1995 Bay of Fundy Scallop Stock Assessments: Digby and 1995 Landings by Statistical District for the Bay of Fundy

By

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Abstract

Landings by the Digby fleet have declined to 1231 mt since the peak of the fishery in 1989. The 1995 landings of 291 mt for the Digby beds reached 80% of 1994 landings, however, with the closure of the Inside Zone and the extended area up to Port Lorne, landings in the Inside Zone (72 mt) were only 53% of 1994 values. Landings from the Outside Zone (219 mt) were stable from 1994 to 1995. Thus the difference in landings is largely an effect of the closure of the Inside Zone. Catch per unit effort (kg/h) was the lowest on record in 1995 in both zones (Inside: 10.6, Outside: 8.75). Effort (hours fished) increased in the Outside Zone, but declined in the Inside Zone. Scallop abundance of recruited year classes remains very low, but has not declined substantially from the 1994 survey estimates. The adult scallops are generally more abundant in the Outside Zone. Overall, densities of 1-100 animals per standard tow were common. This is in sharp contrast to the peak of the fishery (1989-90) where over 2000 animals per standard tow were harvested. Numerically, the number of pre-recruits are the largest we have detected since 1990, however, the magnitude and distribution of pre-recruits in the Digby area is not comparable to the large numbers seen from 1986-1989. This pre-recruit year class (age 2) is predominant in the Inside Zone off Gullivers Head and Centreville, but extends upstream to Delaps Cove. The concentrations of age 3 scallops in the Outside Zone off Digby were detected in the 1994 survey. Overall, there is little evidence of recruitment above Delaps Cove. The 1996 catch projection for the Outside Zone results in yields of 213 mt fishing at $F_{0.1}$ and 311 mt fishing at F_{max}.

Résumé

Les débarquements de la flotte de Digby ont diminué pour passer à 1 231 tm depuis le sommet atteint en 1989. En ce qui concerne les bancs de Digby, les débarquements de 1995, soit 291 tm, correspondaient à 80 p. 100 des débarquements de 1994; cependant, étant donné la fermeture de la zone intérieure et malgré l'élargissement de la zone jusqu'à Port Lorne, les débarquements dans la zone intérieure (72 tm) n'ont été que légèrement supérieurs à la moitié (53 p. 100) des débarquements de 1994. Les débarquements en provenance de la zone extérieure (219 tm) sont demeurés stables en 1994 et en 1995. Donc, l'écart dans les débarquements est attribuable en grande partie à la fermeture de la zone intérieure. En 1995, les prises par unité d'effort (kg/h) ont été les plus faibles jamais recensées dans les deux zones (zone intérieure : 10,6; zone extérieure : 8,75). L'effort (heures de pêche) a augmenté dans la zone extérieure mais a diminué dans la zone intérieure. L'abondance des classes annuelles de recrutement du pétoncle est demeurée très faible mais elle n'a pas diminué de façon marquée par rapport aux estimations du relevé de 1994. En règle générale, les pétoncles adultes sont plus abondants dans la zone extérieure. Dans l'ensemble, une densité de 1-100 individus par trait standard était courante. Cette situation est tout à fait à l'opposée de celle observée en 1989-1990 alors que la pêche était à son meilleur, c'est-à-dire lorsqu'on récoltait plus de 2 000 individus par trait standard. En termes quantitatifs, le nombre de prérecrues est le plus élevé à avoir été observé depuis 1990; cependant, la grandeur et la distribution des prérecrues dans la zone de Digby ne sont pas comparables aux grands nombres observés de 1986 à 1989. Cette classe annuelle de prérecrue (âge 2) est prédominante dans la zone intérieure au large de Gullivers Head et de Centreville mais elle s'étend en amont jusqu'à Delaps Cove. Au cours du relevé de 1994, on a observé des regroupements de pétoncles d'âge 3 dans la zone extérieure au large de Digby. Dans l'ensemble, il y a peu de signe de recrutement au nord de Delaps Cove. D'après les prévisions des prises en 1996 dans la zone extérieure, les rendements sont de 213 tm au niveau $F_{0,1}$ et de 311 tm au niveau F_{max}.

Introduction

The Digby scallop beds are fished according to seasonal zones. The Inside Fishing Zone encompasses an area < 6 miles from shore, from Parker's Cove to Centreville, and is closed by regulation from May 1 to September 30. The rest of the beds are seasonally unrestricted and are referred to as the Outside Zone.

The scallop beds off Digby, N.S. have been unstable over the last decade. Two strong recruitment pulses, first observed in 1986 and 1987 as 2 year old animals, contributed to unprecedented high landings in 1988 through to 1991. While scallop abundance increased in many parts of the Bay due to these year classes, the greatest concentration of scallops was centered on the Inside Fishing Zone and off Cape Spencer, N.B. In the spring of 1989, the incidence of "clappers" (empty paired shells) off Digby rose from an average of 3% over the previous four years to approximately 23%. By the fall, this value further increased to 51%, with over 90% dead in some areas. Approximately 6,000 metric tons of scallops were lost (excluding catches for that year of 2644 mt, and any potential yield of these animals).

Consequently, the Full Bay [of Fundy] fleet targeted the Cape Spencer bed, on the New Brunswick side, during the winter of 1989-90. This fleet returned to fish the Inside Zone in October 1990. In May 1991, poor catches in the Outside Zone led to fishing off Brier Island and the Lurcher Shoals. The Full Bay fleet returned to the Inside Zone in October of 1991. Since 1992, much of the effort has been concentrated on the Brier Island and Lurcher Shoal stocks, with 63% of the 1995 catch coming from those beds. Assessments of these stocks are detailed in another document (Kenchington and Lundy 1996).

In 1995, the Inside Zone regulation closure area was extended from Parkers Cove to Port Lorne (Variation order 1995-106, 1995-132, 1996-006) beginning August 12, 1995, and neither area was opened in October. This was done to protect broodstock and the pre-recruit scallops. In addition, a 1 mile closure in SFA28A from April 19th to December 31 (Variation Order 1995-103, 1995-103,) was effected to avoid conflict with the lobster fishery. This closure area was subsumed by the extended closure of the Inside Zone. Monday to Friday fishing in all areas was established for the period August 11 to October 2, 1995 (Variation Order 1995-108).

An overview (1981-1994) of fishing activity and stock assessments on the Digby beds has been documented recently (Kenchington et al. 1995a, 1995b, 1995c). This report details the results of the 1995 stock surveys and fishing activities. While longer time series are presented, most of the comparisons will be between 1994 and 1995.

Fishery Data

All Full Bay of Fundy license holders are required to provide log book information which provide data on catch, location and effort. Currently, 99 licensees are required to report. The total number of licenses has not changed since 1989, however, only 94 vessels were active in 1995. Log compliance in 1995 was 77%, a decline from the 87% received in 1994 (Table 1). However, this figure is still preliminary. Of these 99 license holders, 54 possess groundfish licenses as well (Table 2). This is a decline from 1994 where there were 58 groundfish licenses held by the fleet. Swordfish, squid, herring, lobster, shrimp and mackerel licenses are also carried (Table 2). The majority of scallop license holders hold only one additional license (44%, Table 3). This is a slight increase from 1994.

Catch trends were estimated using the fishing logbook data available. In 1995, 72 of the 94 vessels submitted logs. Catches were broken down by area using the log data where location fished was known. Some logs provided full information (Class 1), others had only location and catch (Class 2) and still others had only general fishing area and catch with or without effort

(Classes 3 and 5). The percent logged catch per area was calculated, and the estimated total catch per area was derived from the total sales slip catch reported by Statistics Branch (see below). The historical landings reported in Table 4 have been updated to reflect the current Statistic Branch reports (updated with backlogged sales slip data), and may differ slightly from those reported previously (Kenchington et al. 1995 a, b, c). Catch per unit effort (CPUE) was calculated using the mean values from the Class 1 log data and recorded in kg per hour. Effort (hours) was calculated from the Class 1 log data and prorated to the total catch from the Class 1 catch.

Fishermen report their landings, and sell their catch in terms of pounds of meat. Statistics Branch converts this to round weight (whole animal) using a conversion factor of 8.33. To convert Statistics Branch (DFO, Halifax) landings to metric tonnes of meat, the data are reconverted to pounds and then converted to metric weight in tonnes.

Landings by the Full Bay license holders have declined to 1231 mt since the peak of the fishery in 1989 (Table 4). 1995 landings reached 80% of 1994 landings from the Digby beds, however, with the closure of the Inside Zone and the extended area up to Port Lorne, landings in the Inside Zone were only 53% of 1994 values. The current level of Inside Zone landings is similar to that seen in the 1960s and lower than that of recent years (Fig. 1). Landings from the Outside Zone changed little from 1994 to 1995 (Table 4, Fig. 1). Thus the difference in landings is largely an effect of the closure of the Inside Zone. A breakdown of the commercial landings by Zone and quarter of the year is presented in Table 5. Fishing was heavier in the first and second quarter in all areas, than during these same periods in 1994. Fishing in the Outside Zone (6-15.9 miles) was down in the third quarter relative to 1994.

Catch per unit effort was the lowest on record in 1995 in both zones (Table 6, Fig. 2). The summary statistics for CPUE from 1990 to 1995 are shown below:

Year	Mean	Std. Dev.	Min.	Max.	N
Inside Zone					
1990	30.66	11.40	5.62	71.27	266
1991	28.55	14.85	6.66	125.62	515
1992	18.75	7.59	5.61	69.44	625
1993	14.73	5.47	3.53	42.15	361
1994	11.84	4.54	4.46	64.23	394
1995	10.60	4.62	4.35	24.91	205
Outside Zone					
1990	32.85	18.12	2.72	121.52	324
1991	20.82	7.52	5.62	59.36	416
1992	18.40	7.32	5.35	55.29	591
1993	13.76	6.18	1.36	70.68	700
1994	11.23	4.66	3.05	35.58	527
1995	8.75	3.15	1.35	27.38	507

The maximum CPUE values have fallen from 1994 to 1995, bringing the standard deviation down as well. These changes in the CPUE summary statistics reflect the low biomass of scallops on the Digby beds and suggest an even distribution of the population, as supported by research vessel survey information (see below). Effort in the Outside Zone increased in 1995 and remains high (Fig. 2). This increase is probably due to the closure of the Inside Zone. This Zone, which is only fished for 7 months of the year, and therefore has lower total effort than the Outside Zone, saw a decline of effort in 1995 as a result of the closure.

Fishing locations according to log information are illustrated in figure 3. 1995 saw less effort on the Brier Island Lurcher grounds, and increased effort in St. Mary's Bay and in the

Outside Zone off Digby in contrast to 1994 (Fig. 3).

Port Sampling of Commercial Catch

Port sampling of the commercial catch has been carried out from Digby, N.S. (Table 7). When a vessel lands, two samples of approximately 500 grams each are removed from the catch, and date, vessel, location and depth fished are recorded. The catch muscle is then removed from the adductor muscle and each adductor muscle is weighed and recorded for each of the two samples. This separation of the muscles is done because the catch muscle is not always attached to the adductor, as a result of processing. The contribution of the catch muscle to the total weight is later prorated. In 1995, a total of 104 samples were collected from 9 vessels, with 59% of the samples coming from 2 vessels. This is a decrease in the number of samples, and the number of vessels sampled from 1994, and an increase in the percentage coming from 2 vessels (Table 7). 378 meats were sampled from the Inside Zone, and 2,950 meats were sampled from the Outside Zone (Table 8). More samples were collected from areas outside of 16 miles from Digby (Table 8) reflecting the fishing activity in that area (Fig. 3). A breakdown of the commercial catch samples by area and quarter of the year is presented in Table 9. The third quarter (July to September) Outside Zone samples had the best coverage (Table 9).

The mean, standard deviation and range of meat weights are calculated on a monthly basis when data is available. A "meat count" of the sample is then calculated by dividing 500 (g) by the mean meat weight (g). The meat count regulation for this area was 72 meats per 500 g from May 1 to September 31, and 55 meats per 500 g from October 1 to April 30, until June 30, 1995. On July 1, 1995, the meat count was changed to 50 meats per 500 g year round (Variation Orders 1995-078, 1996-07).

The mean meat weight (g) per month and associated statistics are given in Tables 10 and 11. These data do not include the weight of the catch muscle, however, this has been calculated as 5-7% of the total (e.g. 4 g meat could have been landed as a 4.28 g meat with catch on). Also, fishermen do not remove the entire muscle when "shucking" the meat. A portion of the muscle is commonly left on each valve. The percent of the meat discarded has not been calculated for Digby shuckers, and is expected to vary with shell shape in the different parts of the Bay, and with catch abundance. Samples were collected in January and March from the Inside Zone (Table 10) and from all months of the year except June from the Outside Zone (Table 11). The meat count was met on both grounds throughout our sampling periods.

The January samples from the Inside Zone show large meats being caught, however some of the smaller meats from the incoming year class were fished in March, with the mean and minimum meat size both falling (Table 10). Samples originating from the Outside Zone are on average smaller, with meat counts ranging from 22 to 44 meats per 500 g (Table 11).

The weight frequency of the catch from 1990-1995 is illustrated in figure 4, and the sample locations for 1995 are illustrated in figure 5. In 1995 larger numbers of smaller scallops were landed, particularly in January, March and May, when scallops near the legal shell height limit were landed. The minimum meat weight associated with the minimum shell height (76 mm) is approximately 4.6 g (including catch muscle) for each area (Kenchington and Lundy 1993).

Research Vessel Stock Surveys

A stock survey of the Digby grounds was conducted from June 14-23, 1995 using the research vessel "J.L. Hart" with 4 gang gear (Kenchington et al. 1995a). The 76 cm inside width drags are made of 7 rows of 4 mm steel wire rings 75 mm inside diameter knit with rubber washers, 9 across and 3 on the side fastened to an angle iron frame at the mouth and a piece of

wood (2"x4") or plate steel at the tail end. This gear actively selects against small size scallops. Small scallops can avoid the drag path or if caught, escape through the steel rings (Robert and Lundy 1989). To estimate the relative abundance of small scallops (< 80 mm shell height) two drags were lined with 38 mm polypropylene mesh. However, abundance of scallops with shell height under 40 mm is not reliably estimated and can only be used as a qualitative index of recruitment (Kenchington et al. 1995a). For analytical purposes, the average number of scallops caught in unlined gear (> 80 mm) and the average number of scallops caught in lined gear (< 80 mm) were used and then prorated to conventional 7 gang gear to allow for annual comparisons.

Survey stations were randomly assigned according to one of three areas: Core Area, Below Core Area and Above Core Area (Robert et al. 1985), which were originally defined according to commercial catch levels. The number of stations per strata reflect the relative geographic area of each stratum (Kenchington et al. 1995a). Accordingly 56, 13 and 31 stations were assigned to the Core Area, Below Core Area and Above Core Area strata respectively (Table 12). Details of station assignment within Areas are provided in Kenchington et al. (1995a).

The total number of tows by area by year are listed in Table 13 and the location of the 1995 tows are shown in figure 6. All tows were 8 minutes in length. To eliminate the effects of tide and vessel speed on the area covered by the gear, the distance towed was determined either from latitude/longitude of the start and end of tow bearings, or from continuous recordings of location via a computer linked to navigation aids and standardized to a tow length of 800 meters (dragged area of 4256 sq. m). Data recorded for each tow were: 1) direction of tow (magnetic or true compass bearings), 2) depth (m), 3) weight of catch (kg) (individually for each drag), 4) types of substrate, and 5) shell heights in 5 mm intervals for all live and dead (empty paired shells) scallops fished were recorded individually for each drag. Bottom temperature was recorded for each tow using a VEMCO digital sub-surface temperature recorder (Vemco Ltd., Shad Bay, N.S.). This data was given to the Marine Environmental Data Service (MEDS through Dr. K. Drinkwater, DFO) and is not presented here.

The results of the June 14-23, 1995 Digby scallop survey show that abundance of recruited year classes remains very low, but has not declined substantially from the 1994 survey estimates (Table 13). Numerically, the number of pre-recruits are the largest we have detected since 1990, however, the magnitude and distribution of pre-recruits in the Digby area is not comparable to the large numbers seen from 1986-1989 (Table 13). This pre-recruit year class is predominant in the Inside Zone off Gullivers Head and Centreville, but extends upstream to Delaps Cove (Fig. 7). The concentrations of age 3 scallops in the Outside Zone off Digby were detected in the 1994 survey (Fig. 6, Kenchington et al. 1995a). Overall, there is little evidence of recruitment above Delaps Cove (Fig. 8). The adult scallops are generally more abundant in the Outside Zone (Fig. 7). Overall, densities of 1-100 animals per standard tow were common (Fig. 6). This is in sharp contrast to the peak of the fishery (1989-90) where over 2000 animals per standard tow were harvested (Table 13), and well below the historical average. The distribution of recruited scallops is mapped into two age groups, 5-7 year olds and 8+ (Fig. 8). Figure 7, age 8+ scallops, represents the remnants of the 1985 and 1986 year classes (which accounted for the high landings in the early 1990s). The greatest abundance of these older scallops is seen in the area off Hampton, in the Inside Zone. The outside area off Centreville (Fig. 8) which also supports a high abundance of recruited scallops is generally not fished because of the stringy nature and watery condition of the meats there.

The average number of scallops per tow according to shell height intervals is shown in figure 9A for the Inside (0 - 6 miles) and Outside (6 - 16 miles) Zones. Although abundance is low everywhere, there is evidence of recruitment (ages 2 and 3, shell height 10 - 40 mm), especially in the Inside Zone. The greater number of larger animals in the Outside Zone is apparent. The changes in shell height frequency distribution from the survey, over time are

illustrated in figure 9B.

Figure 10 shows the number of live scallops caught, versus the number of clappers (dead paired shells), by area and zone. Large numbers of small scallops are seen in the inside area off Centreville, Gullivers Head, and Digby, with small numbers off Delaps Cove, and few or none north of that. Pre-recruits were also seen in the Outside Zone off Gullivers Head, Digby, Delaps and to some extent Parkers Coves, but none north of Parkers. Of particular concern are the numbers of clappers amongst the pre-recruit sizes. Relatively large numbers of clappers were observed in the Inside Zone off Gullivers Head, Digby Gut, Delaps Cove, and in the Outside Zone off Digby. In the Outside Zone, the number of pre-recruit size clappers exceeds the number of live animals in a similar size group. In all cases the clappers appear in a smaller size mode than the living animals suggesting that they may have died in the spring. Fishermen have commented on the presence of the red (or blood) starfish (*Henricia* sp.) amongst the small scallops off Delaps Cove, which may account for the high mortality in this area.

The number of empty tows encountered during the survey has increased from 1991 to 1995 (Table 14). The number of tows capturing less than 50 scallops has also increased (Table 14) marking the decline of the stock. There is little change in these values from 1994 to 1995 and the largest change appears between 1992 and 1993 (Table 14).

Fishing mortality (F) was calculated for each zone (1988-1995) from the survey numbers. From 1988 to 1992 all animals were included; from 1992 to 1995 only recruited scallops over 80 mm were included (essentially tracking the large 1985 and 1986 year classes as they entered the fishery, excluding small animals excludes subsequent recruitment):

	Outside Zone		Inside Zone	
Year	Z	F	Z	F
1988-1989	0.67	0.57	0.72	0.62
1989-1990	0.66	0.56	1.21	1.11
1990-1991	0.30	0.20	0.70	0.60
1991-1992	0.18	0.08	0.27	0.17
1992-1993	0.37	0.27	0.13	0.03
1993-1994	0.29	0.29	0.37	0.27
1994-1995	0.20	0.10	0	0

Average fishing mortality through this timeframe was 0.28 for the Outside Zone (Z=0.38), assuming a natural mortality of 0.1. In 1990 natural mortality was higher than normal in the Inside Zone, and so the average F for the Inside Zone (0.54) was calculated for the years 1990 to 1994 inclusive. F was higher than average from 1988 to 1990 in both zones. In 1995 there was no detectable fishing mortality in the recruited scallops in the Inside Zone (due to closure) and 0.10 in the Outside Zone.

Buyers Data - A New Data Source?

Scallops are purchased at the wharf and the price is based on a wharf count. If the scallop size is not uniform, the buyer will then pass the meats through a grader and sort them into different size classes. The scallops are then put into scallop bags according to grade, weighed and resold. Price is determined by grade, with the price of small scallops over 50 per pound being fairly steady.

Data from graded samples were obtained from an anonymous scallop buyer. This company buys from five vessels, and in 1995 approximately 75% of the meats purchased were

graded on an Abco Scallop Grader (Liverpool, N.S.). This grader has five different hole sizes grading 10-19, 20-29, 30-39, 40-49 and 50-59 meats to the pound. Meats passing through the 50-59 grade can be smaller than this grade, and so a random count is done to label the final mix. At certain times of the year, the meats will weigh more for a given size. This cycle is anticipated and the size grade labels are adjusted accordingly by a random count. The weight in pounds is recorded for each size grade. This data, by purchase, was provided for 1995. The number of pounds of meat for each grade class, by month is shown in figure 11. Overall, larger meats (10 to 30 meats per pound) were purchased throughout the year (Fig. 12). The change in the meat count to 45 meats per pound (50 meats per 500 g) was introduced in July, and it seems to have reduced the number of meats in the 50-60 count grade and eliminated the small scallops in the 60-70 and 70-80 size classes (Fig. 11). When this data is viewed by month (Fig. 13) there is no obvious change in the catch before and after the change in the count in July. However, the magnitude of such an effect would depend upon fishing location. With few small scallops currently available in the Bay, it may be sometime before the effectiveness of the count can truly be evaluated.

In general, the information from the buyers provides an interesting comparison to the port sampling data. Differences between buyers may also provide insight into the targeting practices of the fleet.

Virtual Population Analyses

A virtual population analysis (VPA; c.f. Mohn 1994) was used to produce matrices of population numbers, biomass and fishing mortality-at-age over time (c.f. Mohn and Cook 1993). These matrices were produced for the outside fishing zone for the years 1983-1995. The Inside Zone was not analyzed as it was closed for most of the year. A detailed VPA of both the Inside and Outside Zones was presented in Kenchington et al. 1995a. Various analytical options were tested in that paper and the optimal approach was the one adopted here.

Height frequency distributions were converted to age frequency distributions through the use of mean height-at-age data (cohort slicing) rather than by use of an age-height key (Mohn 1994). A non-linear least squares (NLLS) algorithm was used to tune the VPA population estimates against the survey estimates. Further iterations are run to refine the estimates of year-class strength and the minimum residual sum of squares from six separate runs determined the optimum solution (Mohn 1994).

The survey data is recorded in shell height frequencies (Fig. 14) and data from the commercial fishery is recorded as a meat weight frequency. The catch-at-weight was converted to a catch-at-height (Fig. 15) using a quarterly regression model standardized to height-at-the-second-quarter (April-June), as the research vessel survey is done in June (Kenchington et al. 1995a). The standardization of shell heights was done with regressions of mean height-at-age for the second quarter versus quarters 1, 3 and 4 as reported in Kenchington et al. 1995a (no new ageing data was available for this area).

Other input parameters to the VPA are selectivity (partial recruitment), mean and standard deviations of size-at-age, natural mortality (M), fishing mortality in the final year (F_{last}), and fishing mortality for the oldest age-class (F_{old}) or terminal F.

The fishing mortality parameters are tuned iteratively within the VPA (Mohn and Cook 1993). The fishing mortality for the oldest age-class (F_{old}) was set to 0.3, and F_{last} was set at 0.1, to begin the iterations.

Initial selectivity was that of the gear (Kenchington et al. 1995a), selectivity was subsequently calculated from the VPA fishing mortality estimates and re-entered into the VPA to tune this parameter (Kenchington et al. 1995a). This was done by averaging F-at-age for 1992-1995, after first normalizing to the highest value within each year to turn them into selectivity

vectors, and also to remove the effects of inter-annual variations in F. The resulting average vector was then normalized to it's highest value to form a selectivity vector.

The mean size-at-age was calculated from aged sample data (Kenchington et al. 1995a), and the standard deviations around these means were estimated for three groups of ages, 1-4, 5-10 and 11+.

The percentage of clappers (Cl) in the catch was converted to a natural mortality estimate (M) by the formula: $Cl=1-e^{-M}$ (Kenchington et al. 1995a). Natural mortality for 4, 5 and 6 year-old scallops in 1989, and 5, 6, and 7 year-old scallops in 1990, was set at 0.9 (determined from size-specific clapper percents of approximately 60%).

The VPA tunes survey catchability (q) and year-class strength using a subset of ages (Mohn 1994). Analyses were performed using data tuned on ages 4-7 (Kenchington et al. 1995a).

Regressions of the sliced research survey biomass against the VPA model biomass for both the whole population and just with the ages used for tuning (4-7) and regressions of CPUE against the biomass of animals over the age of 3 calculated from the VPA were performed. A retrospective analysis of the VPA results was calculated by sequentially removing data over the last eight years (1995-1989).

Results

The resulting selectivity-at-age vector for 1995 was: 0, 0, 0.000731, 0.106208, 0.669044, 1, 0.74105, 0.548735, 0.445621, 0.243646, 0.259664, 0.897449. The estimated catchability coefficient (q) for ages 4, 5, 6 and 7 were: 0.000111966, 0.000212858, 0.000324217, and 0.000435621, respectively. The parameter estimates for the estimated F-at-age in the terminal year (ages 6 and 7), from explicitly tuning the fully selected F in the terminal year, along with their standard errors and coefficient of variation were:

	Est.	Parameter	S.E.	C.V.
Age 6	1	0.473049	0.185859	0.392896
Age 7	2	0.373498	0.161236	0.431692

Sliced catch, survey and VPA population numbers and biomass, fishing mortality-at-age, and the residuals calculated for the tuning ages are shown in Table 15. As previously (Kenchington et al. 1995a), the tuning for year-class strengths in the outside zone VPA did not result in an improvement over slicing, as the best residuals were obtained with the initial sliced data.

Fishing mortality was high (over 0.70) in 1987 on the 8 year-old scallops, and in 1991 on scallops 7 years old (Table 15). The later suggests directed fishing on the large year-class (since it was not uniformly distributed over the grounds), and it can be seen that this year-class has supported the fishery in this area through to the present. 1991 had the highest average fishing mortality of all years surveyed. During the last two years the highest fishing mortality has been on the 6 and 7 year olds with fishing mortality of 0.40-0.48. Average fishing mortality for ages 4 to 7 scallops was 0.30 in 1995. This is higher than the F calculated from the survey catches (0.10, see Research Vessel Surveys above).

Figure 16 illustrates the correspondence between the VPA numbers and those from the q-corrected survey results. The main divergence between the two estimates appears in 1989, where the VPA estimates are much greater than those found in the survey. Since we know from the survey, that the large 1984 year-class was present in 1988 and that the die-off did not occur until 1989, we believe that the survey underestimates the population for this year. Kenchington et al. (1995a) showed that the distribution of 1989 survey stations was inadequate to sample the large

1984 year-class. In 1988, the VPA numbers are less than those of the survey. An examination of the VPA population and survey numbers-at-age (Table 15) shows that in the VPA estimates there is a misallocation of the large year-class, age 4 in 1988, into the age 5 numbers for that year. This would case the model to underestimate the numbers at age 4-7 (Fig. 16).

A regression of the sliced research survey versus VPA biomass, calculated over all ages, is shown in figure 17. R^2 was significant ($P< 0.05$). The slope of the regression is largely determined by the 1988 and 1989 data points. The 1983 and 1988 data points have the largest residual from this regression line. The 1983 data point is the first in the series, and survey data at this time did not cover the area considered in the VPA. In 1983 survey stations were concentrated in the Core Area off Digby, giving an overestimate of abundance with aerial expansion of the data. The large residual in the 1988 data point may be associated with the uncertainties of the 1989 survey estimate (see above), we believe that "true" regression line would be closer to the 1988 point. When just the biomass from the scallops in the tuning ages (4-7) is used, the 1988 point remains well above the regression line, which is significant at $P=0.01$ (Fig. 18). The 1989 point is on the regression line. The line is largely determined by these two points, neither of which we believe to be accurate. If our reasoning is correct, the 1989 point should be higher and the 1988 point should be further to the right.

The regression of VPA biomass of animals aged 3 or greater against CPUE (Fig. 19) is highly significant ($P<0.01$). The close agreement between VPA biomass and CPUE lends support to the accuracy the VPA estimates. The regression of sliced research survey biomass against CPUE (Fig. 19) is also highly significant, however there is a slightly lower R^2 value. However, once again, the extreme biomass estimates of the 1988-1990 period drive the regression.

