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The Redfish Stock Issue in 3P, 4RST and 4VWX

by

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Résumé

Les unités de gestion du sébaste dans l'Atlantique nord-ouest ont été créées au début des années 1970 et sont demeurées inchangées. Diverses études ont révélé qu'elles ne correspondent pas nécessairement aux besoins biologiques, mais jusqu'ici on ne s'est pas attardé beaucoup sur cette question. En 1989, le CSCPCA a conclu, en se fondant sur les résultats des campagnes d'évaluation, que la séparation des stocks de sébaste le long de la limite des divisions 3P4V n'était sans doute pas adéquate et que l'on ne pouvait fournir d'évaluation du sébaste de la division 3P parce que le poisson de cette division ne semble pas constituer une unité biologique distincte. Le CSCPCA a donc recommandé un examen des données scientifiques et commerciales relatives aux divisions 3P, 4RST et 4VWX afin de déterminer quelles seraient les unités de gestion les plus appropriées pour le sébaste. Il jugeait ce travail essentiel à la prestation continue de conseils sur la gestion du sébaste de la région.

L'examen des données scientifiques provenant des résultats du chalutage et des relevés acoustiques a confirmé que la séparation des stocks le long des limites des zones 3P et 4V est inadéquate, le sébaste étant distribué de façon continue le long du chenal Laurentien. Les données sur les prises commerciales et l'effort de pêche émanant du Programme des observateurs confirment cet état de choses et révèlent que le sébaste est distribué de façon continue depuis le chenal Laurentien et le long du bord de la plate-forme néo-écossaise jusqu'au 62° méridien ouest, où la continuité semble se briser. D'ailleurs, les pêcheurs ont confirmé verbalement cette rupture de distribution dans ce secteur. D'après des données antérieures sur la composition des stocks, on en est arrivé à la conclusion que le stock de sébaste du golfe du Saint-Laurent (4RST) est distinct de celui de l'extérieur du golfe, mais qu'il se dirige vers l'embouchure du golfe et pénètre dans les divisions 3Pn et 4Vn durant l'hiver. D'après les données sur les prises et l'effort de pêche, cette migration se produit généralement de janvier à mai, après quoi le poisson revient dans le golfe.

Compte tenu de ces observations, on a conclu que les unités de gestion qui conviennent le mieux à cette zone sont les suivantes : 1) 4RST (de janv. à déc.) + 3Pn (de janv. à mai) + 4Vn (de janv. à mai); 2) 3Pn (de juin à déc.) + 4Vn (de juin à déc.) + 3Ps4Vs4Wfgj (de janv. à déc.) et 3) 4Wdehkl (de janv. à déc.) + 4X (de janv. à déc.).

Comme il faut réorganiser les diverses bases de données pour les faire correspondre à ces nouvelles unités de gestion, il est impossible, pour le moment, de fournir de nouvelles évaluations. On n'a pas jugé nécessaire de modifier le plan de gestion pluriannuel parce que le sébaste dans la région en question est en bonne santé, puisque la classe d'âge de 1980, qui est relativement forte, commence à être recrutée et que la classe d'âge de 1984, qui est elle aussi relativement forte, commencera à être recrutée en 1994 environ. On a donc provisoirement réparti le TPA actuel (102 000 t) entre les nouvelles unités de gestion en se fondant sur les pourcentages de prises moyennes de 1981 à 1990, ce qui donne les TPA suivants pour 1992 : 1) 4RST (de janv. à déc.) + 3Pn (de janv. à mai) + 4Vn (de janv. à mai) = 67 000 t; 2) 3Pn (de juin à déc.) + 4Vn (de juin à déc.) + 3Ps4Vs4Wfgj (de janv. à déc.) = 25 000 t et 3) 4Wdehkl (de janv. à déc.) + 4X (de janv. à déc.) = 10 000 t.

Introduction

Background

The question of redfish stocks in the northwest Atlantic is one of long standing. Martin (1953) suggested that redfish in Subarea 4 (Fig. 1) were different from those in other areas based on their growth characteristics, meristics and parasites. He concluded that there were a number of isolated stocks in this area including a deepwater population along the outer edge of the Scotian Shelf and in Laurentian Channel to Cape Breton. Wise and Jensen (1960) and Mead and Sinderman (1961) suggested that for assessment purposes, three stocks of redfish could be defined in the northwest Atlantic. These were: SA 2 + Div. 3KL, Div. 3M (Flemish Cap), and Div. 3OP + SA 4 + 5. It was felt that there was overlap between the first and third stocks in Div. 3N. Bainbridge and Cooper (1971) concurred with this definition of only 3 stocks based on the distribution of larvae. ICNAF (1962) reviewed information from the commercial fisheries which tended to indicate that subareas 4 and 5 should be separated. Travin *et al.* (1961) suggested that SA 3 could be divided into a northern stock (Div. 3K + northern 3L), a Flemish Cap stock (Div. 3M) and a southern Newfoundland stock (Div. 3NOP). They also concluded that some mixing occurs in southern 3L and 3N. Kohler (1968) reviewed redfish in SA 4, and concluded that Div. 4RS, Div. 4TVnWfgj and Div. 4WdklX should constitute separate stocks. The separation between Div. 4RS and 4T was based on the apparent lack of redfish in the mid–Laurentian Channel between the two areas, while the separation in Div. 4W was based on a shallow area existing in this region. He made no comment concerning any possible relationships to SA 5 or Div. 3OP. Sandeman (1973) regarded redfish in the Gulf of St. Lawrence as a single stock.

Assessments of redfish began in the early 1970s (ICNAF, 1973) and separations were Div. 3K, Div. 3LN, Div. 3M, Div. 3O, Div. 3P, Div. 4VWX and SA 5 for a total of 7 management units plus 4RST controlled by Canada. Parsons and Parsons (1975) based the separation of Div. 3LN from Div. 3OP on the conclusions of Mead and Sinderman (1961) and Bainbridge and Cooper (1971) above. They separated Div. 3O and 3P based on growth differences noted by Sandeman (1969) although Atkinson and Power (1986) suggested that these differences were probably related to sampling of the two species of beaked redfish (*S. fasciatus* in Div. 3O and *S. mentella* + *S. fasciatus* in Div. 3P).

Parsons, Pinhorn and Parsons (1976) provided the first assessment of SA 2 + 3K redfish. They noted that the relationship of fish in this area to those in Div. 3L was uncertain, but treated SA 2 + 3K as a unit according to 'current ICNAF practice'. The origin of this 'current ICNAF practice' is obscure. At the same time, these authors provided an assessment of Div. 3M redfish. This separation was not difficult as all previous studies had concluded that redfish in this area constituted a self-contained stock.

These different units (SA 2 + 3K, 3LN, 3M, 3O, 3P, 4RST, 4VWX and SA 5) have formed the basis for redfish management since, although supporting rational is often non–existent or contrary to available evidence.

Beginning in the 1970s (Barsukov and Zakharov 1972) there were indications that what had been formerly referred to as *S. mentella* was actually 2 species. The work of Ni (1982) conclusively demonstrated this, and he proposed 4 stocks based on species differences (Fig. 2): Baffin Bay and Labrador stock, Flemish Cap stock, Gulf of St. Lawrence stock, Grand Bank stock and Scotian Shelf stock. He noted that although there were no significant differences in vertebral or anal fin ray counts between the Grand Banks and Scotian Shelf fish, the Laurentian Channel may act as a barrier to their mixing. This approach was criticized by Kenchington (1984) who has described the complex redfish population structures in the Scotian Shelf area.

Kenchington (1982) hypothesized that for each of the redfish species there are no genetic barriers over wide areas of the northwest Atlantic, although there are clines in genotype. He proposed that this situation is maintained by exchange of individuals, primarily as larvae, but also by adult drift migrations. The strengths of year classes in different locations is dependent on the drift of larvae, in any particular year, to that location. When the fish mature, they breed in whatever area they grew up in. He proposed that either the entire Scotian

Shelf or each of its separate NAFO divisions might be suitable management units based on the fact that he could find no distinct steps in the phenotypic gradients of the area. He suggested a specific strategy of data collection and analysis to help provide answers, but to date, his suggestions have not been followed. Throughout his discussions, he made no specific reference to relationships with SA 5, Div. 3P or the Gulf of St. Lawrence although a natural extension of his hypothesis is that these areas are not genotypically different on a species by species basis.

Kenchington (1984) detailed a very comprehensive overview of the redfish stock issue in Div. 4VWX along with a more generalized discussion of northwest Atlantic redfish. He proposed that the appropriate unit for management purposes should be selected from the population structure such that the requirements and assumptions of the management techniques are best fulfilled, while pointing out that in many cases these requirements and assumptions are poorly known. He did emphasize that the task of delimiting these units is far more complex than traditional methods, and new ways of managing may have to be developed. He hypothesized 3 recruitment units: Gulf of Maine–Bay of Fundy–Georges Bank–Browns Bank (4X5Y), Banquereau, Canso, St. Pierre and western Grand Banks (3OPs + eastern 4Vs) and Gulf of St. Lawrence, Sydney Bight (3Pn4RSTVn). From this he proposed 4 management units: 3Pn4RSTVn, 3OPs + eastern 4Vs, western 4Vs + 4W + eastern 4X, and western 4X + 5Y.

Zwanenburg (1985) has also reviewed the history of the Div. 4VWX management unit while providing an assessment of the status of the redfish in the area. He noted that 4VWX redfish do not constitute a biological stock based on many of the reports described above.

In 1989, CAFSAC reviewed distribution plots of redfish research catches in the 3P area. These observations led to doubts as to whether redfish in Div. 3P constitute a distinct biological stock. CAFSAC went on to say that because of these doubts, catch rates possibly do not reasonably reflect stock dynamics in the area and thus are not valid indicators of resource status in the area (CAFSAC 1989). In 1990, acoustic data for the entire Laurentian Channel portion of 3P4V were presented which confirmed the continuous distribution of redfish between the 200 m contour lines in the area. CAFSAC concluded that 'the present separation of stocks along the 3P4V line is inappropriate and should be discontinued.' (CAFSAC 1990).

Also in 1990, CAFSAC pointed out that the affiliation of redfish in the 3P4V area to those in 4RST is still unknown. It is well known (and has been for many years) that dense concentrations of redfish form in the southern 4R/3Pn area during winter months. The practise of the commercial fleets in the 1970s is ample testimony to this. Parsons *et al.* (1978) pointed out the need for investigations into the redfish complex in this area. They stated that the total situation appeared to be highly dynamic, and felt that optimal management strategies might by quite complex. Although they did initially conclude that 'typical' 4R redfish were present in 3Pn during winter based on meristic characteristics, they finally concluded that most of the the differences/similarities noted were probably species related, a reflection of the depths where samples were taken. The work of Ni (1982) tended to show that the species mix in the Gulf area is different from that in the waters outside the Gulf (Fig. 2). He used this information to conclude that redfish in the Gulf of St. Lawrence constitute a separate stock. Atkinson (1984) presented data showing the annual movements of redfish in the Gulf of St. Lawrence. Both small and large redfish (≤ 25 cm and > 25 cm respectively) distribute throughout the area in summer but concentrate near the mouth during winter. Small redfish do not appear to move as far south as do large ones. He noted that these aggregations did not appear to be associated with mating as this occurs in October-November prior to completion of the southward movement, nor was it associated with larval release as the fish normally begin to redistribute throughout the Gulf prior to this event.

Overview

With the decline in many of the more lucrative fisheries in the northwest Atlantic in recent years, there has been renewed interest in redfish as a target species. Because of poor recruitment in the SA 2 + 3K stock since the early 1970s, coupled with the relatively high incidence of the parasite *Sphyrion lumpii* plus undersireable black melanin pigmentation, Canadian catches in this area have declined approximately 10 fold since 1985 (from about 20,000 t to 2,000 t in 1990). At the same time interest in the 3P fishery has increased

to the point that over 10,000 t were taken in 1990 (quota of 10,000 t). The quota was increased to 15,000 t in 1991 and it is anticipated that this will be taken since about 12,000 t had already been taken to the middle of April. The winter fishery is also increasing in the 4Vn area. It is therefore becoming increasingly important to understand the relationships between redfish in the3P/4RST/4VWX area in order to be able to provide rational management advice for the continued well being of redfish in this area.

A number of key points can be extracted from previous studies. Much of the earlier work pertaining to stock definition may be invalidated to varying degrees because of the complicating existence of two species. Early work will have confused area differences with species differences.

Kenchington (1982) postulated that there may only be two genetic stocks of redfish in the northwest Atlantic – one for each species. The observed wide spread synchrony of recruitment in the northwest Atlantic would tend to support this hypothesis. We cannot speculate on an appropriate management strategy under this condition. The current situation with regard to poor recruitment in the SA2 + 3K might be indicative of larval drift out of the area without any local retention or drift into the region under this scenario. This would be in addition to, or as an alternative to the currently accepted hypothesis that larval survival in the area has been poor.

Kenchington's (1984) hypothesis concerning the existence of three spawning units in the 3P/4RST/4VWX/SA5 area is also complicated by the existence of the two species which were not separated in his analyses, and are not now separated commercially. If the larvae are retained after hatching within each spawning unit then they could be managed as a group if one desired to manage genetic units separately, and traditional assessment methodologies would be appropriate. But if there is significant leakage of larvae due to passive drift, and if exchange of adults occurs to some unknown degree, then a more complicated situation exists that would require a different management approach.

Kenchington (1984) proposed a somewhat radical new approach to management of redfish based on relative year-class strengths with long term allocations being made from their estimated total yields. He concluded that unless this type of approach is adopted no accurate assessment of Scotian Shelf redfish would be possible. By extension, his conclusions may be applicable to much wider areas of the northwest Atlantic. CAFSAC (1989) has stated that general production analyses using 3P catch rates is not appropriate because the redfish in this area probably do not constitute a biological stock.

A third stock hypothesis (Kenchington 1982) is that each concentration or pocket of redfish constitutes a separate stock although there may be larval exchange resulting in genetic similarities between areas. Once the larvae settle, they will spend the rest of their lives within a relatively small area.

With this information as background, it may seem, on the surface, that far reaching extensive studies of all stages of the life history of northwest Atlantic redfish separated by species are necessary before any statements may be made concerning appropriate management units and assessment methods. Nonetheless, it may be possible with currently available data, to arrive at approximate unit boundaries between which simultaneous responses to fishing effort and recruitment variabilities may be minimized.

The purpose of this paper is to present available data and analyses used to address the questions of stock definition in the 3P/4RST/4VXW area. There are three questions to be addressed; 1) the relationships between redfish in 3P and those in 4V in the Laurentian Channel, 2) the relationships between redfish in Laurentian Channel and those in the rest of 4VWX, and 3) the relationships between redfish in 4RST with those outside the Gulf. Once the above questions have been answered, the imposition of quotas for 1992 is discussed.

Materials And Methods

a) Div. 3P/4V in the Laurentian Channel

Information from the winter surveys in Div. 3P have been contoured and presented previously as have results from a summer acoustic survey to 3P in 1988. Some of these were reproduced for this document as part of the discussion of question 1 above.

Summer acoustic surveys for redfish in the 3P area commenced in 1986, and in 1989 the coverage was expanded to include both 3P and the channel area of 4V. The surveys encompassed all of the area between the 200 m contours. The methodologies used have been described previously (Atkinson and Power 1990). The 1990 survey was expanded (Fig. 1) to include the outer edge of the Scotian Shelf as far as 4W as well as the southeastern portion of 4R. The coverage was increased in order to investigate whether there were any obvious breaks in the distribution of redfish in these areas.

The point density estimates (gm/m^2) were contoured to illustrate the redfish distribution in the area during summer.

b) The Larentian Channel–Remainder of 4VWX

Annual stratified random bottom trawl surveys have been conducted on the Scotian Shelf since the early 1970s. The catch weight data from 1986 to 1990 were combined and contoured to investigate the possibility of discontinuities in distribution which might indicate possible boundaries for management purposes. These surveys are routinely only carried out to 366 m and it is known that redfish are distributed deeper in the area. Surveys of the deeper areas carried out in the late 1970s and during 1985 to 1988 indicated that significant amounts of redfish are found deeper than 366 m so that the summer survey results were only of limited value in determining distribution patterns.

Catch rate data from the commercial redfish fishery in the 4VWX area from 1981–1990 were available from the Regional observer databases, and were summarized by 10° squares, then plotted to illustrate locations of the highest catch rates and to determine if any breaks in the distribution of the fisheries occurred during this 10 year period. Verbal information from industry had indicated that there was a break in the distribution of redfish along the outer edge of the Scotian Shelf in the region of Dawson Canyon at about 62° W.

Information on the distribution of larval redfish in the Scotian Shelf area as described by Kenchington (1984) was also examined to determine if separate groupings of redfish might be apparent.

c) 3P4V / 4RST

Annual stratified random bottom trawl surveys have also been conducted during the winter since 1973 in 3P and since 1978 in 4RST. The catch weight data from the two survey areas for 1986 through 1990 were combined on an annual basis then contoured to demonstrate the distribution of redfish in the 3P/4RST survey area during winter. There were no survey data available from the 4V portion of the Laurentian Channel.

Catch rate data from the commercial redfish fisheries in the 3P/4RST/4V area were available for 1981–1990 from the regional observer databases. These were summarized weekly and by 10° squares, then plotted to illustrate changes in location of the highest catch rates over the period of a year. It was considered that changing distribution of high catch rates should reflect changes in the distribution of the fish.

Finally, commercial length frequency information from the 1990 fishery was plotted to look for differences/similarities between areas. This analysis was only preliminary and further more detailed examinations will be carried out over the next year.

d) Quota Management for 1992

Catch information from the 1981–1990 commercial fisheries was used in conjunction with the total 1991 TAC for the 3P/4RST/4VWX area combined to derive TACs for the newly proposed management units for 1992. This was necessary because of the time required to re–organize the existing databases to conform with the new boundaries.

Results and Discussion

a) 3P/4V in the Laurentian Channel

Previous analyses of winter trawl survey data (Atkinson and Power 1989) indicated that it was not reasonable to assume that distribution of redfish across the Laurentian Channel is discontinuous (eg. Fig. 3). Examination of the Scotia-Fundy deepwater survey results (Fig. 4), although based on relatively few fishing stations, would lead one to the same conclusion.

The acoustic survey results from the summers of both 1989 and 1990 (Fig. 5 and 6) also confirmed that there is no discontinuity in the distribution of redfish in the deeper waters of the Laurentian Channel outside of Cabot Strait.

From commercial catch rate data (Fig. 7), it appeared that during various times of the year there is almost continuous effort across the 3P4V line in the middle of the channel. This too was considered to be supportive evidence against the 3P4V line forming an appropriate separation of management units. It is not considered unreasonable to assume that there is movement of fish concentrations back and forth across this line.

Ni (1982) did not find any difference in the mix or relative distribution of the two species of beaked redfish (*Sebastes mentella* and *S. fasciatus*) between the two areas (Fig. 2).

As a result of these observations, it was concluded that the 3P/4V boundary in Laurentian Channel is not an appropriatew separator of redfish stocks in the area. Instead, redfish in the entire Channel area should be managed as a single unit.

b) The Larentian Channel–Remainder of 4VWX

As noted above, the 1990 acoustic survey coverage was extended to include the outer edge of the Scotian Shelf as far south as the 4W/4X boundary. Because of the very high densities of euphausiids along the outer edge of the Scotian Shelf, the data collected there were not suitable for the enumeration of fish, so these data could not be used to discern if breaks in the distribution of redfish occurred in this area.

Examination of the Scotia-Fundy summer survey results (Fig. 8) provided further information concerning the distribution of redfish in the 4VWX area. There are substantial concentrations of redfish in the 4Vn area extending down into 4Vs in the Laurentian Channel. There do not appear to be dense concentrations along the outer edge of the shelf until into 4X but this appearance is most likely an artifact of sampling only to 366 m since it is known that redfish can be found down to about 700 m in this general area. Also of note is the number of pockets of redfish concentrations in the deeper gulleys shoreward of the shelf edge.

As noted above, verbal information from the fishing industry suggested a break in redfish distribution in the along the outer edge of the Scotian Shelf in the region of Dawson Canyon. The combined commercial cath rate data (Fig. 9) support this information, indicating a break in catch rates (and also effort) at about 62° W. There is also clear separation between the edge fisheries and those in the near shore gulleys. The dashed line in the figure represents the approximate boundary of statistical units 4Wfgj. Over the 10 year period the data represent, the fisheries appear to have been continuous in Laurentian Channel, around the corner in 4Vs, past The Gulley and into these units of 4W.

It was therefore concluded that the Laurentian Channel (3P4V) as well as the 4Vs + 4Wfgj portion of the outer edge of the Scotian Shelf should be included in one management unit, and the remainder of 4W (4Wdehkl) + 4X as another.

This conclusion was supported by Kenchington's (1984) information concerning the distribution of larvae in the Scotian Shelf area. He determined that there was a separation of spawning units between the eastern and western regions, although he did not comment on the area between Banquereau and Western Banks along the outer edge, nor did he comment on spawning in the near shore basins. A review of the observed distribution of larvae from surveys to the area supported his conclusions.

