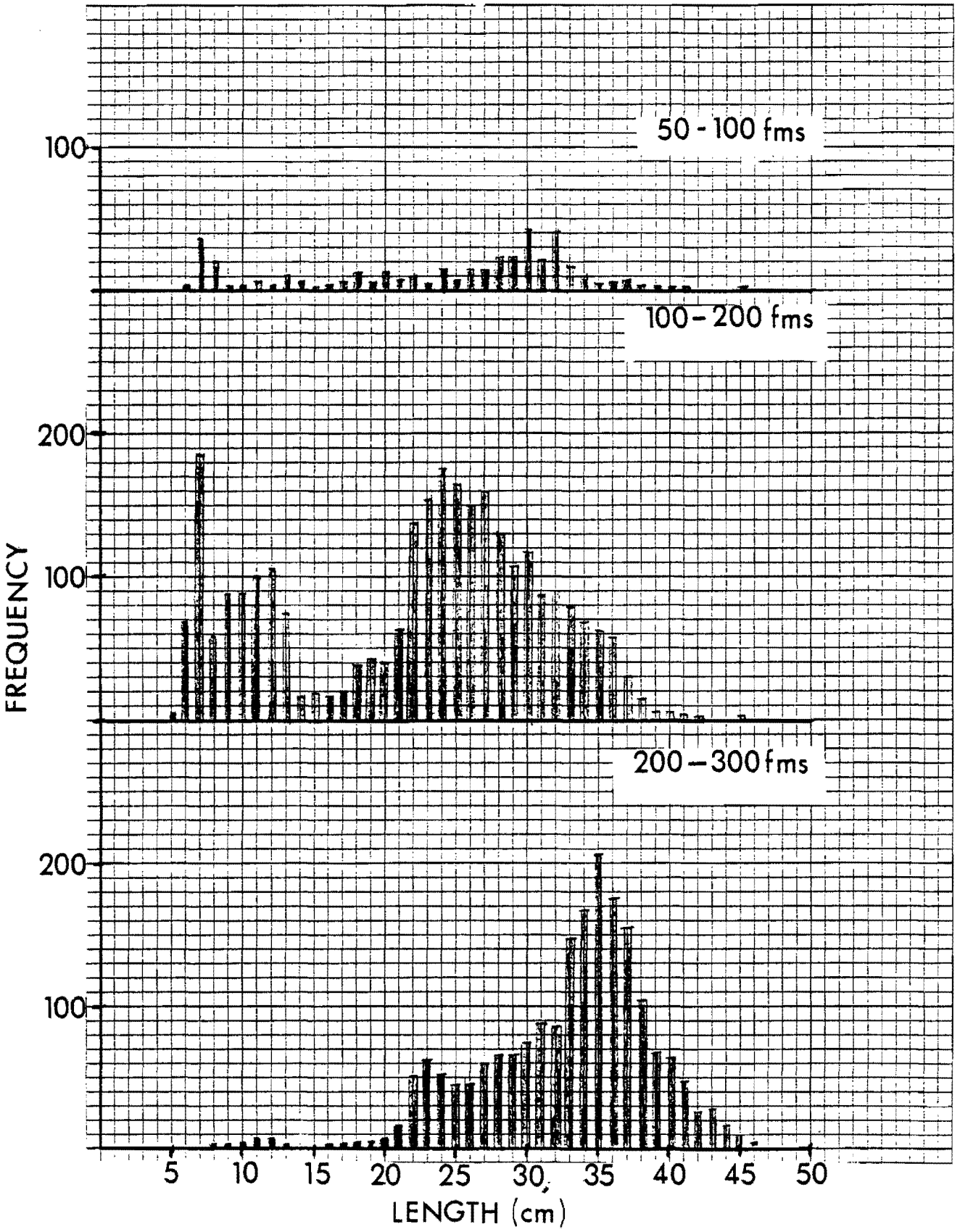

Fig. 6. Redfish length frequency distributions stratified by depth for the March-April redfish survey.

Fig. 7. Catch rates of redfish and the four most commonly associated commercial species, stratified by depth. Date from the March/ April redfish survey.