Retrospective analysis (Fig. 20) of the data shows that biomass estimates are stable, with the exception of years 1988 and 1989, for reasons discussed above. The analysis shows that error in the current year appears to result in an underestimate of biomass, which would result in a conservative stock estimate. Fishing mortality estimates for the current year are also relatively stable, except for the years 1990 and 1991. This may be due to the large changes in F-at-age associated with targeting. In 1990 and 1991 our estimates of F would have been too high. This again would result in conservative advice.

Catch Projections and Yield-per-Recruit Analyses

Catch projections (Mohn and Cook 1993) were made for the 1996 stock based on the standing stock in 1995, as determined from the VPA model. The population matrices produced by the VPA were projected forward to the start of the following year (1996). Projected catch for 1996, fishing at $F_{0.1}$ and F_{max} levels, were produced using a Thompson-Bell yield-per-recruit model with meat weight-at-age and the 1995 selectivity, calculated from the VPA, as input.

The resultant values are $F_{0.1}=0.23$ and $F_{max}=0.35$. The 1996 catch projection for the Outside Zone based on these values results in yields of 213 mt fishing at $F_{0.1}$ and 311 mt fishing at F_{max}.

1995 Landings By Statistical District ,Vessel Size Class and Month

The total catch landed in the Bay of Fundy in 1995 by all license types was approximately 1533 mt. Eighty percent of this was harvested by the Full Bay License holders, and fifty-two percent of this was landed in Digby by the vessels over 25.5 G.T. The Digby landings represent an increase of 15% over 1994.

The 1995 landings in the Upper Bay are provided by month in Table 16. Total landings were approximately 23 mt, with 86% of this being landed by small vessels (under 25.5 G.T.). In

1995 landings were reported for all months except December. Landings are generally harvested from resident stocks.

In 1995, landings for the southwest New Brunswick area, including Grand Manan (District 50) were approximately 230 mt (Table 17). A large area south of Grand Manan is closed from April 1 to the second Tuesday in January by variation order. The effect of this closure is seen in the landings from the smaller vessels which largely fish these beds. Landings by the larger vessels in District 50 continue throughout the year but are highest in the first half.

The landings for Statistical Districts 48 and 49 (Saint John and surrounds, Table 18) were approximately 79 mt. Most of these landings were in District 49, and by vessels under 25.5 G.T. Combined landings of Districts 48 to 53 were approximately 309 mt.

Landings in Statistical Districts on the Nova Scotia side of the Bay of Fundy are shown in Tables 19 and 20, and detailed in this document and in Kenchington and Lundy (1996). In contrast to other Statistical Districts, landings in these areas are almost exclusively by vessels over 25.5 G.T.

Annual Trends in Landings By Statistical District and Vessel Size Class (1986-1995)

Statistical District 52 (Charlotte Co.) was the only District to show an increase in landings in 1995 compared to 1994. This increase was seen in the under 25.5 G.T. vessel landings. Annual landings in the Upper Bay Districts (Districts 40, 44, 79, 24) are illustrated in figure 21. Most of the landings in these Districts since 1986 are reported by small vessels under 25.5 G.T., however, in 1989, landings from the larger vessels begin to appear. Landings by the over 25.5 G.T. vessels in the Upper Bay declined again by 1994 and were negligible in 1995 except in District 40 (Fig. 21).

Annual landings in the Grand Manan area and surrounds are shown in figure 22. In contrast to the Upper Bay, landing pattern by vessel size has shifted during the period of 1986-1995. In Grand Manan itself (District 50), small vessels contributed most to the catch from 1986 to 1988. Since 1988, most of the landings have been by over 25.5 G.T. vessels. This pattern is also seen in District 53, beginning in 1991, but 1995 saw a shift back to small boats landing the majority of the catch. In District 51 large vessels dominated the catch from 1988 to 1991, however from 1992 small vessels have landed more in this area. In District 52, small vessels have consistently dominated the catch since 1986, however the total amount landed in this District is small relative to Districts 50, 51 and 53.

The annual landings by vessel size class from 1986 to 1995 for the Saint John area (Districts 48, 49) are shown in figure 23. Smaller vessels contribute most to the landings. Landings in District 48 peaked in 1989 and 1990 as the result of an exceptionally strong year class reaching the legal size limit in this area. These landings have since declined to just above 1986 and 1987 levels. In District 49 landings peaked in 1993 and remain high. Landings for the combined area peaked in 1989 and 1990 at 735 mt, but are currently at approximately 309 mt, a level consistent with landings reported by Robert and Lundy (1987) from 1981 to 1985.

Annual landings for the Digby area, including Digby Neck, (District 37, 38, 39) are shown in figure 24. Large vessels have consistently dominated the catch in this time series. Some landings by small vessels were reported in 1989 from the Parker's Cove area (District 39). Landings in District 38 (Digby) have declined steadily since the peak in 1989, while landings in Districts 34 and 36 (Meteghan, Yarmouth, Fig. 24) have increased sharply from 1991 to 1993 and 1994 respectively. Both of these areas have seen a decline in 1995. These landings reflect the heavy exploitation by the Digby fleet, of the grounds in the Brier Island and Lurcher Shoal areas beginning in 1990 (Kenchington et al. 1995a).

Relationship Between Landings and Value By Fleet Sector (1986-1995)

Although the District landings show trends by geographical area and vessel size class, the performance of each fleet sector can only be estimated from these data. Figure 25 illustrates the landings and revenue by each fleet sector. Recently, market price for Bay of Fundy scallops has been determined by size, with larger meats demanding the highest price. Thus the relationship between landings and revenue is not strictly one of amount caught versus dollar paid, as size of the product is factored into the value.

Landings and revenue for the Full Bay fleet peaked in 1989 and then fell in 1990 and 1991. Prior to 1992 revenue followed the landing pattern, however in 1992 market prices began to increase and in 1994 revenue was at its second highest value. In 1995 revenue fell sharply as a result of lower landings, although the price has remained high. The volume decrease was largely noted in the fall. Landings and revenue were also linked in the Mid Bay fleet statistics until 1992, however revenue peaked in 1993. Revenue earned by this fleet also fell sharply in 1995. A similar pattern is seen in the Upper Bay fleet with the decline in revenue beginning in 1994 and continuing to 1995. Overall, revenues and landings in 1995 have dropped dramatically (Table 21). A full account of the economic performance of the fleet from 1986 to 1993 can be found in Digou (1994).

Prognosis

Landings and revenue in the Bay of Fundy fell by approximately 33% in 1995. Prices remained high in 1995 as in 1994, and the drop in revenue is attributed to the fall in landings. Abundance on the Digby grounds continues to be very low and CPUE is the lowest on record in this area. The 1994 and 1995 surveys detected more pre-recruits than had been seen in recent years (since 1990), however, the magnitude and distribution (not seen above Delaps Cove) of pre-recruits in the Digby area is not comparable to the large numbers seen from 1986-1989. There were also a high number of clappers in some areas as a result of starfish predation. These animals may serve to sustain the fishery in this area for a short time, but they can easily be fished out in one year. The closed area off Digby served to protect (from growth overfishing) these two small incoming year classes and approximately 70 mt of the broodstock (see Fishery Data above). The low abundance in this bed will have implications throughout the Bay of Fundy as effort is increased on other beds.

The bulk of the 1995 landings was harvested below Brier Island (Kenchington and Lundy 1996). These beds have now been largely fished down, and there is no sign of a strong recruitment pulse to the area. Landings in 1996 are expected to decline further. The future of the fishery depends on the protection of incoming year classes and the prevention of growth and recruitment overfishing.

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

Year	(1)	(2)	(3)	% log compliance	% of logs Class 1	% of logs Class 1-3,5
1981	99	68	65	95.6	n/a	n/a
1982	107	66	63	95.5	n/a	n/a
1983	115	77	74	96.1	n/a	n/a
1984	106	82	76	92.7	n/a	n/a
1985	96	70	67	95.7	n/a	n/a
1986	96	67	57	85.1	n/a	n/a
1987	95	80	44	55.0	n/a	n/a
1988	98	91	16	17.6	n/a	n/a
1989	98	96	14	14.6	n/a	n/a
1990	99	94	13	13.8	81.3	97.1
1991	99	91	26	28.6	71.3	97.7
1992	99	90	44	48.9	67.8	95.7
1993	99	99	63	63.6	55.7	96.3
1994	99	92	80	86.9	50.4	99.8
1995	99	94	72	76.6*	54.5*	99.5*

*preliminary

Table 2. Number of Full Bay of Fundy scallop licenses and additional licenses carried from 1981-95. Source: Licensing Unit, Resource Allocation and Licensing Branch, DFO, Halifax

Year	Scallop	Groundfish	Squid	Herring	Lobster	Shrimp	Swordfish	Crab	Mackerel	Salmon
1981	99	81	12	36	23	3	5	-	4	1
1982	107	86	12	32	20	2	6	1	1	1
1983	115	91	15	30	20	3	7	-	1	1
1984	106	79	13	30	16	1	7	-	3	-
1985	96	73	12	25	12	2	7	-	2	-
1986	96	74	12	26	10	3	30	-	1	-
1987	95	73	12	17	9	3	45	-	1	-
1988	98	68	12	17	8	3	50	-	1	-
1989	98	61	13	13	4	2	47	-	-	-
1990	99	61	12	9	7	2	42	-	-	-
1991	99	64	13	9	6	2	32	-	-	-
1992	99	61	12	9	4	2	27	-	-	-
1993	99	59	11	9	4	2	25	-	-	-
1994	99	58	11	9	4	2	24	-	-	-
1995	99	54	12	11	4	1	27	-	1	-

Table 3. Number of Bay of Fundy scallop licenses with 'n' additional licenses from 1981-94. Source: Licensing Unit, Resource Allocation and Licensing Branch, DFO, Halifax

	Number of Additional Licenses						
Year	0	1	2	3	4	5	# Scallop Lic.
1981	12	35	31	17	4	-	99
1982	16	38	40	10	3	-	107
1983	20	41	39	12	3	-	115
1984	21	41	28	12	4	-	106
1985	19	37	28	8	4	-	96
1986	10	38	31	13	3	1	96
1987	8	34	39	10	2	2	95
1988	12	33	38	11	3	1	98
1989	16	38	33	9	1	1	98
1990	19	42	27	9	1	1	99
1991	25	36	28	8	1	1	99
1992	29	38	22	8	1	1	99
1993	31	39	19	8	1	1	99
1994	31	40	18	8	1	1	99
1995	28	44	16	8	2	1	99

Table 4. Estimated Catches (mt) of Scallop Meat Derived from Percentages of Log Information from Each Zone Applied to the Statistics Branch Sales Slip Landings. Shading Indicates Portion of the Data Set Used for VPA

Year	< 6 mi.	6-15.9 mi.	> 16 mi.	German /Lurcher	Brier Island	Georges Bank	Browns Bank	Total (mt)
1980	320.4	231.2	6.8	108.5	163.3	0.0	46.9	877.3
1981	436.7	197.4	14.5	246.5	240.4	288.7	25.5	1,449.6
1982	489.8	234.3	19.2	150.4	203.6	0.8	8.8	1,106.9
1983	404.7	378.4	24.3	42.0	45.8	0.0	0.0	895.2
1984	313.1	318.2	25.8	37.9	28.5	0.1	0.0	723.6
1985	272.8	382.9	22.3	1.9	12.7	14.5	4.6	711.6
1986	99.0	145.4	2.9	59.6	3.6	194.1	61.1	566.3
1987*	214.6	209.0	0.9	1.6	0.0	696.6	0.0	1,122.7
1988	1,901.1	1,103.5	0.0	0.0	0.0	8.4	0.0	3,013.0
1989	1,454.8	1,775.2	694.0	0.0	0.0	0.0	0.0	3,924.0
1990	480.9	744.2	1185.9	0.0	0.0	0.0	0.0	2,411.0
1991	595.7	579.3	195.1	189.5	261.5	0.0	0.0	1,821.0
1992	329.2	392.5	403.4	458.8	368.1	0.0	0.0	1,952.0
1993	191.7	339.7	392.5	568.6	422.4	0.0	0.0	1,916.0
1994	134.6	226.8	100.8	661.9	719.6	0.0	0.0	1,844.0
1995†	71.6	219.3	165.9	353.9	413.5	0.0	0.0	1,231.0

* In September 1986 the Inshore/Offshore Agreement between fleet sectors formally restricted the inshore fleet from fishing below latitude 43°40' N. The phase in period allowed the inshore fleet 548 mt from Georges Bank in 1987.

† Data for 1995 is preliminary.

Table 5. Breakdown of the Commercial Landings of the Full Bay Licence Holders into Metric Tonnes of Meats Landed by Area by Quarter of the Year. Shading Indicates Portion of the Data Set Used for VPA Analyses

Area	Jan.-March	April-June	July-Sept.	Oct.-Dec.	Year
< 6 miles	70	92	2	156	1980
	144	71	16	206	1981
	134	65	29	262	1982
	108	93	31	173	1983
	85	66	27	134	1984
	63	70	32	108	1985
	43	15	6	35	1986
	0	0	1	213	1987
	437	196	11	1,256	1988
	888	308	3	256	1989
	32	67	101	281	1990
	209	125	55	207	1991
	85	66	9	169	1992
	44	32	12	104	1993
	20	9	16	90	1994
	53	16	2	1	1995
6-15.9 miles	5	130	91	6	1980
	6	70	113	8	1981
	2	82	139	12	1982
	5	186	177	11	1983
	13	112	154	39	1984
	31	163	184	4	1985
	23	64	56	3	1986
	45	54	82	27	1987
	40	230	787	47	1988
	122	644	734	275	1989
	160	254	140	190	1990
	131	181	178	90	1991
	89	143	95	65	1992
	51	107	108	73	1993
	42	38	98	49	1994
	69	63	57	31	1995
> 16 miles	3	3	0	1	1980
	1	5	7	2	1981
	1	1	7	11	1982
	3	9	5	8	1983
	5	3	11	7	1984
	2	4	14	3	1985
	1	1	1	0	1986
	0	1	0	0	1987
	0	0	0	0	1988
	290	135	38	231	1989
	501	374	309	2	1990
	36	66	66	26	1991
	119	120	102	63	1992
	109	133	74	76	1993
	28	16	38	19	1994
	68	49	22	26	1995

Table 6. Catch (mt), Effort (hours) and CPUE (kg/hour) for (A) the Inside (< 6 mile) and (B) the Outside (6-15.9 mile) Scallop Fishing Zones, Off Digby. CPUE is Calculated From Class 1 (complete) Log Data

(A) Inside Zone (< 6 miles)

Year	Class 1 Catch (mt)	Class 1 Effort (h)	CPUE (kg/h)	Total Catch (mt)	Total Effort (1000 h)
1976	34.8	1,387	25.81	-	-
1977	150.5	3,592	47.75	-	-
1978	193.3	4,566	47.49	-	-
1979	189.1	4,981	42.06	-	-
1980	261.6	6,336	44.71	320.4	7,166
1981	321.3	7,654	44.54	436.7	9,805
1982	369.4	9,870	39.86	489.8	12,288
1983	293.5	11,936	27.28	404.7	14,835
1984	260.7	14,438	19.92	313.1	15,718
1985	198.1	14,544	14.47	272.8	18,853
1986	55.3	5,070	11.51	99.0	8,601
1987	40.2	438	111.78	214.6	1,920
1988	165.0	1,887	91.44	1,901.1	20,791
1989	112.3	1,489	81.80	1,454.8	17,785
1990	57.9	1,965	30.66	480.9	15,685
1991	107.0	4,024	28.55	595.7	20,865
1992	102.8	5,653	18.75	329.2	17,557
1993	52.3	3,762	14.73	191.7	13,014
1994	45.2	3,934	11.84	134.6	11,368
1995	22.0	2,103	10.60	71.6	6,755

(B) Outside Zone (6-15.9 miles)

Year	Class 1 Catch (mt)	Class 1 Effort (hm)	CPUE (kg/h)	Total Catch (mt)	Total Effort (1000 hm)
1976	17.7	925	23.80	-	-
1977	118.5	4,005	33.41	-	-
1978	162.8	5,809	33.15	-	-
1979	142.7	6,143	26.21	-	-
1980	189.7	6,059	33.85	231.2	6,830
1981	146.8	5,017	33.13	197.4	5,958
1982	176.8	5,605	34.96	234.3	6,702
1983	257.0	13,471	20.97	378.4	18,045
1984	259.3	17,648	17.07	318.2	18,641
1985	276.3	21,900	13.71	382.9	27,929
1986	78.4	7,029	11.69	145.4	12,438
1987	50.8	3,064	22.46	209.0	9,305
1988	89.6	2,831	36.83	1,103.5	29,962
1989	143.6	3,305	47.71	1,775.2	37,208
1990	79.9	2,582	32.85	744.2	22,654
1991	84.9	4,121	20.82	579.3	27,824
1992	99.9	5,806	18.40	392.5	21,332
1993	103.6	7,981	13.76	339.7	24,688
1994	59.9	5,615	11.23	226.8	20,196
1995	49.7	5,851	8.75	219.3	25,063

Table 7. Breakdown of the Commercial Catch Samples into Number of Samples, Number of Vessels and the Percentage of Samples from 2, 3, and 4 Vessels by Year

Year	# samples	# vessels	% samples from 2 vessels	% samples from 3 vessels	% samples from 4 vessels
1983	131	12	44.3	59.5	71.8
1984	327	16	32.1	41.6	49.8
1985	247	17	41.7	53.0	61.1
1986	170	17	42.4	52.9	61.2
1987	105	16	32.4	41.9	49.5
1988	235	12	27.2	39.6	50.6
1989	255	15	30.6	43.5	55.7
1990	156	14	32.7	44.2	52.6
1991	108	12	36.1	51.9	63.0
1992	211	19	25.6	34.6	43.6
1993	334	29	34.1	49.7	57.5
1994	167	14	32.3	47.9	58.1
1995	104	9	58.7	77.9	85.6

Table 8. Breakdown of the Commercial Catch Samples into Number of Scallop Meats Sampled by Area, Brackets Indicate the Number of Samples. Shaded Area Identifies the Data used to Calculate the VPA for the"Outside" Zone

Year	< 6 miles	6-15.9 miles	> 16 miles	Brier Island	Unknown	Total
1983	0(0)	9663 (124)	0 (0)	191 (2)	427 (5)	10281 (131)
1984	4061(82)	19541 (232)	1372 (11)	0 (0)	131 (2)	25105 (327)
1985	1332 (30)	16038 (202)	1432 (13)	0 (0)	213 (2)	19015 (247)
1986	1809 (30)	12768 (124)	1905 (15)	0 (0)	112 (1)	16594 (170)
1987	3215 (29)	8463 (70)	623 (5)	0 (0)	117 (1)	12418 (105)
1988	5703 (65)	22847 (170)	0 (0)	0 (0)	0 (0)	28550 (235)
1989	2561 (36)	19786 (169)	8070 (49)	0 (0)	164 (1)	30581 (255)
1990	1448 (31)	8899 (95)	2183 (16)	57 (1)	1290 (13)	13877 (156)
1991	573 (16)	4861 (66)	634 (5)	1905 (15)	501 (6)	8474 (108)
1992	3444 (63)	4490 (61)	4876 (53)	2957 (34)	0 (0)	15767 (211)
1993	4236 (76)	10272 (145)	5378 (67)	3298 (37)	776 (9)	23960 (334)
1994	1534 (22)	3275 (46)	2068 (29)	4630 (70)	0 (0)	11507(167)
1995	378 (7)	2950 (37)	3242 (47)	909 (13)	0 (0)	7479(104)

Table 9. Breakdown of the Commercial Catch Samples into Number of Meats Sampled by Area by Quarter of the Year. Shading Indicates Portion of the Data Set Used for VPA Analyses

Area	Jan.-March	April-June	July-Sept.	Oct.-Dec.	Year
< 6 miles	0	0	0	0	1983
(regulated)	0	1418	443	2,200	1984
	0	440	83	809	1985
	0	287	324	1,198	1986
	0	0	0	3,215	1987
	0	1,185	0	4,518	1988
	0	103	656	1,802	1989
	0	95	212	1141	1990
	0	0	0	573	1991
	0	0	389	3,055	1992
	2,116	300	131	1,689	1993
	447	0	0	1,087	1994
	378	0	0	0	1995
6-15.9 miles	0	5,016	4647	0	1983
	0	9411	10130	0	1984
	0	5731	10,307	0	1985
	0	4,564	7,659	545	1986
	0	686	5,627	2,150	1987
	0	8,433	14,063	351	1988
	0	10,609	9177	0	1989
	0	2828	5873	198	1990
	0	2,475	2,215	171	1991
	0	268	1,702	2,520	1992
	3657	3,250	1,826	1,539	1993
	841	816	1,508	110	1994
	509	876	1050	515	1995
> 16 miles	0	0	0	0	1983
	0	206	1,166	0	1984
	0	270	1,162	0	1985
	0	1,201	704	0	1986
	0	359	264	0	1987
	0	0	0	0	1988
	0	107	7,963	0	1989
	0	574	1,609	0	1990
	0	365	269	0	1991
	0	0	2,760	2,116	1992
	2,051	1,826	1,171	330	1993
	0	1231	837	0	1994
	689	468	805	1280	1995

Table 10. Meat weight (g) statistics by month (1-12) and year (19xx) for the Regulated Inside Zone off Digby, calculated from port samples of the commercial catch

Year	Month	n	Mean (g)	s.d.	Min.	Max.	Meat Count no. of meats/500g
91	10	573	28.10	9.69	7.58	57.03	17.8
92	7	310	9.49	2.59	3.40	21.80	52.7
92	9	79	29.75	9.97	9.10	55.90	16.8
92	10	1533	18.62	9.16	3.90	66.20	26.8
92	11	953	23.99	12.74	5.00	79.50	20.8
92	12	569	26.98	11.07	4.30	62.50	18.5
93	1	848	20.38	10.75	2.30	54.90	24.5
93	2	440	13.62	7.76	4.30	52.70	36.7
93	3	828	14.55	6.62	4.90	41.20	34.4
93	4	49	22.29	7.88	5.80	37.20	22.4
93	5	251	14.96	4.05	5.40	26.60	33.4
93	7	131	12.95	5.81	5.90	31.80	38.6
93	10	882	21.94	8.84	6.80	57.40	22.8
93	11	444	25.55	8.42	8.30	50.60	19.6
93	12	363	21.07	7.60	8.00	40.90	23.7
94	1	94	22.96	8.27	8.70	40.40	21.8
94	2	353	17.01	8.44	6.20	44.30	29.4
94	10	523	14.83	6.84	4.50	46.30	33.7
94	11	59	17.34	3.39	11.20	28.40	28.8
94	12	505	13.88	6.43	4.60	36.80	36.0
95	1	89	36.73	10.37	15.10	63.50	13.6
95	3	289	15.81	7.23	5.00	41.40	31.6

Table 11. Meat weight (g) statistics by month (1-12) and year (19xx) for Outside Zone off Digby (6-16 miles), calculated from port samples of the commercial catch

Year	Month	n	Mean (g)	s.d.	Min.	Max.	Meat Count no. of meats/500g
91	5	1992	13.14	4.14	3.80	31.98	38.1
91	6	483	10.36	5.77	2.11	35.54	48.3
91	7	746	14.79	4.69	3.82	35.86	33.8
91	8	791	14.08	4.45	4.04	29.37	35.5
91	9	678	14.84	6.23	4.36	37.65	33.7
91	10	171	17.60	5.52	5.98	36.93	28.4
92	6	268	11.32	4.18	3.50	25.40	44.2
92	7	224	8.68	2.45	3.00	15.20	57.6
92	8	495	16.07	5.37	4.90	40.80	31.1
92	9	983	14.87	7.06	3.30	49.90	33.6
92	10	988	15.38	7.91	3.50	45.60	32.5
92	11	896	16.48	8.54	4.80	43.80	30.3
92	12	636	15.52	8.11	4.10	48.10	32.2
93	1	1174	15.74	7.60	5.00	39.20	31.8
93	2	1095	17.18	7.24	4.20	46.90	29.1
93	3	1388	15.67	5.16	3.80	39.60	31.9
93	4	787	15.49	7.86	1.30	50.20	32.3
93	5	1271	11.87	5.84	2.60	31.20	42.1
93	6	1192	14.08	6.43	3.20	62.60	35.5
93	7	903	14.85	5.11	4.60	34.00	33.6
93	8	332	15.62	4.41	6.50	36.20	32.0
93	9	591	12.77	5.74	4.70	45.40	39.2
93	10	692	17.74	6.78	5.20	44.00	28.2
93	11	717	18.40	7.00	5.40	45.80	27.2
93	12	130	15.96	6.78	6.90	33.90	31.3
94	1	265	15.38	7.60	4.70	45.80	32.5
94	2	41	24.06	3.69	18.70	29.80	20.8
94	3	535	16.08	7.28	5.10	54.80	31.1
94	4	500	13.65	4.69	5.20	31.70	36.7
94	5	316	13.95	4.50	3.80	27.50	35.8
94	7	724	15.42	5.81	4.20	39.60	32.4
94	8	384	14.12	5.28	4.10	31.30	35.4
94	9	400	17.83	5.91	5.90	40.70	28.0
94	11	47	25.38	8.87	9.60	47.20	19.7
94	12	63	17.39	6.12	5.00	30.30	28.8
95	1	140	16.32	13.08	3.50	57.40	30.6
95	2	199	22.38	12.09	4.10	53.00	22.3
95	3	170	15.45	7.77	4.50	36.00	32.4
95	4	270	13.78	5.04	3.40	31.20	36.3
95	5	606	11.46	6.79	2.90	36.00	43.6
95	7	393	15.11	6.42	4.10	38.00	33.1
95	8	283	13.28	4.69	5.70	29.60	37.7
95	9	374	12.88	4.66	4.80	26.90	38.8
95	10	161	16.11	5.94	4.90	32.20	31.0
95	11	249	18.68	8.25	6.10	45.10	26.8
95	12	105	24.51	8.50	6.70	42.00	20.4

Table 12. Number of Survey Stations by Area Stratum with Fishing Zone Indicated

Area Stratum	Fishing Zone	1991	1992	1993	1994	1995
Below Core	Centreville	10	12	12	11	13
Core	Gulliver's Head	27	23	20	17	18
	Digby Gut	29	27	21	21	23
	Delap Cove	19	12	17	15	15
Above Core	Parker's Cove	3	3	10	12	11
	Young Cove	2	4	10	10	10
	Hampton	10	8	10	10	10
Total		100	89	100	96	100

Table 13. 1986-1995 stock surveys: Average number of scallops-at-age caught in a seven-gang Digby drag projected from an end, unlined bucket for recruits (age >4 years) and from a centre, lined bucket for prerecruits (age ≤4 years). Average number of scallops-at-age caught in a seven-gang Digby drag projected from the average of an end and a middle, unlined bucket for recruits (age >4 years) and from the average of an end and a middle, lined bucket for prerecruits (age ≤4 years)

	Age (years)											
	2	3	4	5	6	7	8	9	10+	Total	No. of Stations	% Clappers
Zone stratum:												
Inside 6 mile												
1986	591	186	18	10	16	17	10	9	17	874	48	2.4
1987	457	373	727	253	18	10	8	7	22	1875	38	2.2
1988	52	298	662	788	527	55	12	7	19	2420	45	34.2
1989	7	98	86	292	288	159	49	16	13	1008	59	66.5
1990	1	4	22	53	53	70	49	21	18	291	57	29.4
1991	3	4	6	15	32	29	24	17	24	154	38	11.8
1992	2	4	8	7	13	18	21	17	24	114	42	10.4
1993	5	7	5	12	15	15	15	13	31	118	38	12.5
1994	10	9	9	6	8	12	13	11	19	99	42	5.3
1995	25	6	12	15	12	9	9	7	19	114	37	10.8
Outside 6 mile												
1986	230	26	17	33	38	38	31	21	30	464	72	5.0
1987	51	355	296	31	31	26	18	11	22	841	81	4.7
1988	11	94	178	715	87	30	19	10	15	1159	59	25.3
1989	2	12	39	187	177	94	17	5	8	541	51	58.1
1990	1	8	20	71	68	53	32	13	13	279	79	28.8
1991	2	3	6	25	44	47	41	27	27	222	62	12.6
1992	2	6	14	18	38	46	33	20	25	202	48	5.2
1993	2	2	5	21	27	22	20	14	23	136	62	10.8
1994	5	15	7	11	15	21	19	13	16	122	54	9.5
1995	9	8	10	13	14	15	14	10	13	106	63	5.2