It is true that Kenchington (1982) found no stepped gradients in characteristics across all of 4VWX suggesting only species related differences. He did conclude that with assessment models other than that proposed by himself, management units would most likely be partially arbitrarily bordered, and would perhaps be similar to his recruitment units described above which led to his defining in 4 stocks (3Pn4RSTVn, 3OPs + eastern 4Vs, western 4Vs + 4W + eastern 4X, and western 4X + 5Y). The separation of 4Vs into eastern and western may have been due to the information of Scott (1976, 1981) (Fig. 10) which suggested a break in redfish distribution at the mouth of Laurentian Channel. As can be seen from Fig. 8, it is possible that this break may be an artifact of incomplete sampling – during the 1986 to 1990 period all sets made in this area were shallower than 200 m. The commercial fishery data suggest a more continuous distribution through this area (Fig. 9).

c) 3P4V / 4RST

As noted above, Kenchington (1984) combined 4RST with 3Pn and 4Vn. Typical summer distribution of redfish in 4RST was described by Atkinson (1984). Results from more recent stratified random bottom trawl surveys conducted during the summer (Fig. 11) confirmed that redfish are distributed throughout the Gulf of St. Lawrence, although there are still quite large concentrations found in the southern 4R area in certain years. The 1987 data which included fishing stations in 3Pn as well as southern 4R revealed a concentration of fish overlapping the border between the two areas. The 1989 data suggest that a similar situation may have existed in that year.

Atkinson (1984) also reported a migration of redfish to the mouth of the Gulf during winter. Based on winter survey results (Fig. 12) there are certainly pockets of redfish in the southern 4R – 3Pn area at that time of year. It is also evident that these concentrations are different from year to year, and it can be expected that they probably also change over time during any one year. The survey data provide nothing more than a snap shot of an obviously dynamic situation.

It can also be assumed that there are extensions of these concentrations into the 4Vn area although there are no survey data available to test this. What movement may occur coincidentally in 3Pn and 4Vn is unknown at present, and the interaction and overlap of 4RST fish with those normally resident in the two former areas cannot be quantified. Thus it cannot be determined what proportion of the winter 3Pn and 4Vn fisheries are made up of 4RST fish.

Kenchington (1984) concluded that there is probably little annual migration of redfish in the Scotian Shelf area. This conclusion is consistent with that of earlier researchers (eg. Templeman 1959) for redfish in the northwest Atlantic in general. The situation in the Gulf of St. Lawrence is obviously different with annual migrations to the mouth occurring each winter. If the fish mate (Oct. – Nov.), and then release their larvae (April – July) while primarily present in the Gulf itself, then it may be reasonable to consider these fish as a separate management unit. It is possible that there will be larval drift from the Gulf area to the Laurentian Channel beyond Cabot strait. In this situation, the yield per hatched larva potential within the Gulf will be somewhat diminished but it will be enhanced outside so that the total potential of the two areas combined should be approximately maintained. If the fish are largely sedentary outside the Gulf, and do not return, then they are available to the 3P4V fishery once recruited, and fishing pressure in this area will not impact on future

recruitment to the Gulf area. In addition, when they spawn, the recruits will be available to the 3P4V fisheries. An argument against significant larval drift out of the Gulf may be found in the results of Ni (1986) (Fig. 2) in that the proportion of *mentella* – type appears to be greater in the Gulf. Since this species releases larvae earlier than *S. fasciatus* (Ni and Templeman 1985), any larval drift out of the Gulf would be expected to include a greater proportion of *S. mentella*, and the ratio of species in the 3P4V area might be expected to more closely resemble that in the Gulf itself. Based on both of these perspectives it was concluded that the separation of 4RST redfish from those in the 3P4V area for management purposes should be maintained.

The remaining question is one of how to approach the winter situation when Gulf fish move into 3Pn and 4Vn temporarily. Commercial catch rate data (Fig. 13) demonstrate a gradual movement of heavier concentrations toward the mouth of the Gulf in the fall then back later in the spring. These data also show the interrelationship between 3P, 4R and 4Vn during the winter period in particular. Close examination of these data suggested that on average during the 1981–1990 period, the mixing of redfish from 4RST with those in the 3Pn4Vn areas primarily occurred during the January through May period. After the end of May, the redfish appeared to have returned to 4RST.

Commercial frequencies (Fig. 14) suggested that in January, 1990 there were two size groups of redfish in 3Pn. One of these was similar to fish in 3Ps, while the other appeared to be a mix of 3Ps and 4Vn, 4R and 4S fish. In February, there was clearer separation with one group similar to 3Ps while the other resembled 4Vn. The sample from 3Pn in March more closely resembled the 4R September sample than the 3Ps March samples. The observation of two size groups within this area in 1991 has also been made by commercial fishermen. It appeared that the concentration overlapping 3Pn4R constituted one size group, while that further inside 3Pn constituted the other. Whether similar observations can be made in 4Vn, and whether these represent actual separations of resident 3P4V fish from 4RST fish, or are only reflective of a separation of size groups is unknown at present. Further studies are being carried out to investigate this more fully.

Further work is necessary to determine the proportion of fish of different origin taken in any one area as well as if fish of different origin are taken in different areas of these subdivisions, and work to clarify this is ongoing.

Nonetheless, it was concluded that the present winter fisheries most likely take predominently 4RST redfish, and as such the most appropriate management unit would be 4RST + 3Pn4Vn (January – May). Outside the Gulf the management units would be 1) 3Pn4Vn (June – December) + 3Ps4Vs + 4Wfgj, and 2) 4Wdehkl + 4X.

d) Quota Management for 1992

Because of the newly proposed management units for redfish, it was not possible to provide advice based on assessments because the research and commercial data must be re–combined along the new management lines prior to analyses. CAFSAC is presently not concerned about the status of the redfish in these areas. The relatively strong year classes of the early 1980s are now recruiting to the fisheries and this should result in increased catch rates in 1992. In addition, the 1984 year class appears to be relatively strong and should begin to recruit in 1993 or 1994. Thus prospects for the redfish fisheries in this area appear good for the next number of years. As such, it was concluded that the total TAC for the entire 3P/4RST/4VWX area, 102,000 t, could remain in effect until assessments of the new management units are available.

The average catches in each of the new units for the 1981–1990 period were determined (Fig. 15) and expressed as percents as follows:

Area	Average Percent (81-90)	Proportion of total TAC (102,000 t)
4RST	58 %	59,528
3Pn (Jan.-June)	4 %	4,138
4Vn (Jan.-June)	3 %	3,468
3Pn (June-Dec.)	3 %	3,531
4Vn (June-Dec.)	8 %	8,187
3Ps	5 %	5,516
4Vs	8 %	7,713
4W	3 %	2,787
4X	7 %	7,132
4RST/3Pn/4Vn	66 %	67,134
3P4V	24 %	24,947
4WX	10 %	9,919

Based on the above, it was concluded that the TACs for 1992 could be set as follows:

4RST/3Pn/4Vn	66 %	67,000
3P4V	24 %	25,000
4WX	10 %	10,000

Summary

1. Redfish in the Laurentian Channel portion of 3P4V should not be separated into different management units.

2. Laurentian Channel (3P4V) redfish should be combined with those along the outer edge of the Scotian Shelf in 4Vs and 4Wfgj for management purposes.

3. Redfish in 4RST are separate from those outside the Gulf but migrate to the 3Pn4Vn area during winter and mix with redfish in that area until approximately the end of May.

4. The 3 new redfish management units in this area, as well as their 1992 quotas are proposed to be:

   1) 4RST (Jan.–Dec.) + 3Pn (Jan.–May) + 4Vn (Jan.–May) – 67,000 t.
   2) 3Pn (June–Dec.) + 4Vn (June–Dec.) + 3Ps4Vs4Wfgj (Jan.–Dec.) – 25,000 t.
   3) 4Wdehkl (Jan.–Dec.) + 4X (Jan.–Dec.) – 10,000 t.

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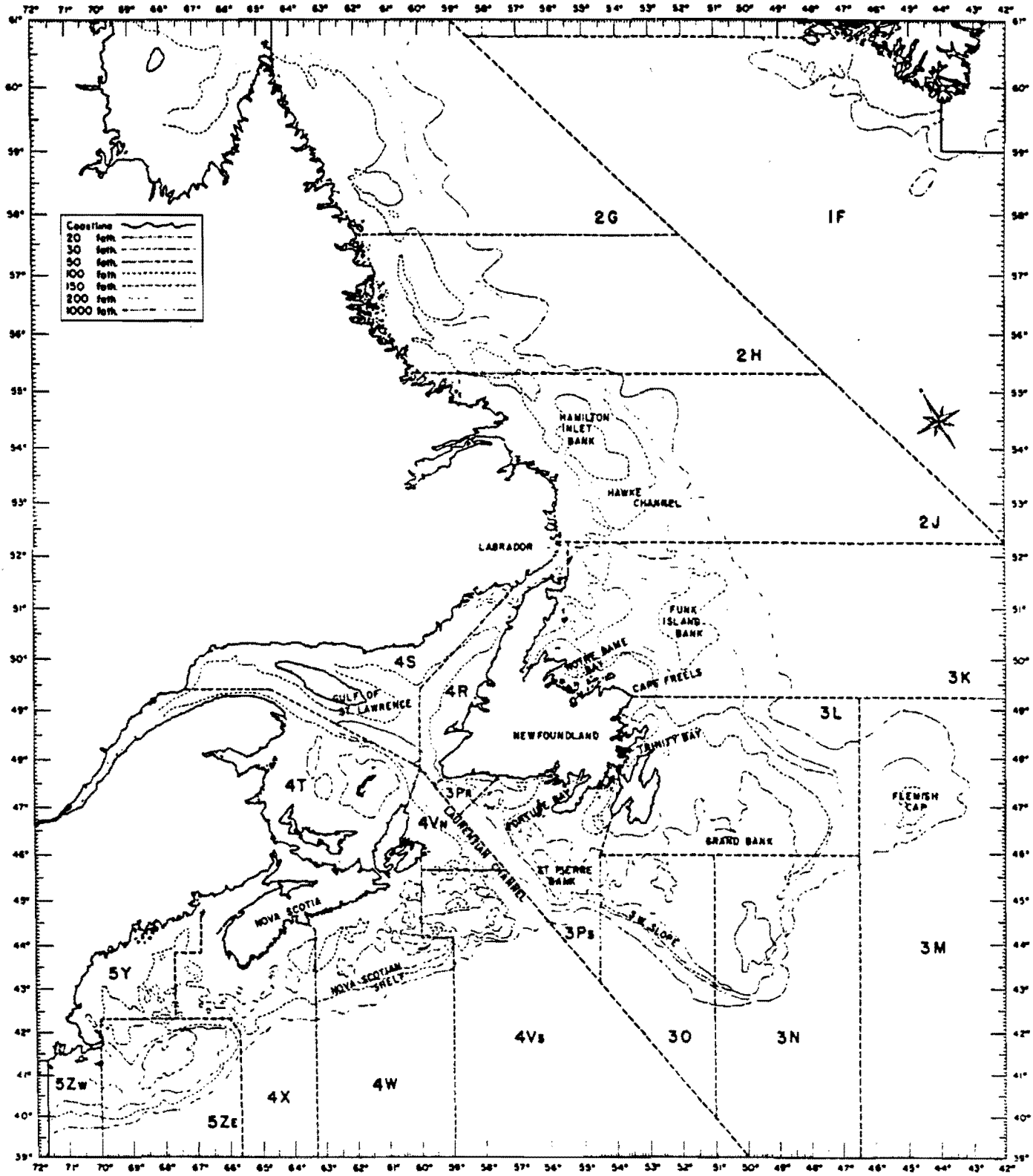


Fig. 1: Map showing NAFO Divisions in the northwest Atlantic.

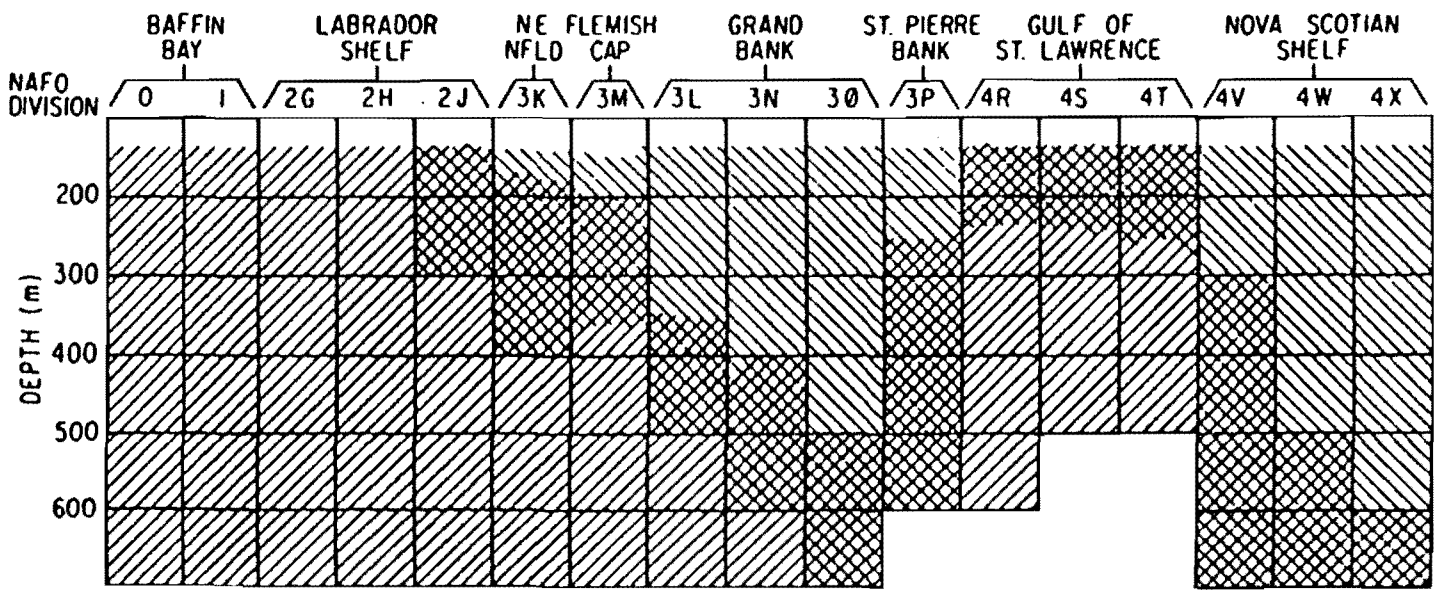


Fig. 2: The distribution of *S. mentella* and *S. fasciatus* in division–depth blocks (from Ni, 1982).

▨: *S. mentella*, ▧: *S. fasciatus*, ▩: mixture of *S. mentella* and *S. fasciatus*.

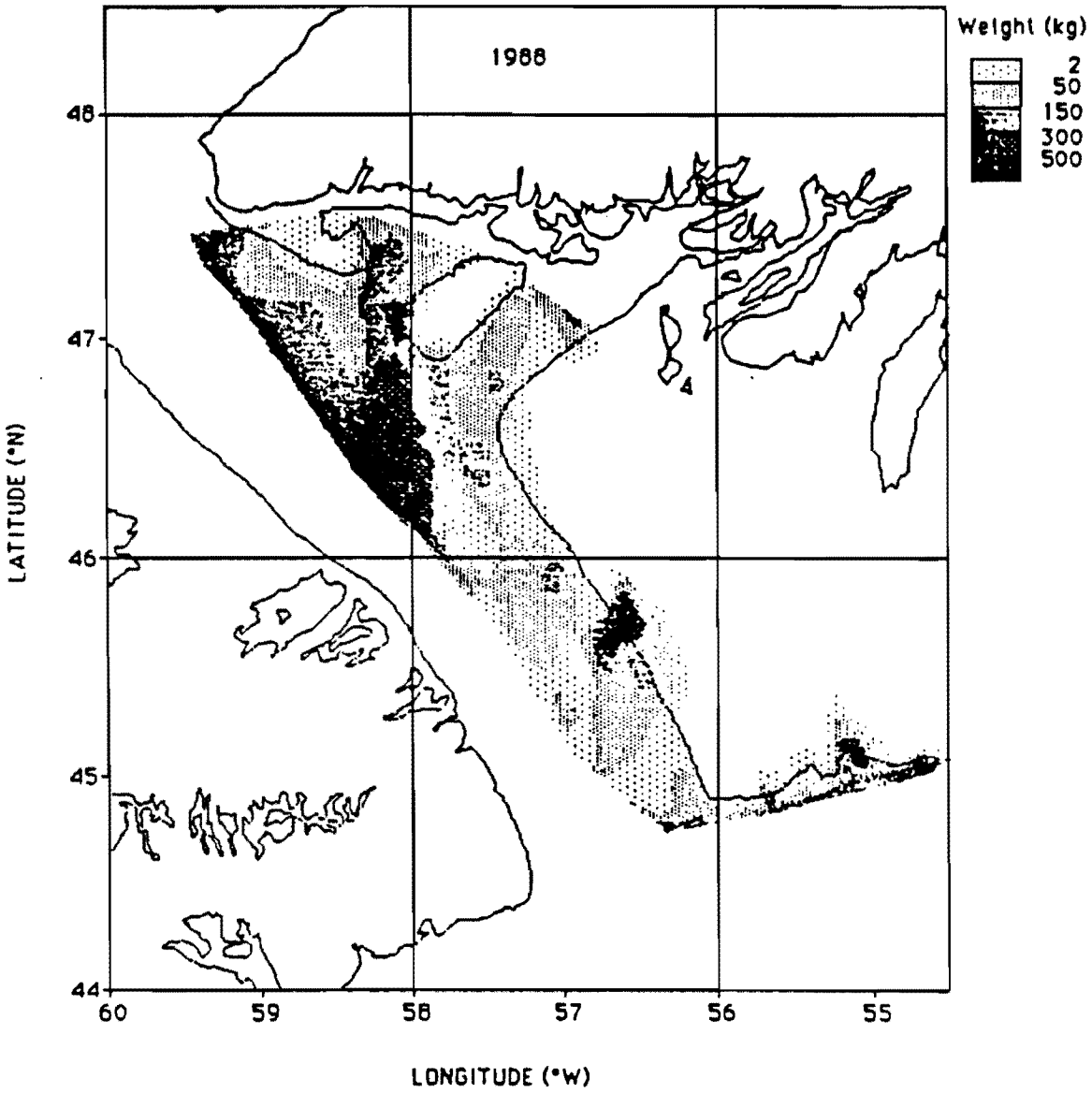


Fig. 3: The distribution of redfish from a stratified random bottom trawl survey, February 1988.

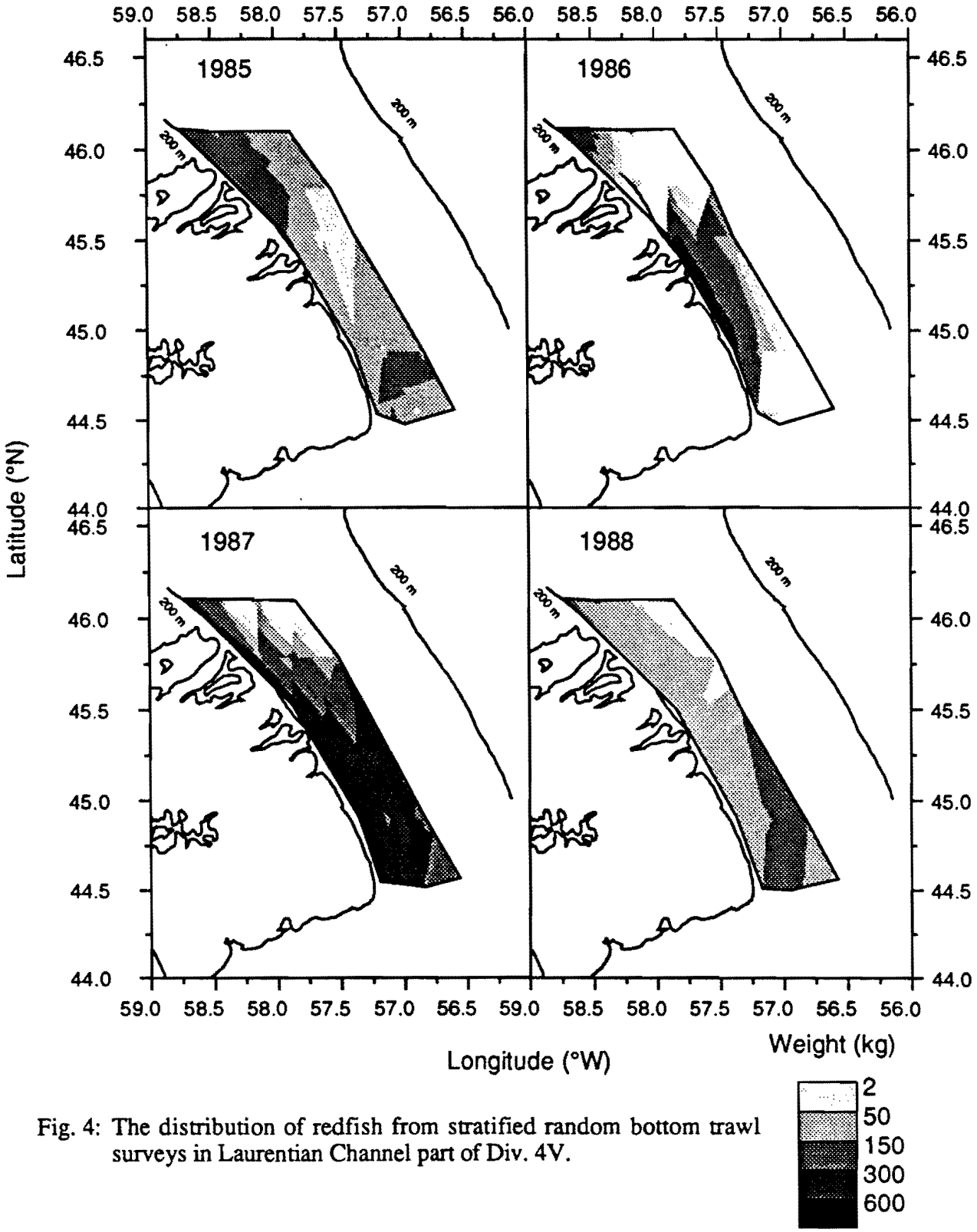


Fig. 4: The distribution of redfish from stratified random bottom trawl surveys in Laurentian Channel part of Div. 4V.

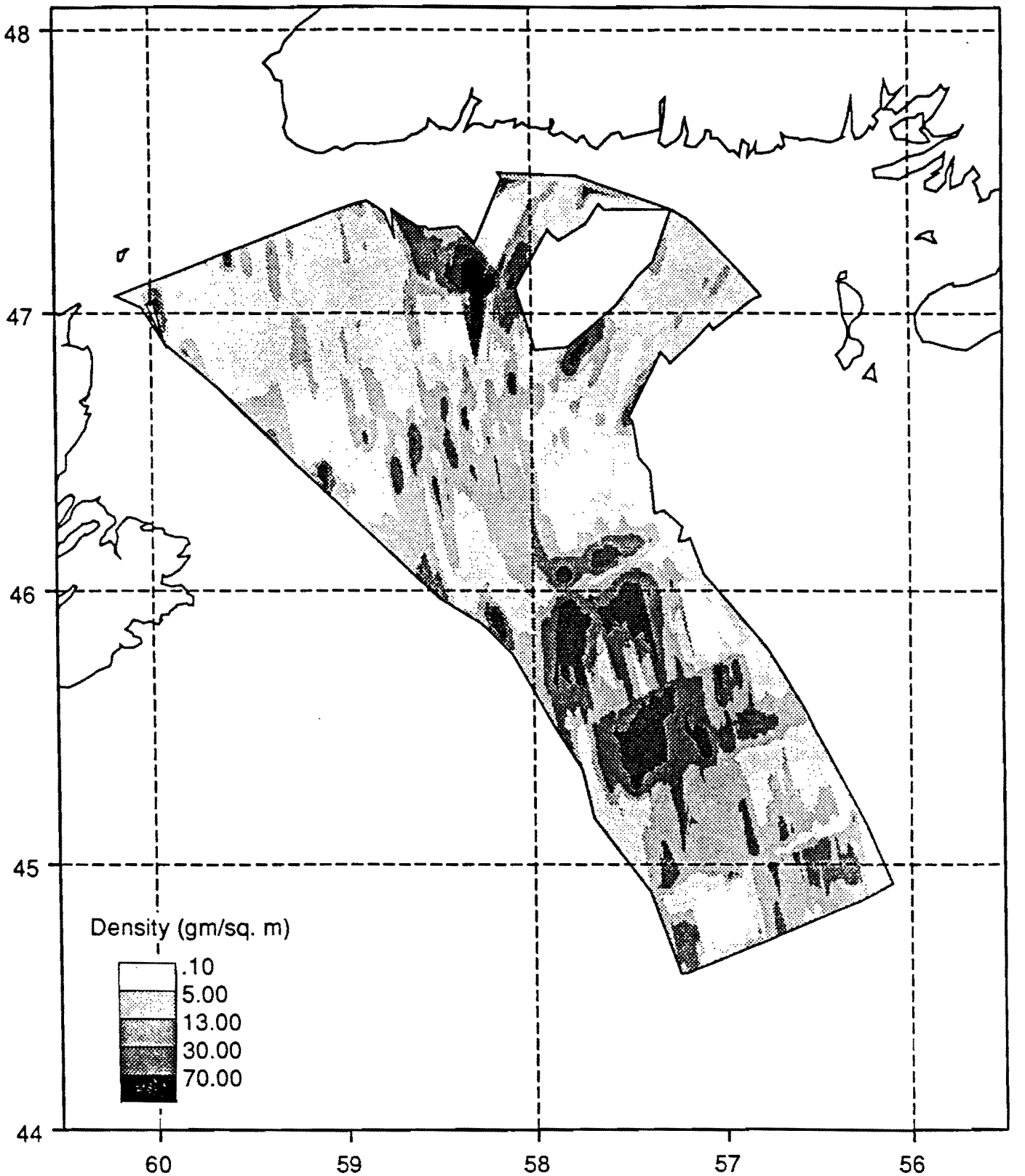


Fig. 5: The distribution of redfish from acoustic survey in Laurentian Channel during summer, 1989.

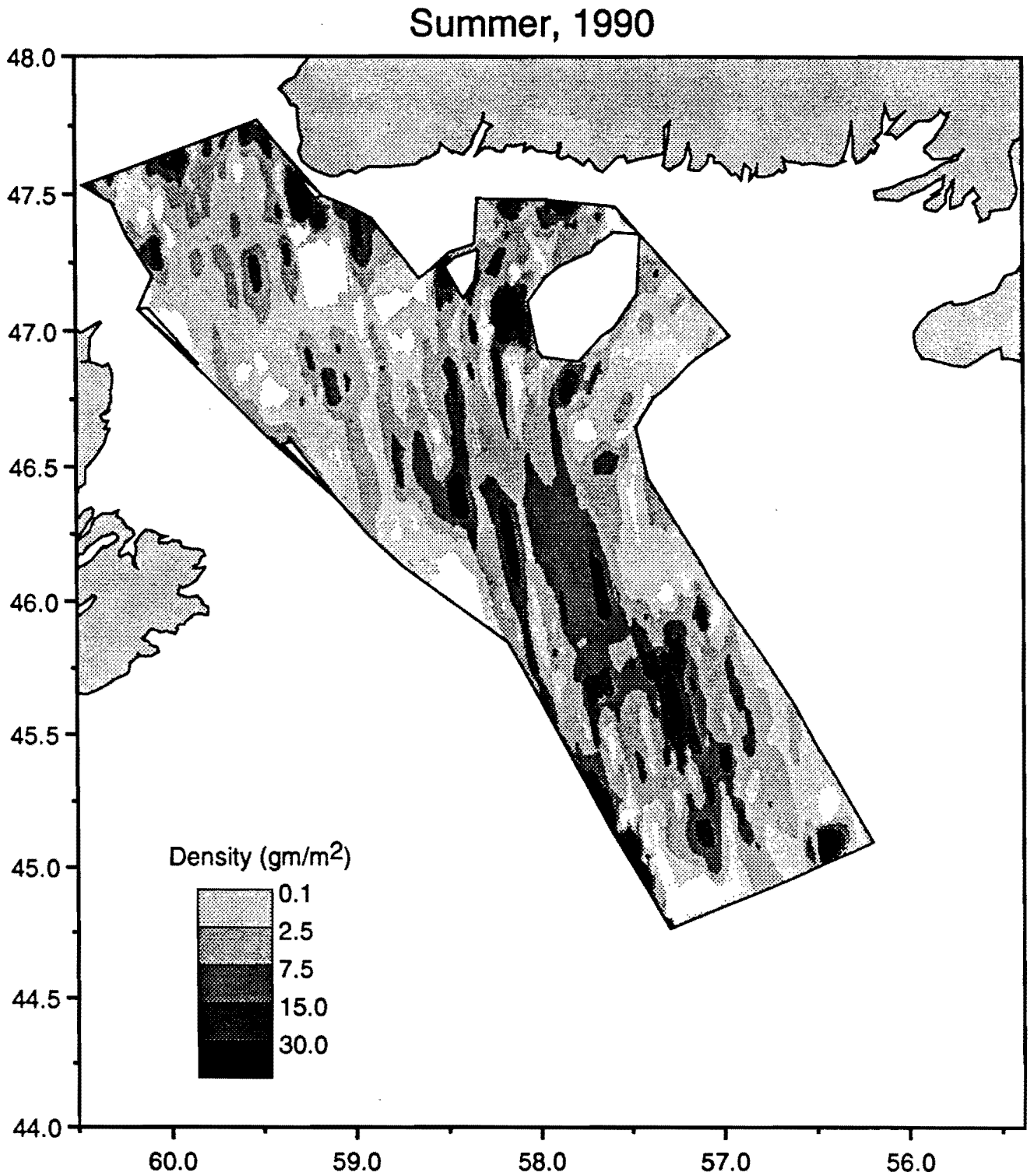


Fig. 6: The distribution of redfish from acoustic survey in Laurentian Channel during summer, 1990.

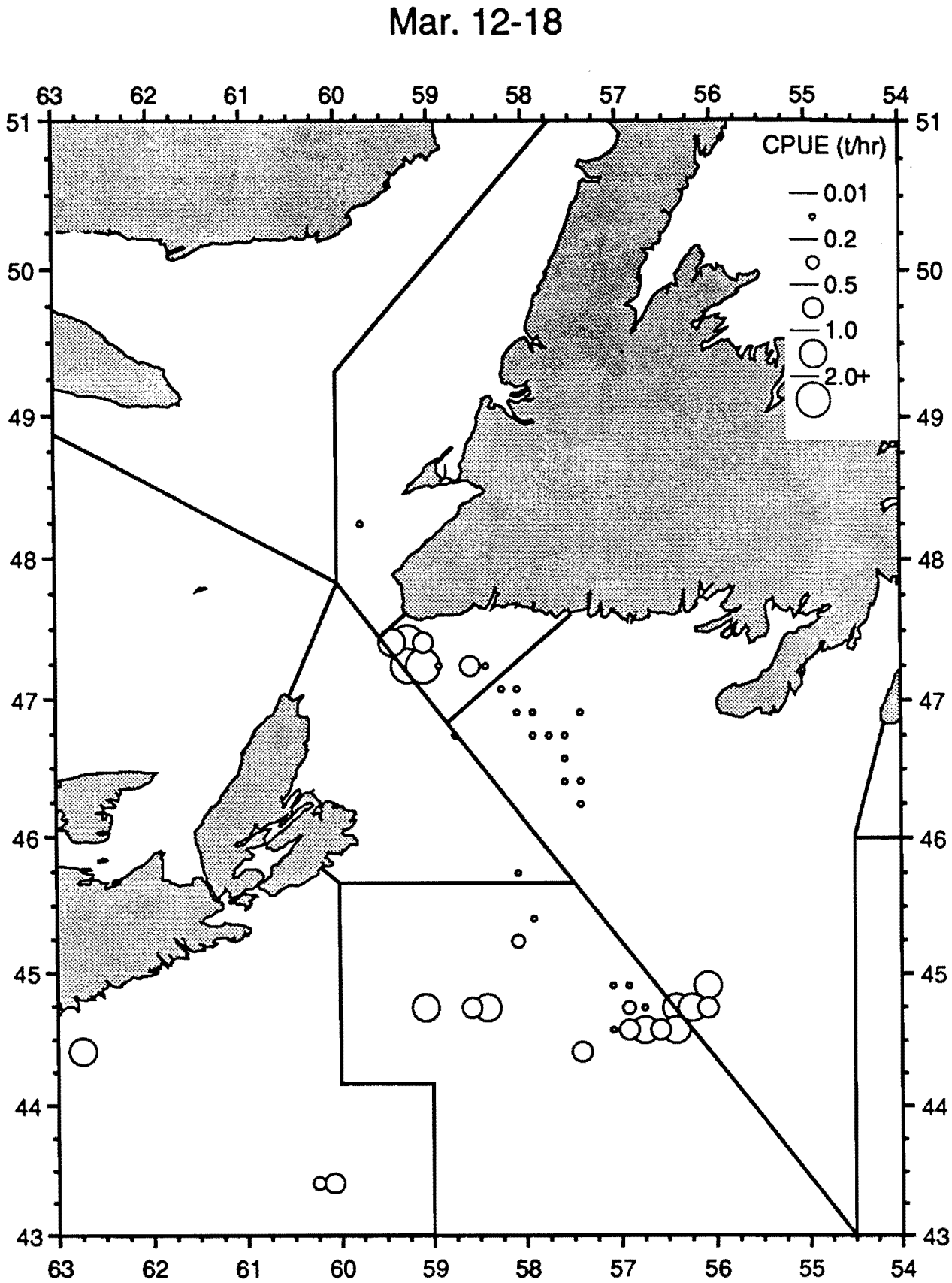


Fig. 7a: The distribution of redfish commercial catch rates in Laurentian Channel during March 12–18 of 1981–1990 combined showing continuous distribution of effort across 3P/4V line.

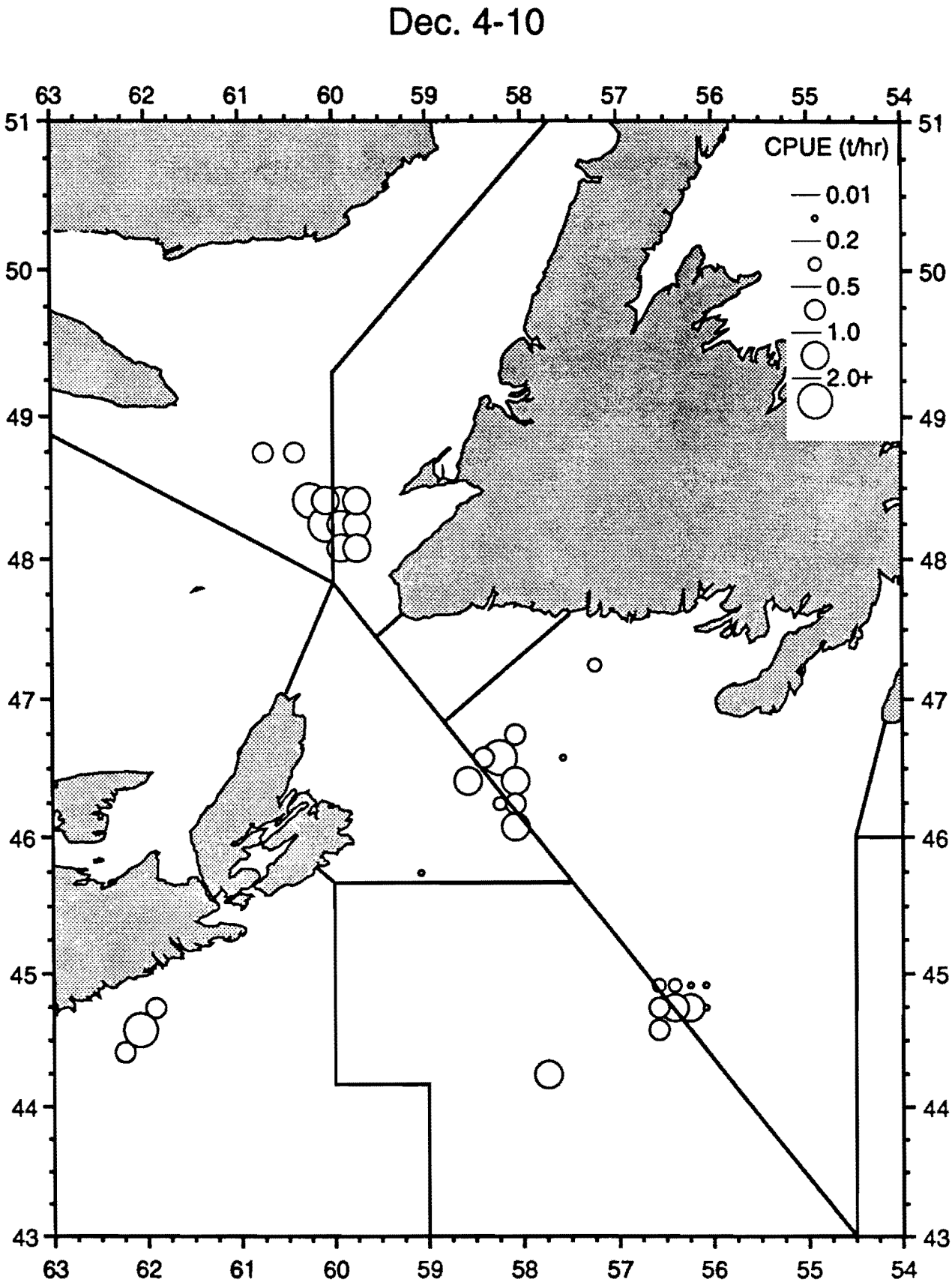


Fig. 7b: The distribution of redfish commercial catch rates in Laurentian Channel during Dec. 4–10 of 1981–1990 combined showing continuous distribution of effort across 3P/4V line.

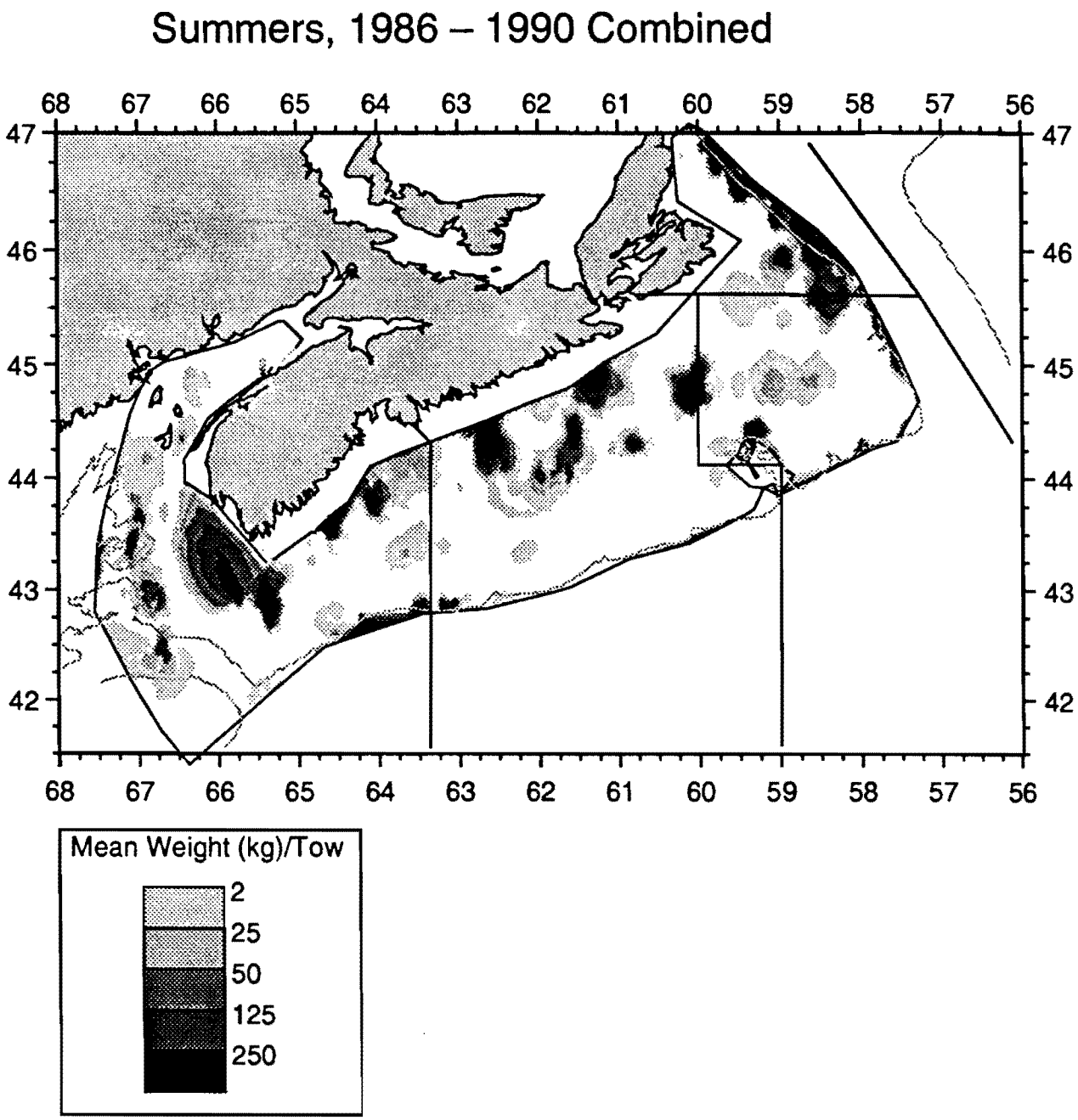


Fig. 8: The distribution of redfish from stratified random bottom trawl surveys on Scotian Shelf during 1986–1990 combined. Surveys only carried out to 386 m.