Table 14. Number of Tows Which Caught 'x' Number of Scallops in Each Category During Research Vessel Surveys (1991-1995)

	Number of Scallops / Tow			
	0	1-10	11-25	26-50
1991	3	2	0	5
1992	1	1	1	5
1993	5	4	5	7
1994	8	1	3	10
1995	6	4	3	10

	Number of Scallops / Tow			
	0	<10	<25	<50
1991	3	5	5	10
1992	1	2	3	8
1993	5	9	14	21
1994	8	9	12	22
1995	6	10	13	23

Table 15. Total Numbers of Scallops-at-Age in the Catch, Survey Data and VPA model for the Outside Fishing Zone (6-15.9 miles) off Digby. Fishing Mortality and the Residuals of the VPA Model are presented as well as Biomass-at-age estimates for the VPA and Survey

Sliced Catch Numbers-at-Age (x 10^3)

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2	0	5	19	13	22	2	23	7	11	10	1	4
4	1,090	114	864	2,308	1,146	1,814	3,214	11,328	10,645	2,923	690	821	225
5	2,924	630	4,369	5,123	4,508	4,980	7,265	71,044	82,755	19,655	5,952	6,354	3,324
6	1,962	862	8,064	6,301	7,152	3,832	6,507	43,816	69,912	20,258	10,815	8,899	5,954
7	1,451	688	7,847	5,797	6,681	2,345	2,429	9,171	26,727	13,329	10,208	6,349	3,894
8	689	448	5,145	3,631	4,542	1,333	1,283	2,536	6,931	6,835	7,134	3,288	2,750
9	412	248	2,903	2,061	2,743	632	539	1,405	2,725	3,082	4,547	2,020	2,105
10	158	118	908	803	1,176	180	192	696	986	959	1,577	831	1,211
11	116	88	662	592	872	131	141	519	725	699	1,157	615	908
12	420	889	797	1,083	1,782	195	474	1,043	915	961	2,298	1,761	2,541
Total	9,223	4,085	31,565	27,718	30,615	15,465	22,045	141,581	202,329	68,712	44,388	30,940	22,915

Sliced Research Vessel Survey Numbers-at-Age (x 10^6)

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.19	0.02	0.03	5.82	0.62	0.25	0.01	0.03	0.04	0.23	0.09	0.28	0.41
2	1.54	1.30	0.65	59.65	19.61	5.06	1.40	0.60	1.01	0.46	0.49	2.20	2.65
3	3.99	2.86	1.76	5.83	118.83	45.34	4.29	2.80	0.92	2.51	0.52	3.65	2.29
4	4.90	4.01	3.70	5.02	31.34	118.60	19.88	8.04	2.59	4.02	2.16	2.24	2.91
5	10.67	7.87	7.49	8.13	8.15	99.92	49.48	19.79	7.93	6.27	7.18	2.92	3.18
6	15.29	9.99	9.19	7.17	7.68	18.09	46.98	17.31	10.29	10.24	6.54	3.38	3.97
7	15.12	9.24	10.48	7.39	6.67	2.71	20.54	12.77	10.15	10.79	5.19	4.73	3.45
8	11.87	6.61	8.10	5.58	4.22	1.84	5.21	8.12	8.67	7.64	4.65	4.03	2.95
9	8.16	4.31	5.47	3.93	2.63	1.28	1.76	4.46	6.35	4.90	3.22	2.94	1.99
10	4.44	2.65	3.14	2.02	1.39	0.83	0.71	1.80	3.15	2.54	1.87	1.79	0.85
11	3.32	1.99	2.36	1.51	1.04	0.62	0.52	1.33	2.35	1.90	1.40	1.34	0.63
12	8.54	4.90	7.04	4.62	3.33	2.50	1.81	1.81	4.74	3.99	3.02	3.63	1.87
Total	88.02	55.75	59.40	116.67	205.51	297.04	152.58	78.84	58.16	55.50	36.33	33.14	27.14

Table 15. cont'd. Total Numbers of Scallops-at-Age in the Catch, Survey Data and VPA model for the Outside Fishing Zone (6-15.9 miles) off Digby. Fishing Mortality and the Residuals of the VPA Model are presented as well as Biomass-at-age estimates for the VPA and Survey

VPA Model Numbers-at-Age (x 10^3)

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	54,349.4	334,594.8	769,372.6	1,341,369.5	232,900.6	101,846.1	53,659.8	37,812.2	20,027.1	6,381.1	13,237.2	0.0
2	51,119.6	49,177.3	302,753.9	696,157.1	1,213,721.3	210,737.1	92,154.1	48,553.4	34,213.9	18,121.3	5,773.8	11,977.5
3	38,104.9	46,254.9	44,497.5	273,943.0	629,909.0	1,098,220.5	190,682.9	83,384.5	43,932.9	30,958.0	16,396.8	5,224.4
4	33,803.1	34,476.6	41,852.7	40,257.9	247,856.1	569,952.6	993,690.0	172,535.4	75,427.1	39,745.1	28,001.7	14,826.6
5	32,235.1	29,549.9	31,087.4	37,048.3	34,231.5	223,179.0	513,988.6	401,955.1	145,341.4	58,123.3	33,182.4	24,681.0
6	24,376.7	26,386.4	26,138.7	23,972.7	28,650.0	26,685.8	197,203.1	204,339.5	118,123.2	52,791.7	33,895.7	24,362.7
7	10,624.3	20,190.6	23,055.6	15,980.1	15,697.8	19,120.7	20,500.9	76,027.8	55,140.0	40,380.3	28,497.7	20,382.7
8	10,533.0	8,233.1	17,614.5	13,397.4	8,944.8	7,849.0	15,070.5	16,239.8	25,062.9	24,469.1	23,858.4	16,075.6
9	5,935.8	8,875.2	7,023.3	11,044.0	8,668.6	3,773.5	5,833.8	12,415.8	12,282.0	16,084.5	15,639.3	14,801.7
10	3,180.4	4,978.6	7,794.6	3,593.4	8,032.8	5,234.5	2,813.7	4,766.2	9,898.0	8,520.7	11,622.2	9,826.0
11	28,668.4	2,727.9	4,392.9	6,188.7	2,487.6	6,149.3	4,565.0	2,363.4	3,650.3	8,018.3	6,797.5	9,015.9
12	3,735.9	25,829.8	2,384.9	3,345.0	5,036.2	1,421.4	5,440.0	3,996.5	1,644.6	2,613.6	6,590.6	5,050.5
Total	296,666.6	591,275.0	1,277,968.6	2,466,297.2	2,436,136.3	2,274,169.6	2,095,602.4	1,064,389.7	544,743.6	306,207.1	223,493.4	156,224.7

Fishing Mortality

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.10	-0.04
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.03	0.00	0.02	0.06	0.00	0.00	0.01	0.07	0.16	0.08	0.03	0.06	0.05
5	0.10	0.02	0.16	0.16	0.15	0.02	0.02	0.32	0.91	0.44	0.21	0.32	0.32
6	0.09	0.03	0.39	0.32	0.30	0.16	0.05	0.41	0.97	0.52	0.41	0.48	0.48
7	0.15	0.04	0.44	0.48	0.59	0.14	0.13	0.21	0.71	0.43	0.47	0.40	0.36
8	0.07	0.06	0.37	0.34	0.76	0.20	0.09	0.18	0.34	0.35	0.38	0.24	0.26
9	0.08	0.03	0.57	0.22	0.40	0.19	0.10	0.13	0.27	0.22	0.36	0.15	0.21
10	0.05	0.03	0.13	0.27	0.17	0.04	0.07	0.17	0.11	0.13	0.15	0.09	0.12
11	0.00	0.03	0.17	0.11	0.46	0.02	0.03	0.26	0.23	0.10	0.20	0.07	0.13
12	0.13	0.04	0.43	0.41	0.46	0.16	0.10	0.32	0.87	0.49	0.45	0.45	0.43
Ave 4-7	0.09	0.02	0.25	0.26	0.26	0.08	0.05	0.25	0.69	0.37	0.28	0.31	0.30

Residuals

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
4	0.32	0.09	-0.18	0.19	0.17	0.67	-1.27	-0.79	-1.05	-0.01	-0.31	0.38	1.78
5	0.54	0.29	0.25	0.16	0.24	0.81	-0.33	-0.85	-0.86	-0.41	0.17	-0.38	0.38
6	0.75	0.22	0.33	0.13	0.01	0.87	0.17	-0.69	-0.78	-0.21	-0.26	-0.56	0.01
7	1.31	0.12	0.31	0.35	0.32	-1.01	0.95	-0.40	-0.46	-0.23	-0.59	-0.38	-0.31
Ave 4-7	0.73	0.18	0.18	0.21	0.19	0.34	-0.12	-0.68	-0.79	-0.21	-0.25	-0.23	0.46

Table 15. cont'd. Total Numbers of Scallops-at-Age in the Catch, Survey Data and VPA model for the Outside Fishing Zone (6-15.9 miles) off Digby. Fishing Mortality and the Residuals of the VPA Model are presented as well as Biomass-at-age estimates for the VPA and Survey

VPA Biomass-at-age estimates (tonnes meat weight)

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.1	0.7	1.6	2.9	0.5	0.2	0.1	0.08	0.04	0.01	0.03	0	0
2	16.5	15.9	97.8	225.0	392.4	68.1	29.8	15.7	11.1	5.8	1.9	3.9	0
3	62.8	76.3	73.4	451.7	1038.7	1810.9	314.4	137.5	72.4	51.1	27.0	8.6	17.8
4	134.1	136.7	166.0	59.7	983.0	2260.5	3941.2	684.3	299.2	157.6	111.1	58.8	18.8
5	220.7	202.3	212.8	253.6	234.3	1527.7	3518.4	2751.5	994.9	397.9	227.1	168.9	86.5
6	240.2	260.0	257.5	236.2	282.3	262.9	1943.1	2013.4	1163.9	520.2	334.0	240.1	160.5
7	134.8	256.2	292.6	202.8	199.2	242.6	260.2	964.8	699.7	512.4	361.6	258.7	172.3
8	160.1	125.1	267.7	203.6	135.9	119.3	229.0	246.8	380.9	371.9	362.6	244.3	188.5
9	102.8	153.7	121.6	191.3	150.1	65.4	101.0	215.0	212.7	278.5	270.8	256.4	197.7
10	60.6	94.9	148.5	68.5	153.1	99.8	53.6	90.8	188.6	162.4	221.5	187.3	218.6
11	586.4	55.8	89.8	126.6	50.9	125.8	93.4	48.3	74.7	164.0	139.0	184.4	165.7
12	80.5	556.8	51.4	72.1	108.6	30.6	117.3	86.5	35.5	56.3	142.1	108.9	163.4
Total	1782.9	1917.8	1681.4	1966.0	3336.1	6545.6	10571.5	7238.6	4122.5	2672.3	2196.9	1716.2	1389.7

Sliced Survey Biomass-at-age estimates (tonnes meat weight)

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	19	6	2	0	0	0	0	0	1	1
3	7	5	3	10	196	75	7	5	2	4	1	6	4
4	19	16	15	20	124	470	79	32	10	16	9	9	12
5	73	54	51	56	56	684	339	135	54	43	49	20	22
6	151	98	91	71	76	178	463	171	101	101	64	33	39
7	192	117	133	94	85	34	261	162	129	137	66	60	44
8	180	100	123	85	64	28	79	123	132	116	71	61	45
9	141	75	95	68	46	22	30	77	110	85	56	51	34
10	85	50	60	39	26	16	13	34	60	48	36	34	16
11	68	41	48	31	21	13	11	27	48	39	29	28	13
12	184	106	152	99	72	54	39	39	102	86	65	78	40
Total	1100	662	770	571	765	1574	1321	806	748	675	445	380	268

Table 16. 1995 landings in metric tonnes of scallop meats by Statistical District for the Upper Bay. King's Co.: 40; Cumberland Co.: 24, 44; Albert Co.: 79. (1 indicates landings from vessels < 25.5 G.T., and 2 indicates landings from vessels ≥ 25.5 G.T.). Source: Commercial Data Division, Program Coordination and Economics Branch, DFO, Halifax

	40		24		44		79	
Month	1	2	1	2	1	2	1	2
January	0.12	-	-	-	-	-	0.36	-
February	0.24	0.12	-	-	-	-	0.24	-
March	0.24	0.36	-	-	0.36	0.12	-	-
April	0.84	0.60	-	-	-	-	2.53	-
May	0.12	0.72	-	-	0.48	0.12	1.93	-
June	0.12	-	-	-	0.48	0.12	1.57	-
July	-	-	-	-	0.60	-	1.57	-
August	0.12	0.60	-	-	0.36	-	2.29	-
September	0.12	0.24	-	-	2.05	-	1.81	-
October	-	-	-	-	0.60	-	0.36	-
November	-	-	-	-	0.24	-	-	-
December	-	-	-	-	-	-	-	-
Total	1.92	2.64	-	-	5.29	0.36	12.66	-

Table 17. 1995 landings in metric tonnes of scallop meats by Statistical District for Grand Manan and surrounds. Grand Manan: 50; Campobello: 51; Charlotte Co.: 52, 53. (1 indicates landings from vessels < 25.5 G.T., and 2 indicates landings from vessels ≥ 25.5 G.T.). Source: Commercial Data Division, Program Coordination and Economics Branch, DFO, Halifax

	50		51		52		53	
Month	1	2	1	2	1	2	1	2
January	28.92	20.12	6.99	3.37	1.33	0.36	2.41	2.05
February	14.46	7.35	6.14	1.81	1.81	-	1.81	0.24
March	18.80	14.58	2.41	0.24	2.17	-	1.08	0.72
April	5.66	11.08	0.96	-	0.36	-	0.36	0.36
May	3.01	9.64	2.05	0.96	-	-	0.48	-
June	1.69	20.84	1.20	-	-	-	0.12	-
July	1.20	8.31	0.84	-	-	-	0.84	-
August	0.60	4.82	0.96	-	-	-	0.60	-
September	2.41	2.53	0.72	-	-	-	-	-
October	1.81	3.86	-	-	-	-	-	-
November	0.12	1.20	-	-	-	-	-	-
December	-	0.72	-	-	-	-	-	-
Total	78.68	105.05	22.27	6.38	5.67	0.36	7.70	3.37

Table 18. 1995 landings in metric tonnes of scallop meats by Statistical District for Saint John and surrounds. Saint John: 48, 49. (1 indicates landings from vessels < 25.5 G.T., and 2 indicates landings from vessels ≥ 25.5 G.T.). Source: Commercial Data Division, Program Coordination and Economics Branch, DFO, Halifax

	48		49	
Month	1	2	1	2
January	0.72	-	9.52	2.89
February	0.48	-	2.53	3.37
March	-	0.24	5.54	3.98
April	0.96	0.48	7.11	4.58
May	0.48	1.20	3.37	2.41
June	-	1.08	1.45	0.72
July	0.24	0.96	2.89	0.84
August	1.08	0.96	2.77	3.73
September	0.48	0.72	2.77	3.13
October	0.84	0.60	0.72	2.41
November	-	0.12	-	0.12
December	-	-	-	-
Total	5.28	6.36	38.67	28.18

Table 19. 1995 landings in metric tonnes of scallop meats by Statistical District for Digby and surrounds. Digby: 37, 38, 39. (1 indicates landings from vessels < 25.5 G.T., and 2 indicates landings from vessels ≥ 25.5 G.T.). Source: Commercial Data Division, Program Coordination and Economics Branch, DFO, Halifax

	37		38		39	
Month	1	2	1	2	1	2
January	-	-	-	58.80	-	0.60
February	-	-	-	35.18	-	1.08
March	-	0.60	-	78.67	-	1.57
April	-	4.22	-	119.16	-	3.86
May	-	2.89	-	91.45	-	1.69
June	-	23.01	0.72	73.98	0.12	0.72
July	-	9.76	-	54.58	-	2.89
August	-	2.05	-	61.20	-	0.84
September	-	0.60	-	57.95	-	1.33
October	-	0.72	-	79.28	-	0.72
November	-	0.36	0.12	22.53	-	0.24
December	-	-	-	5.30	-	0.12
Total	-	44.21	0.84	738.08	0.12	15.66

Table 20. 1995 landings in metric tonnes of scallop meats by Statistical District for Yarmouth (34) and Meteghan (36). (1 indicates landings from vessels < 25.5 G.T., and 2 indicates landings from vessels ≥ 25.5 G.T.). Source: Commercial Data Division, Program Coordination and Economics Branch, DFO, Halifax

	34		36	
Month	1	2	1	2
January	-	2.53	-	1.33
February	-	2.17	-	1.45
March	-	24.10	-	14.22
April	-	20.96	-	16.14
May	0.96	57.83	-	28.67
June	1.08	56.87	-	100.96
July	-	45.42	-	57.47
August	-	33.49	-	28.55
September	-	37.83	-	25.66
October	-	21.45	-	16.87
November	-	2.29	-	3.25
December	-	-	-	-
Total	2.04	304.94	-	294.57

Table 21. Landed Value ($000) by Fleet Sector

Year	Full Bay Licenses	Mid Bay Licenses	Upper Bay Licenses	Total (mt)
1985	9332.0	2979.4	114.9	938.4
1986	6948.5	3164.8	148.0	762.4
1987	13371.8	2411.5	371.4	1400.5
1988	28183.8	2295.3	560.5	3278.6
1989	33604.8	4163.5	726.4	4446.9
1990	21691.3	5604.4	820.1	3086.6
1991	17412.0	4210.8	725.8	2304.2
1992	22093.0	5493.8	546.8	2442.5
1993	28426.5	7240.0	740.9	2429.2
1994	30035.5	7065.2	339.4	2253.9
1995†	19909.8	5145.1	146.1	1533.3

† Data for 1995 is preliminary.

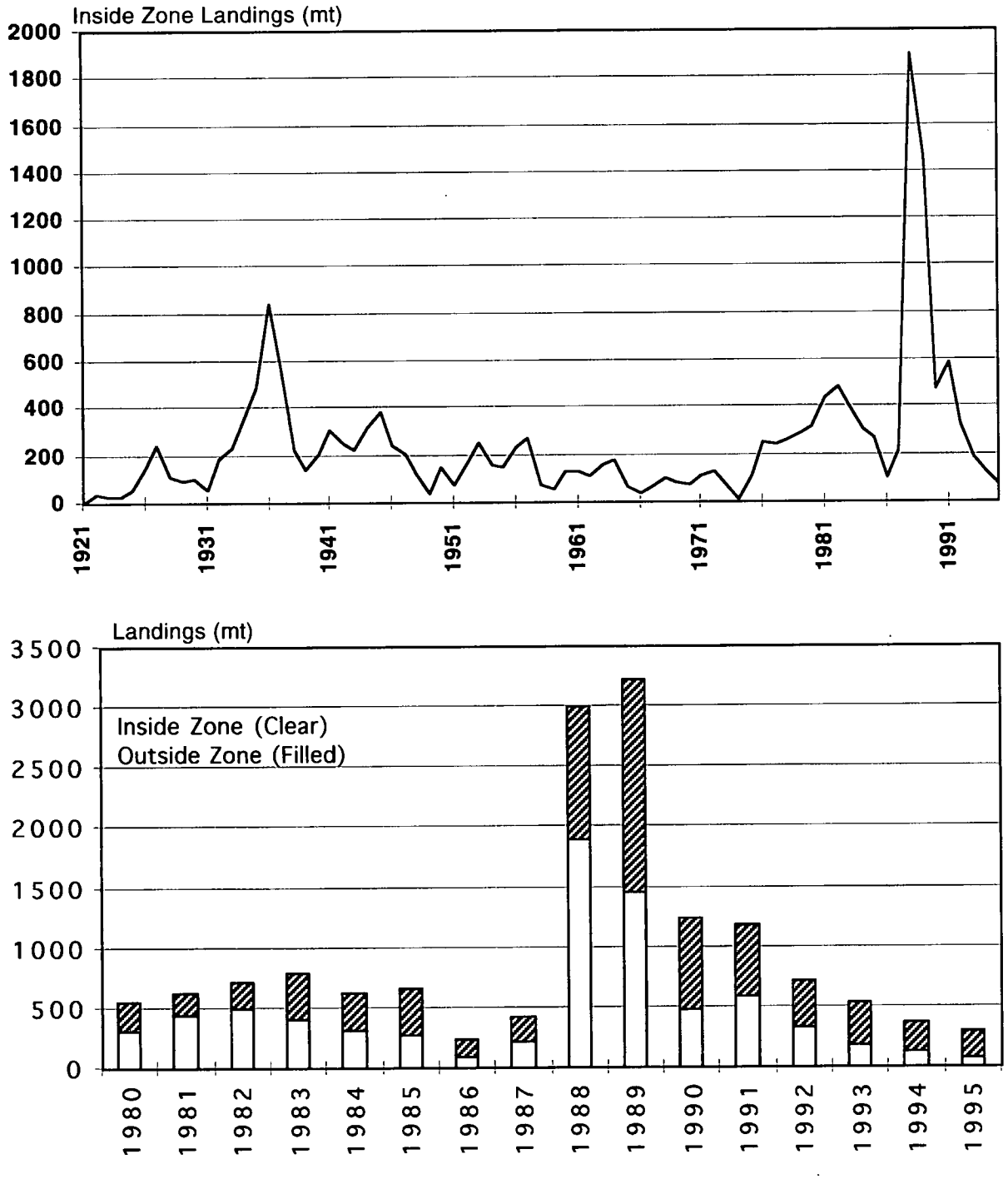


Figure 1. Landings by the Full Bay license holders according to Fishing Zone (1921-1995, Inside Zone only; 1980-1995 Inside and Outside Zones).

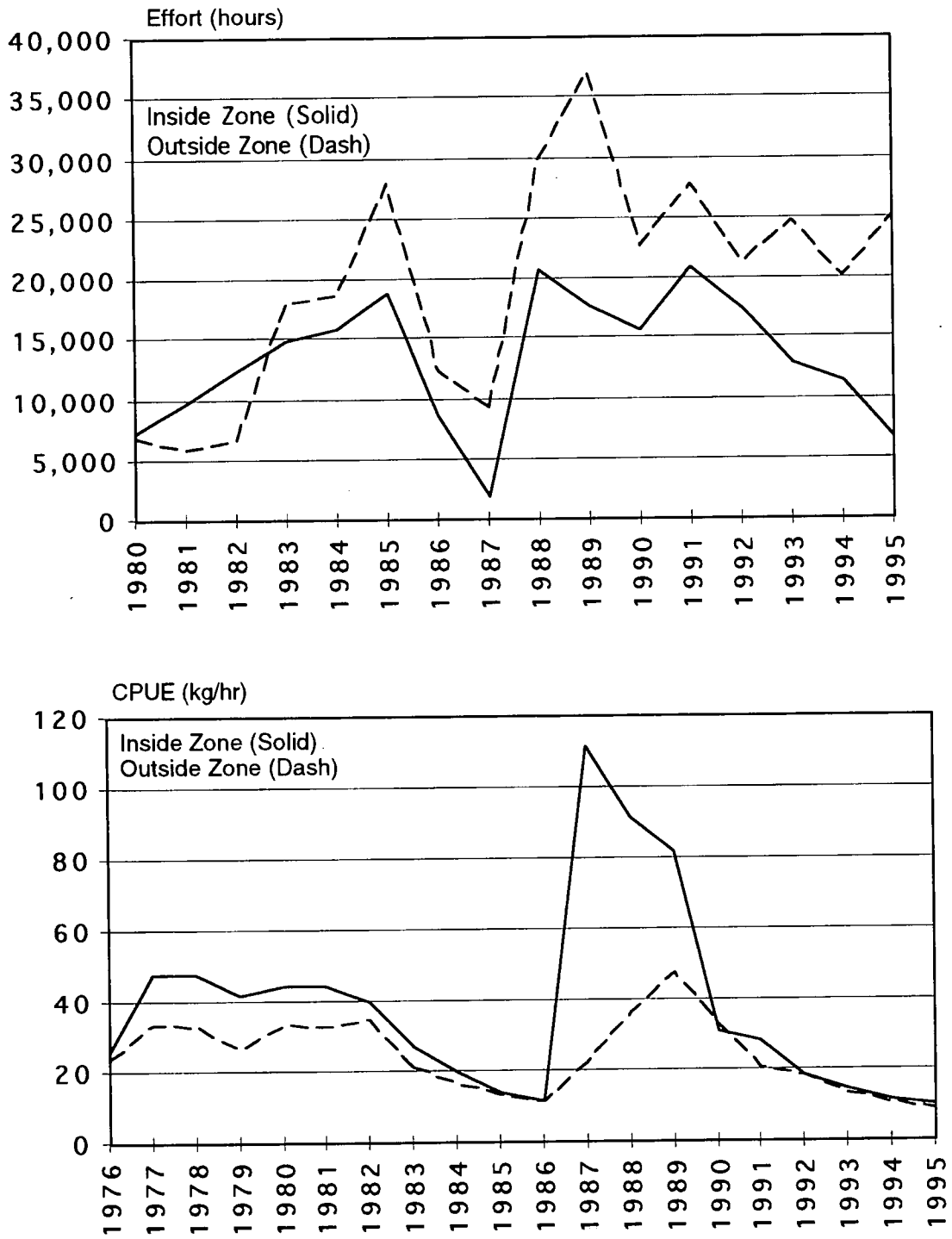


Figure 2. Effort trends (hours) and Catch per unit Effort (CPUE, kg per hour fished) for the Inside and Outside Zones.