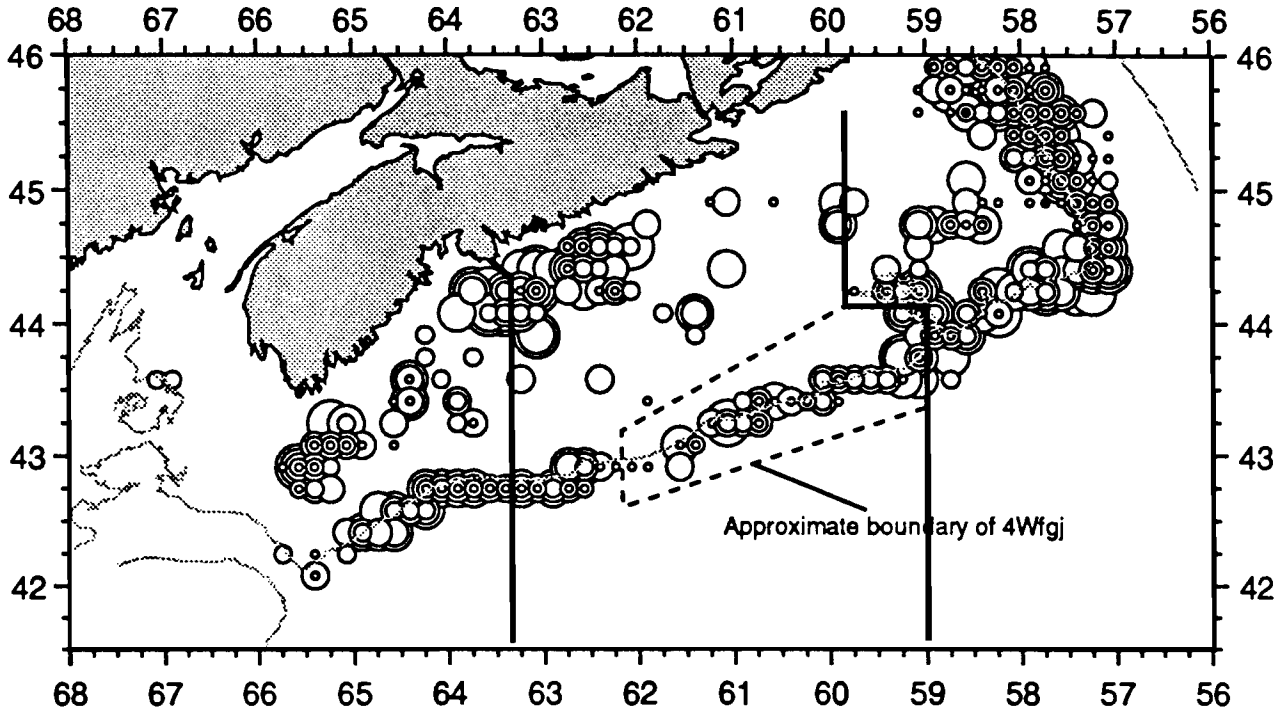


Fig. 9: The distribution of commercial catch rates for redfish from observer data during 1981–1990 combined showing a break in catch rates and effort at approximately 62° W along the outer edge.

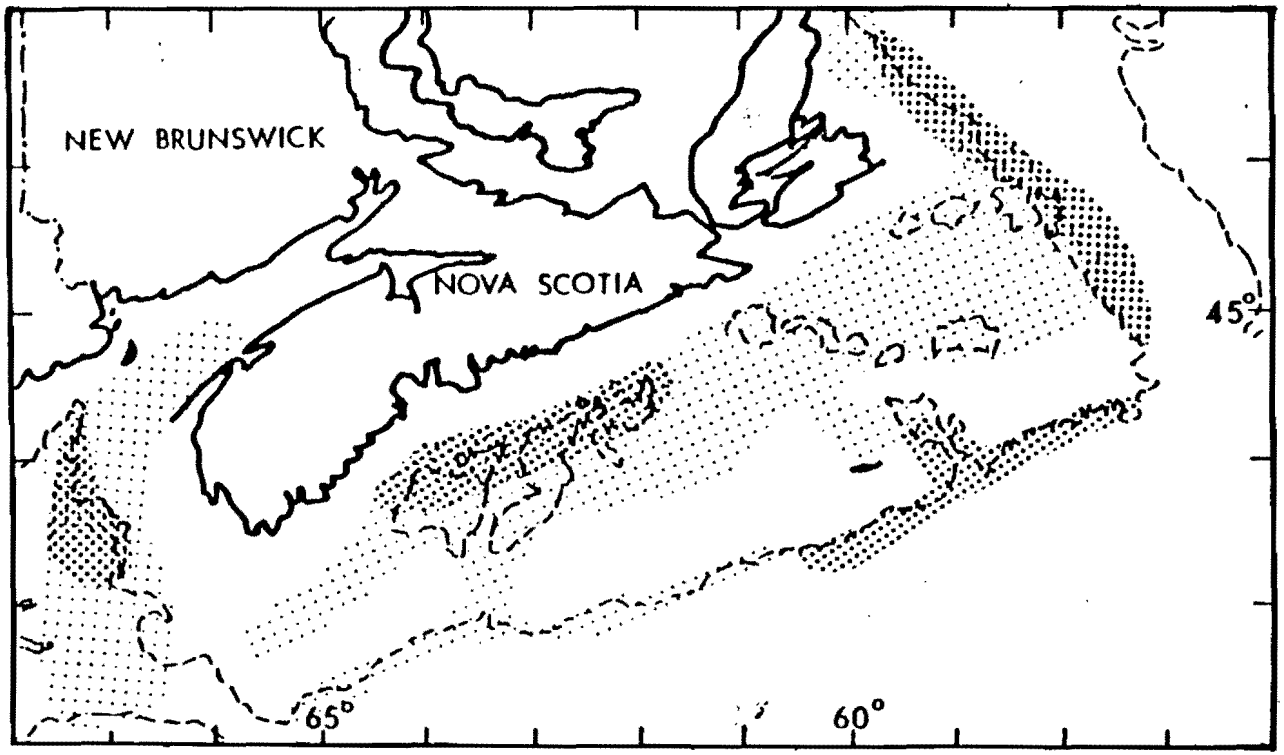


Fig. 10: Distribution of redfish in the area of the Scotian Shelf as described by Scott (1976, 1981)

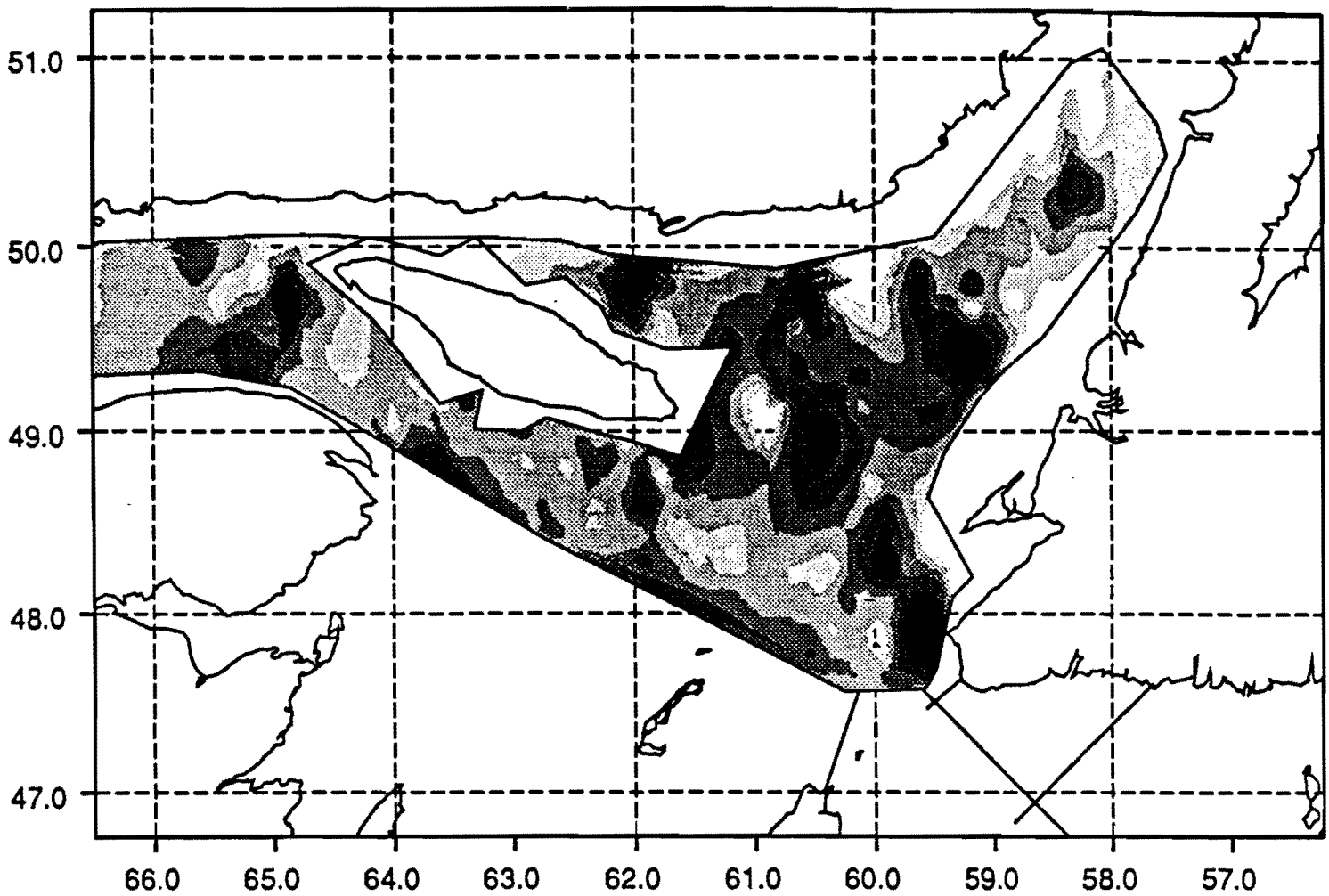


Fig. 11: Summer distribution of redfish in the Gulf of St. Lawrence as determined from stratified random bottom trawl surveys.

4RST, summer 1986

Weight (kg)

2
50
150
300
600

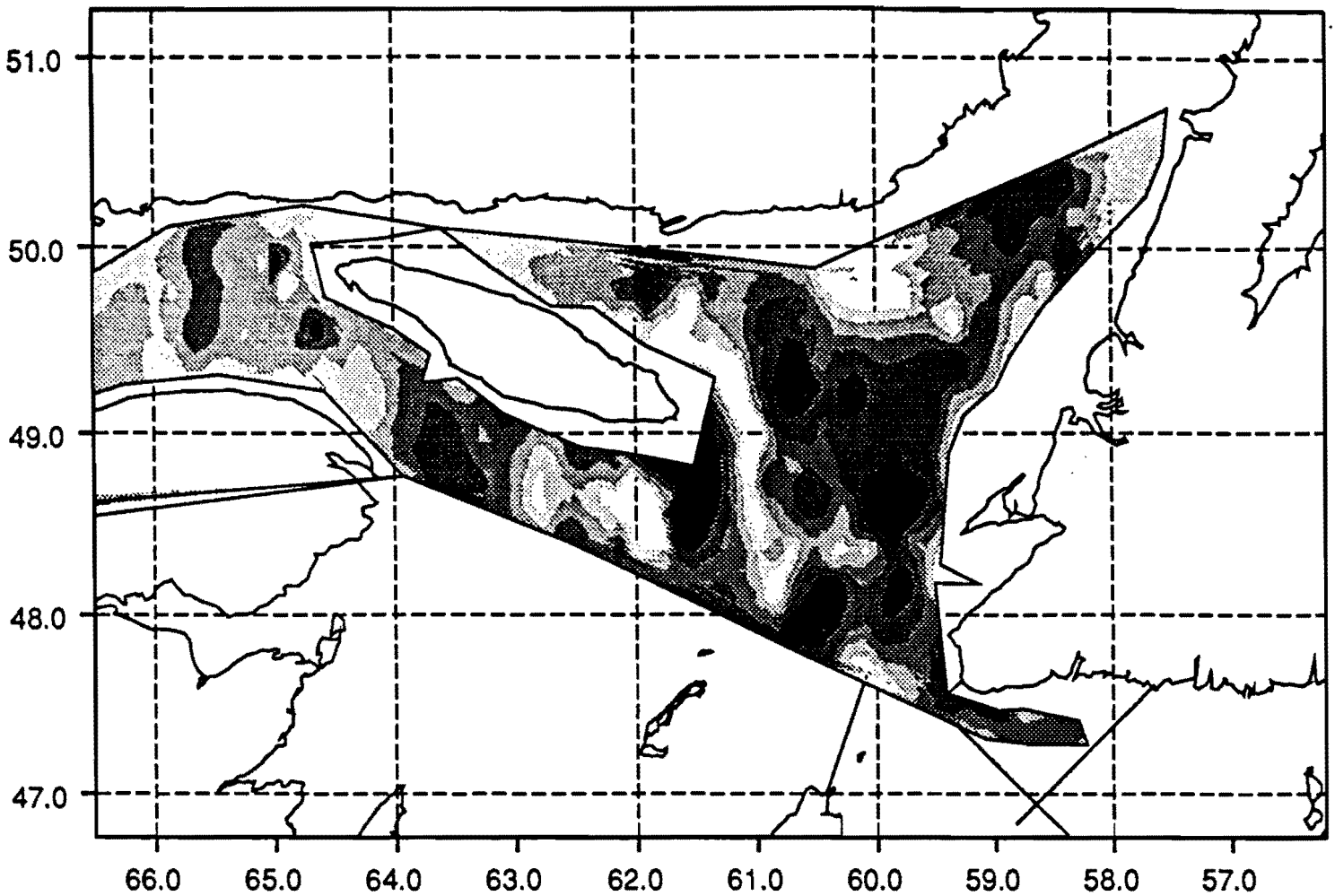
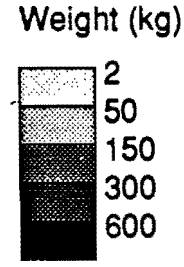


Fig. 11: Continued.

4RST, summer 1987



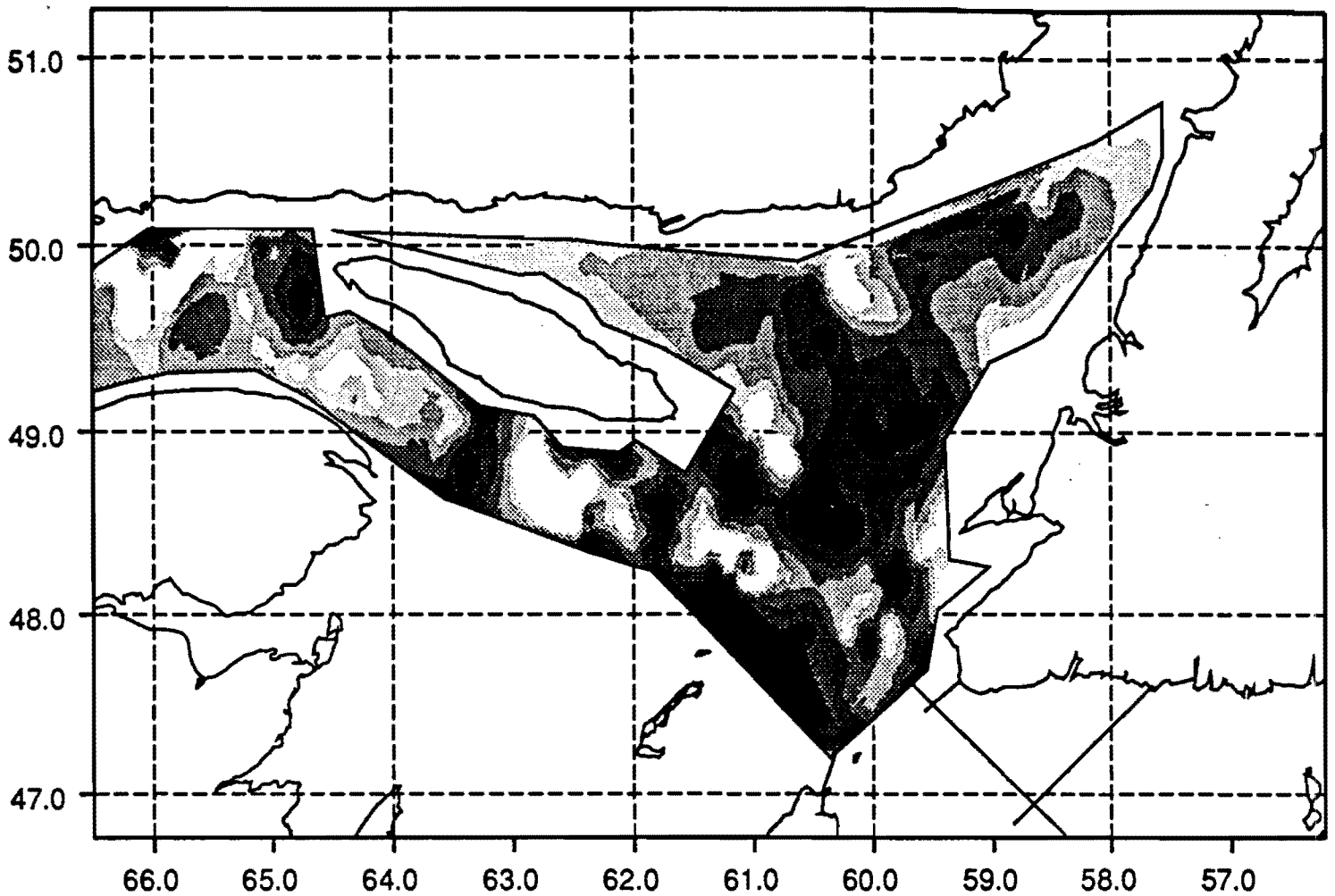


Fig. 11: Continued.

4RST, summer 1988

Weight (kg)

2
50
150
300
600

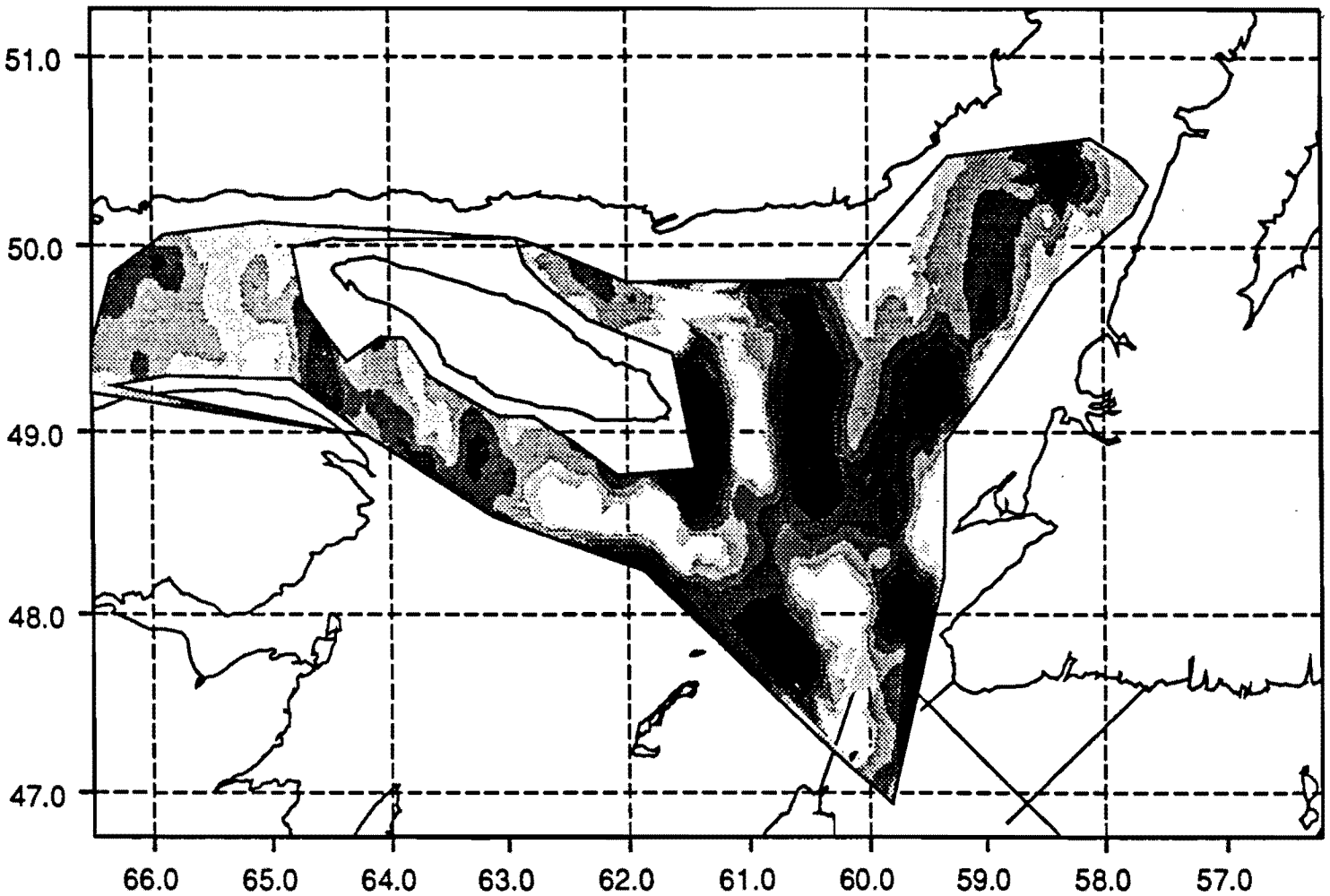
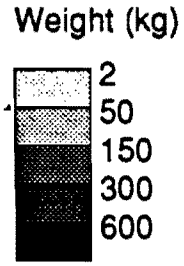


Fig. 11: Continued.