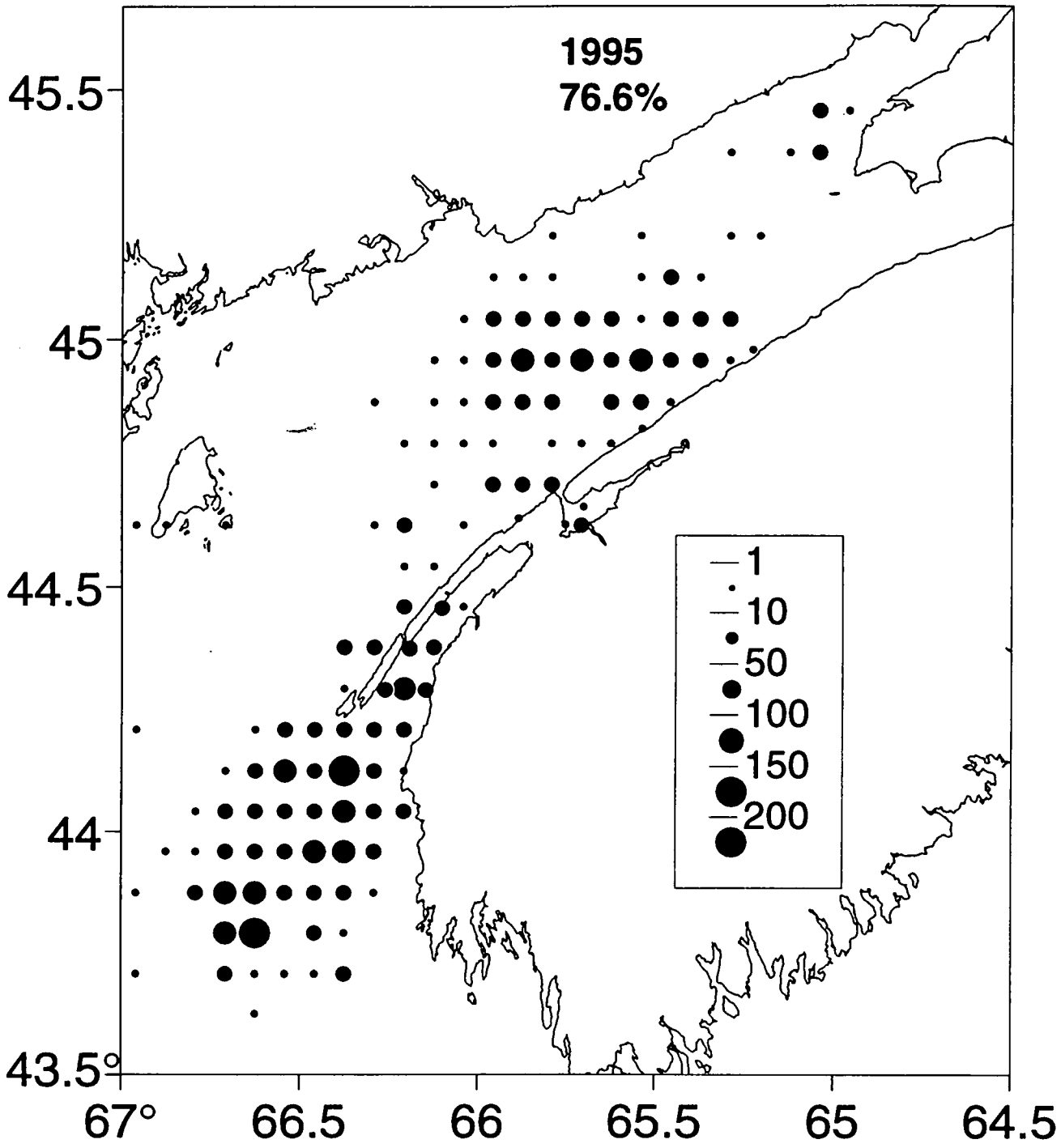


Figure 3. Distribution of fishing locations (days fished) by 5 minute square for 1995* for the Bay of Fundy fleet as reported from fishing logbooks. Increasing symbol size depicts increasing number of days fished (% log compliance shown).
*1995 preliminary data

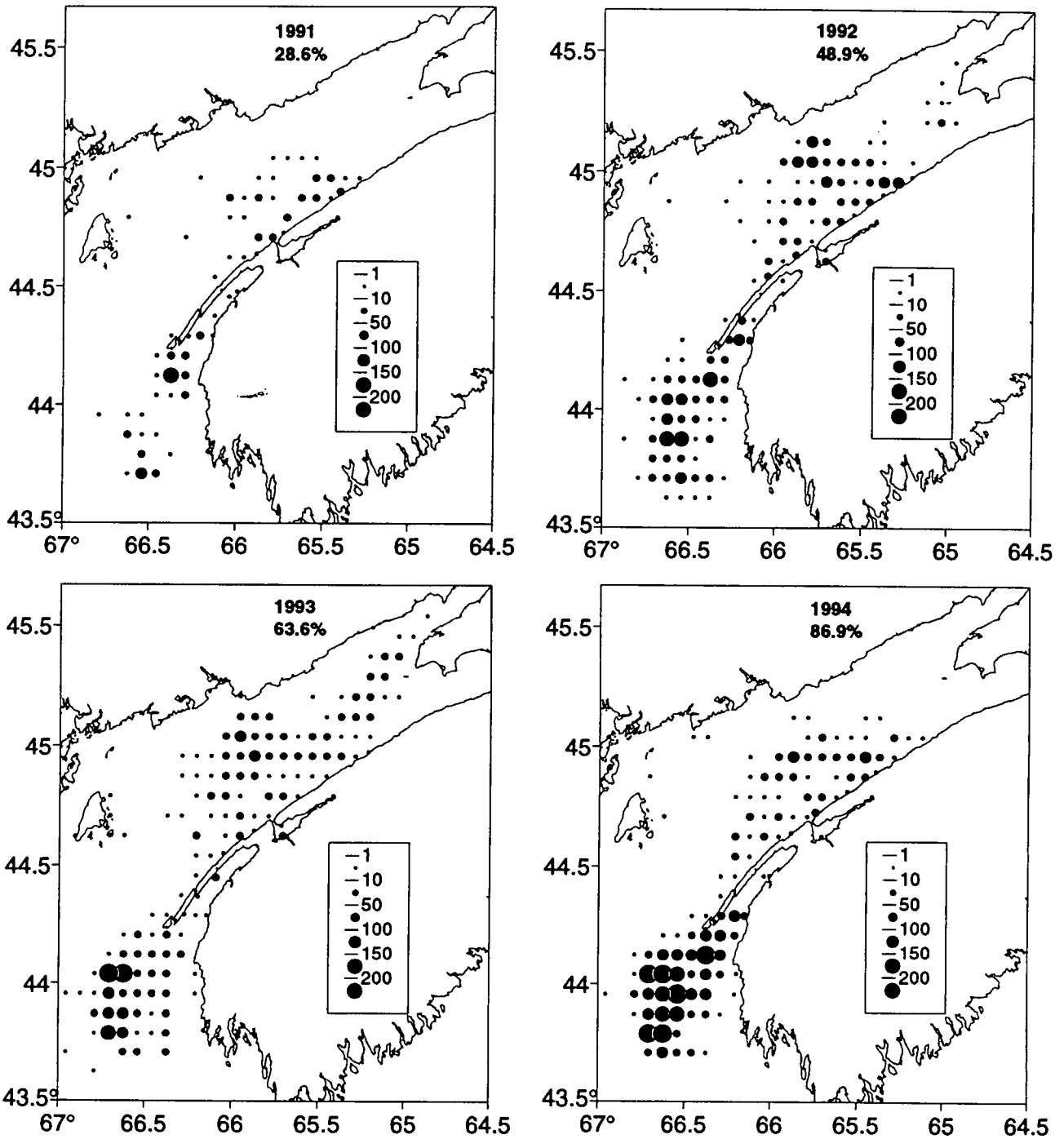


Figure 3 cont'd. Distribution of fishing locations (days fished) by 5 minute square for 1991-1994 for the Bay of Fundy fleet as reported from fishing logbooks. Increasing symbol size depicts increasing number of days fished (% log compliance shown).

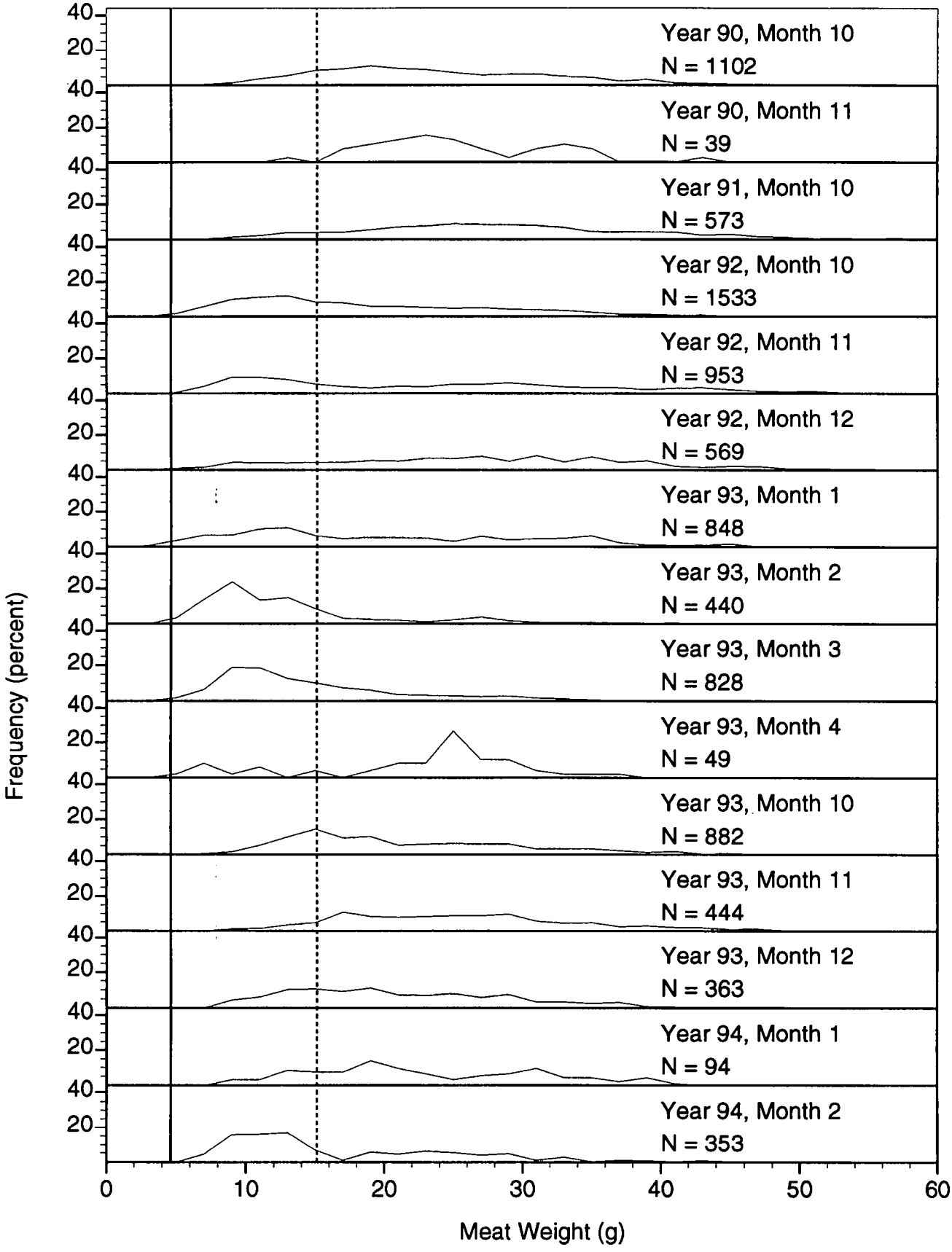


Figure 4a. Frequency distribution (percent) of meat weights from the commercial catch from the regulated inside zone off Digby. The minimum meat size which corresponds with the 76 mm shell height is 4.6 g. To avoid growth overfishing meats larger than 15 g should be harvested.

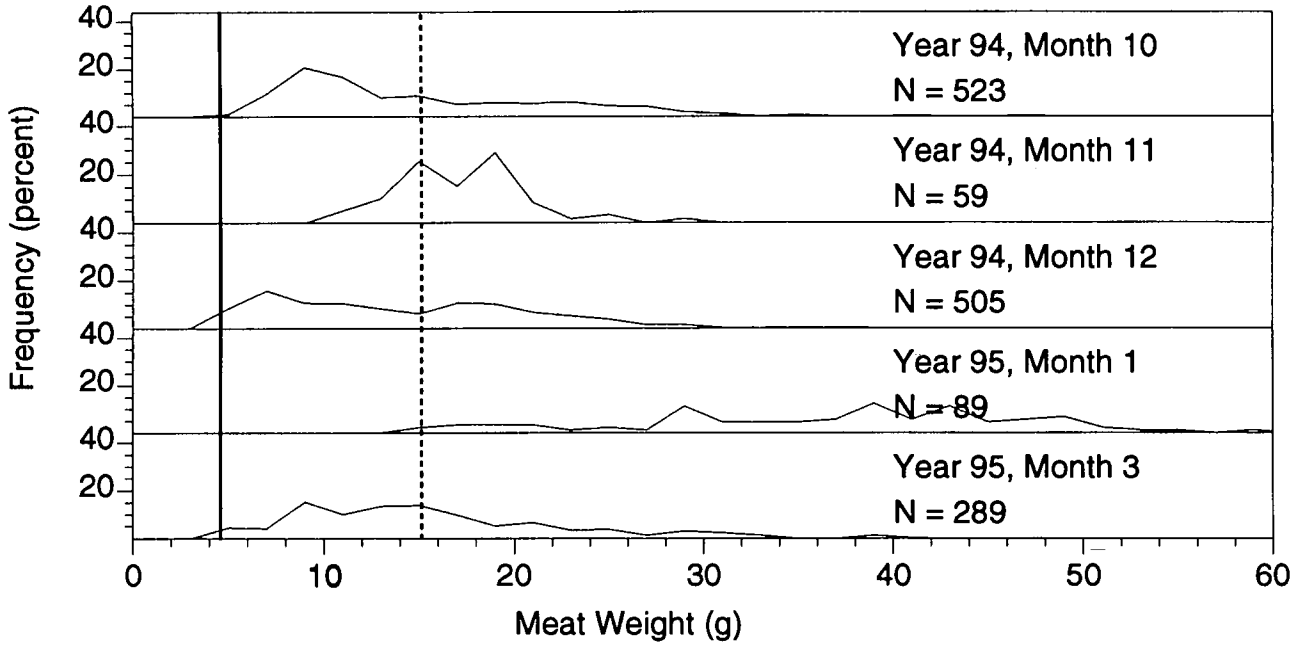


Figure 4a cont'd. Frequency distribution (percent) of meat weights from the commercial catch from the regulated inside zone off Digby. The minimum meat size which corresponds with the 76 mm shell height is 4.6 g. To avoid growth overfishing meats larger than 15 g should be harvested.

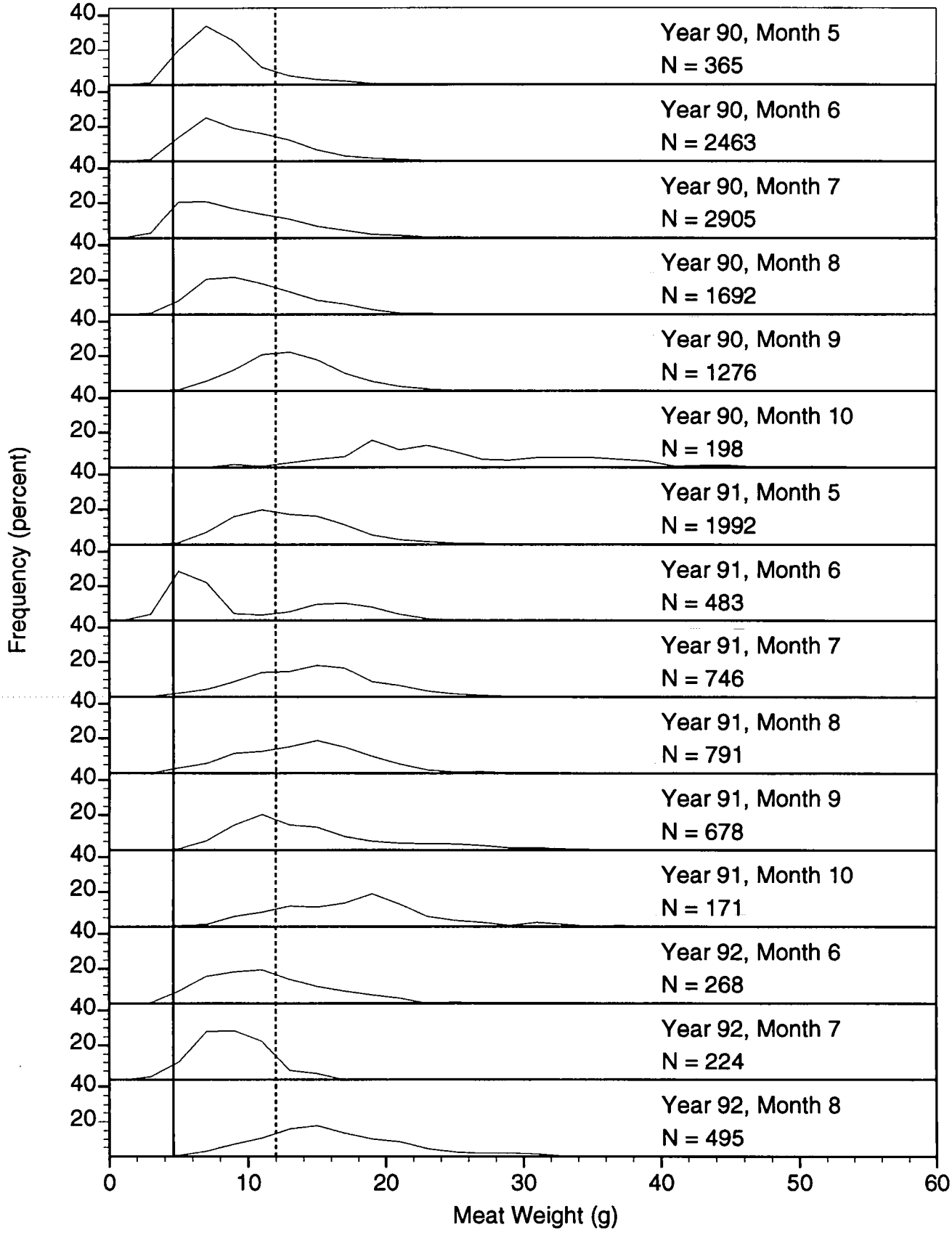


Figure 4b. Frequency distribution (percent) of meat weights from the commercial catch from the outside zone off Digby. The minimum meat size which corresponds with the 76 mm shell height is 4.6 g. To avoid growth overfishing meats larger than 15 g should be harvested.

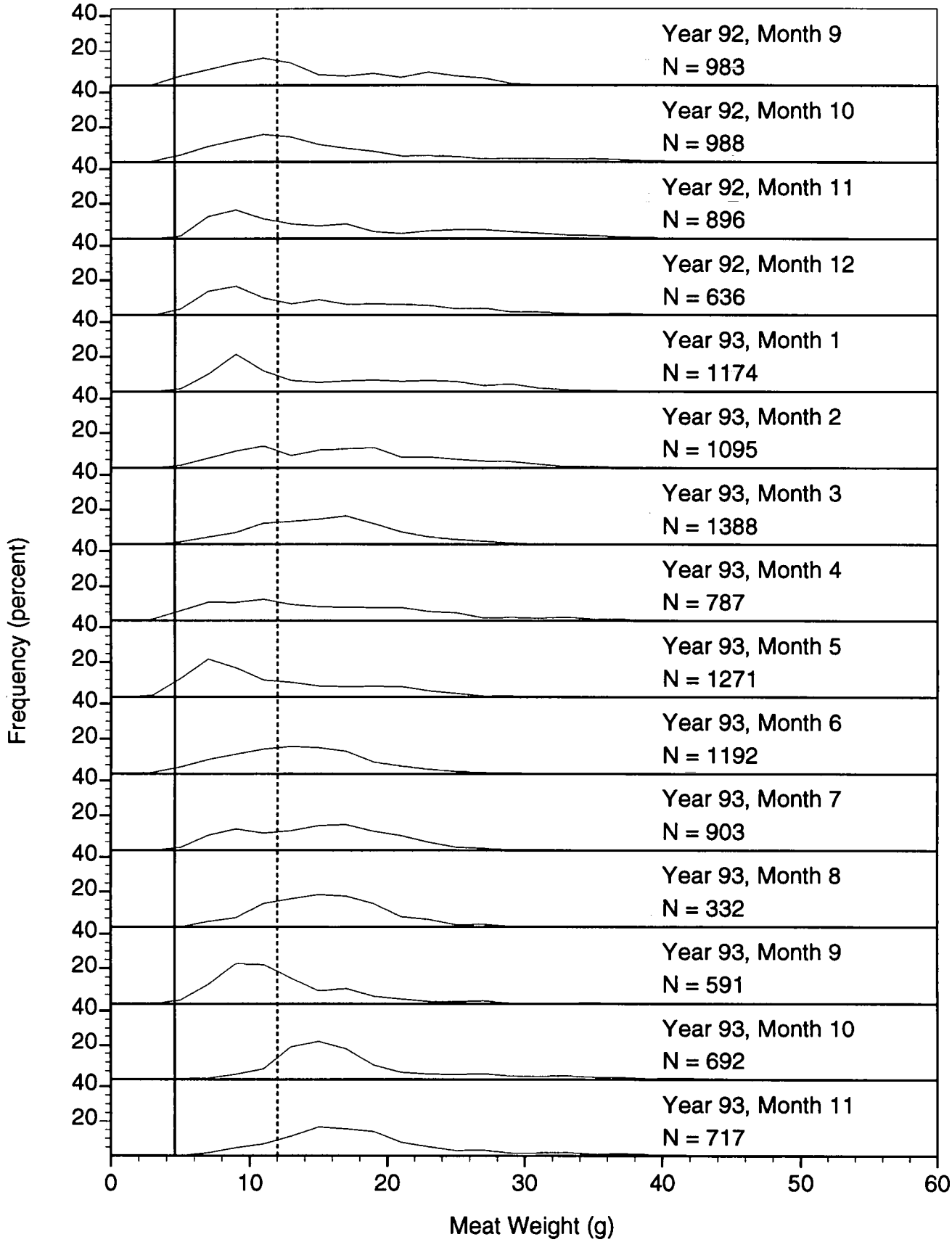


Figure 4b cont'd. Frequency distribution (percent) of meat weights from the commercial catch from the outside zone off Digby. The minimum meat size which corresponds with the 76 mm shell height is 4.6 g. To avoid growth overfishing meats larger than 15 g should be harvested.

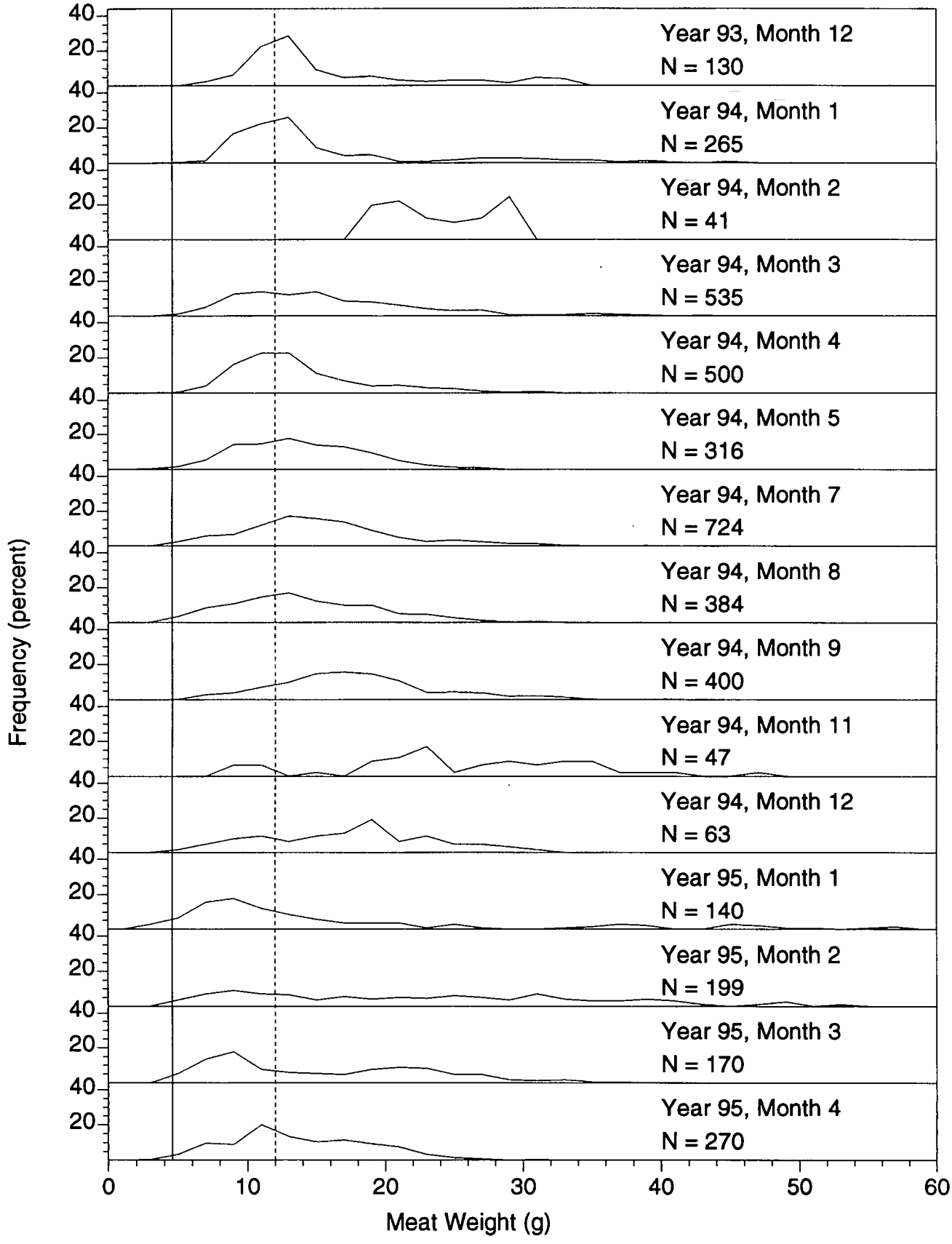
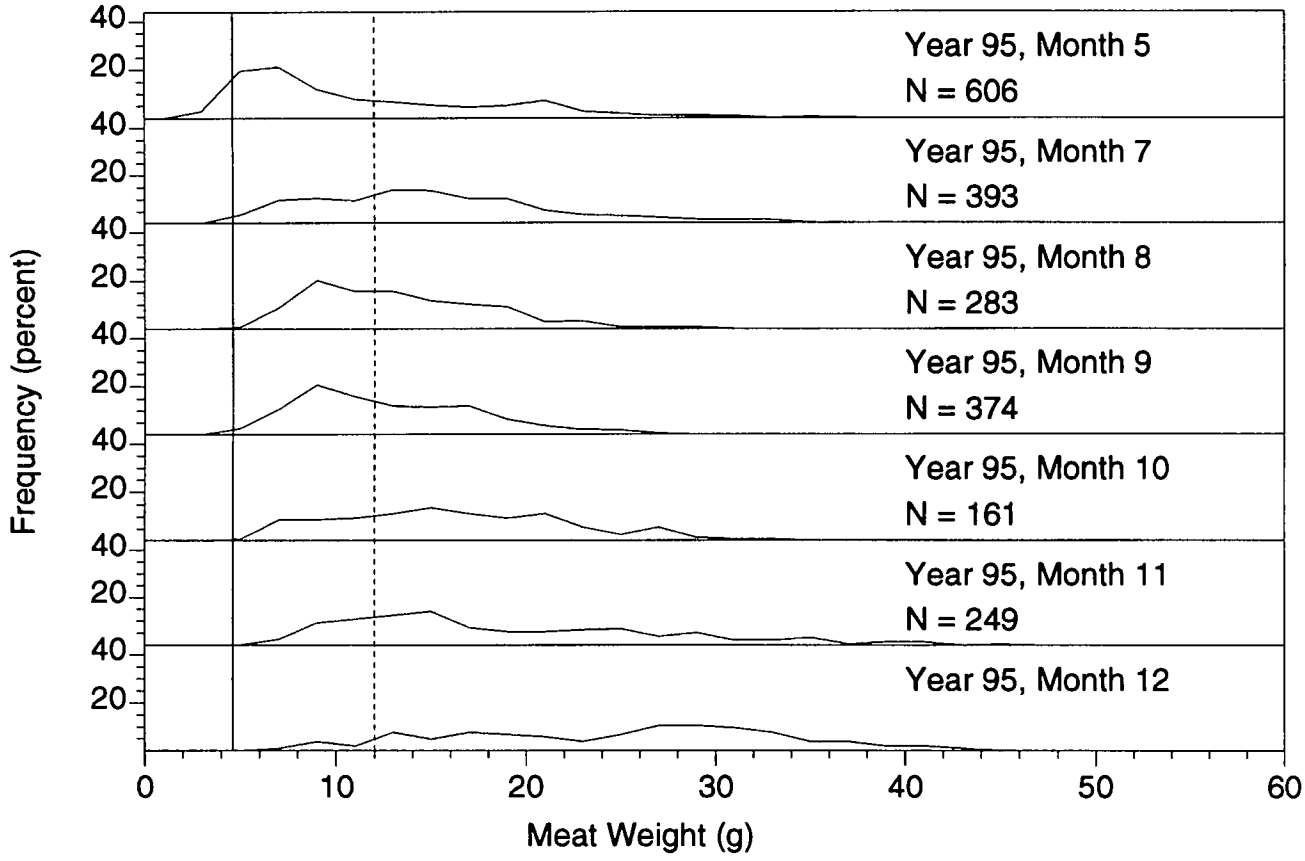


Figure 4b cont'd. Frequency distribution (percent) of meat weights from the commercial catch from the outside zone off Digby. The minimum meat size which corresponds with the 76 mm shell height is 4.6 g. To avoid growth overfishing meats larger than 15 g should be harvested.



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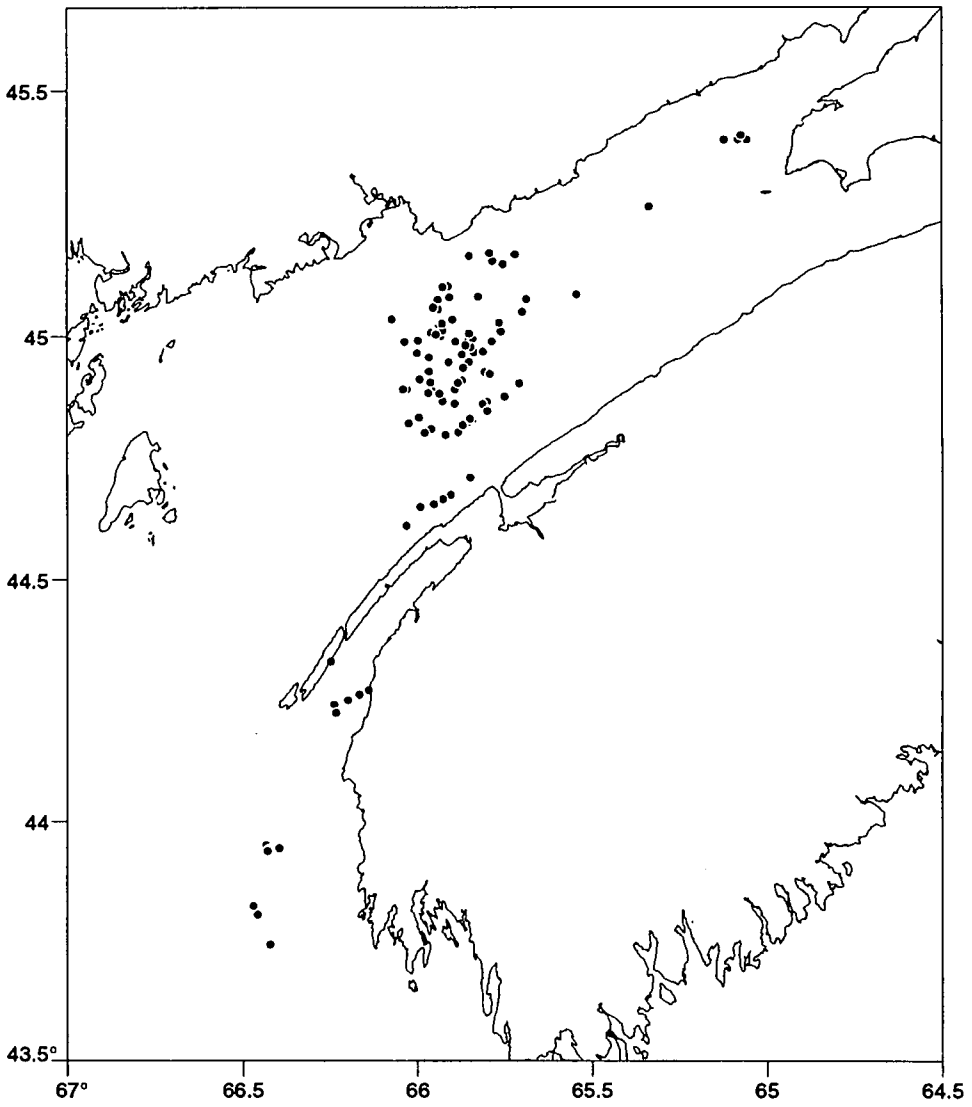


Figure 5. Locations of 1995 commercial meat weight samples.

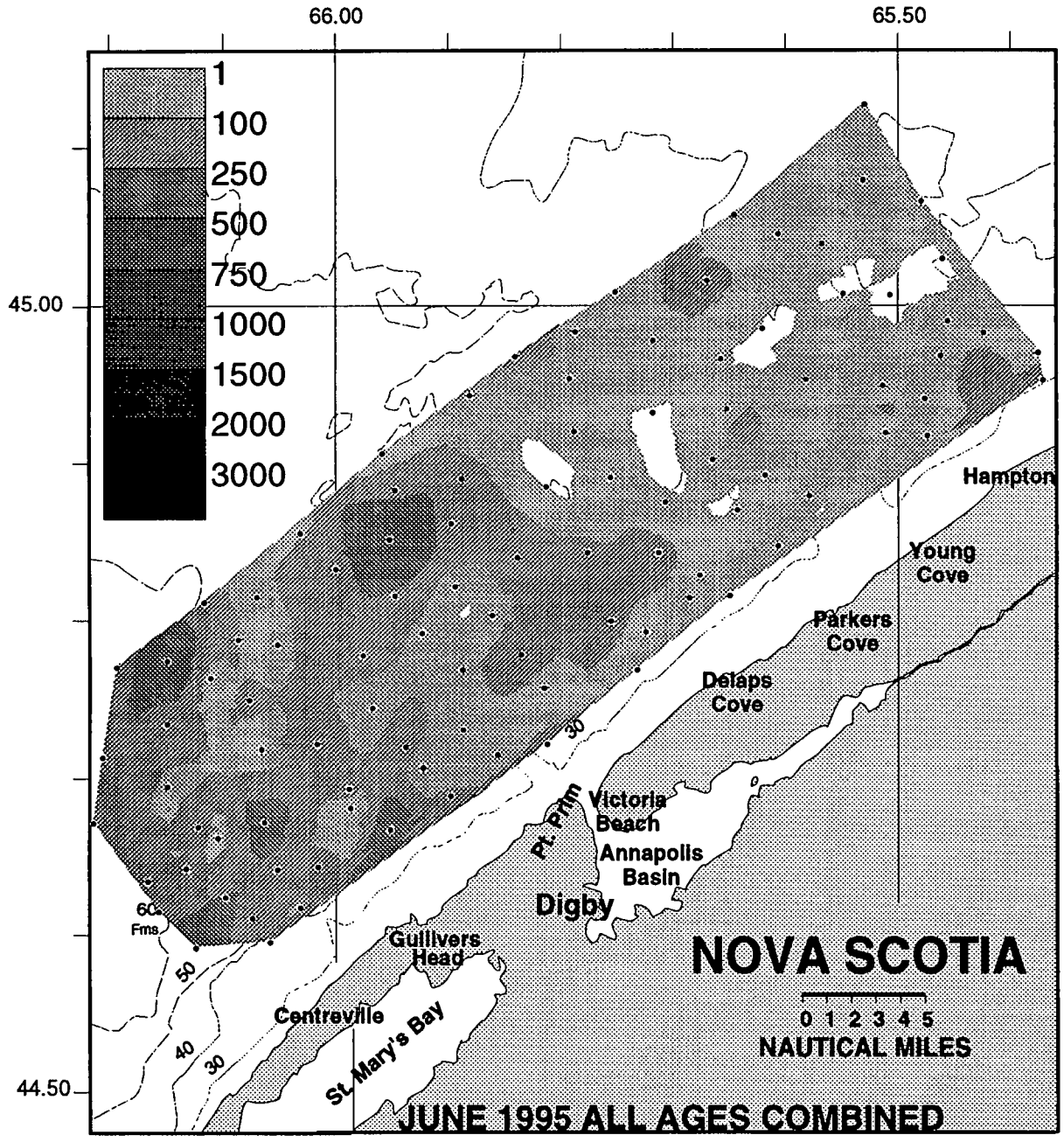


Figure 6. Spatial distribution of scallops (all ages combined) contoured using ACON derived from Delaunay triangulation and inverse distance weighted interpolation. Darkening shades of grey within isopleths refer to increasing numbers of scallops per standard tow. Closed circles depict tow locations.

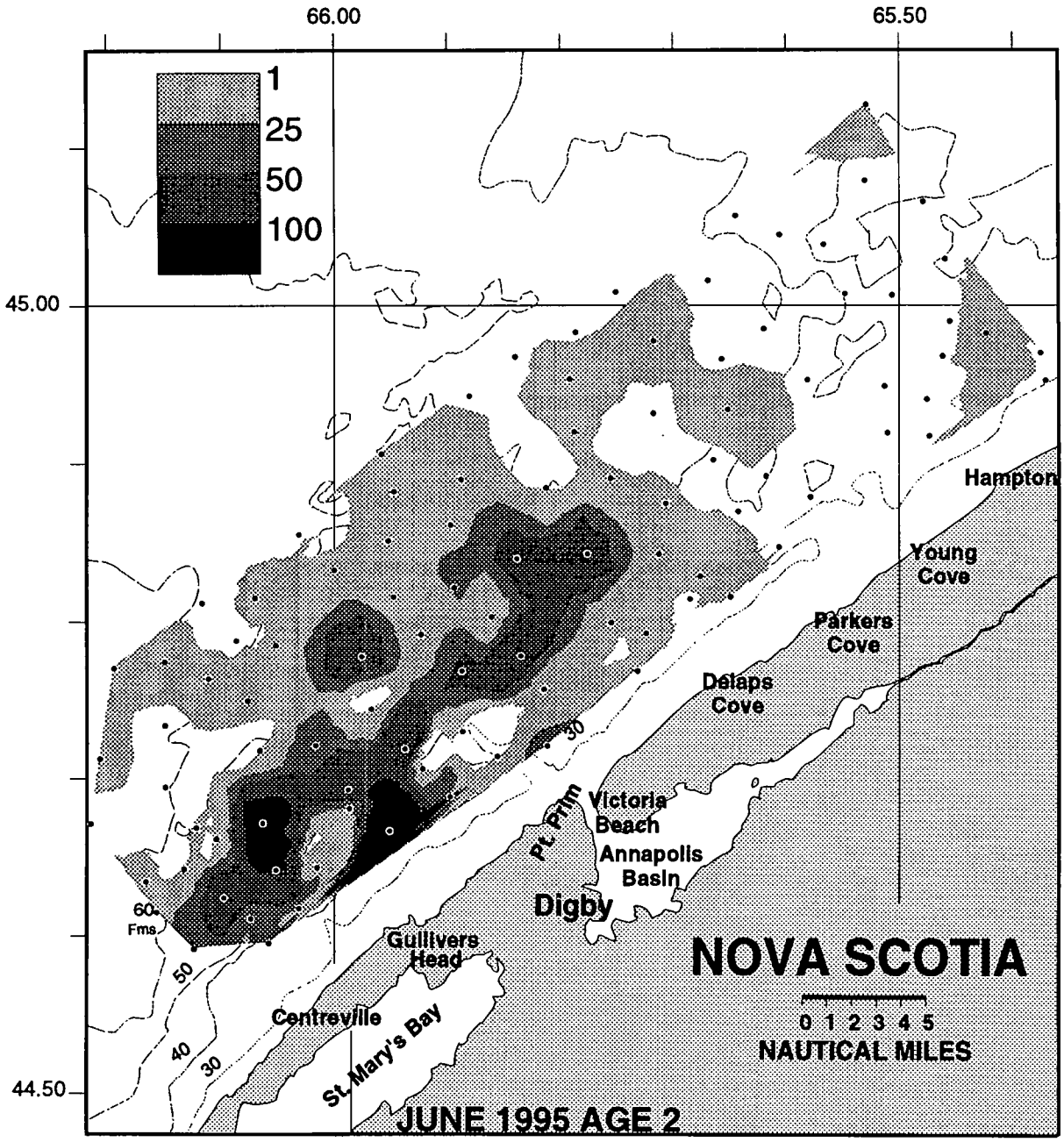


Figure 7. Spatial distribution of scallops by age contoured using ACON derived from Delaunay triangulation and inverse distance weighted interpolation. Darkening shades of grey within isopleths refer to increasing numbers of scallops per standard tow. Closed circles depict tow locations.

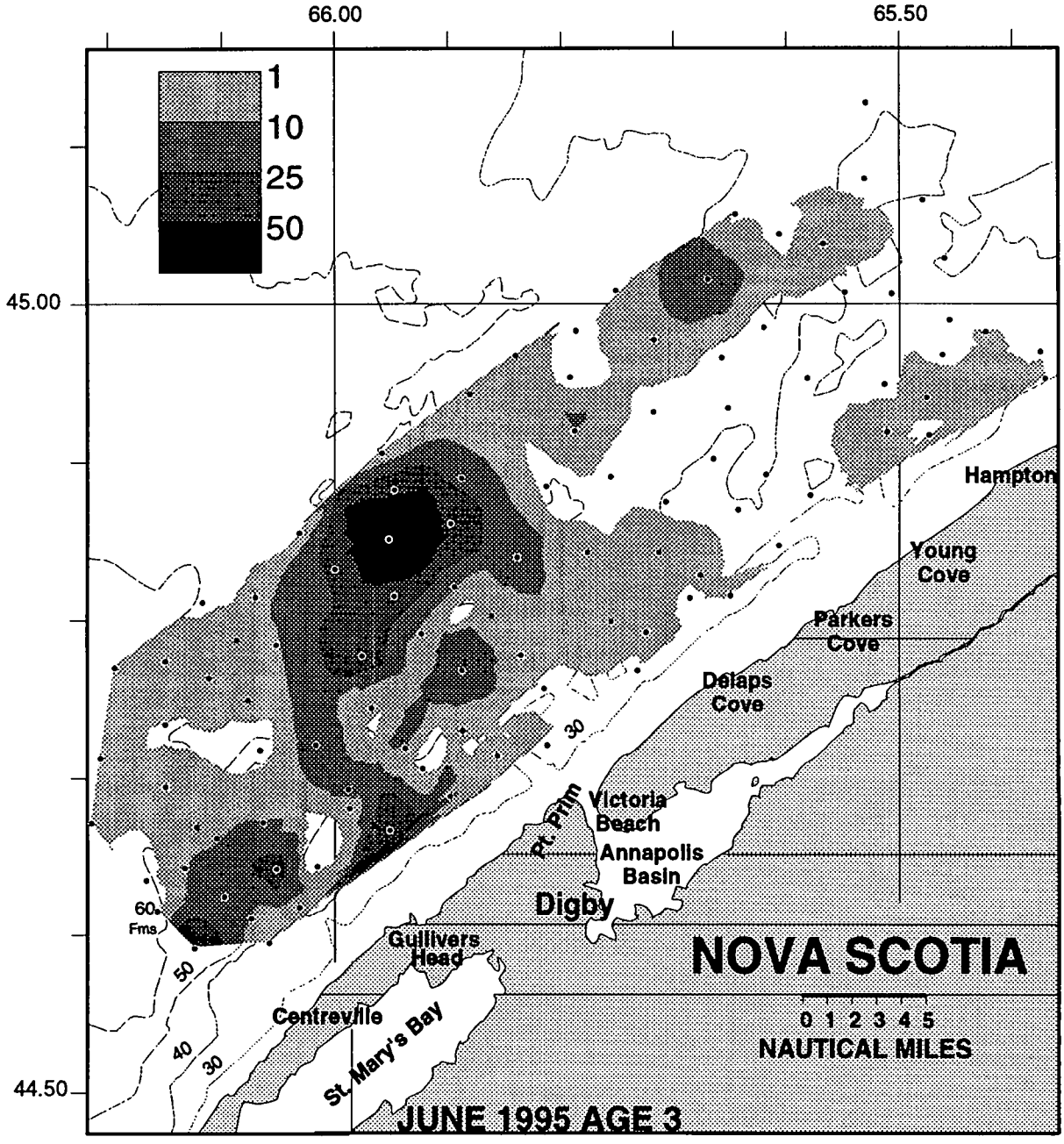


Figure 7. cont'd Spatial distribution of scallops by age contoured using ACON derived from Delaunay triangulation and inverse distance weighted interpolation. Darkening shades of grey within isopleths refer to increasing numbers of scallops per standard tow. Closed circles depict tow locations.

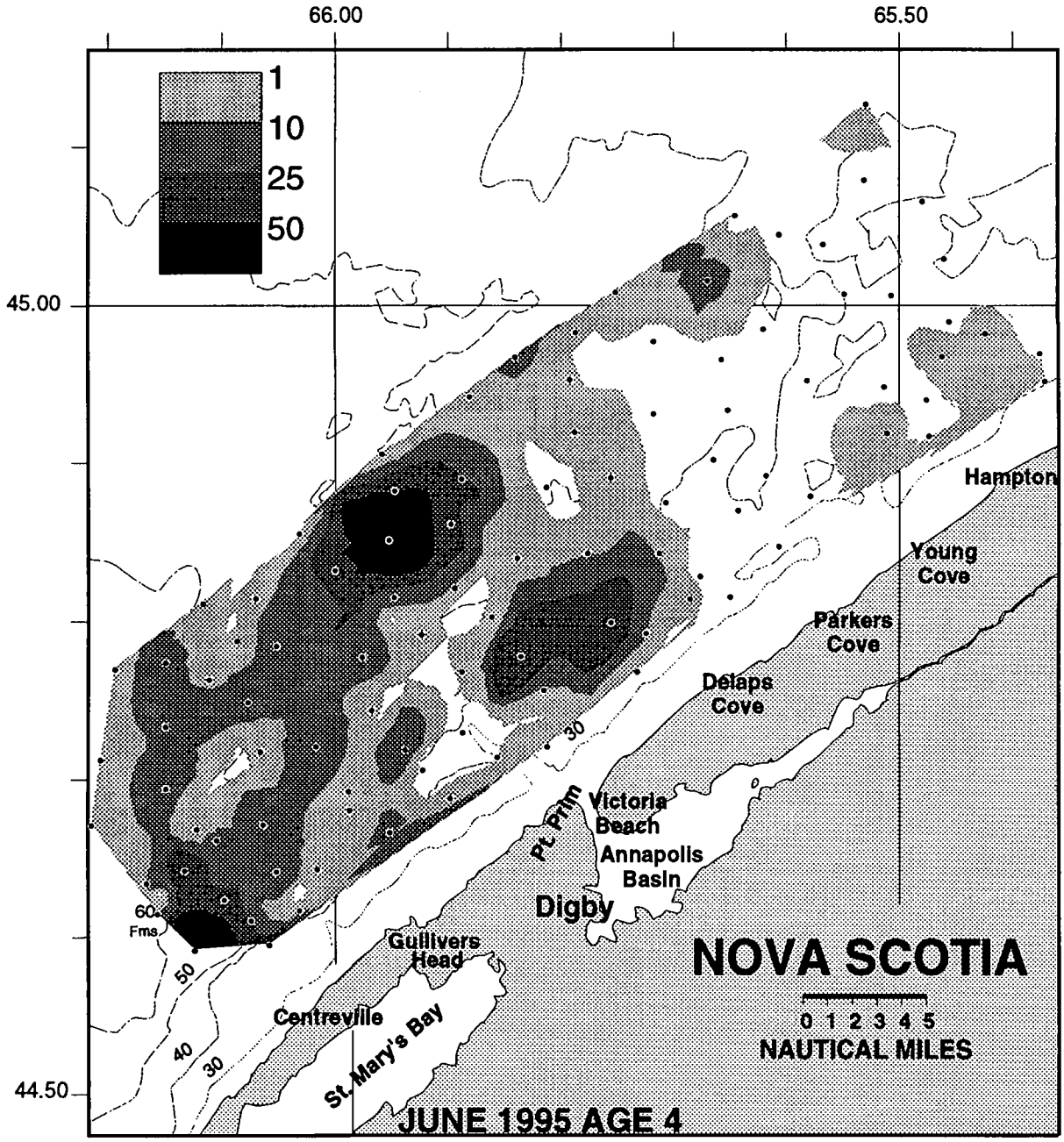
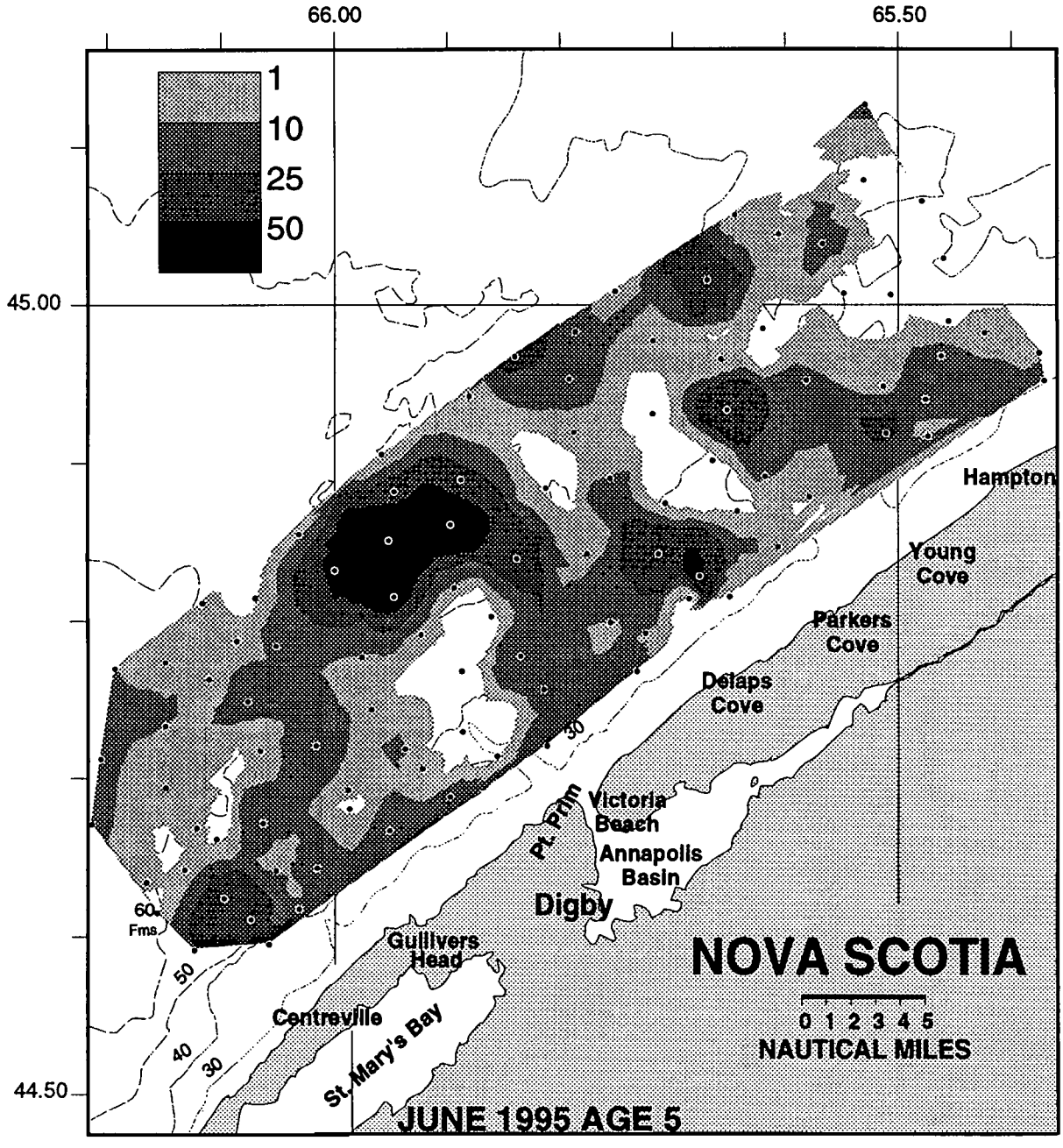


Figure 7. cont'd Spatial distribution of scallops by age contoured using ACON derived from Delaunay triangulation and inverse distance weighted interpolation. Darkening shades of grey within isopleths refer to increasing numbers of scallops per standard tow. Closed circles depict tow locations.



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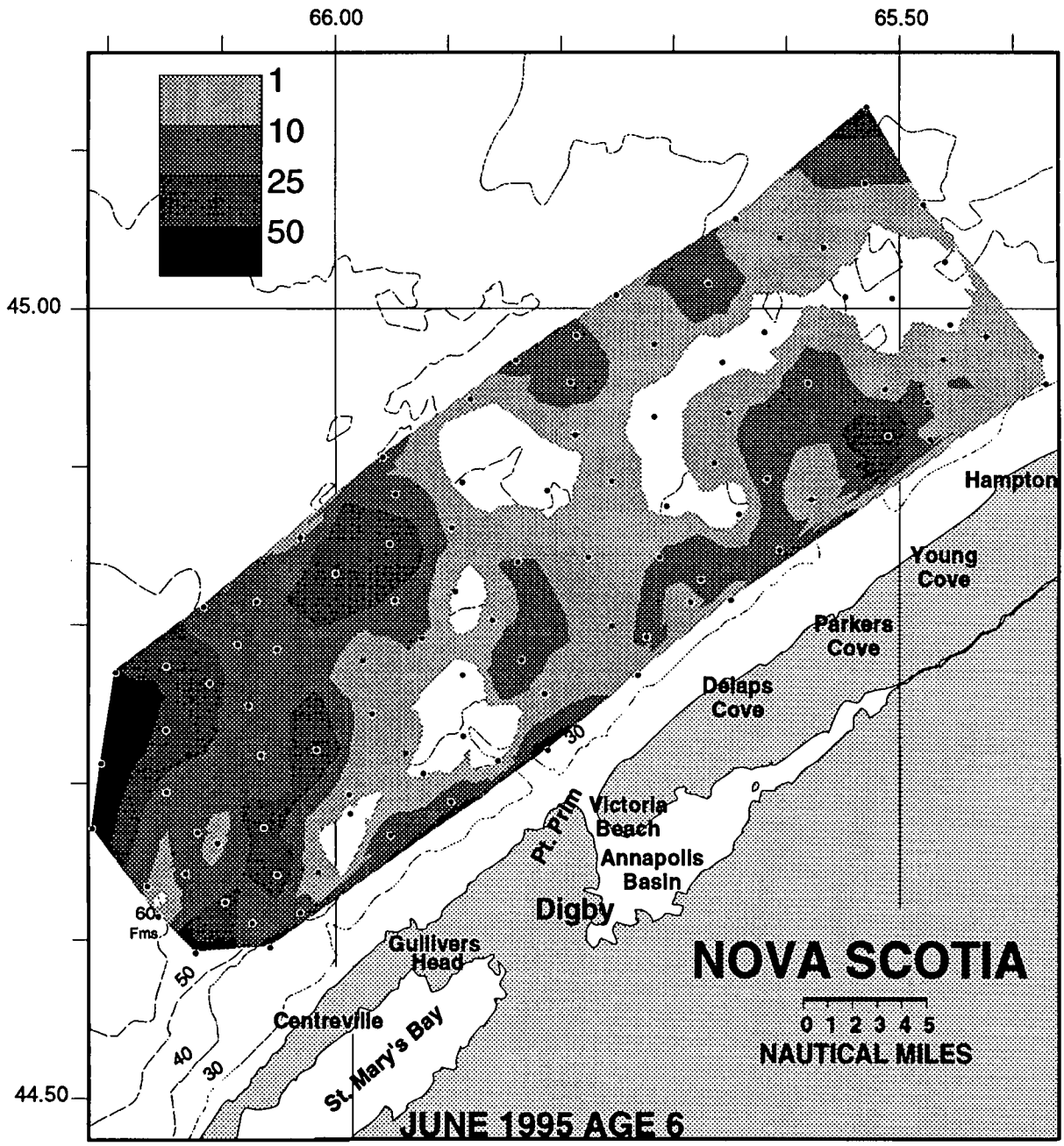

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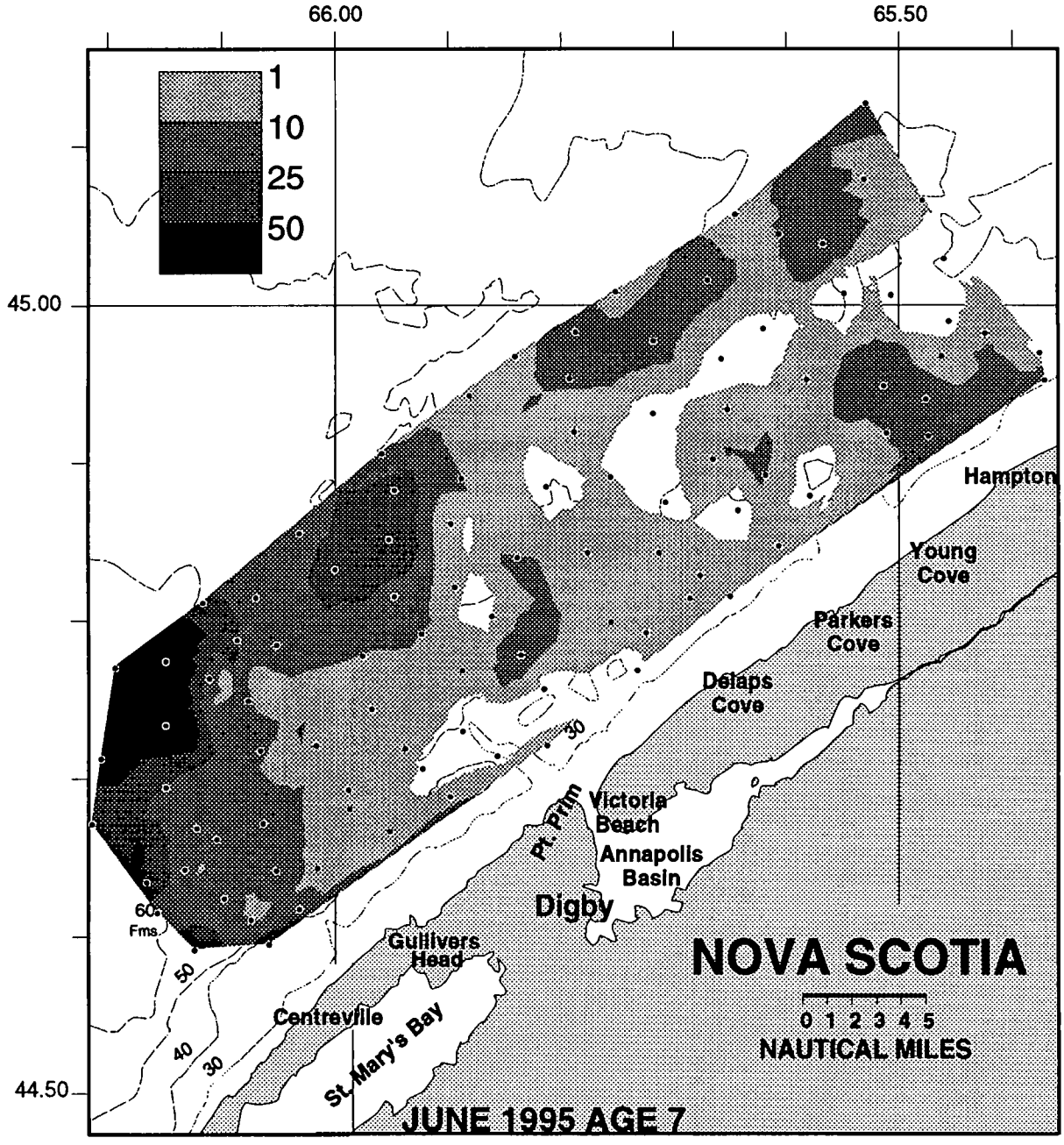