4RST, summer 1989



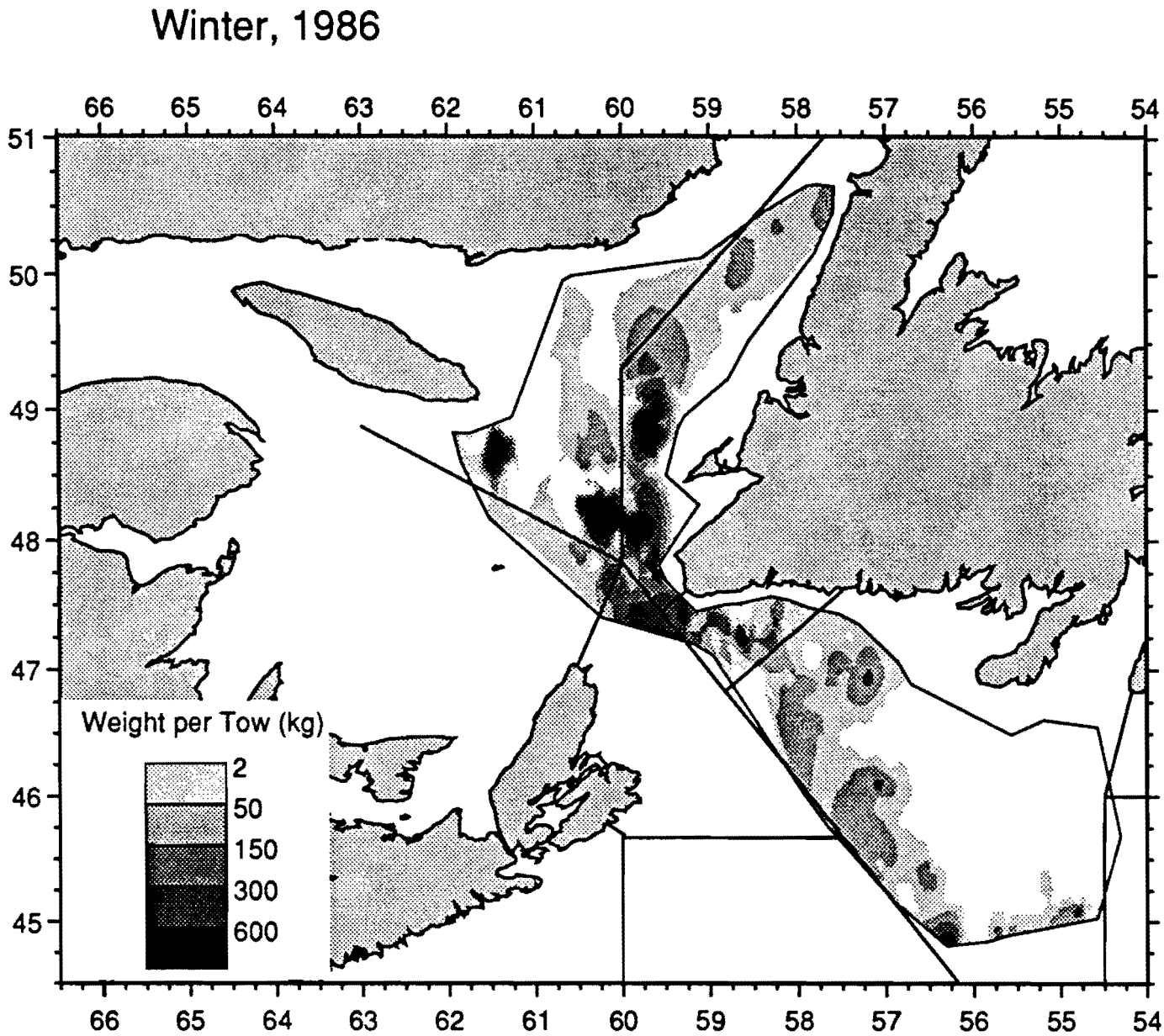
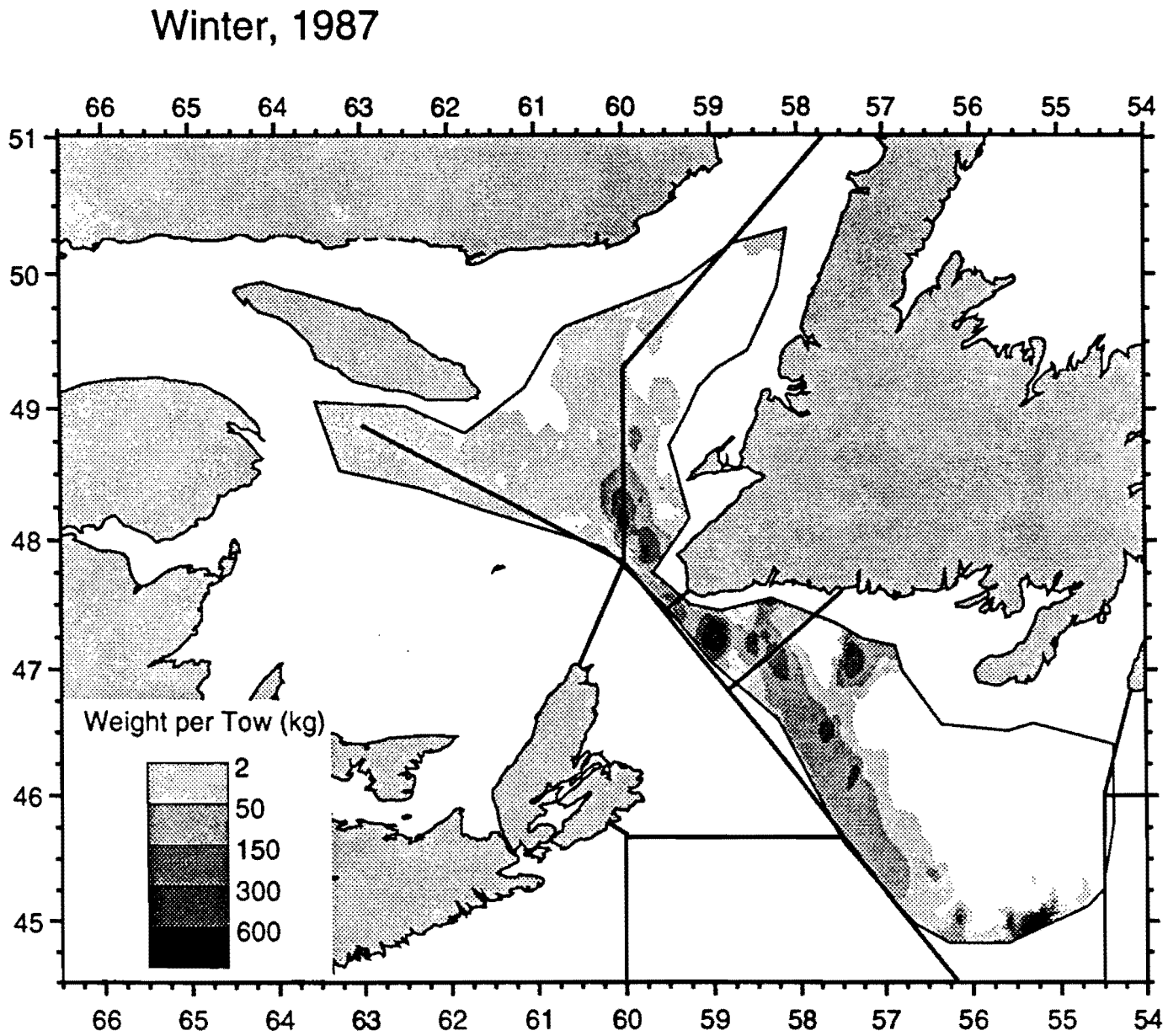


Fig. 12: Winter distribution of redfish in Div. 3P and 4RST as determined from stratified random bottom trawl surveys to 4RST in January and 3P in February.



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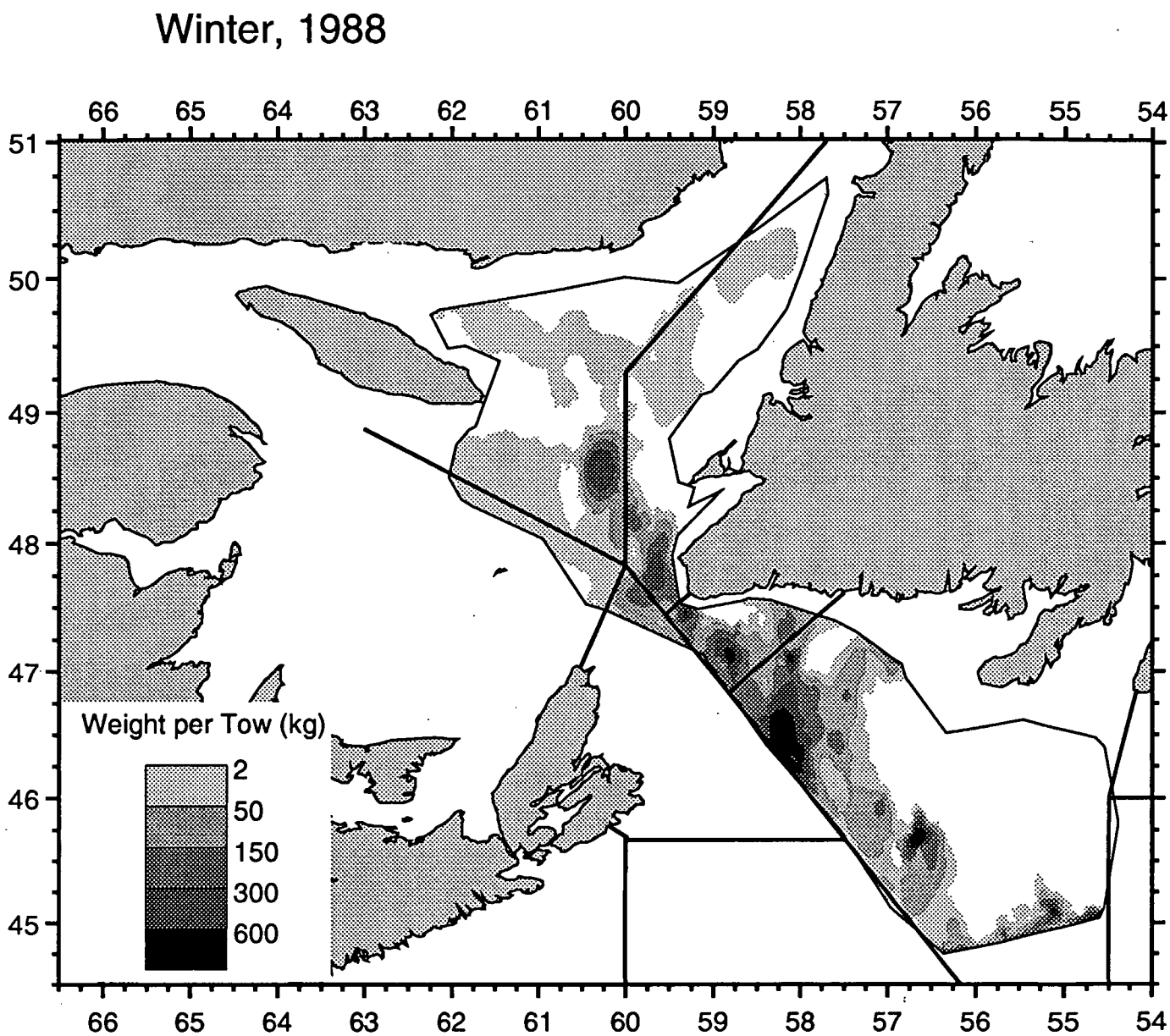

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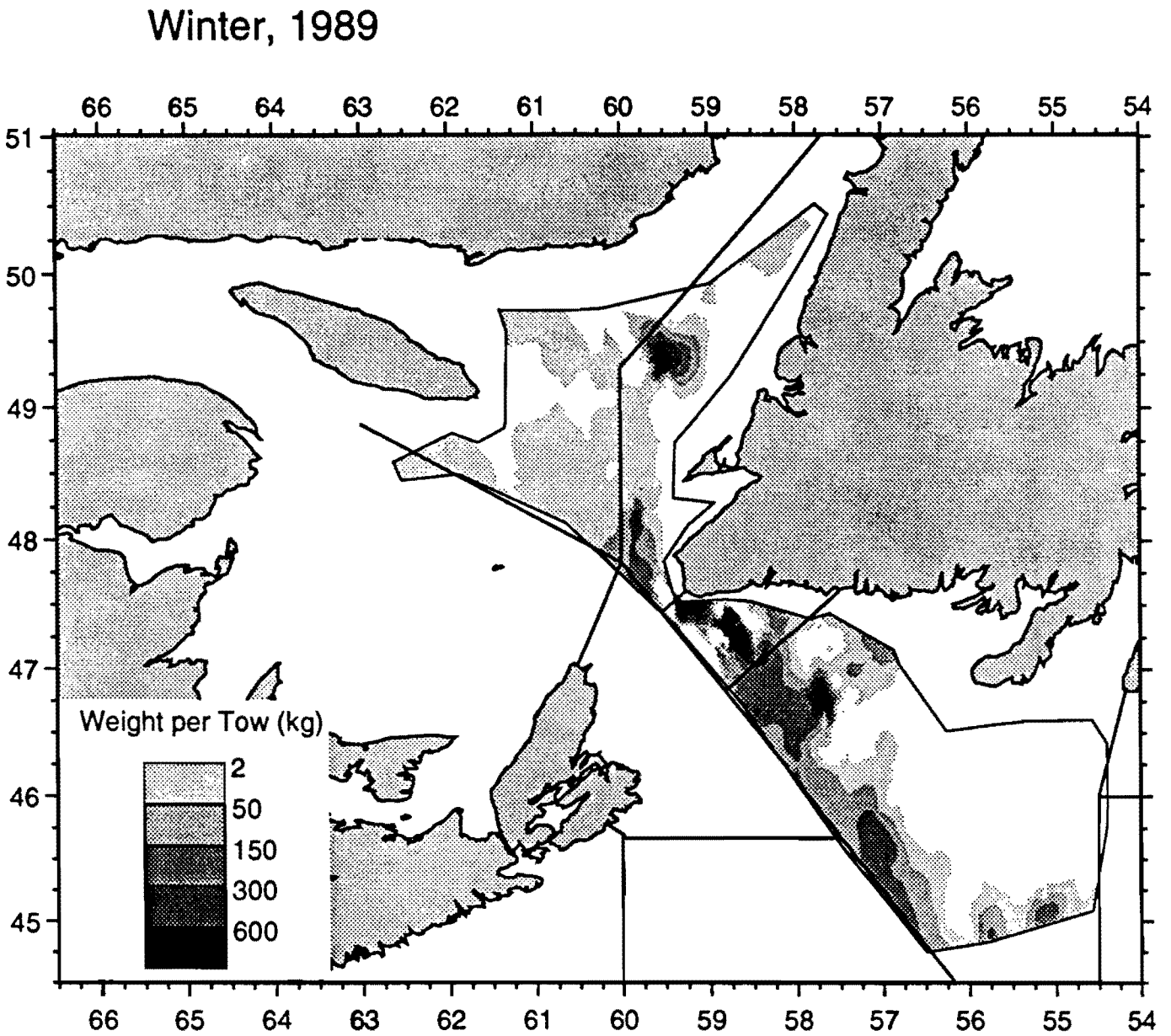

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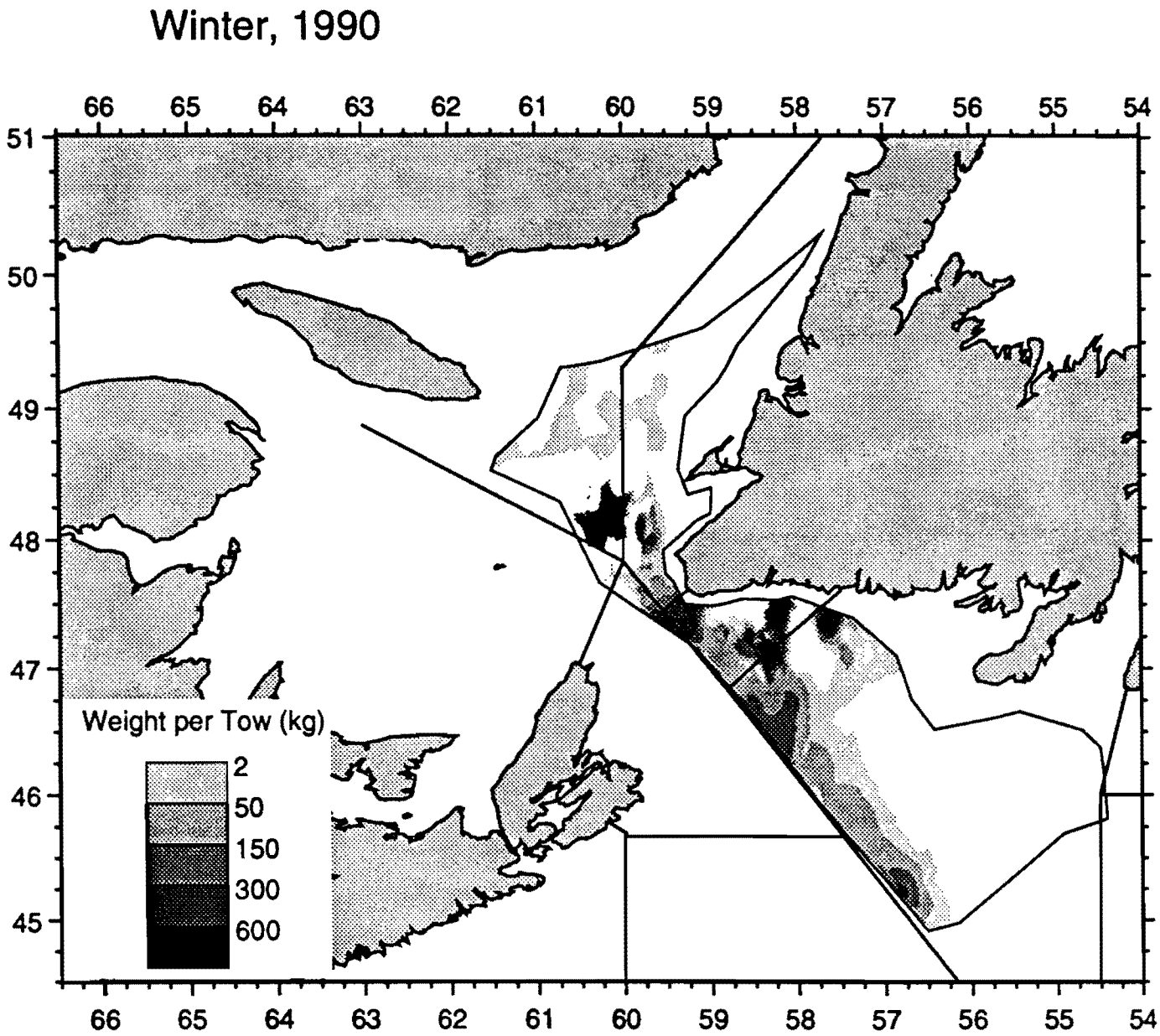