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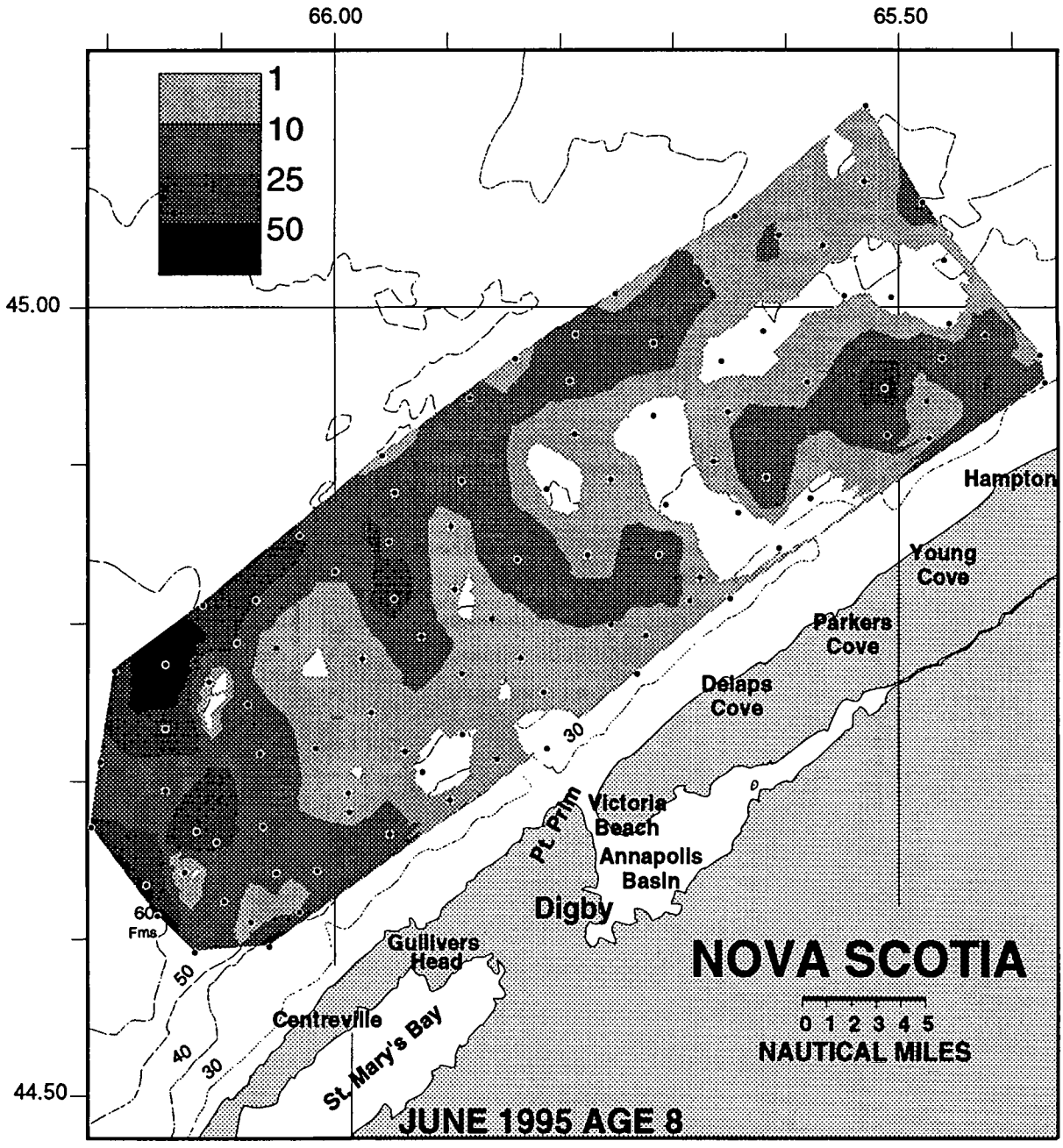

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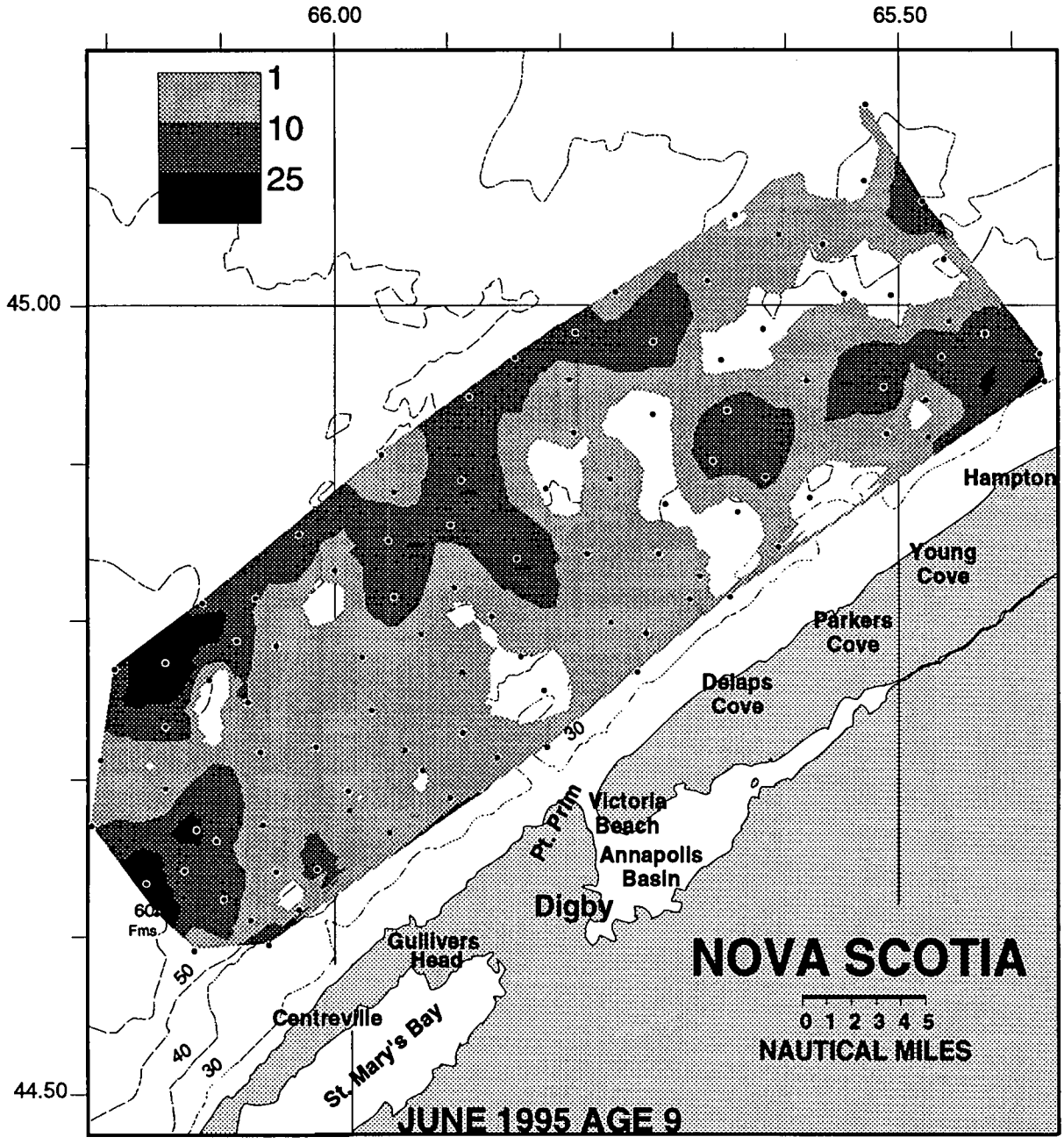

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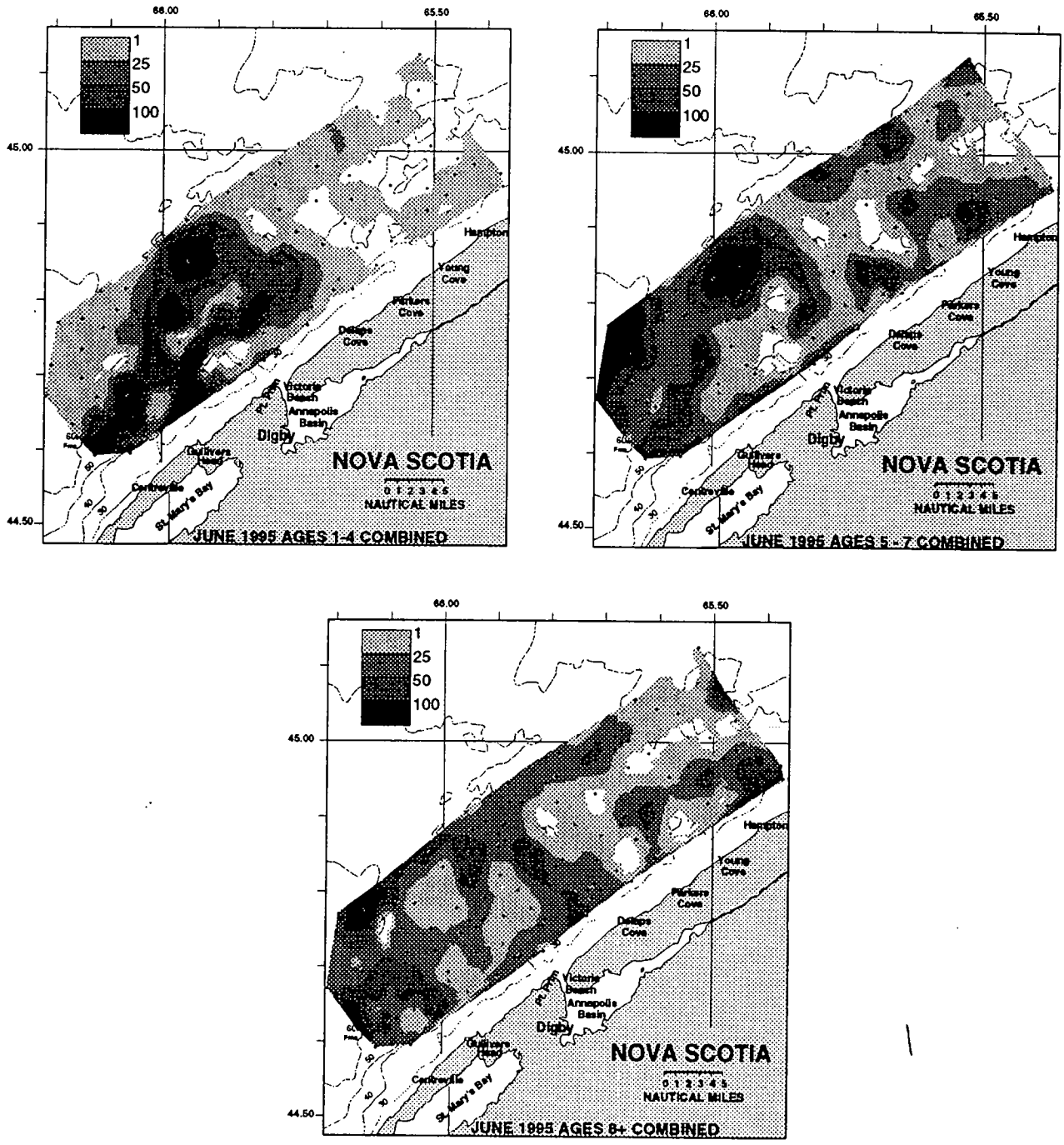


Figure 8. Spatial distribution of scallops by age grouping contoured using ACON derived from Delaunay triangulation and inverse distance weighted interpolation. Darkening shades of grey within isopleths refer to increasing numbers of scallops per standard tow. Closed circles depict tow locations.

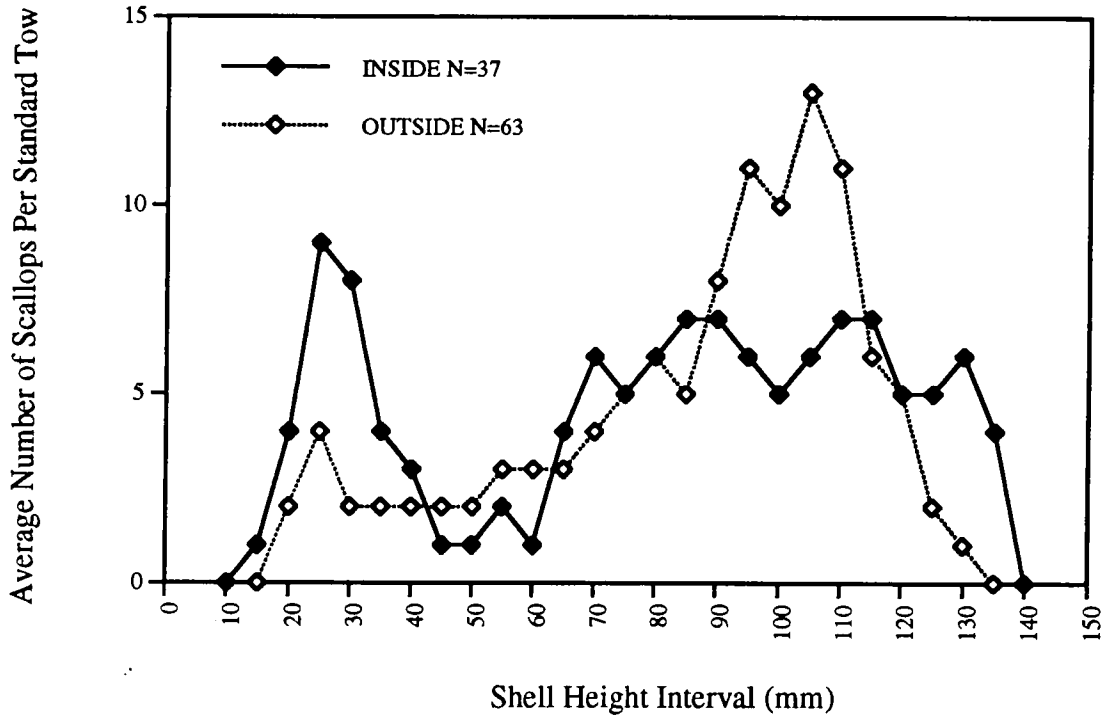
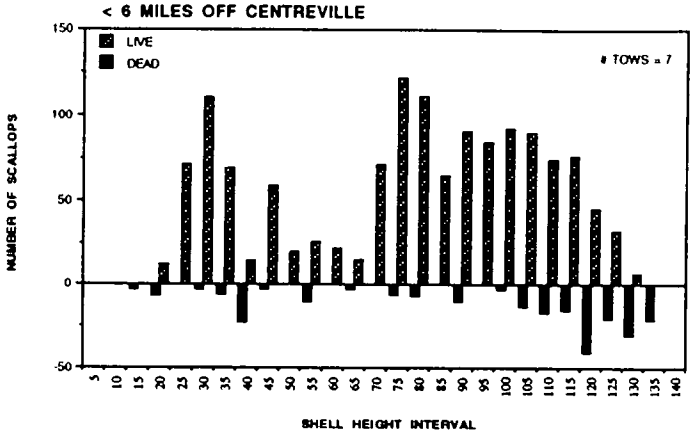
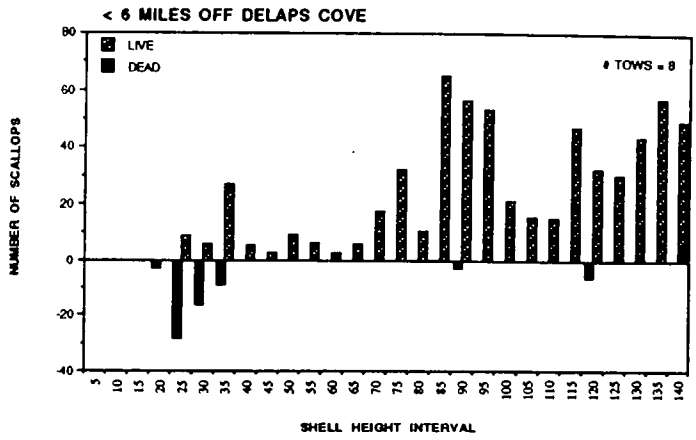
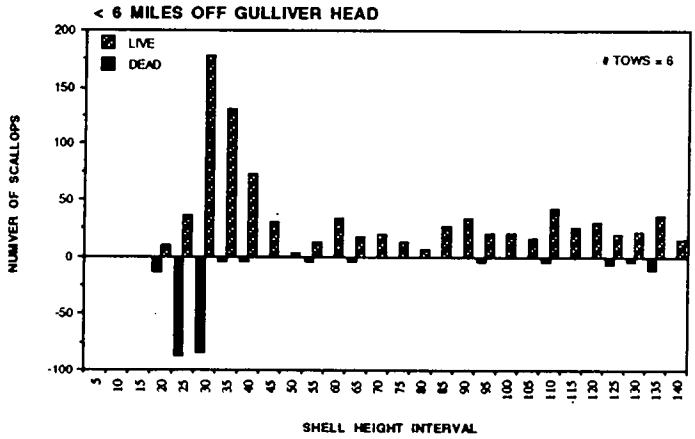
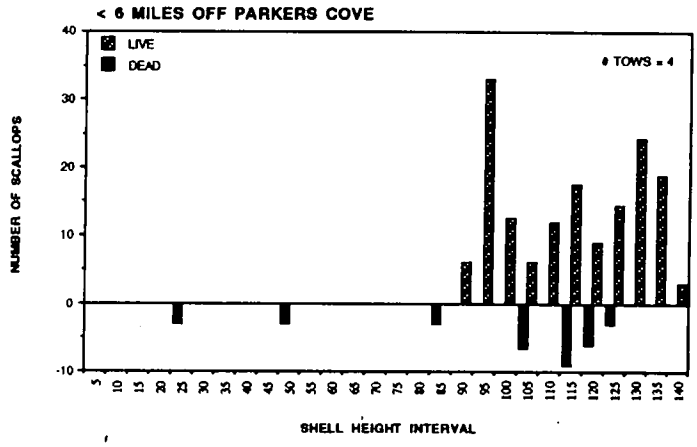


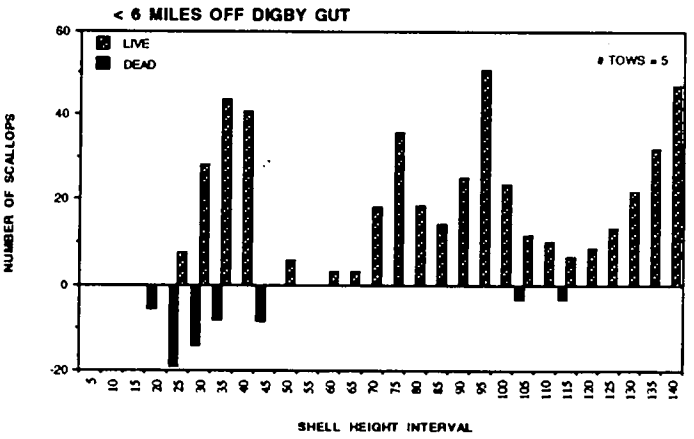
Figure 9. Average number of scallops caught per standard tow in research vessel surveys of the Inside and Outside Zones off Digby.

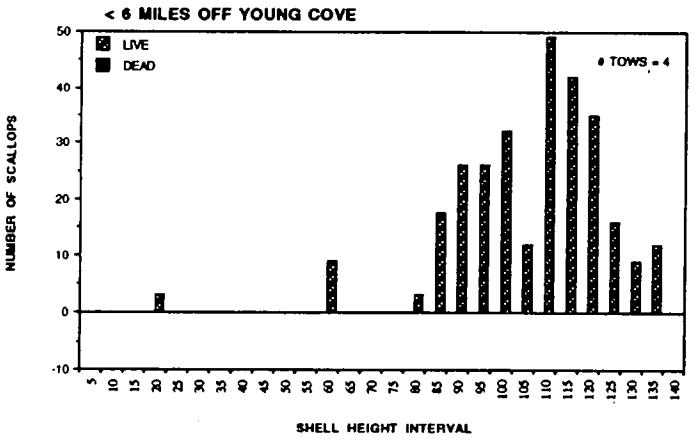












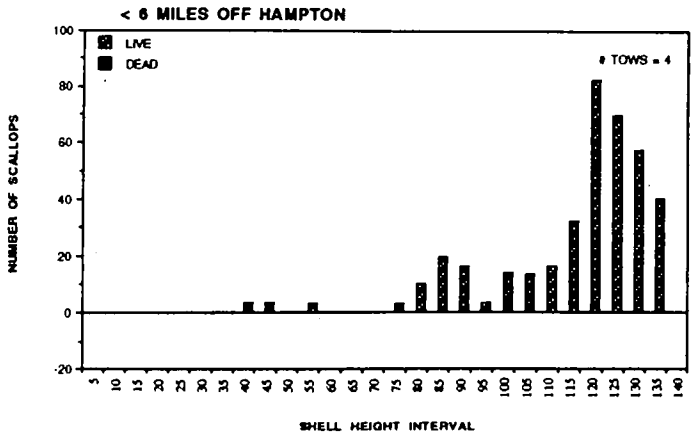
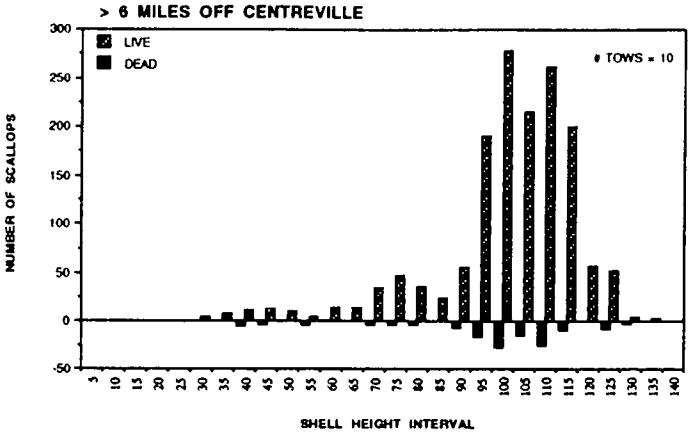
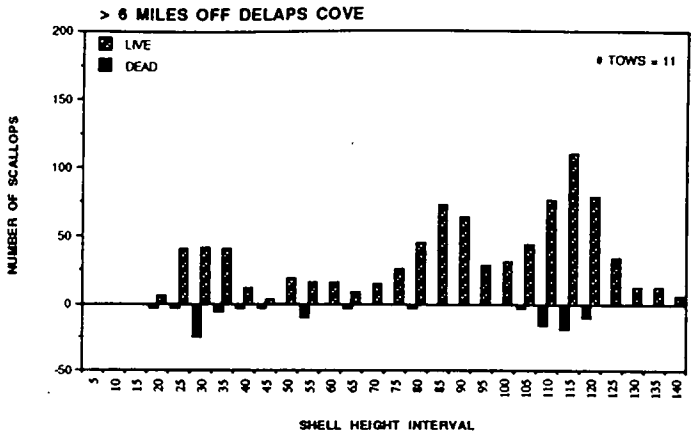
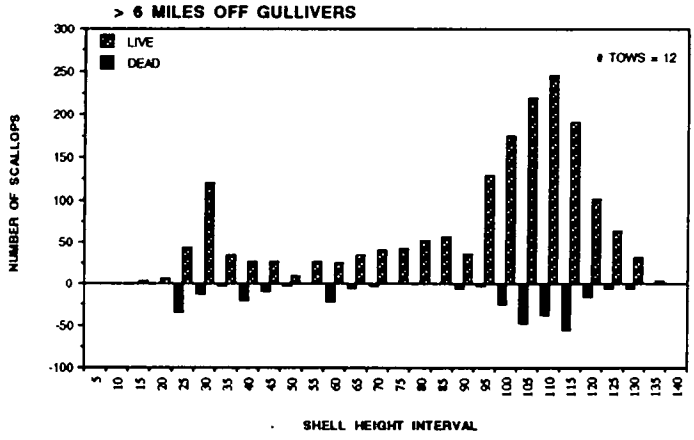
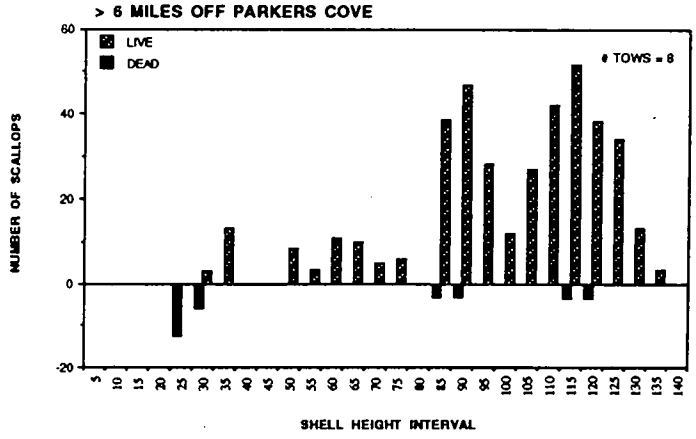


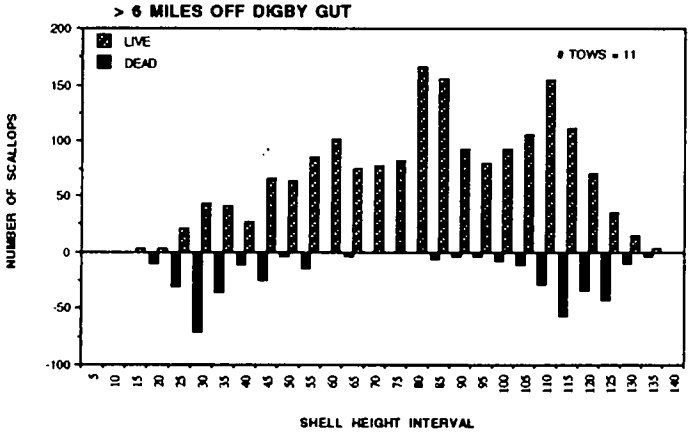
Figure 10. Frequency distribution of live versus dead (empty paired shells) by area caught (scales differ) in the 1995 stock survey.