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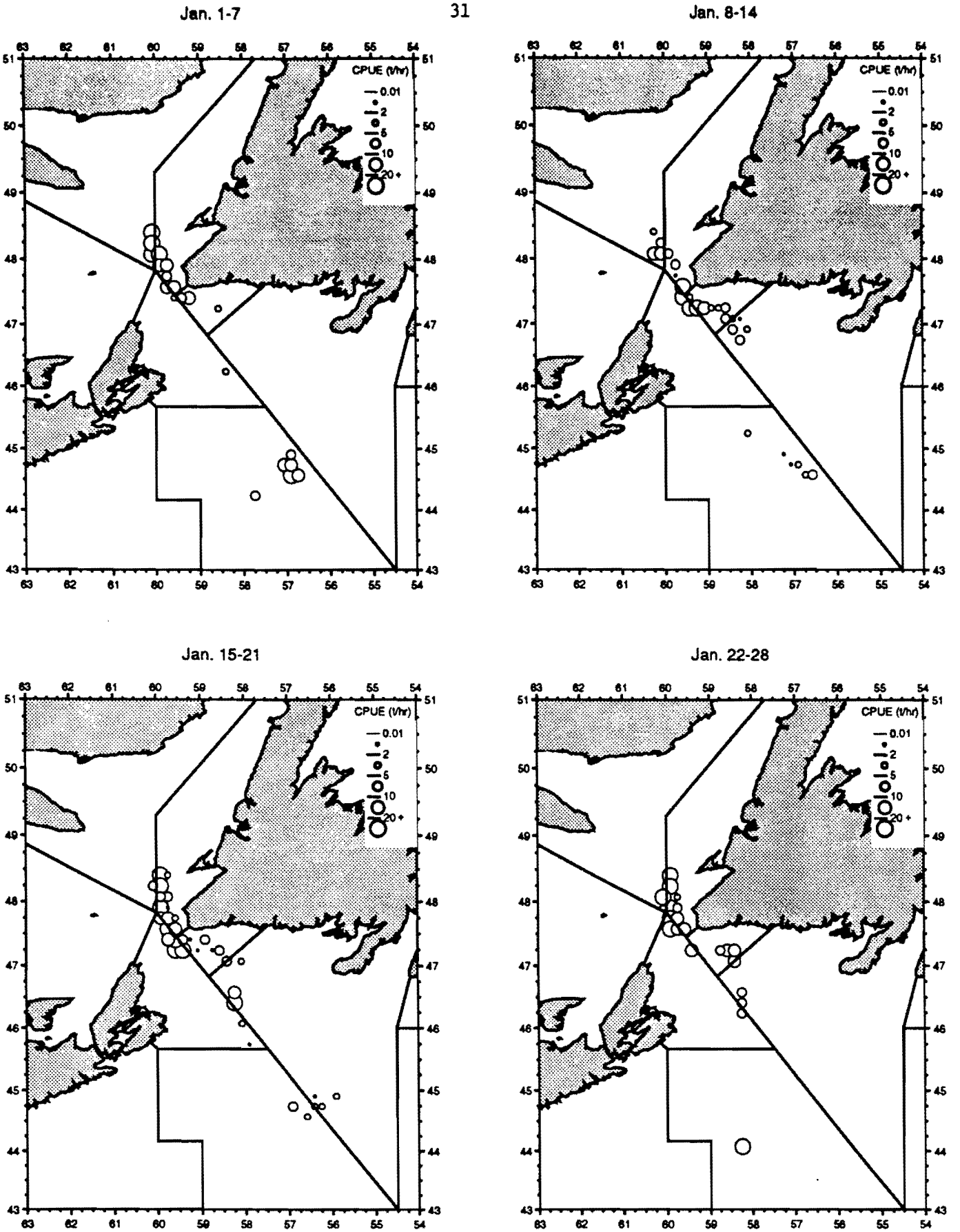


Fig. 13: Distribution of catch rates for redfish by week for 1981–1990 combined as determined from observer data (NOTE: catch rates are x 10, eg 10 is actually 1.0 t/hr).

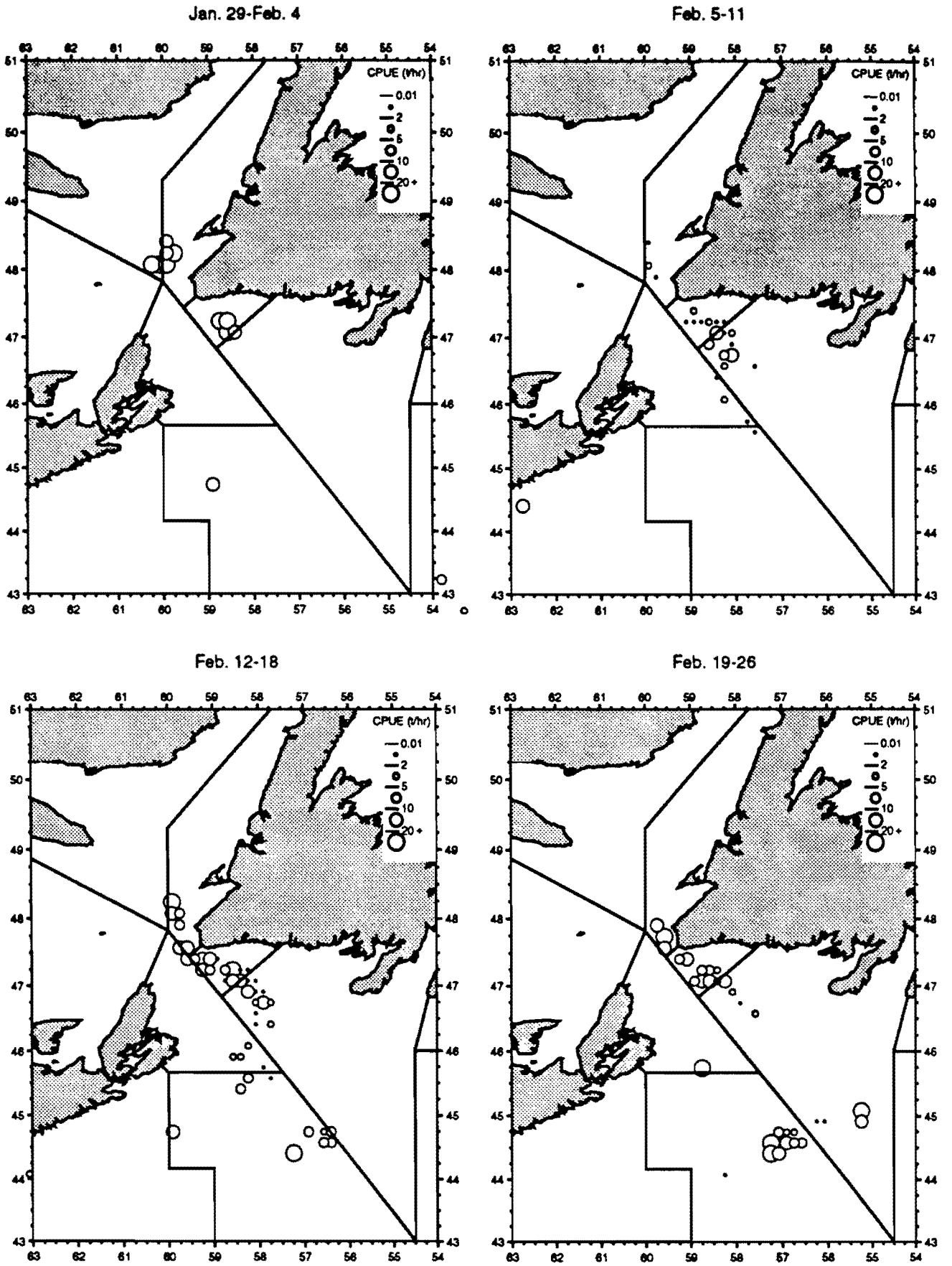


Fig. 13: Continued (NOTE: catch rates are x 10, eg 10 is actually 1.0 t/hr).

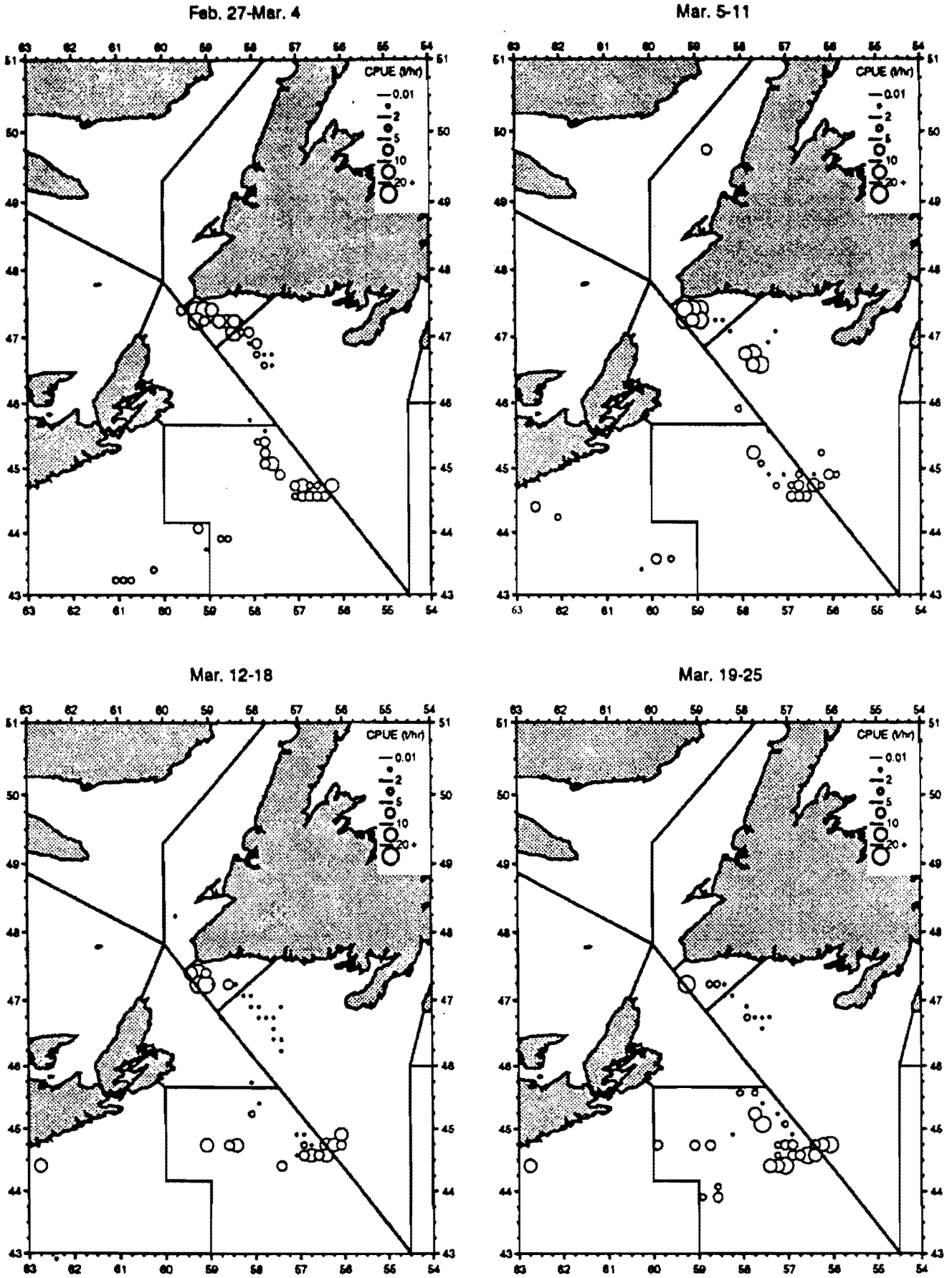


Fig. 13: Continued (NOTE: catch rates are x 10, eg 10 is actually 1.0 t/hr).

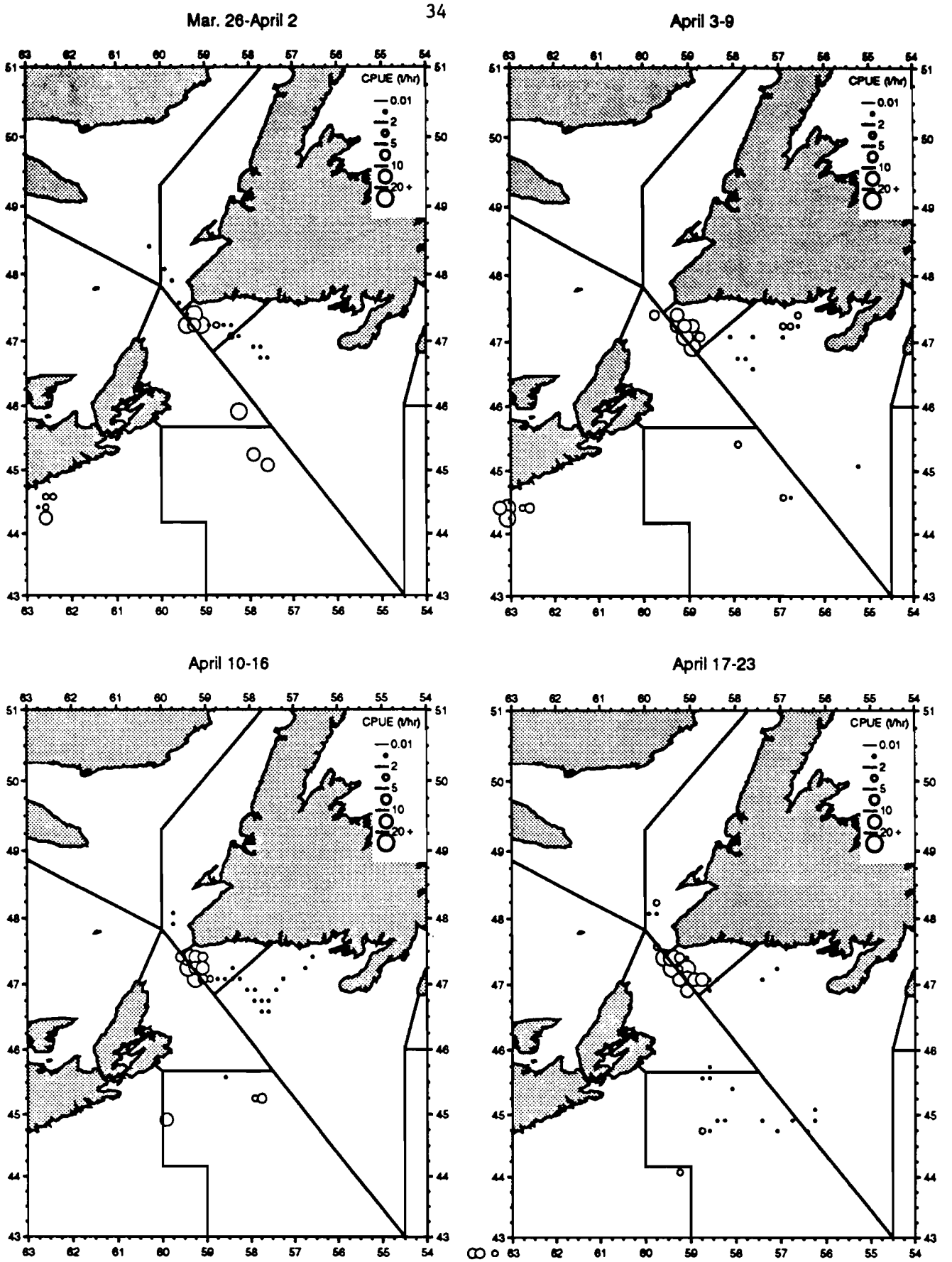
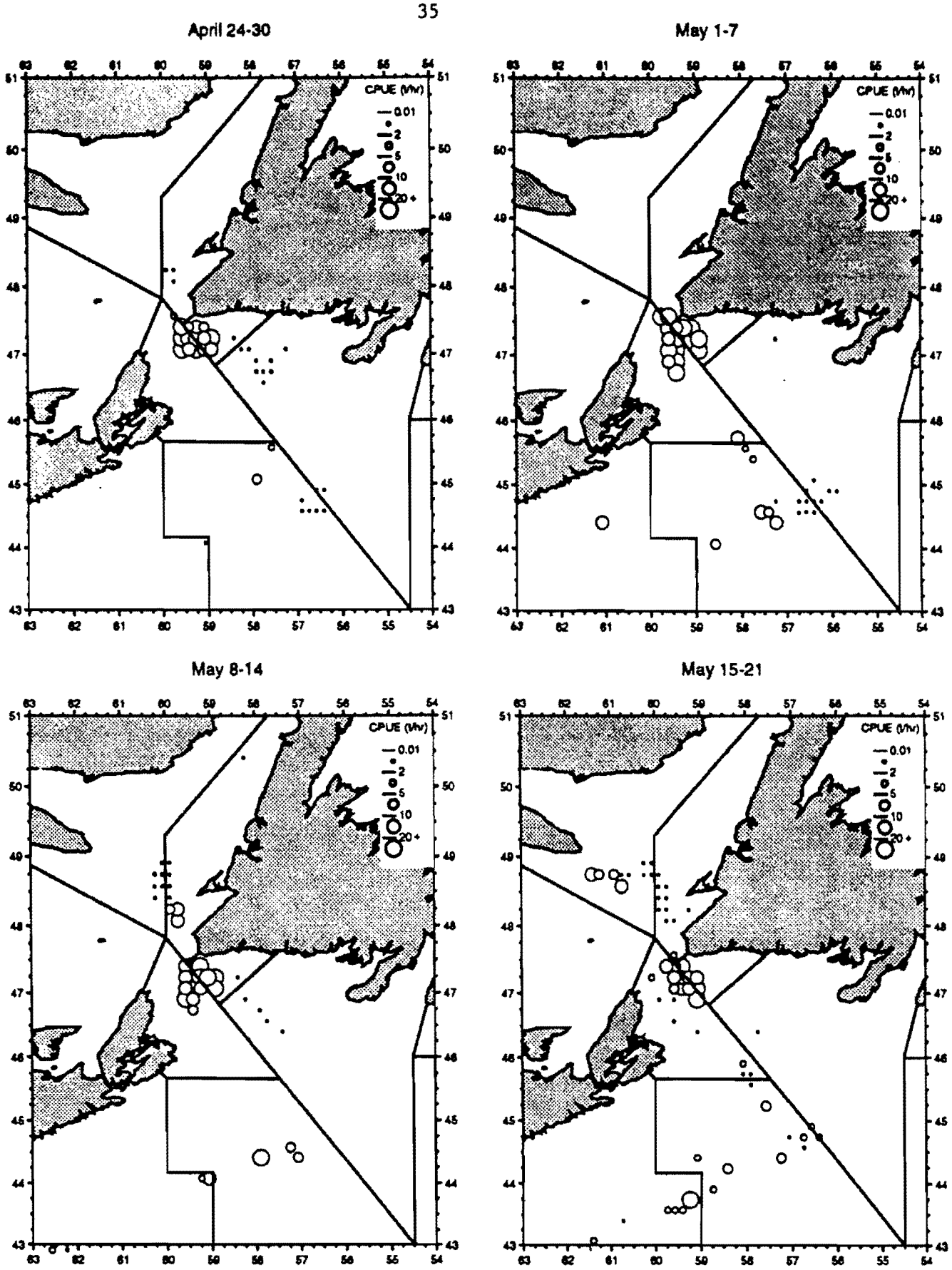


Fig. 13: Continued (NOTE: catch rates are x 10, eg 10 is actually 1.0 t/hr).