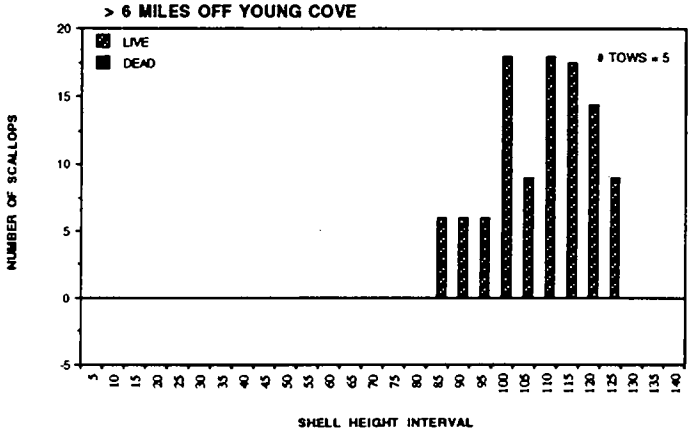












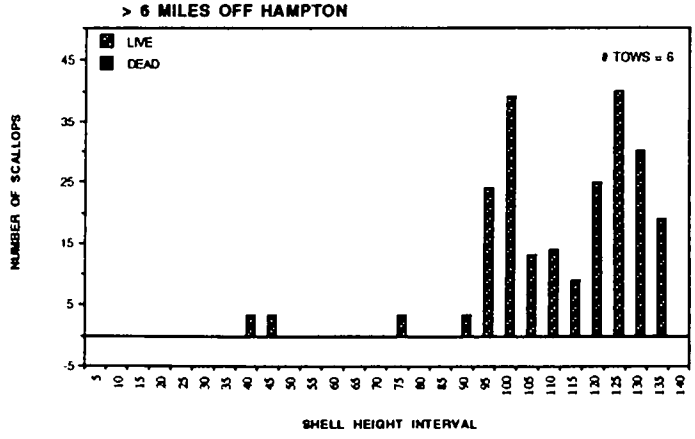


Figure 10. cont'd. Frequency distribution of live versus dead (empty paired shells) by area caught (scales differ) in the 1995 stock survey.

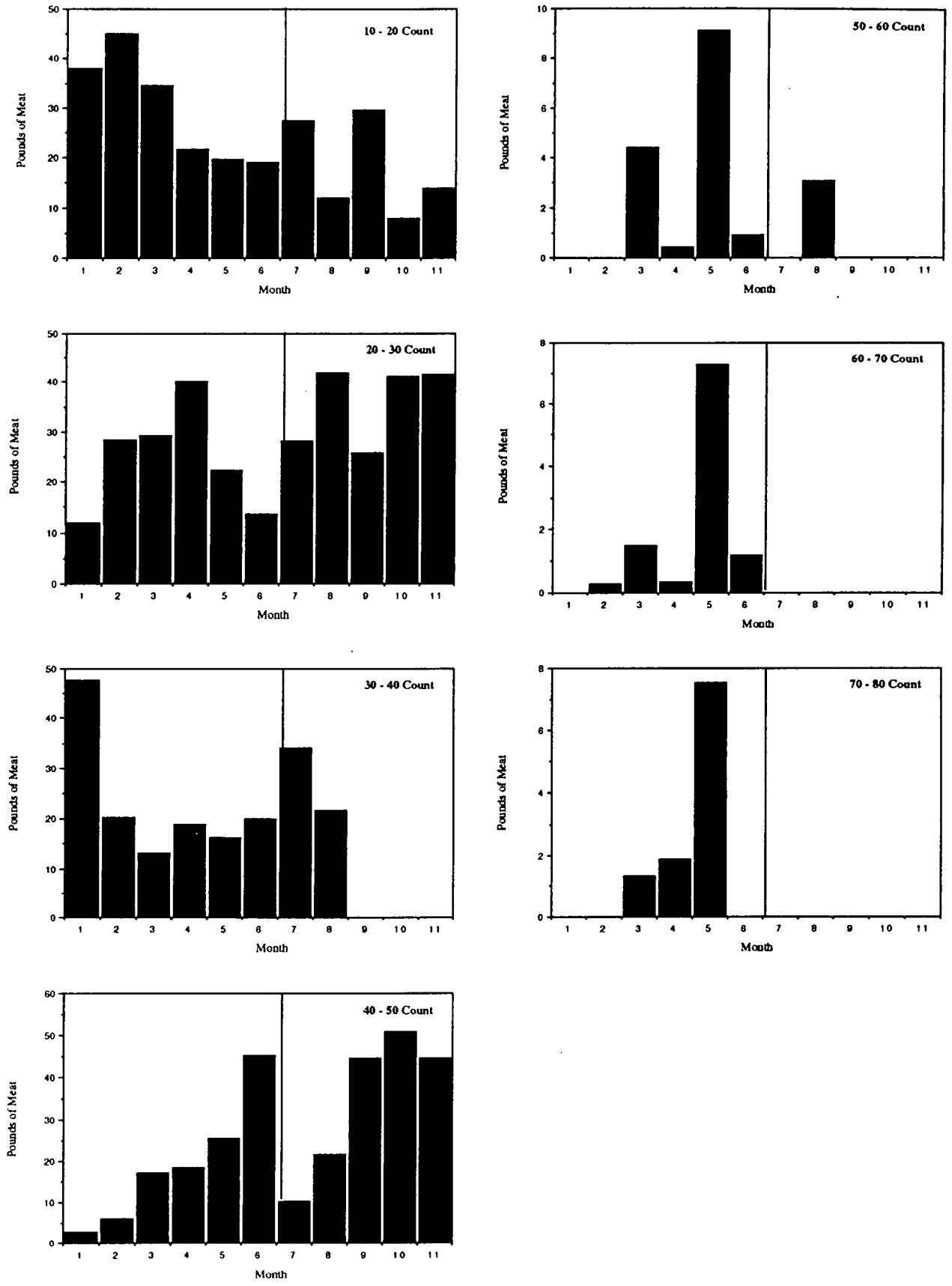


Figure 11. Frequency distribution of graded landings by month of a scallop buyer. Solid line depicts when Variation Order 50 meats per 500 g came into effect.

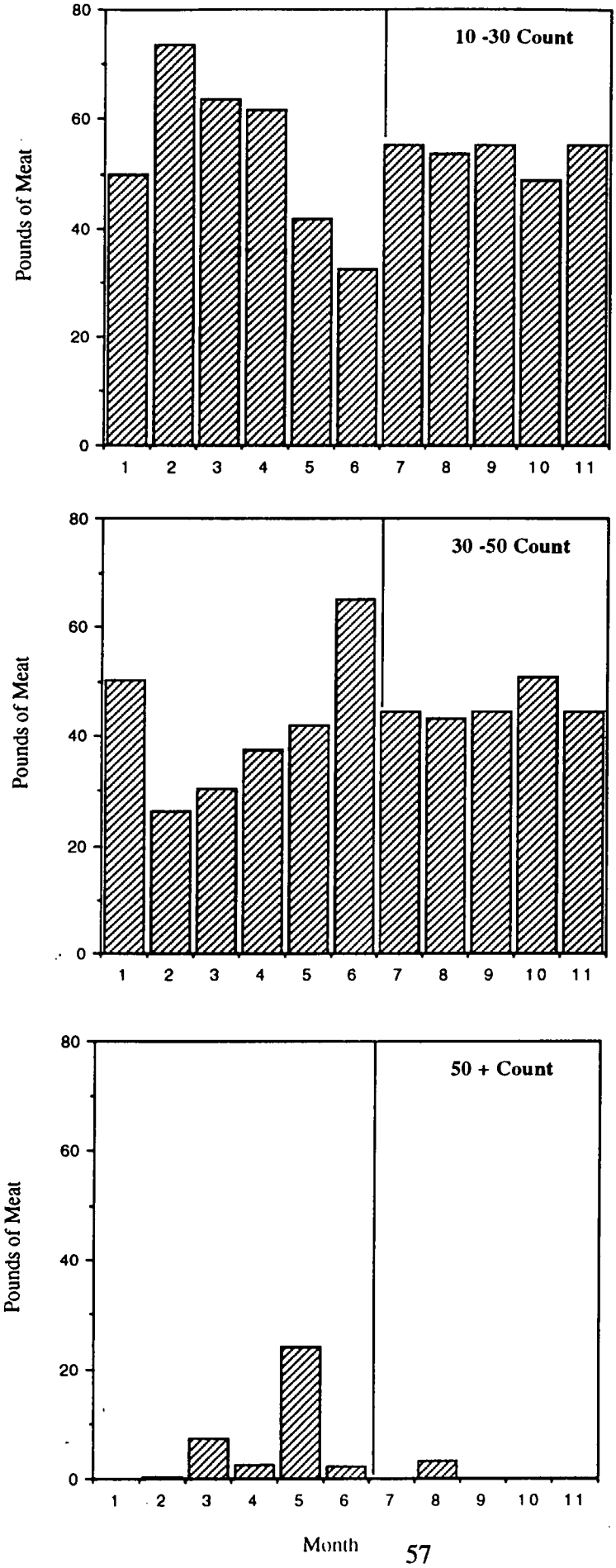


Figure 12. Frequency distribution of graded landings by month of a scallop buyer. Solid line depicts when Variation Order 50 meats per 500 g came into effect.

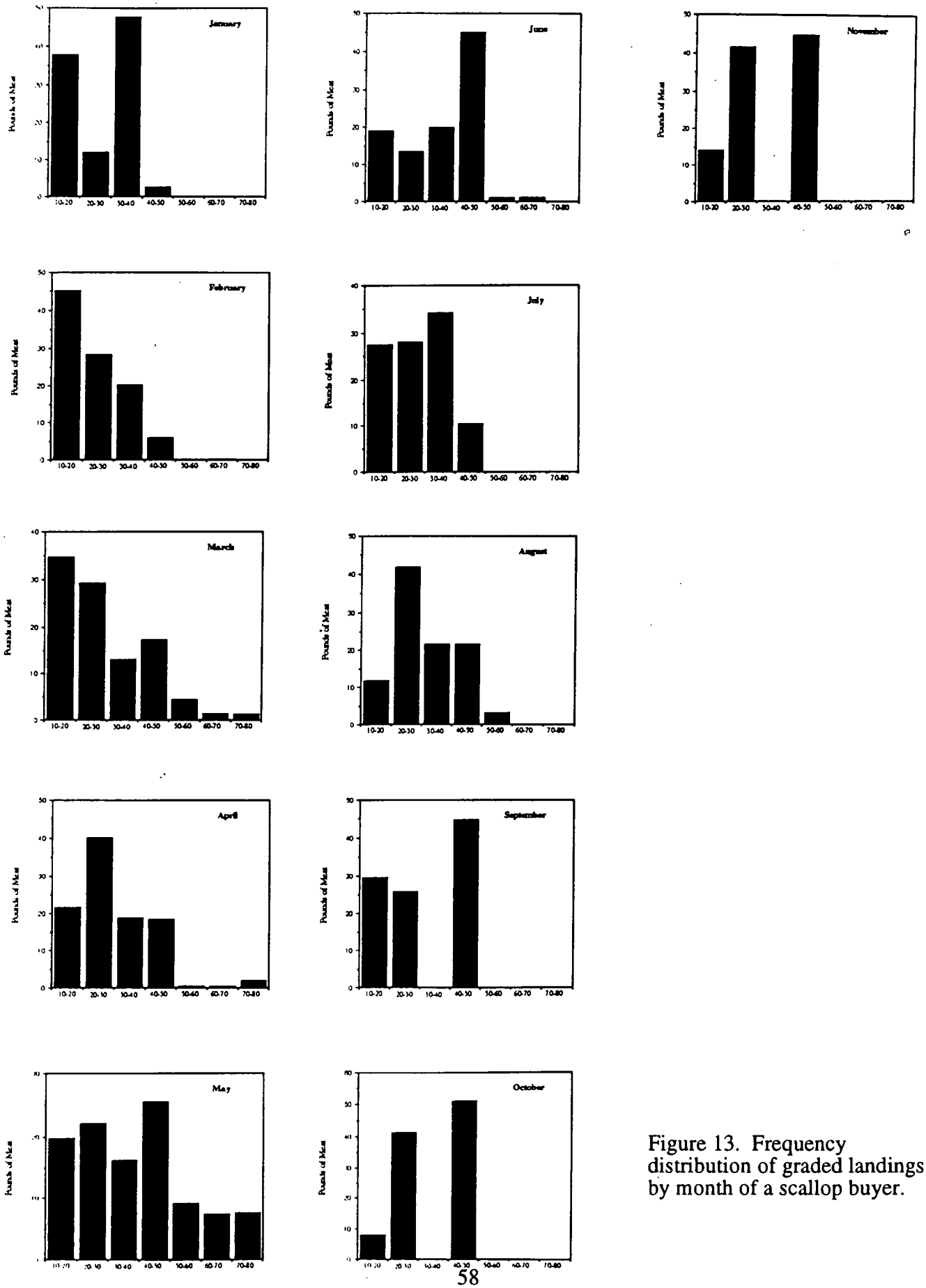


Figure 13. Frequency distribution of graded landings by month of a scallop buyer.

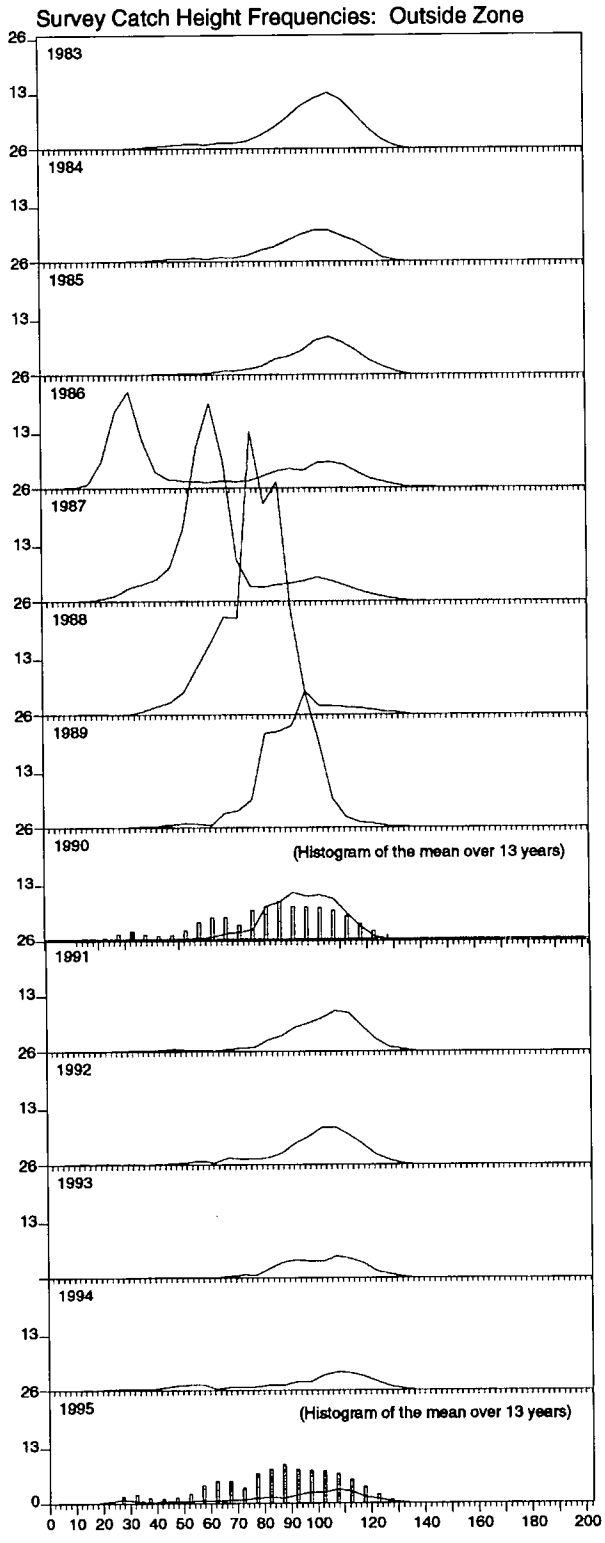


Figure 14. Shell height distribution pattern from research vessel survey catches from the Outside Zone, for 1983-1995. The mean over 13 years is represented.

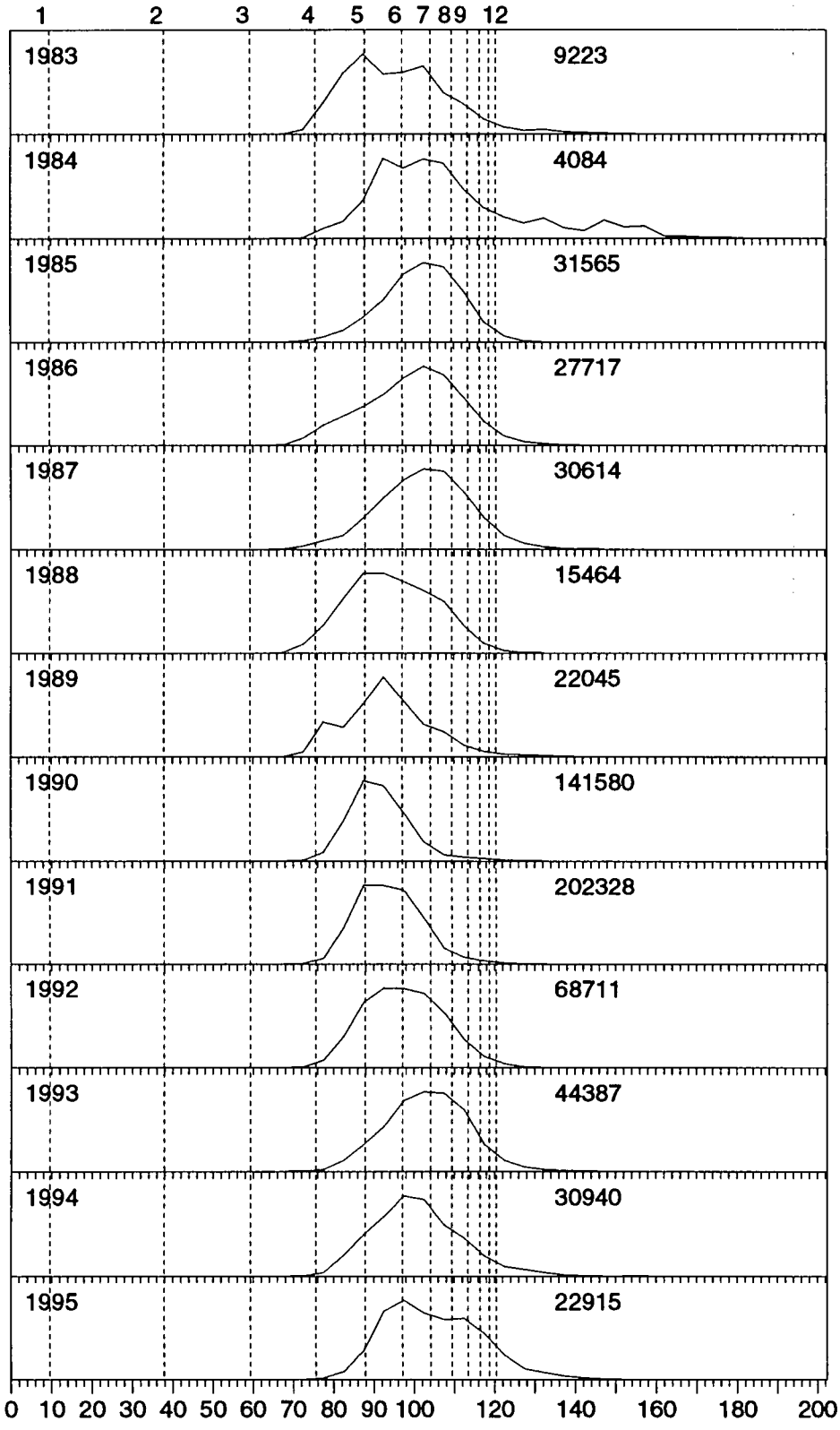


Figure 15. Shell height distribution pattern for the commercial catch from the Outside Zone, estimated from port sampling meat weight data from 1983-1995. Total number of scallops (x 1000) is given in the upper right of each graph.

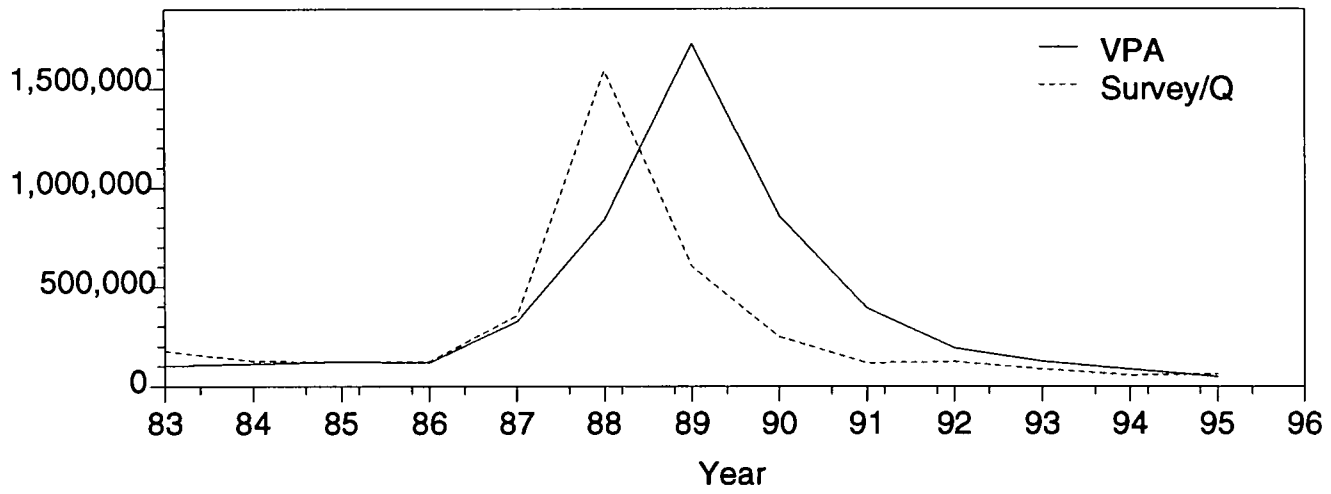


Figure 16. VPA and q-adjusted survey numbers for ages 4-7 for the Outside Zone, 1983-1995.

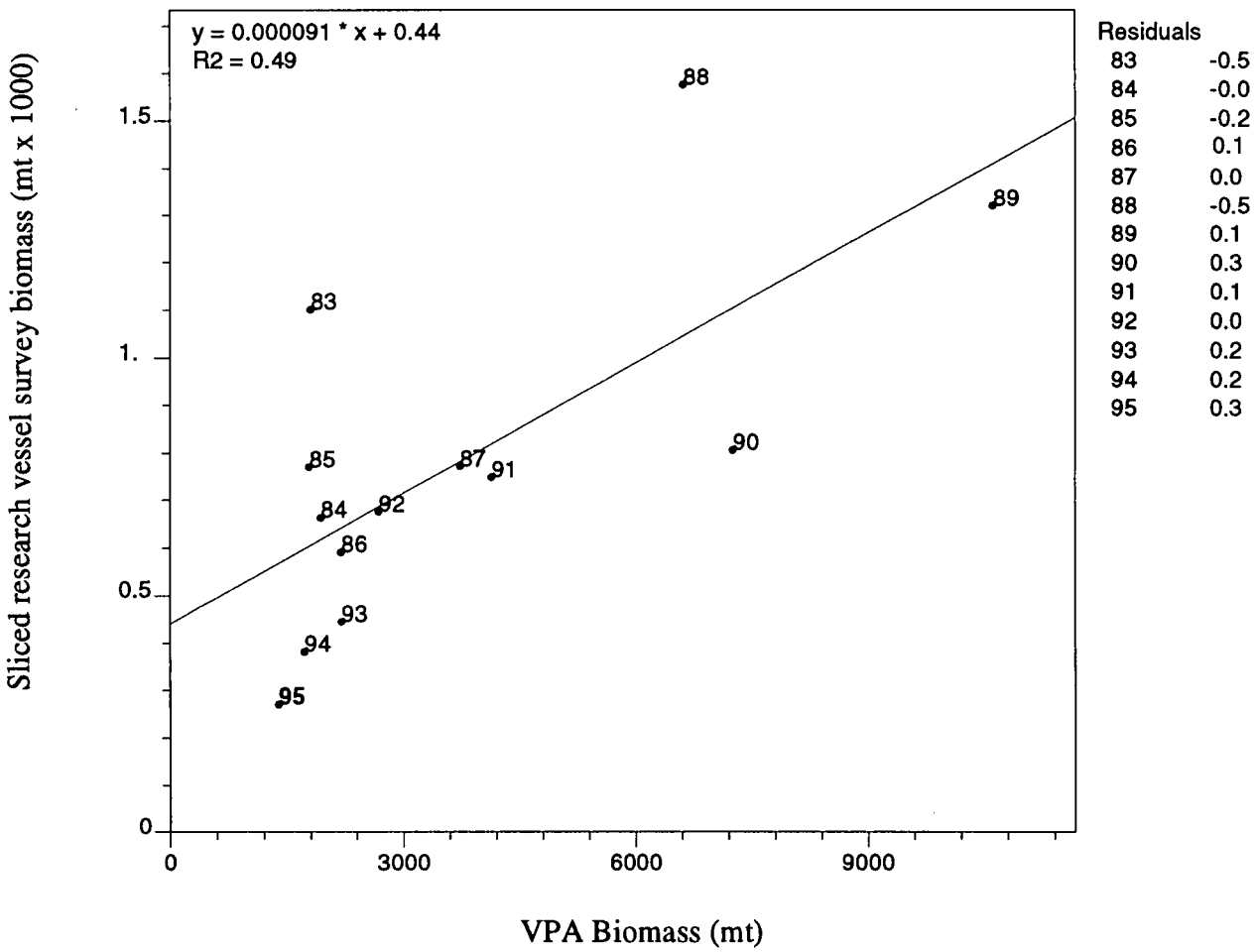


Figure 17. Regression of sliced research versus VPA BIomass estimates for ages 1+, for the Outside Zone, 1983-1995. The residual for each yearly point is shown in the upper right margin of the graph.

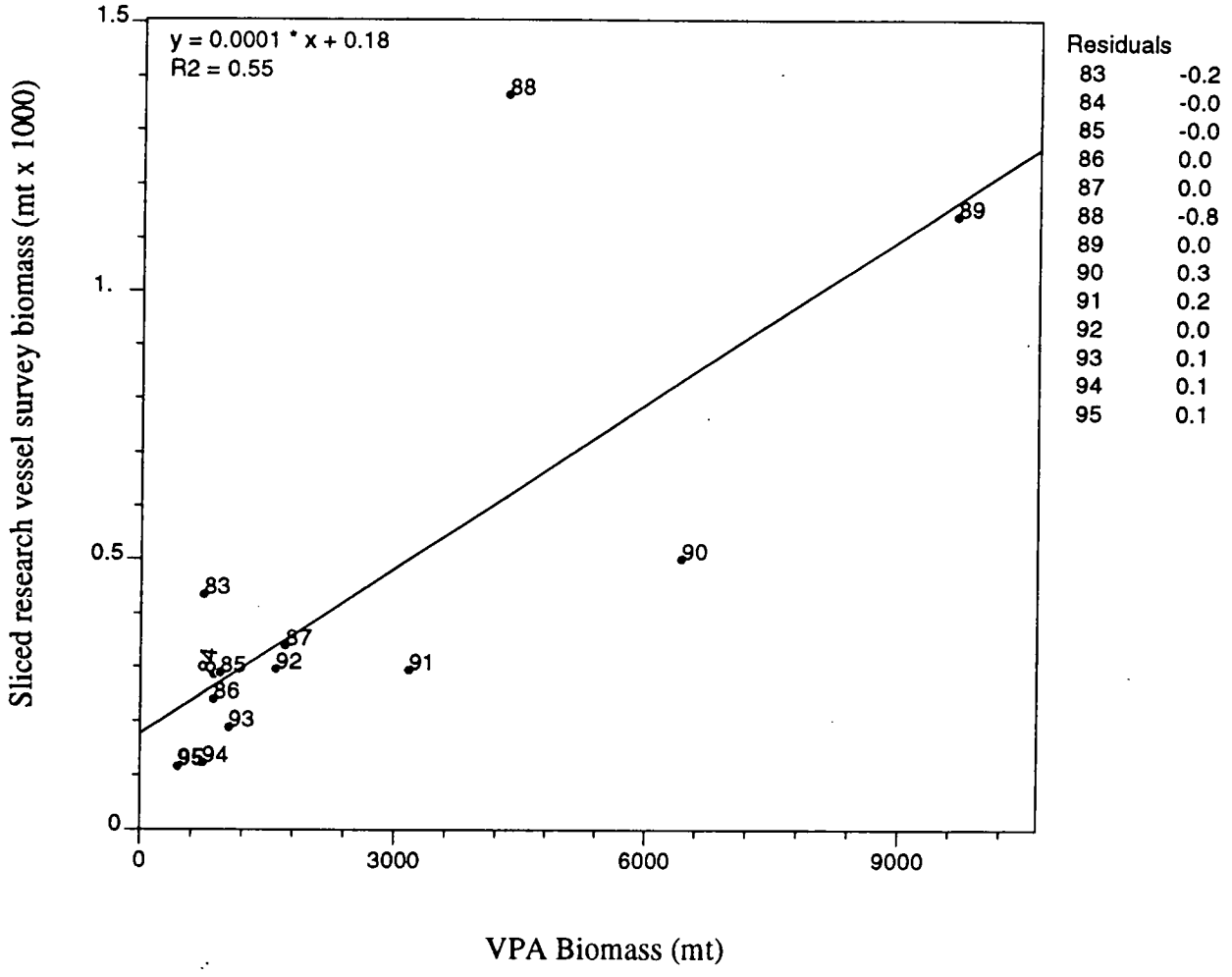


Figure 18. Regression of sliced research versus VPA biomass estimates for ages 4-7, for the Outside Zone, 1983-1995. The residual for each yearly point is shown in the upper right margin of the graph.