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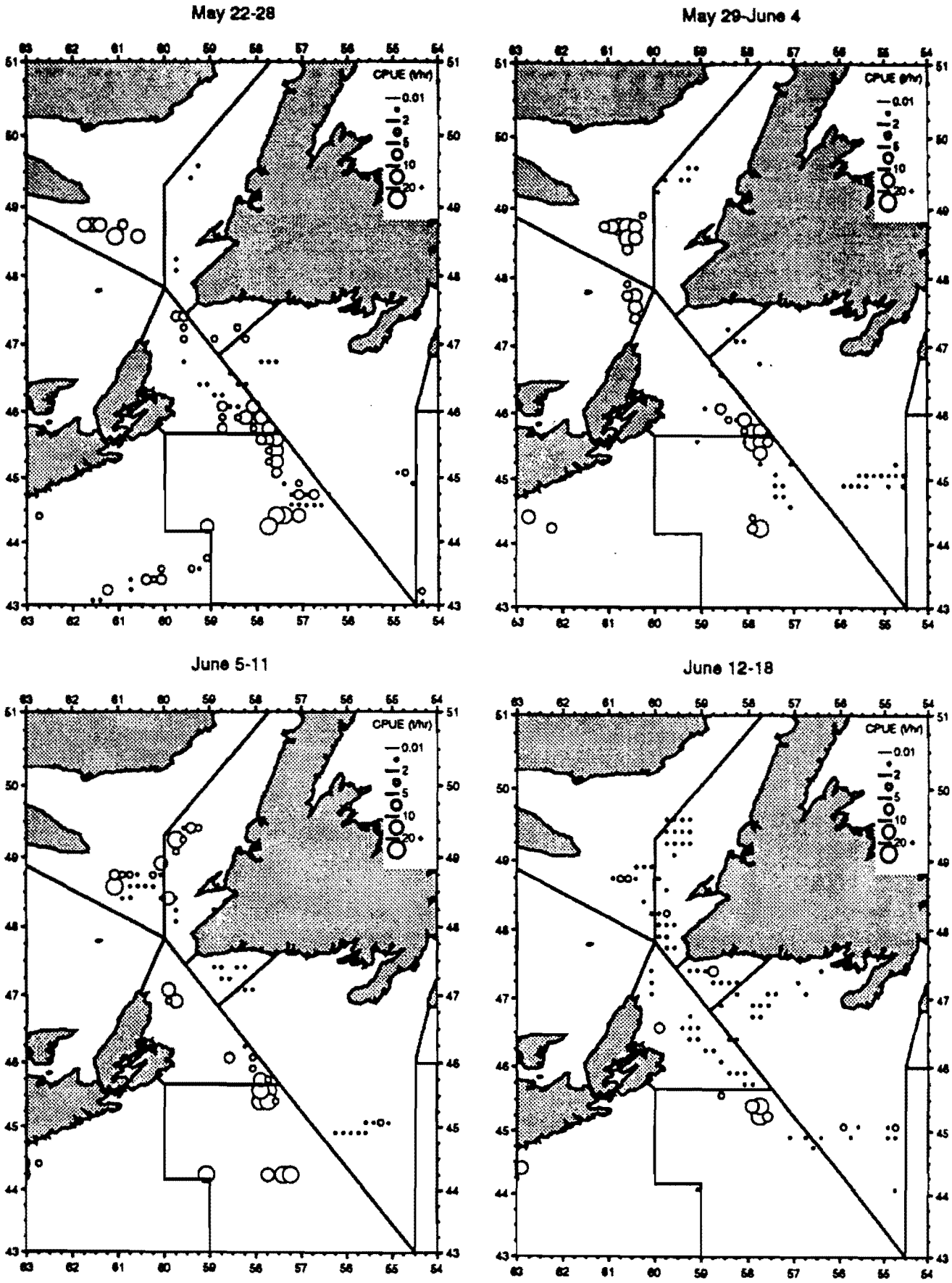

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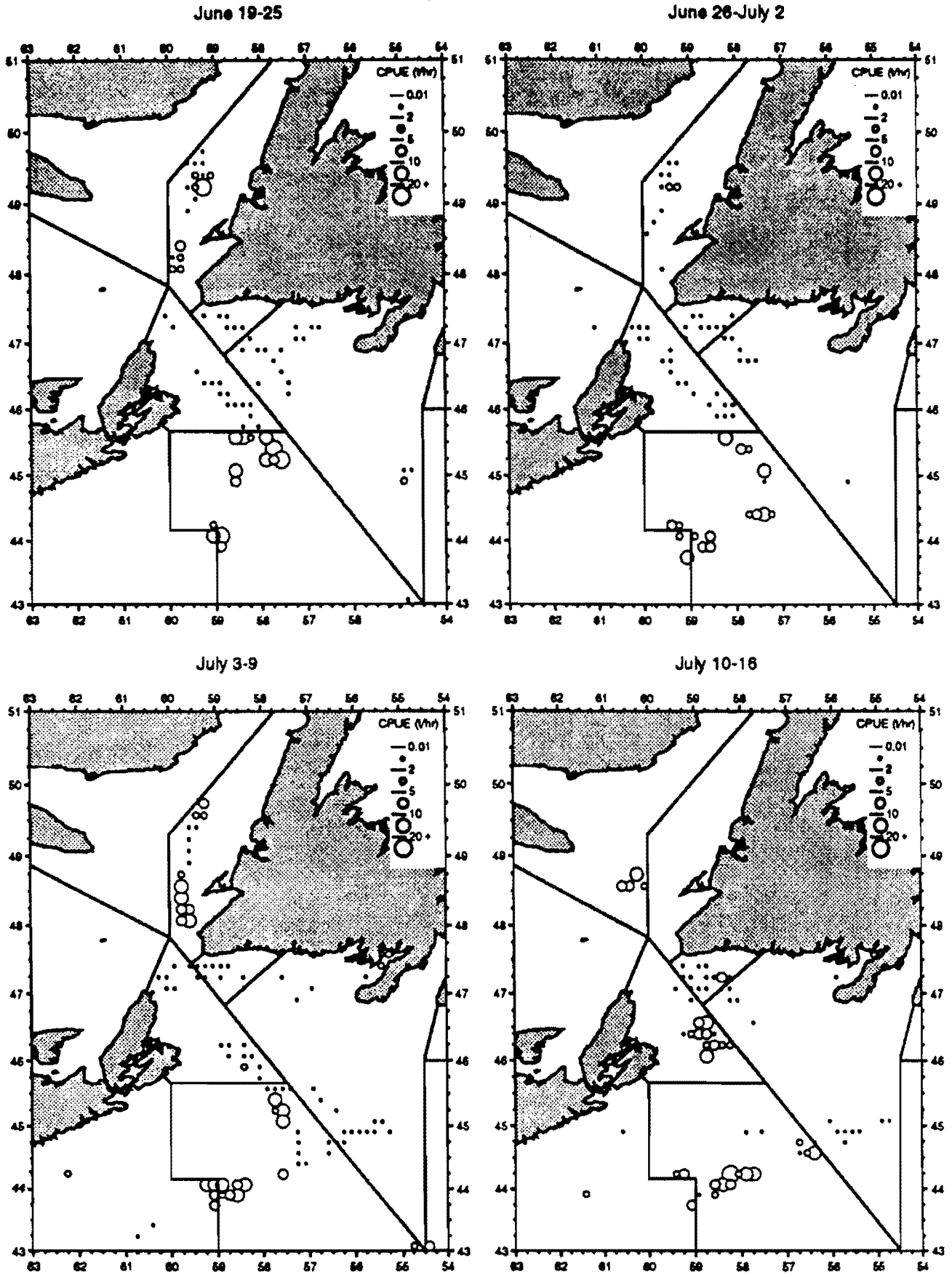

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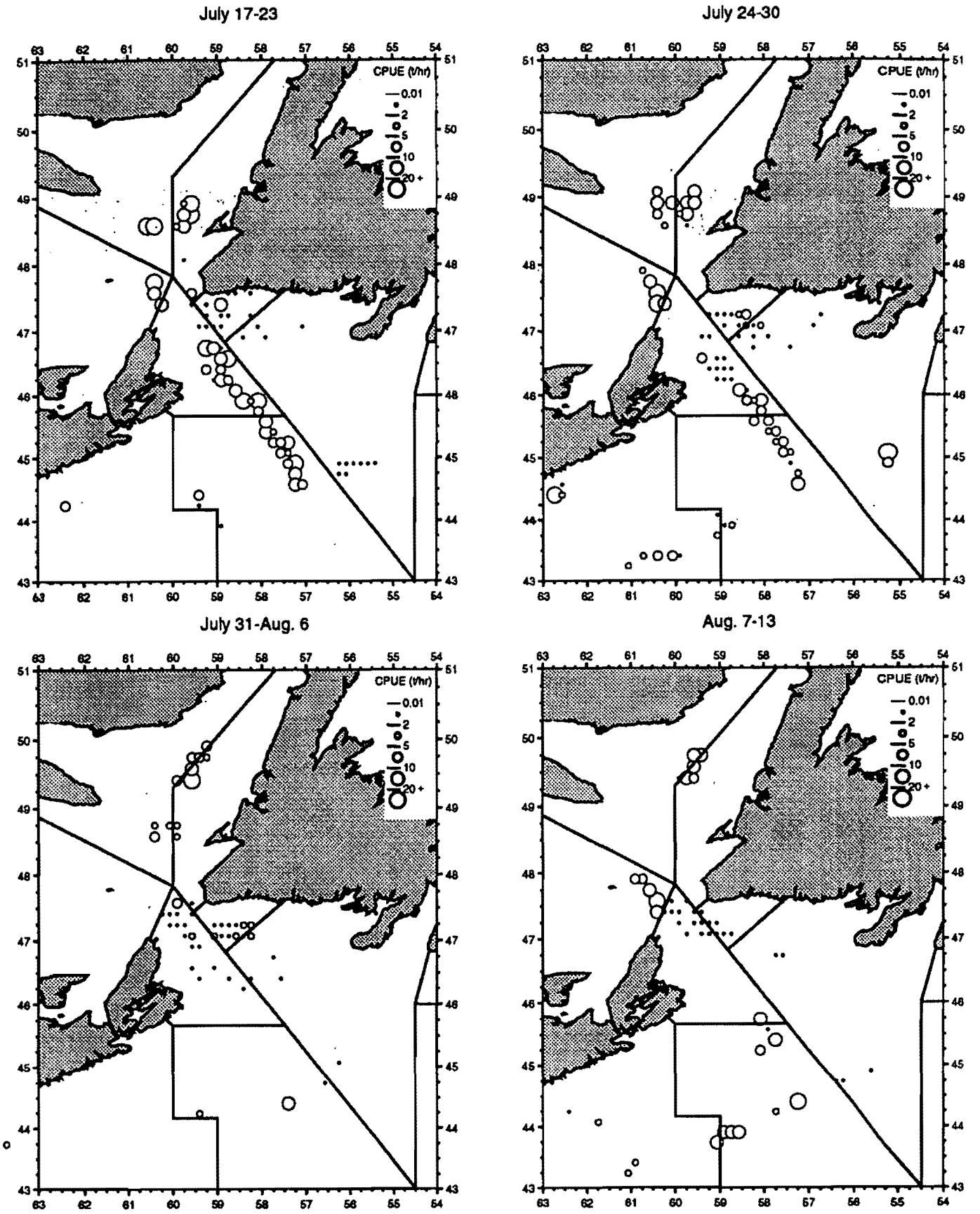

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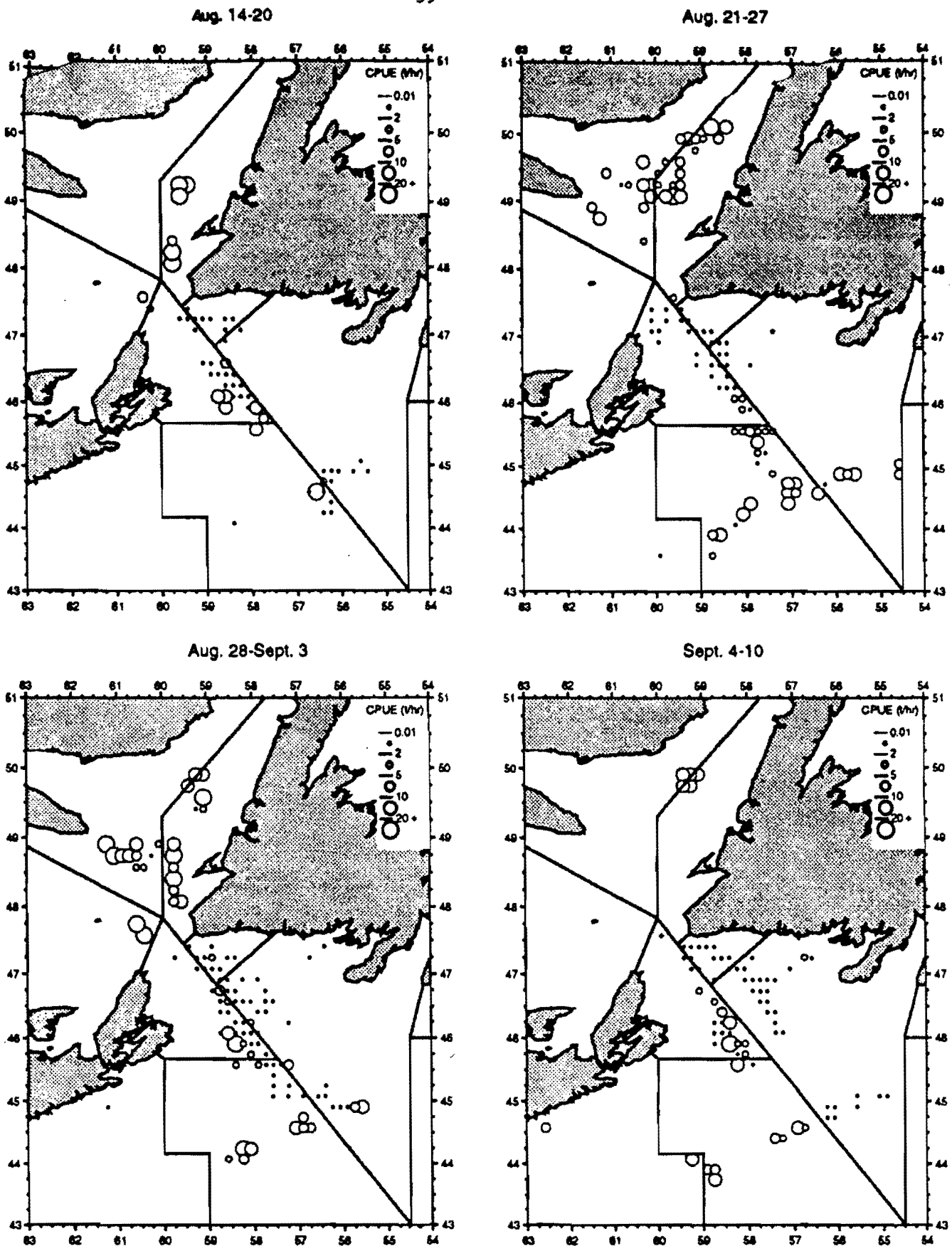

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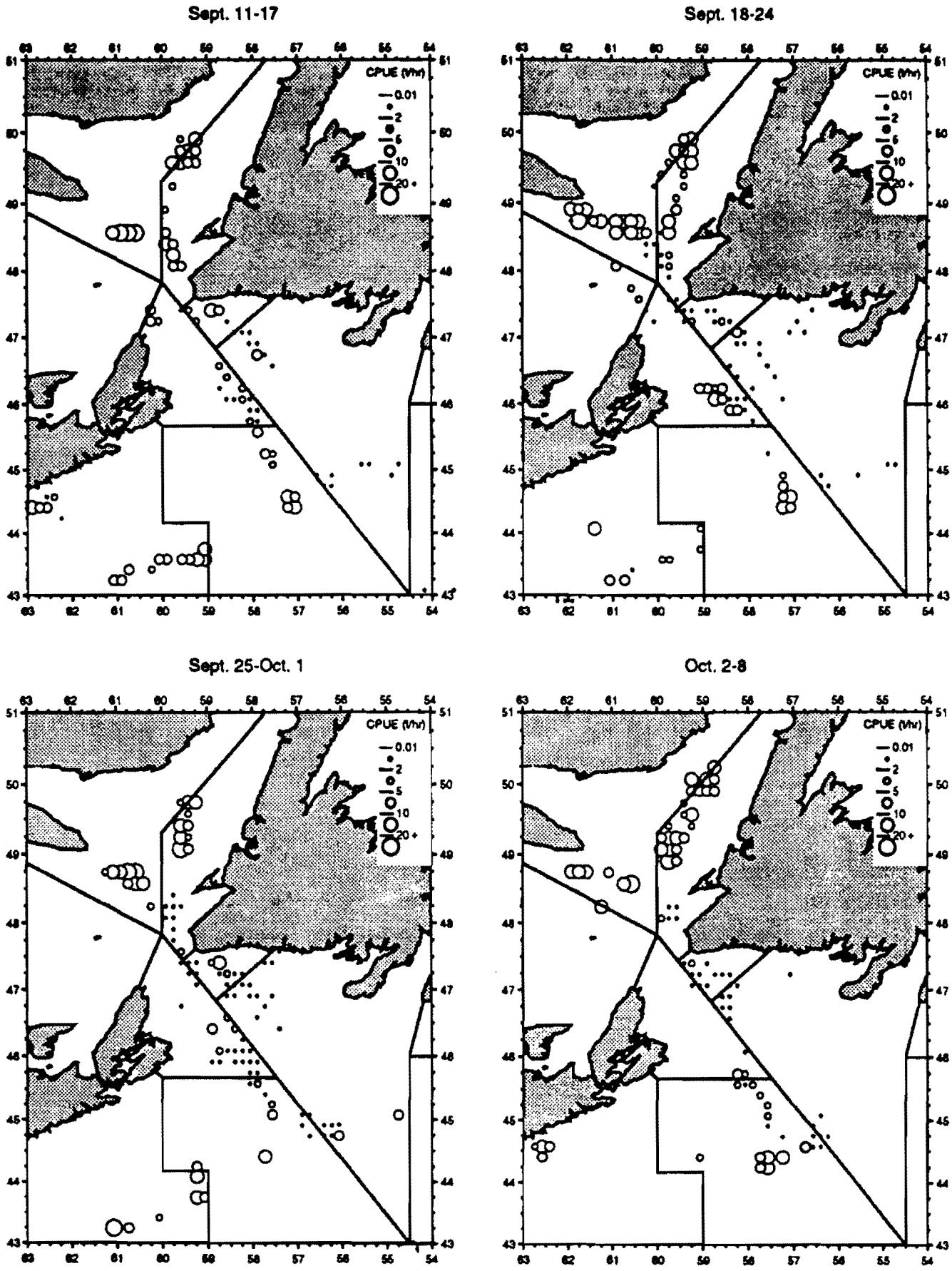

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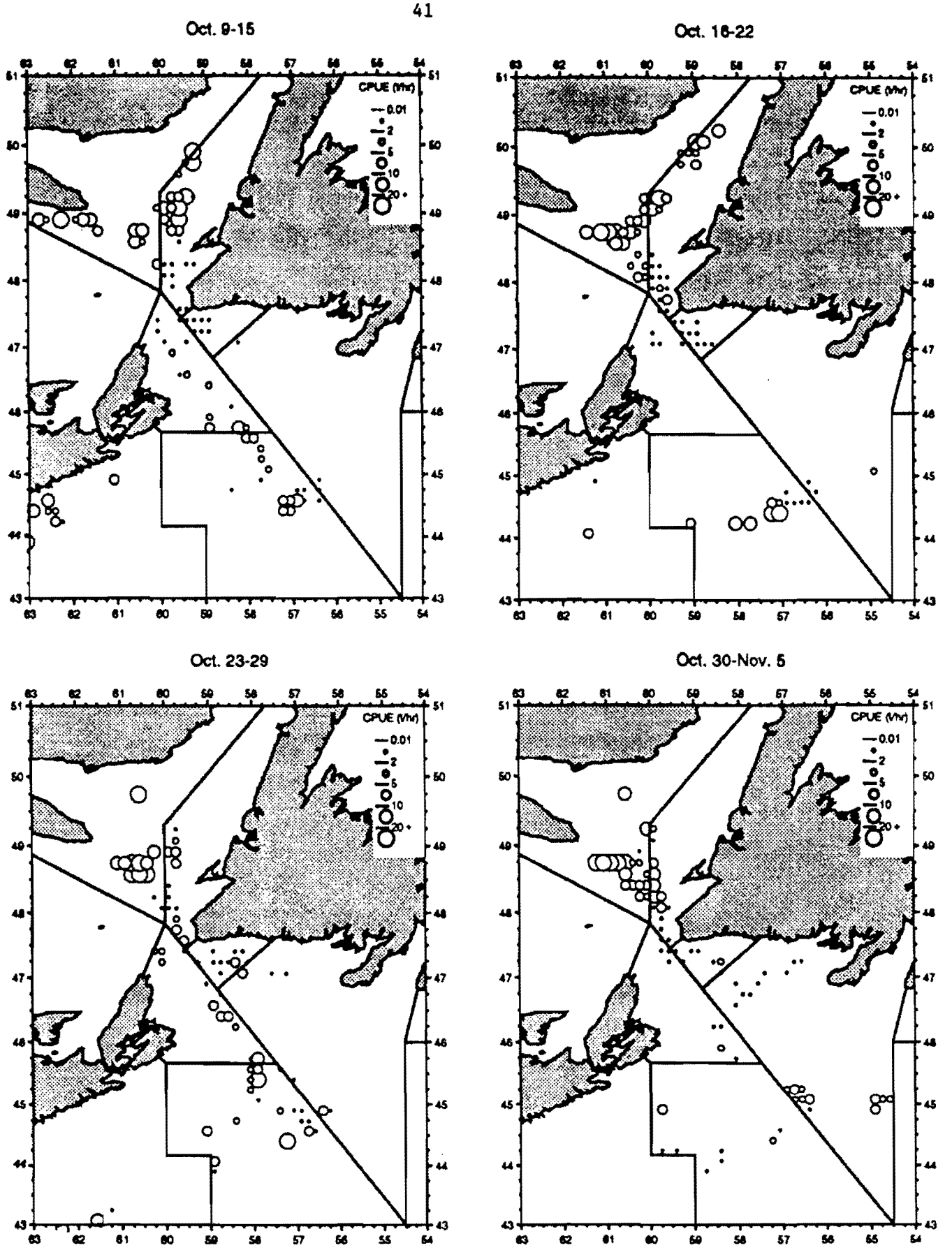