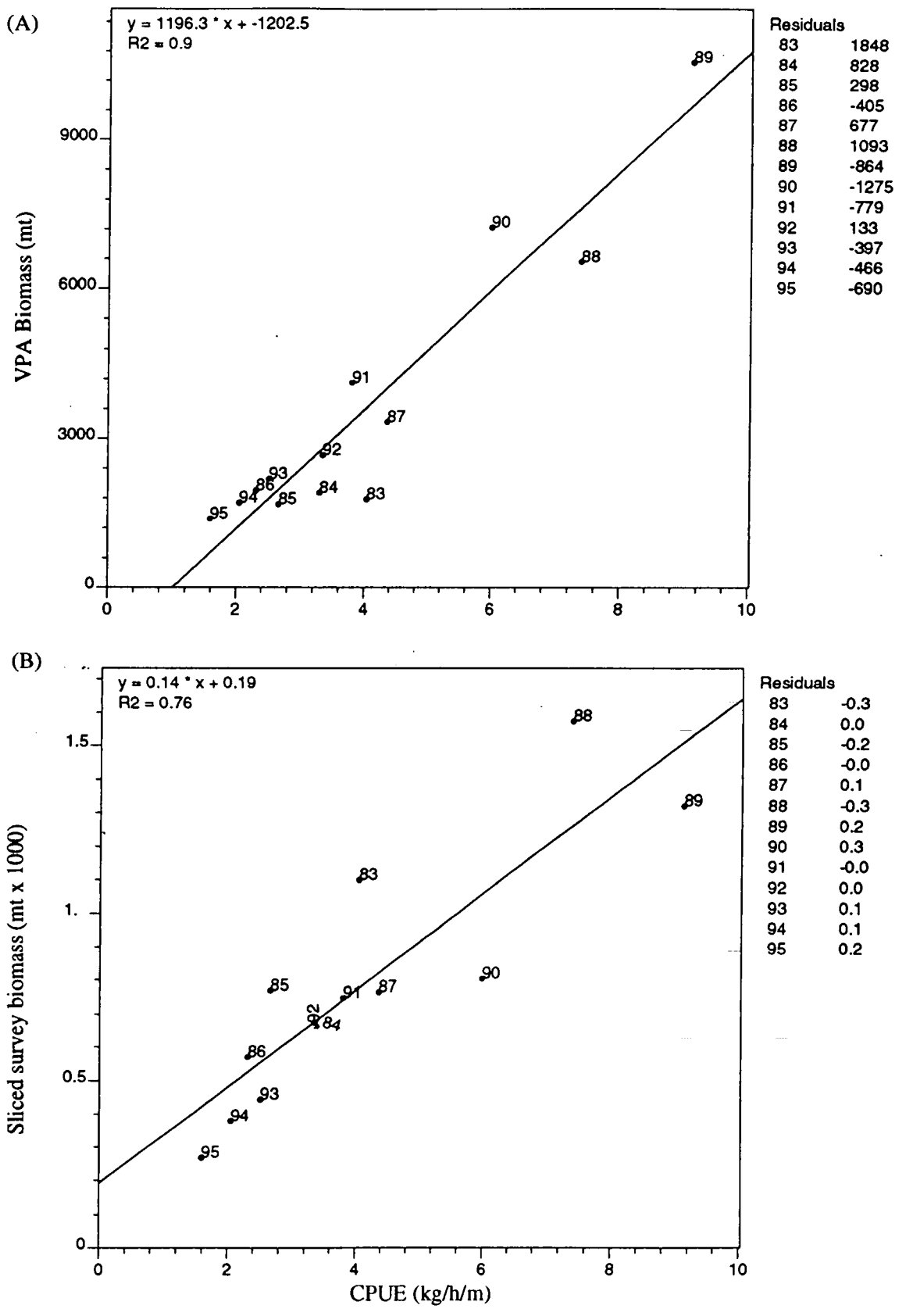


Figure 19. Regresssion of 3+ biomass versus CPUE for (A) the VPA and (B) sliced survey results for the Outside Zone, 1983-1995. The residual for each yearly point is shown in the margin.

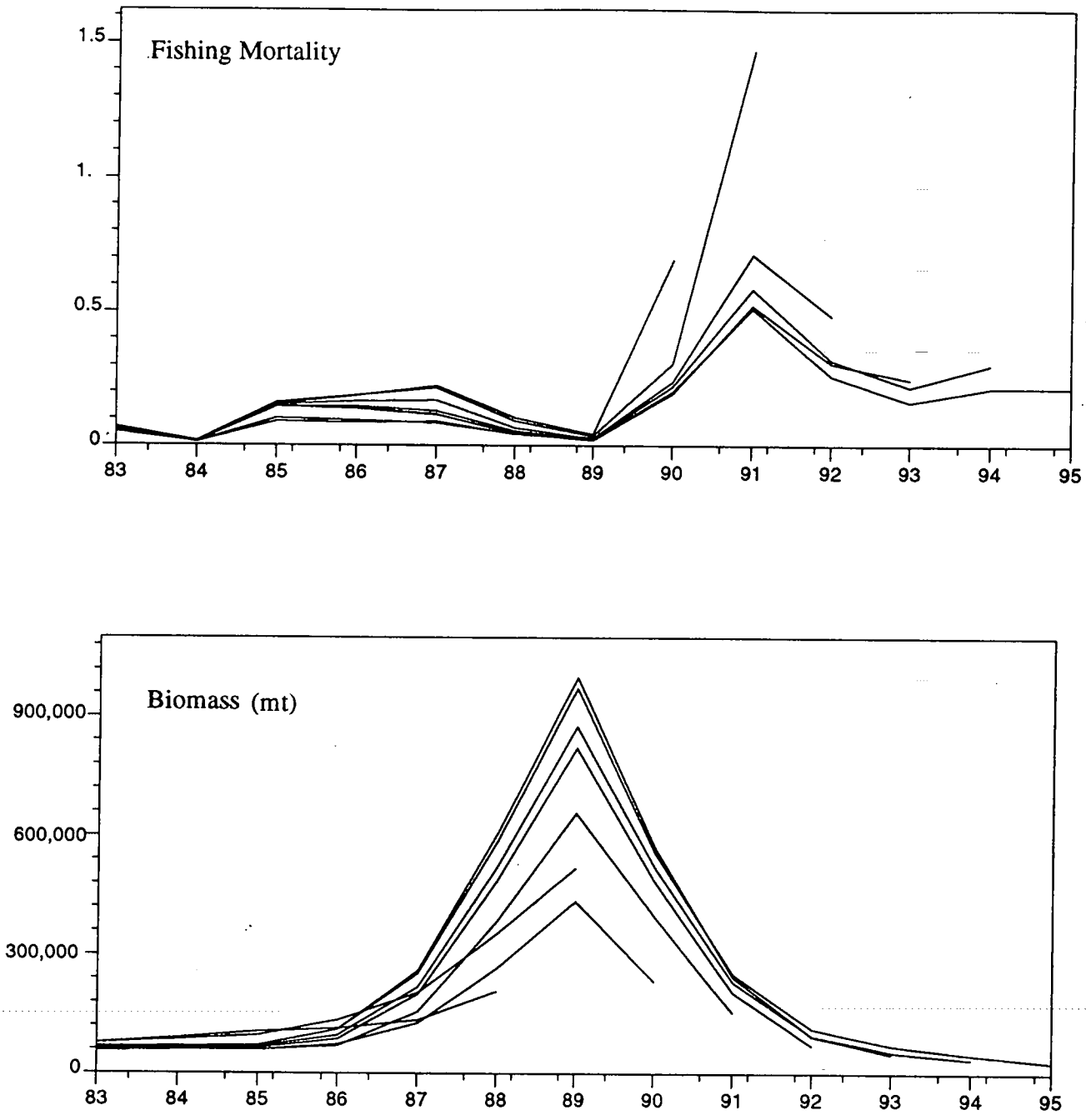


Figure 20. Retrospective analysis of fishing mortality (F) and biomass (mt) for ages 4-7 for the Outside Zone, sequentially peeling off the last 8 years data.

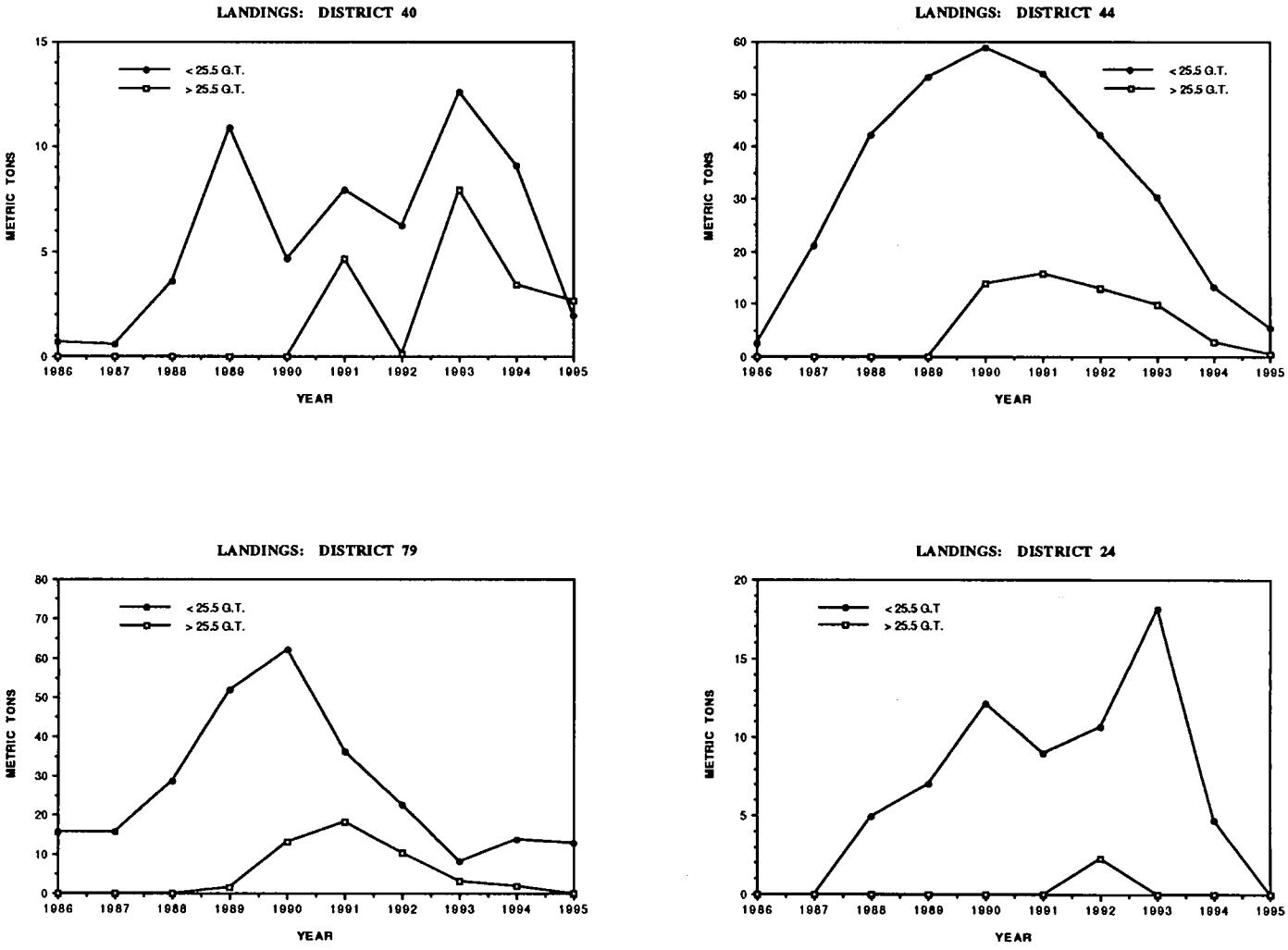


Figure 21. Annual landings in metric tons of scallop meats for the Upper Bay statistical districts by vessel class. King's Co.: 40; Cumberland Co.: 24,44; Albert Co.: 79. Source: Statistics Division, D.F.O., Halifax.

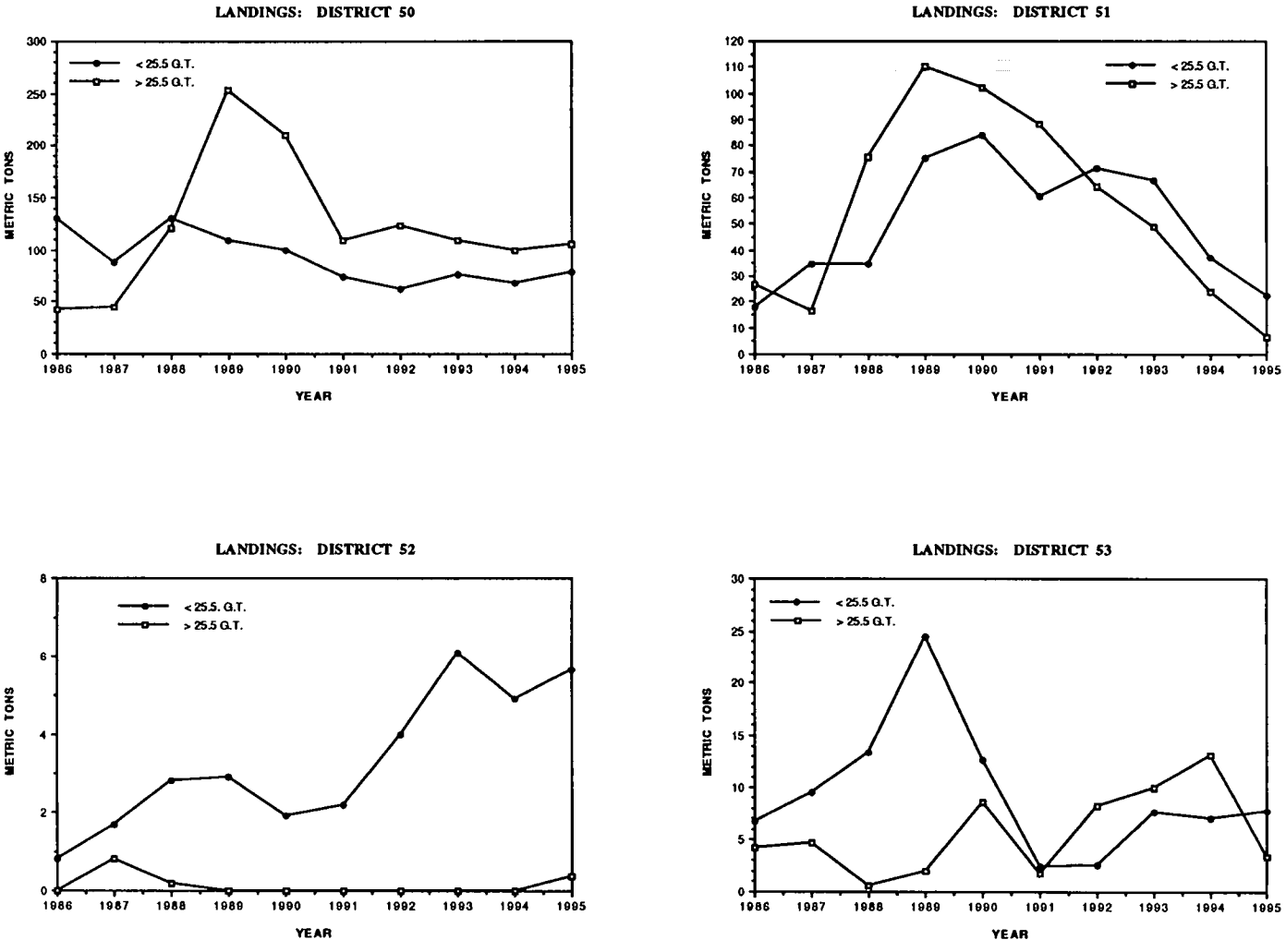


Figure 22. Annual landings in metric tons of scallop meats for the statistical districts in the Grand Manan and surrounds by vessel class. Grand Manan.: 50; Campobello: 51; Charlotte Co.: 52, 53. Source: Statistics Division, D.F.O., Halifax.

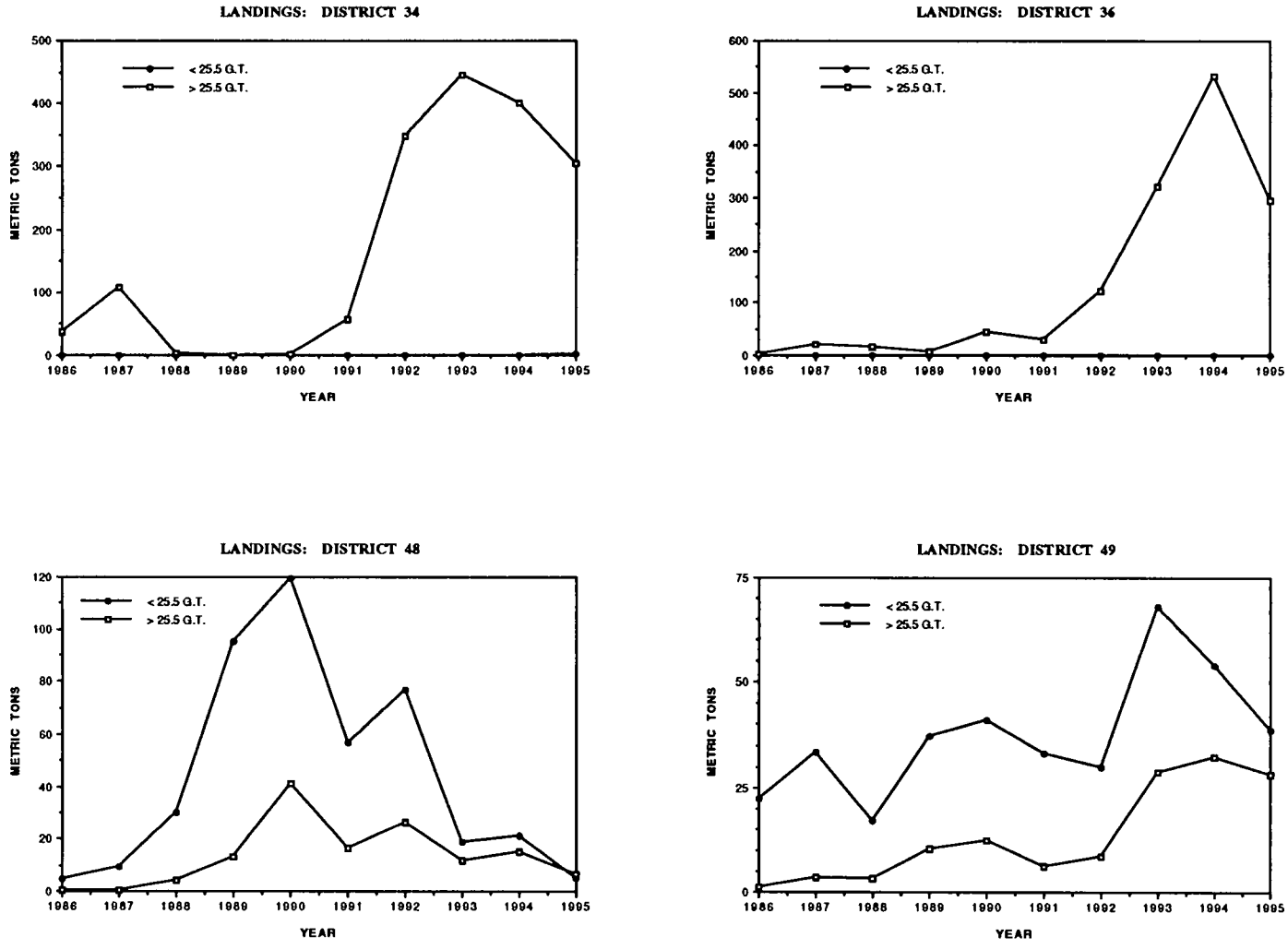


Figure 23. Annual landings in metric tons of scallop meats for the statistical districts in the Yarmouth area, Meteghan area, and Saint John area by vessel class. Yarmouth: 34; Meteghan: 36; Saint John: 48, 49. Source: Statistics Division, D.F.O., Halifax.

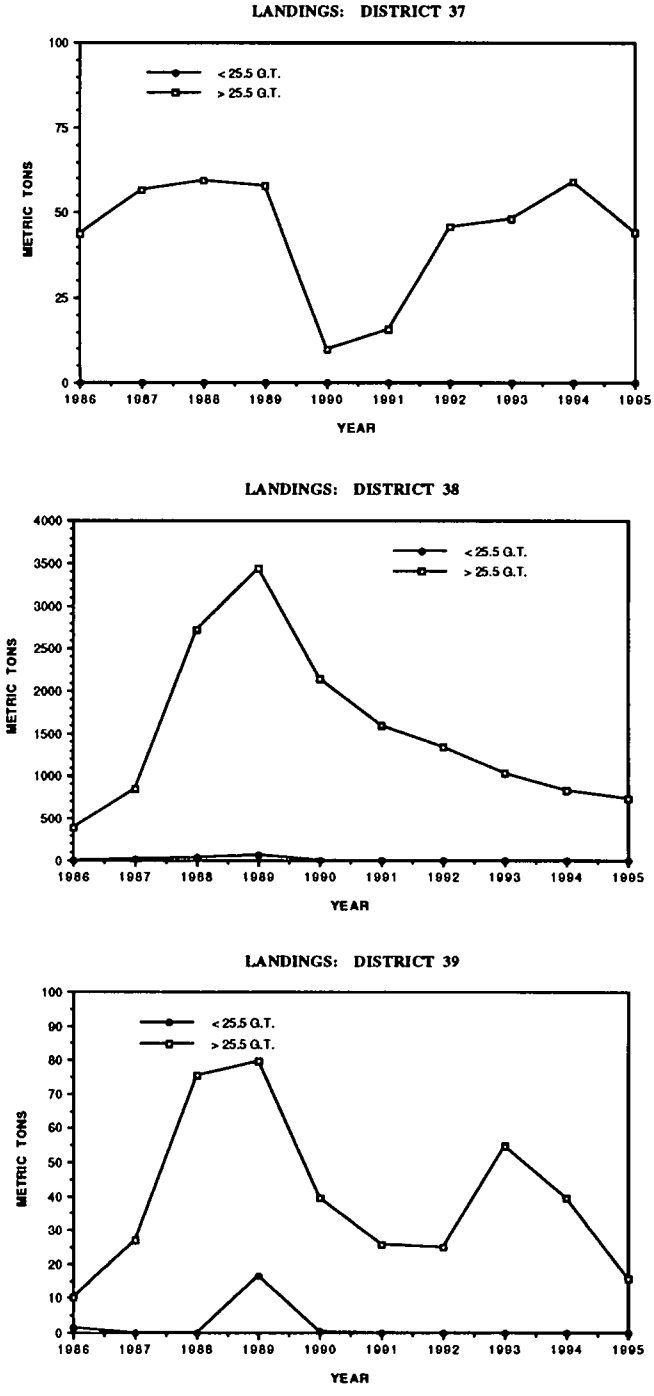


Figure 24. Annual landings in metric tons of scallop meats for the statistical districts in the Digby area by vessel class. Digby Co.: 37, 38; Annapolis Co.: 39; Source: Statistics Division, D.F.O., Halifax.

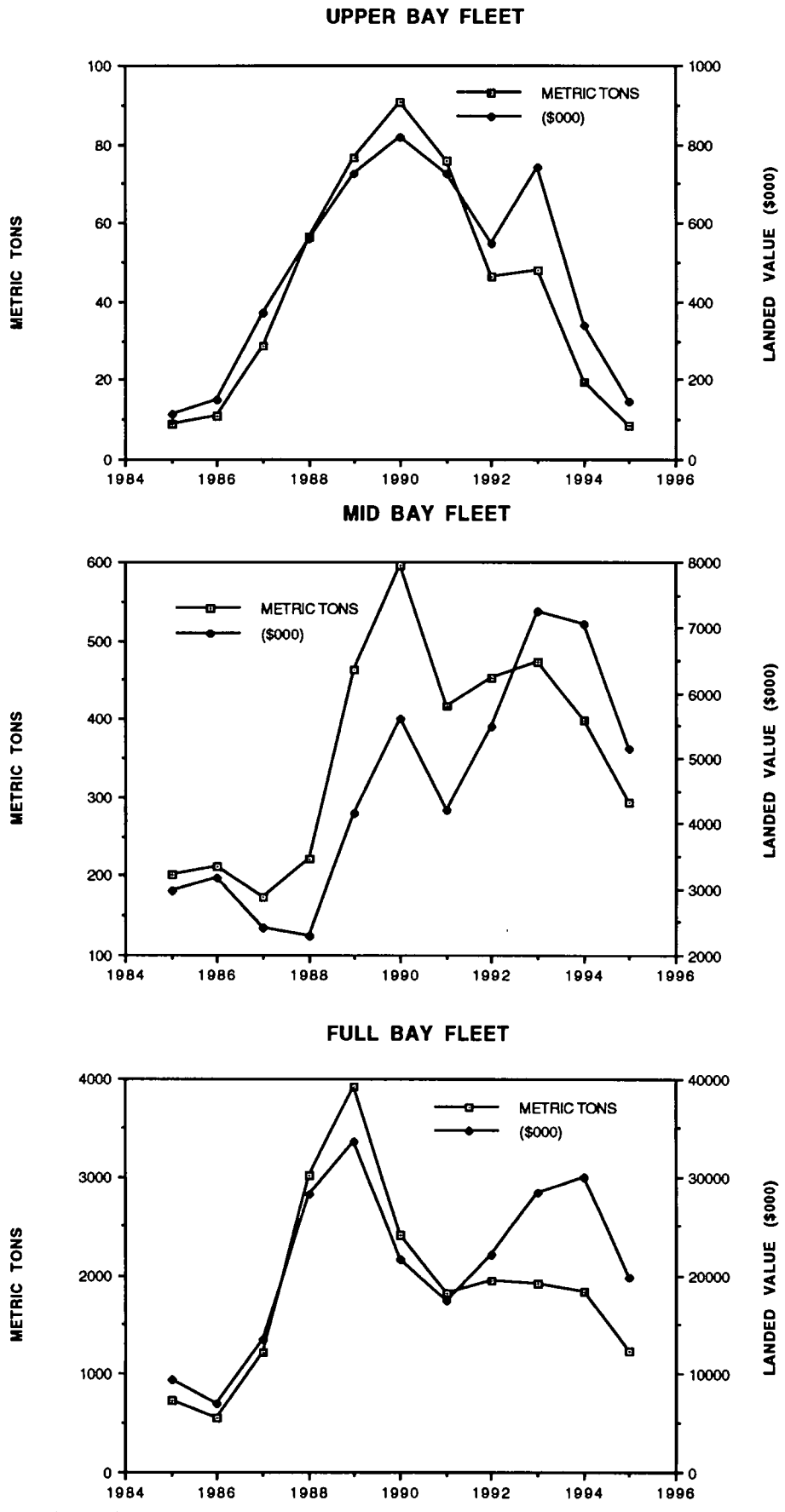


Figure 25. Annual landings and landed value by fleet sector.