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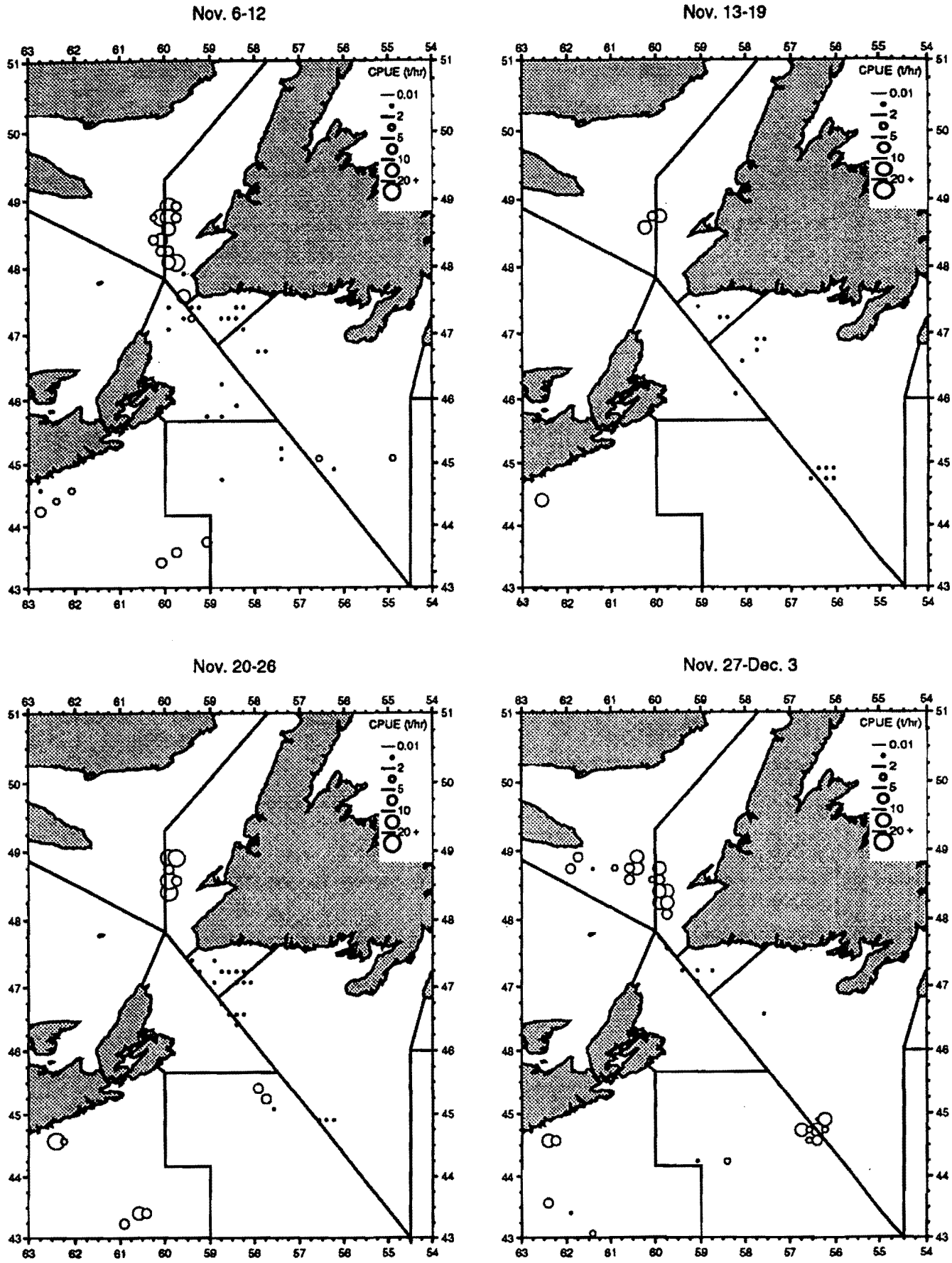

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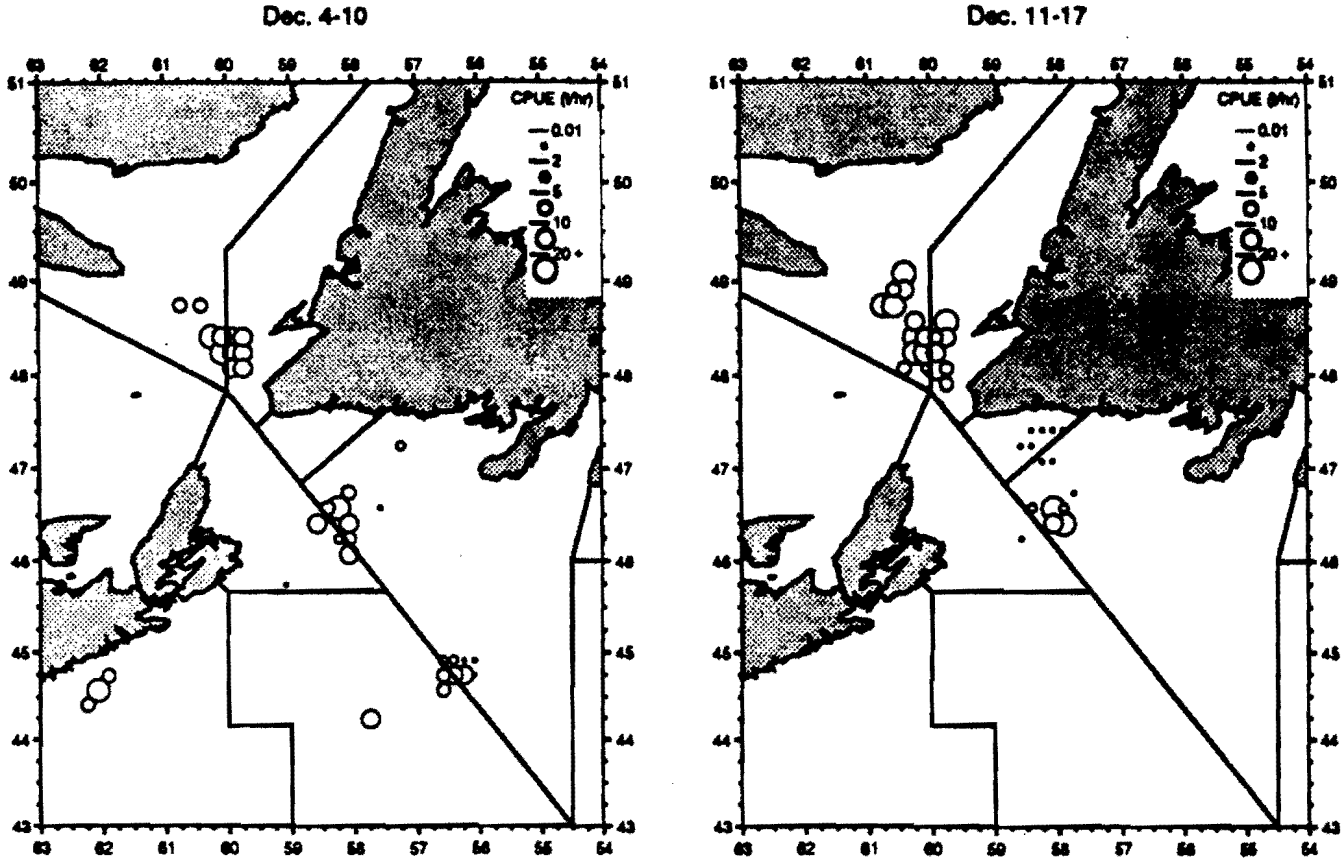

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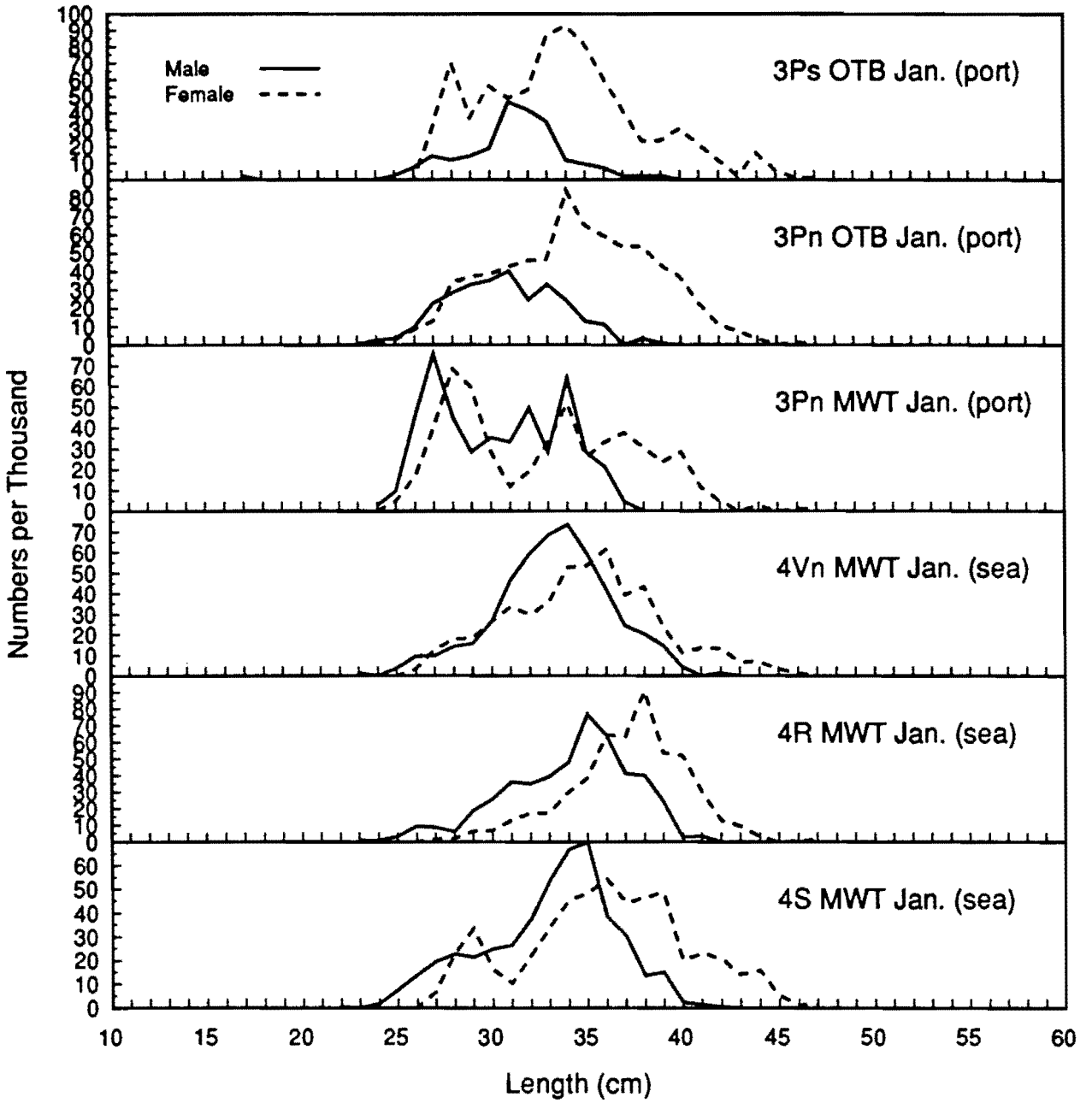

Figure 14a: Commercial redfish frequencies from 3P/4RS/4Vn for January, 1990

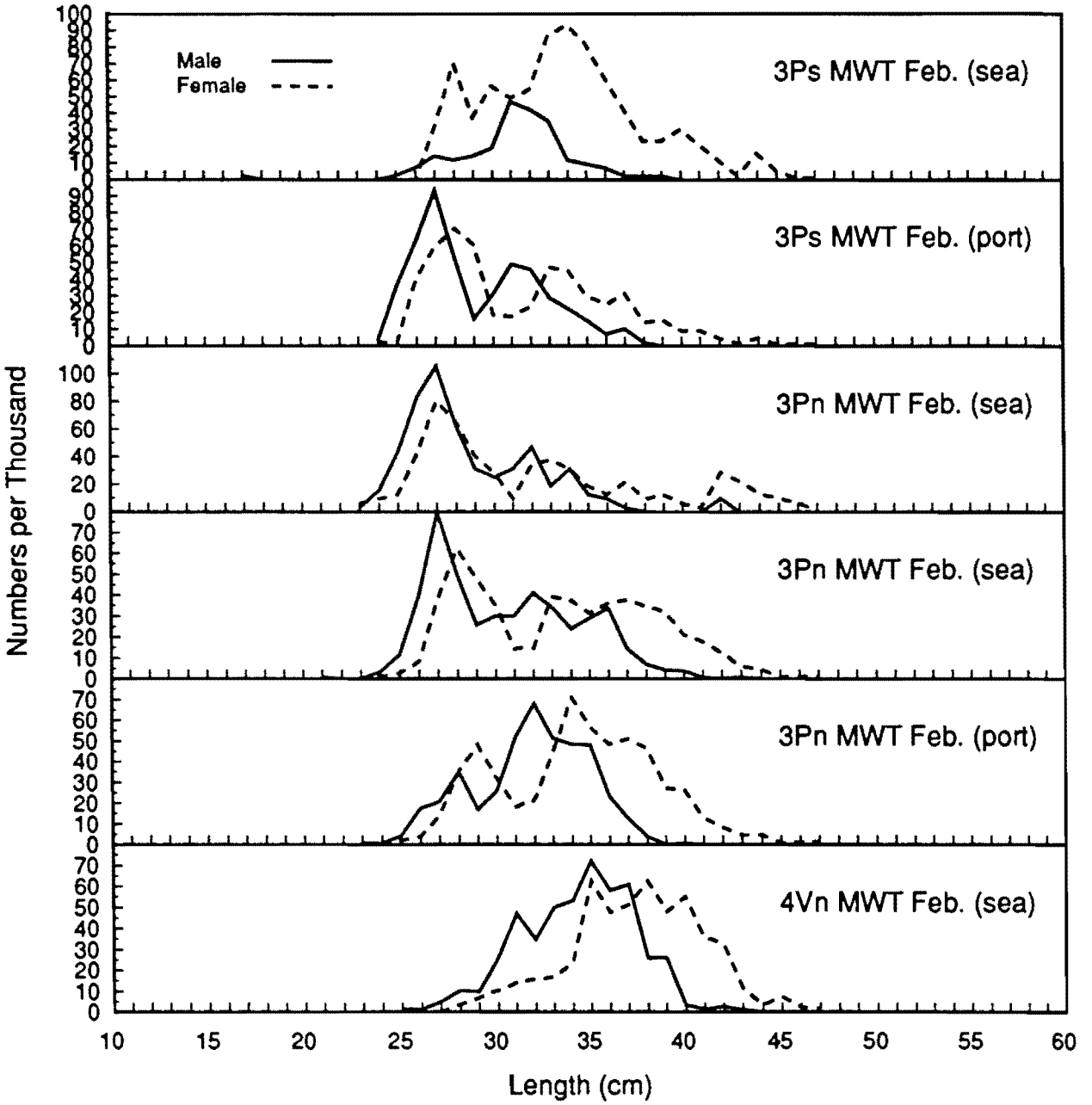

Figure 14b: Commercial redfish frequencies from 3P/4RS/4Vn for February,1990

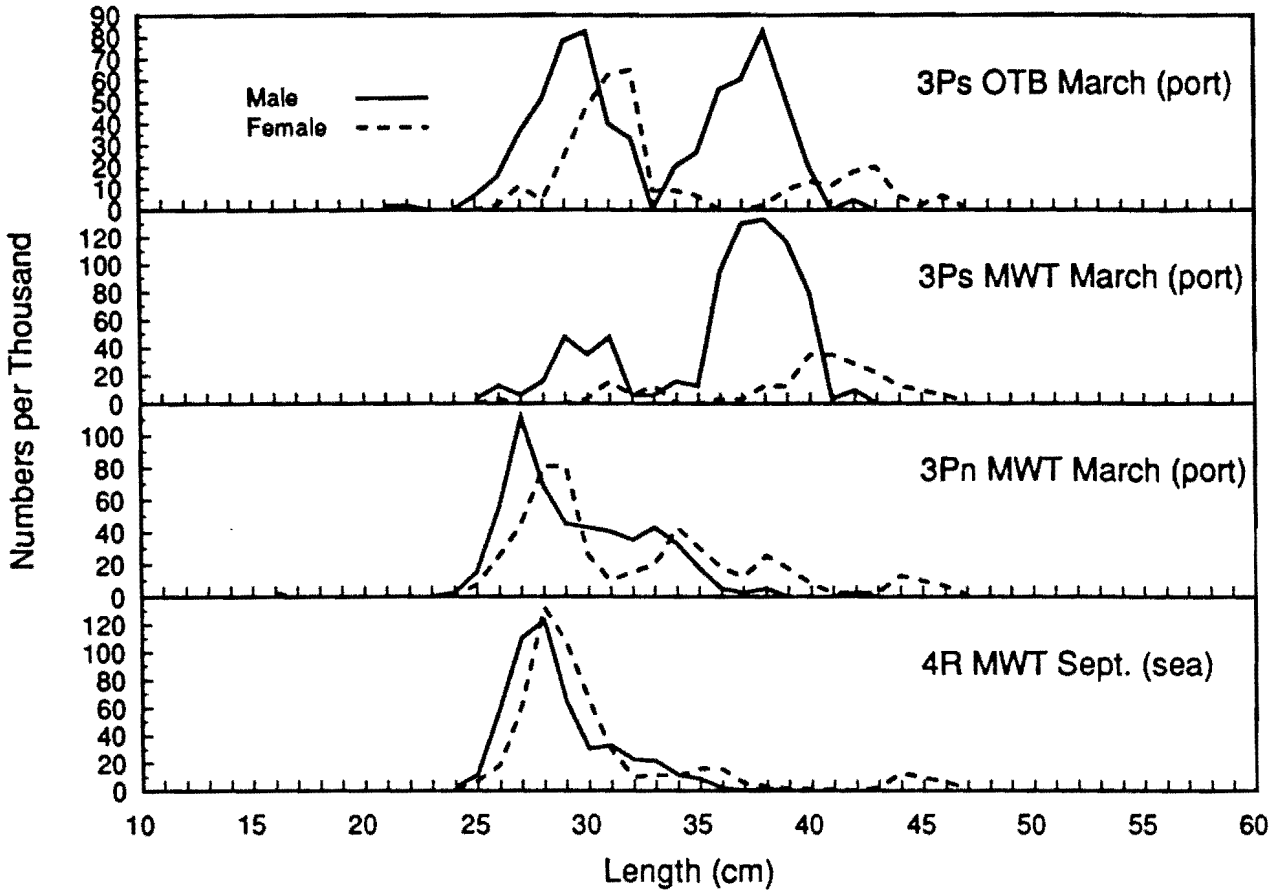

Figure 14c: Commercial redfish frequencies from 3P/4RS/4Vn for March etc.,1990

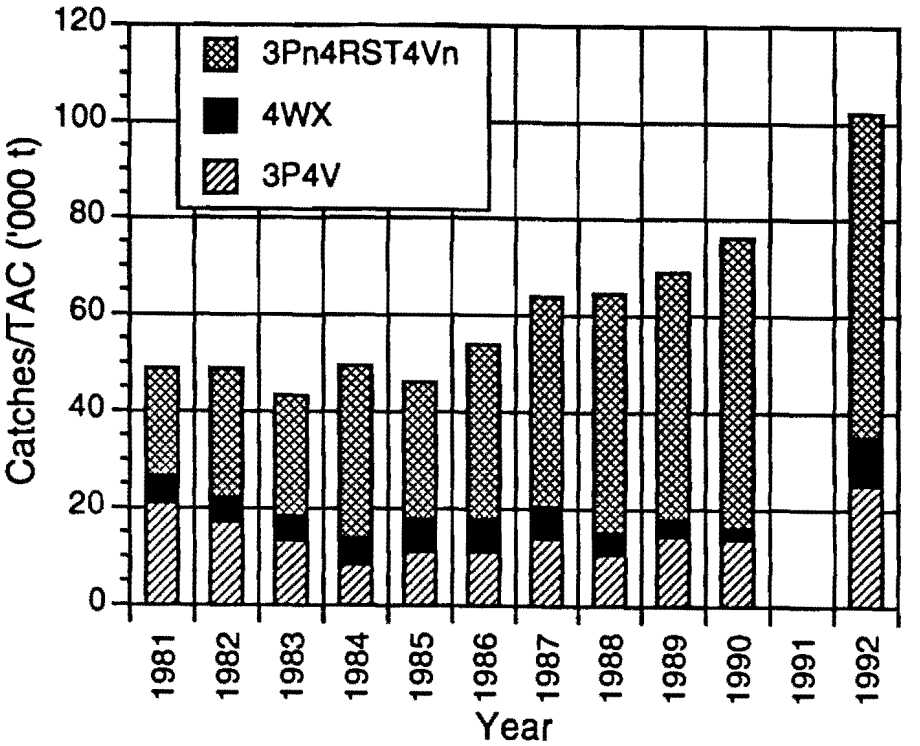

Fig. 15: Distribution of annual catches in the newly proposed redfish management units, and the proposed TACs for 1992 in each of these.